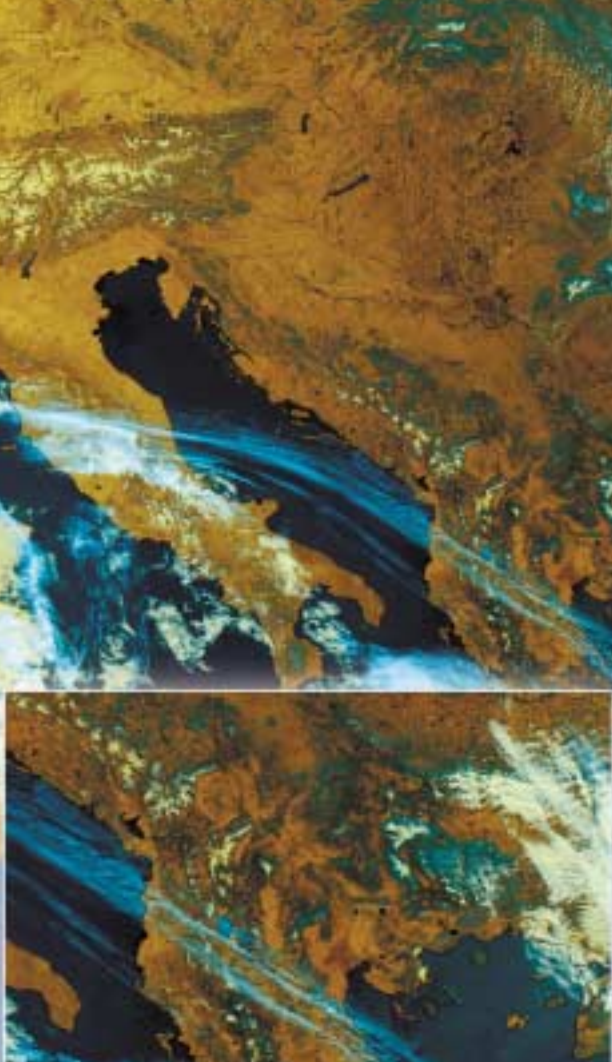
The European Forecaster



Newsletter of the WGCEF

N°12
May 2007

Contents

Cover: High resolution composite colors image from METOP.
Crédit: Météo-France/CMS-Lannion

Printed by Météo-France

Editor Nick Graham - Met Office

Lafout Kirsi Hindstrom - Basic weather Services

Published by Météo-France
Direction commerciale et de la communication - D2C/IMP - Trappes

Introduction

Dear Reader,

I welcome you to another issue of the European Forecaster, this being the twelfth newsletter of the Working Group on Cooperation between European Forecasters (WGCEF). All of the articles here were presented at the last meeting but as always we encourage any reader to contribute to future issues of the newsletter in the interests of developing a best practice across Europe when forecasting the weather. A growing list of contacts can be found at the back of the newsletter if you feel that you would like to get involved.

Our visit to Athens in September 2006 turned into a very special event. All of the details are in the following Chairpersons report so I will not repeat things here. Once again, the benefits of operational meteorologists sharing information were clear to all who attended. Another example of sharing can be found in the form of the Meteoalarm system which is now 'going live' following its official launch in March 2007.

The WGCEF website found at http://www.euroforecaster.org will continue to provide you with extra information and includes links to future conferences. Our next meeting will be held in Spain in October 2007 in conjunction with the next ECAM/EMS meeting. One of the items on the agenda will be to choose a new Chairperson since my four-year tenure will expire at the end of the year.

Nick **Grahame**
Chairperson of WGCEF

Report on the Twelfth Meeting of the Working Group on Cooperation between European Forecasters (WGCEF)

Fenix Hotel, Athens, Hellas, 29th September 2006

Introduction

The twelfth annual meeting of the WGCEF took place in Athens, Hellas on Friday 29th September 2006 at the Fenix Hotel. In a beautifully laid out room, each representative found that they had a personalised key ring to remind them of this meeting in Greece. The meeting was opened by Nick Grahame (Chairperson, WGCEF) who welcomed everyone and then handed over the chair to the Deputy Director of HNMS, Dr. Maria Refene who stated how honoured she was to have the WGCEF come to Hellas and hoped that the meeting would be successful. Nick Grahame expressed his gratitude to the HNMS for hosting the meeting and thanked Chryssoula and Adamantia in particular for their help in organising the meeting. Copies of the agenda were circulated and a final agenda agreed. In total, there were 19 participants representing 13 Meteorological Services across Europe. Jean Quiby from EUMETNET was an invited guest and Manfred Kurz (Germany and founder member of the group) was welcomed back. Apologies and best wishes from those who couldn't attend the meeting were read out (e.g. Theresa Abrantes (Portugal)).

Two talks then fol-lowed by members of HNMS to highlight the work that was being done in Hellas. Dr. Ioannis Papageorgiou gave a talk on numerical forecasting activities in HNMS followed by Dimitrious Ziako-poulos who presented an overview of the HNMS.

Actions from last meeting

Dirk Heizenreder (Germany) to provide members with additional information on PEPS – completed.

Nick Grahame to contact the Polish meteorological service to see if they could send a representative to WGCEF meetings – ongoing.

Report of the chairperson of the WGCEF

The chairperson mentioned the visit of Claude Sales (Luxembourg) to the Met Office in November 2005 to sit in with forecasters for a couple of days. A short visit of two Met Office forecasters to the Meteo-France regional office in Rennes in March 2006 marked the start of developing stronger links between the two centres. The chairperson attended a WMO CBS ET PWS DPM meeting in Beijing in June 2006 where EMMA/Meteoalarm was promoted and integration into the Severe Weather Information Centre (SWIC) discussed. It was also noted that Gerald Fleming had sent out a survey on severe weather warning systems to WMO members and had asked the chairperson to remind European NMS's to complete the survey if they had not done so already. In that survey, it was interesting to note that 35% of respondents in RA VI were concerned about model accuracy relating to heavy rainfall events in the early part of the forecast. This highlights that there is a definite need for a greater understanding of the characteristics of high-resolution models and for forecasters and researchers to work together.

It was reported that Saviour Porter has become a new member of WGCEF, representing Malta. Saviour expressed regret at not being able to attend this meeting but hopes to meet members in the future. Other enquiries about membership of WGCEF have been received via contacts of HNMS. The Working Group now has representatives from 32 countries.

The track of ex-hurricane Gordon in September 2006 caused concern for some European NMS's. Information and views were exchanged between the Portuguese Met Service, Met Eireann and the Met Office.

Finally the chair updated the group on changes that were taking place in the Met Office. Forecast production had been centralised at Exeter and Aberdeen, with all other weather centres closed. Local contacts with customers were achieved via advisors or consultants around the UK. The defence network remains unchanged.

Discussion of Newsletter No.11 and WGCEF website

Nick Grahame mentioned that the articles had been sent in within the timescales requested but the lack of a secretary meant that there was a delay in editing and proof-reading them. All contributions were sent to Bernard Roulet (France) by early June 2005 and many thanks go to Météo-France for publishing the newsletter in time for the meeting. The front cover (chosen by Bernard) was impressive and promotes a positive image for the group. Copies of the finalised newsletter will be distributed to directors of European National Meteorological Services (NMS's), EUMETNET and the EMS.

Andre-Charles Letestu (Switzerland) continues as webmaster for our site www.euroforecaster.org. The current format allows Andre-Charles to update information easily and it was agreed that this was and will be beneficial to the group. Nick Grahame thanked Andre-Charles for his hard work.

Invited speaker – Jean Quiby (EUMETNET)

Jean presented a talk entitled: 'A EUMETNET idea: Exchange of a set of forecasts of common format for the benefit of forecasters'. At present, there are many sources of forecast model data available in various formats but no general adherence to WMO GRIB file policy. The proposal put forward is to agree a common format for forecast data (e.g. same projection, same coastline/border definition). Jean wanted to seek approval from WGCEF members and develop a user requirement. It was made clear that these would be supplementary products to what is already available.

In an around the table discussion, all agreed that standardisation of product is a good idea in principle and would benefit European forecasters (and their customers). A few issues were raised such as timeliness, security of data sharing, duplication of effort, identification of the optimum point of chart production (centrally or locally) and potential difficulties in standarisation of output to suite varying needs. Dirk Heizenreder (Germany) pointed out that the NINJO system already has the capability of displaying GRIB files in any format. Jean thanked the group for general approval of the idea and would take these points forward when reporting back to EUMETNET.

Contributions from WGCEF members

The enthusiastic response to contributions was again noted and highlights the importance of the meeting to provide the opportunity for sharing information.

Herbert Gmoser (Austria) - Satrep Online - A new concept to train satellite meteorology in combination with NWP

Herbert Gmoser (Austria) – The Warning System of ZAMG for Austria; Concept and Applications

Antii Pelkonen (Finland) – TAF/Auto-TAF production at FMI

Ana Casals (Spain)– SIGTAF: TAF automated generation system developed in Spain

Dr Ioannis Pytharoulis (Greece) – An exceptional snowfall over Hellas in January 2006

Frank Kroonenberg (Netherlands) – update on EMMA/Meteoalarm

Frank Kroonenberg (Netherlands) – Towards a new and better balanced systematic in assigning weather alarms in the Netherlands

Bernard Roulet (France) - Examples of arpège ensemble forecast use

Will Lang (United Kingdom) - Exploiting Ensemble members: Forecaster-Driven EPS Applications

Dirk Heizenreder (Germany) – Fore-casting Severe Thunderstorms at DWD

Tomas Halenka (Czech Republic) – EMS Distance Learning Packages

Details of most of the above presentations can be found on the WGCEF website.

Photos from lunch and excursion to Delphi

Listed actions from this meeting

12.1 Polish Met Service to be contacted to see if they can be represented in WGCEF (Nick Grahame)

12.2 Liaise with European Meteorological Society (EMS) to see how many other remaining European NMS's are interested in providing a representative for WGCEF (Nick Grahame/Tomas Halenka)

12.3 Develop a password protected operational forecaster database (Nick Grahame/Frank Kroonenberg)

12.4 Copy of latest WGCEF newsletter to be sent to WMO representative (Bernard Roulet)

12.5 Provide links to WMO and Meteoalarm from WGCEF website (Andre-Charles Letestu)

12.6 Group members to propose extension of PEPS to 48 hours (All/Dirk Heizenreder)

12.7 Updates to members on progress with EUMETNET proposal for common format of forecasts (Jean Quiby)

12.8 Group members to provide user requirement for above proposal (All)

12.9 Exchange of AutoTAF software (Dirk Heizenreder/Antii Pelkonen)

12.10 Propose topics on 'Probability Forecasting' and 'Fore-casting Impacts' at the 2007 meeting (Nick Grahame)

Plan of action for 2007

1) Members to provide full support for Meteoalarm.
2) Close liaison with EUMETNET on 'common format forecast information'.
3) Develop closer links with EMS.

4) Push boundaries of where value can be added by forecasters and investigate opportunities (e.g. innovative products, focus on customer requirements, expanding ensemble product base).
5) Include more scientific explanation in presentations at next meeting.

Date and place of next meeting

The next meeting is planned to follow ECAM2007, to be held at El Estorial in Spain from 1st to 5th October. Ana Casals kindly agreed to make the necessary arrangements. Further details will be put on the website.

AOB (any other business) and closing of meeting

Enquiries were made about how Liisa Fredrikson (ex-Chairperson) was progressing following a period of ill health. Antii Pelkonen (Finland) stated that he would pass on best wishes from the group. The Chairperson officially closed the meeting just in time for members to be transported to HNMS for a tour of the forecast room.

Other related events

A very pleasant get-together was spent at an outdoor restaurant in the centre of Athens (just below the Acropolis) on Friday evening. The meal was accompanied by traditional Greek music.

The following day (Saturday), an excursion to the historic site of Delphi had been arranged by HNMS. The group had a guided tour of this stunning archaeological city in beautiful weather. A truly wonderful experience.

On the way back, Chryssoula had arranged for the group to stop off at the country home of one of her relations to experience a very traditional Greek meal. This was enjoyed by everyone but was then followed by the added bonus of spontaneous Greek dancing from members of Chryssoula's family (with many of the group members also joining in). A truly special experience.

The chairperson and vice-chairperson (Frank Kroonenberg) presented Chryssoula and Adamantia with a boquet of flowers on return to Hotel Fenix on Saturday evening to thank them for everything on behalf of WGCEF representatives.

Nick **Grahame**
Chairperson WGCEF

Appendix 1

List of participants:
Jean Nemeghaire (Belgium),
Konstantina Zeini (Greece),
Panagiotis Giannopoulos (Greece),
Will Lang (United Kingdom),
Antii Pelkonen (Finland),
Nick Grahame (United Kingdom),
Bernard Roulet (France),
Andre-Charles Letestu (Switzerland),
Herbert Gmoser (Austria),
Ole O Kristensen (Denmark),
Frank Kroonenberg (Netherlands),
Jean Quiby (EUMETNET),
Dirk Heizenreder (Germany),
Chryssoula Petrou (Greece),
Manfred Kurz (retired),
Ana Casals (Spain),
Claude Sales (Luxembourg),
Tomas Halenka (Czech Republic),
Nikolaj Weber (Denmark).

SIGTAF: an interactive TAF generation system

Introduction

• SIGTAF has been developed by Guillermo Ballester as an interactive system to generate TAF bulletins.

• SIGTAF is based on several dynamic libraries developed for this project and some binary cgi. The source code is written in C language, so that the rapidity of execution and the resources consumed are very well optimised.

• The visible part of SIGTAF is a binary cgi that generates webpages in an Apache2 server using Linux. However, the most complex tasks are carried out in dynamic libraries to which it is linked.

• SIGTAF analyses the format of the different character sequences of the aviation meteorological messages.

• Also it extracts all the values contained in those messages to be analysed.

• In addition, it contains useful routines for the comparison of observations (METAR) and forecasts (TAF).

• It interacts between the meteorological messages database and numerical model products. The Used DB is a local database specifically optimised to allow quick access.

• It uses the data from the numerical model (currently HIRLAM 0,05º) to generate an automatic TAF message (AutoTAF).

• SIGTAF provides powerful and efficient tools for the management and analysis of METARs and TAFs. In a PC environment, it provides analysis speeds of over 1000 messages per second and the generation of automatic TAFs in less than 0,1 second.

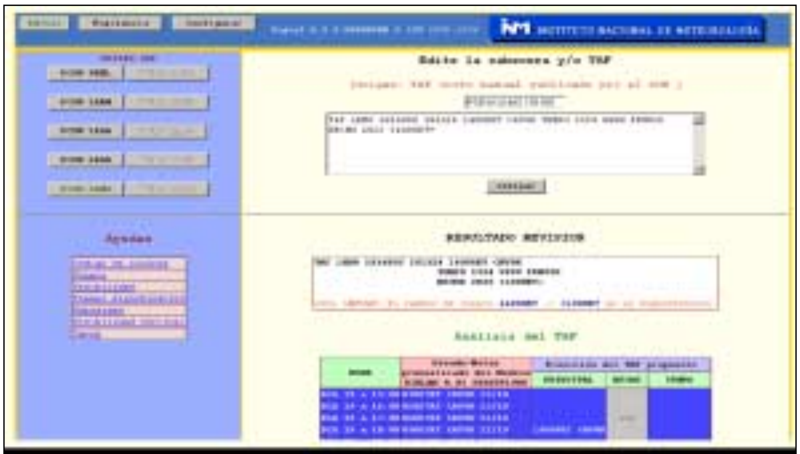
• It generates web pages with relatively simple HTML code.

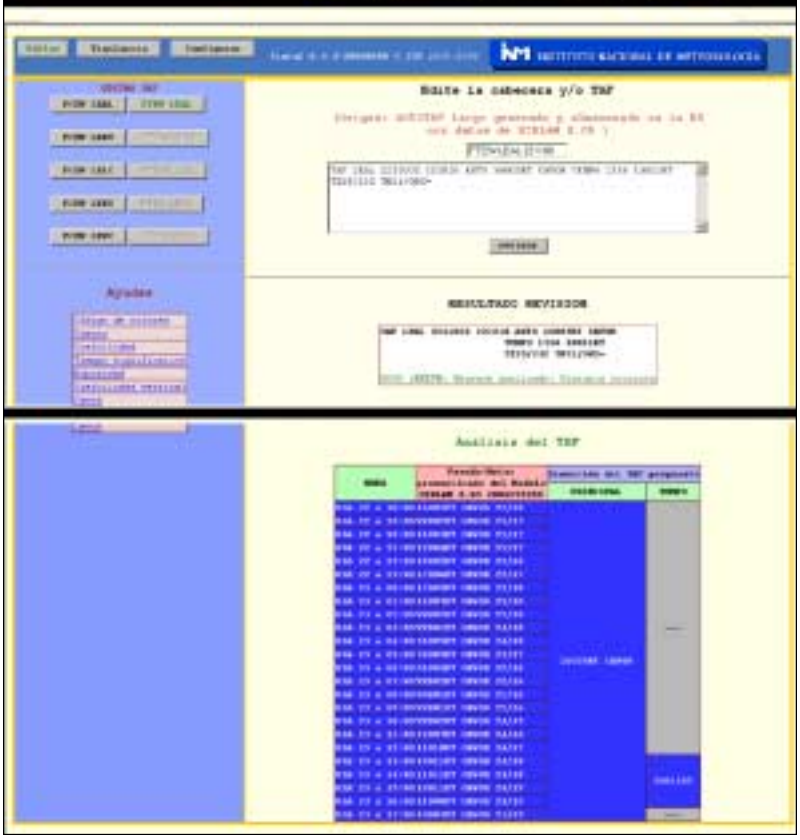
How it works

• SIGTAF consists of three essential modules, activated by clicking the keys on the upper bar.

Configuration

The airports to be analysed are selected individually or by regional groups. It is also possible to select the date and a time period for the analysis. There is a module of communications that is able to send the complex messages to the Communications System (SCM), although at the time of writing it was deactivated.





Editing

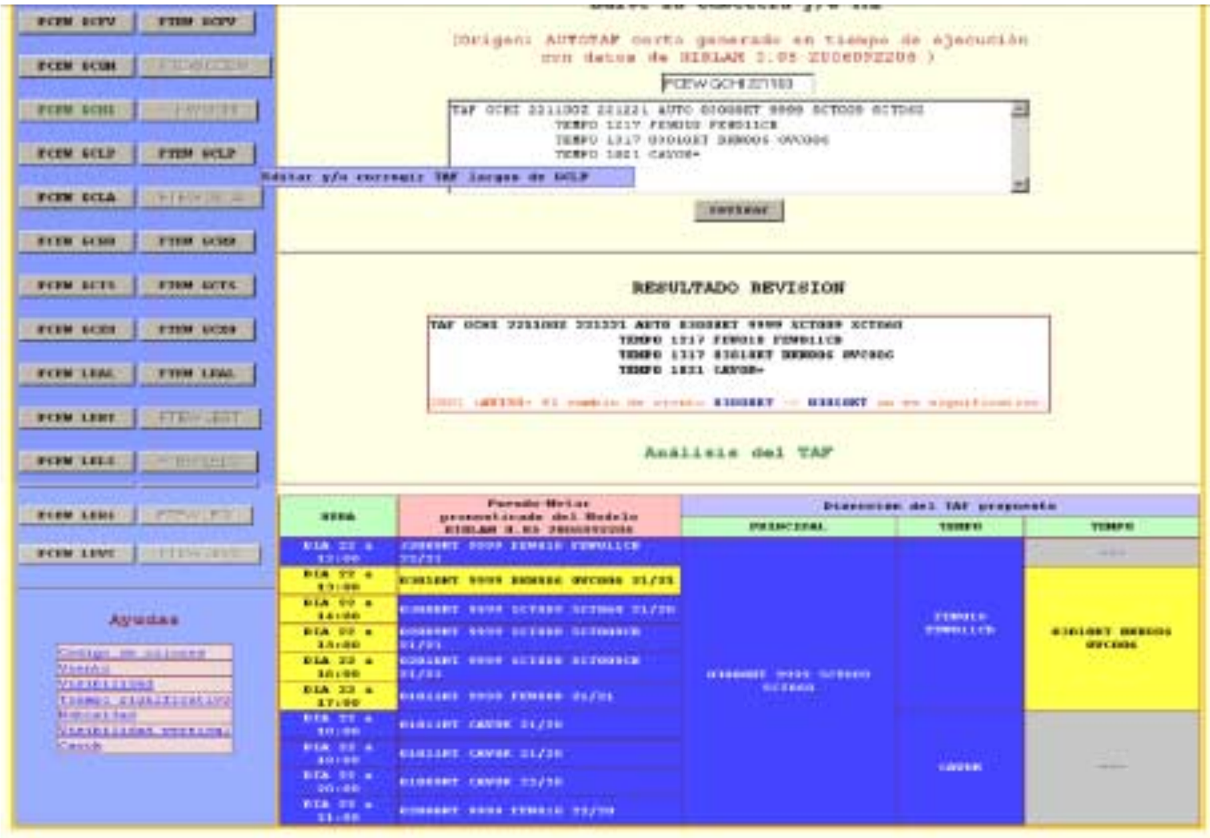
The system helps the forecaster to prepare the TAF. After selecting a type of message to issue (short or long TAF) for the chosen station, SIGTAF presents/displays a visual aid to make it easy:

Editing windows with the Bulletin header and the TAF. Any bulletins that have already been issued through the SCM are immediately displayed in both windows. If there are no available bulletins, the automatic TAF is displayed (this is what usually happens in the preceding hour at the time of issue of the TAF). The automatic TAF can come from the database of Autotafs or be generated at that point in time.

Analysis of the proposed TAF in the editing window. Any errors relating to the TAF coding are shown in plain language.

Exhaustive Analysis of the proposed TAF in the editing window. The active groups and the change groups are displayed on an hourly basis within the table. Additionally, if there are numerical model data available, sequences of pseudo-METAR's are displayed and these contain the predicted meteorological conditions in aeronautical language. The colour of each cell in this table is the NATO colour state that relates to the meteorological conditions described.

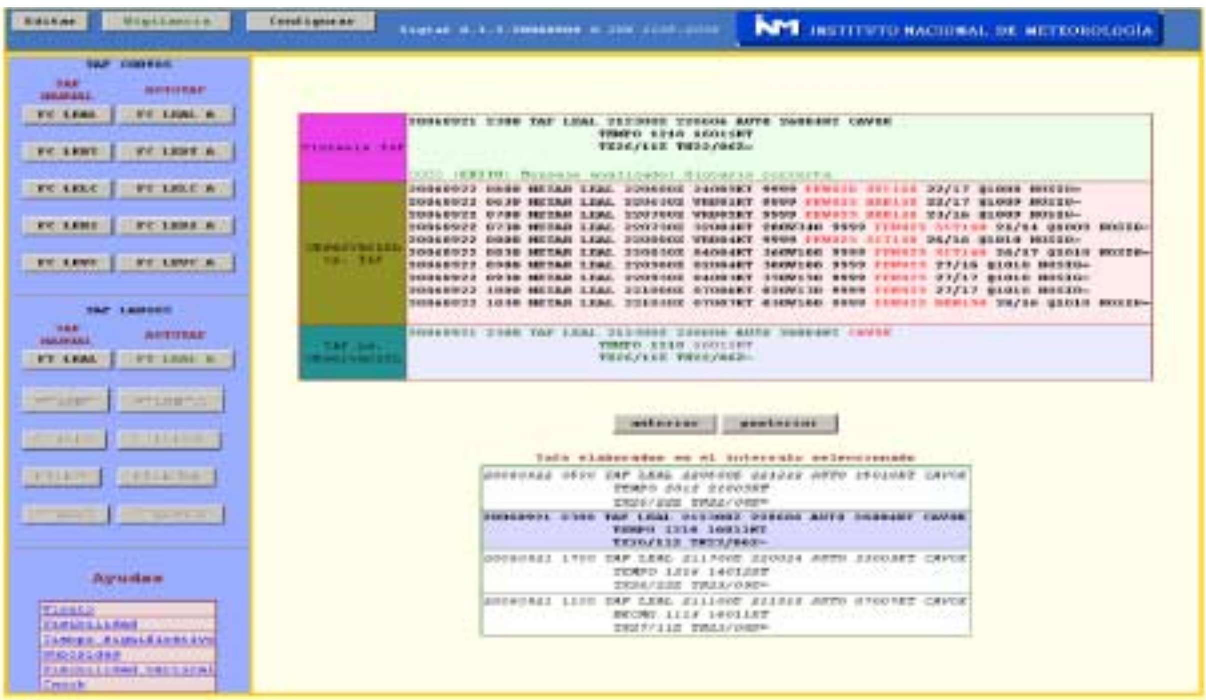
An AutoTAF is generated using Hirlam 0,05° data and stored in the database. Two examples are shown below.



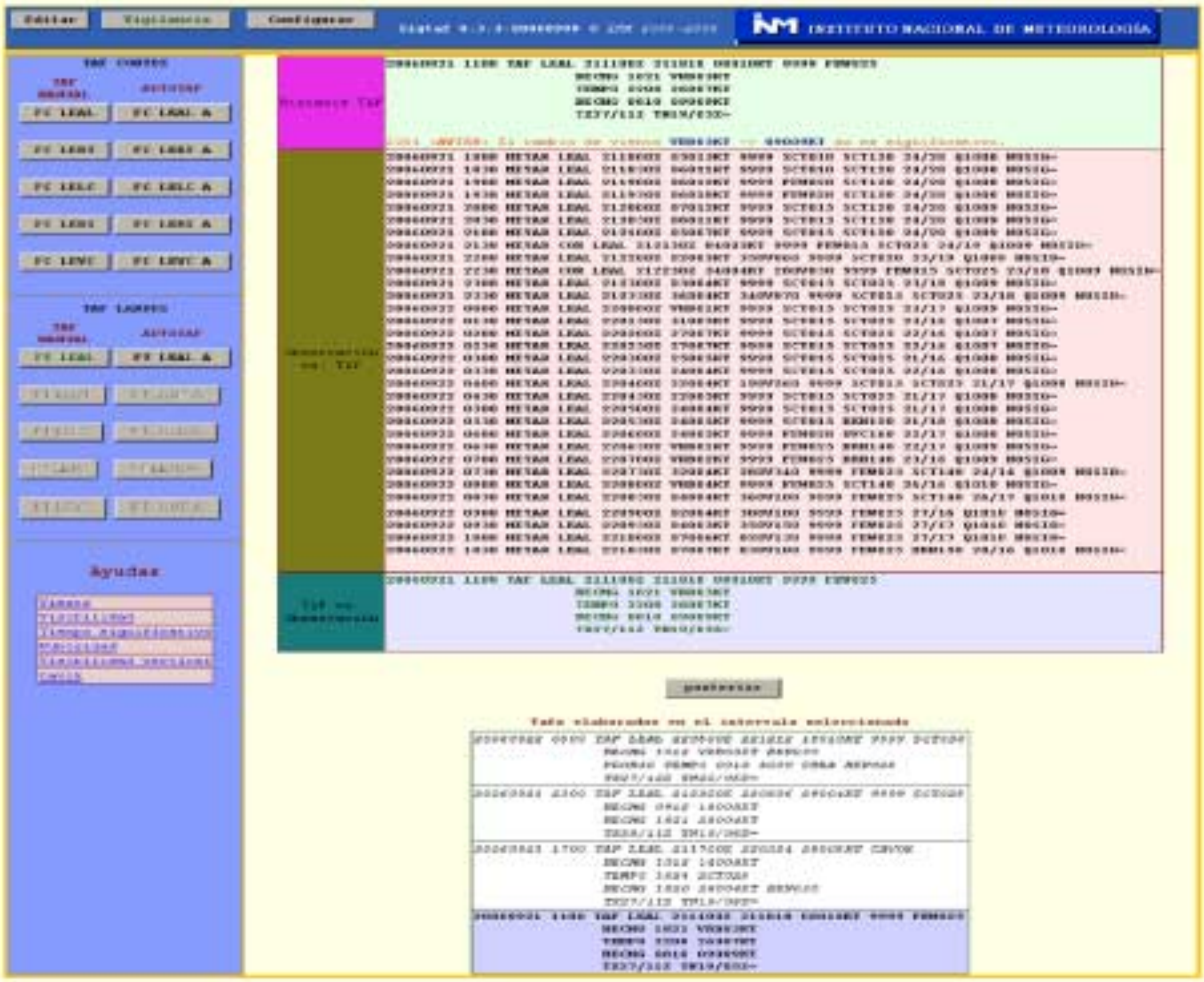
Monitoring

A key on the left panel allows the user to choose the station and message type. It has four sections:

1 **Syntax Window.** The result of the syntax analysis of the TAF is shown.



2 **Observation versus prediction (METAR versus TAF).** A list with all METAR and SPECI issued during the validity period of the TAF is displayed. In cases where a weather element is observed but has not been suitably predicted by the TAF, the corresponding part of the METAR is emphasised in a red colour.



3 **Prediction versus Observation.** In this case, if a weather element has been predicted (TAF) but has not been verified, the corresponding part is emphasised in colour (orange is used for TEMPO groups and red for the main groups). If there is no observation to compare against, the message will be grey.

4 **Spread messages win-dow**. With the keys “previous” and “later”, the user can select the TAF to be moni-tored.

Ana **Casals**
Instituto Nacional de Meteorología, Madrid, Spain

Examples of ARPEGE ensemble forecast use

Introduction

The ensemble model based on ARPEGE is named PEARP (PEARP=Prévision d'Ensemble ARPege). It is a small ensemble of eleven members including ARPEGE as the control run and ten perturbed members with the same resolution as ARPEGE. The perturbed runs are built with the singular vectors method (16 first singular vectors, optimization time window 0-12 hours, total energy norm, no physics, singular vector computation with a T63 regular truncation). The ensemble PEARP is run once a day at 18 UTC with a 60-hour range.

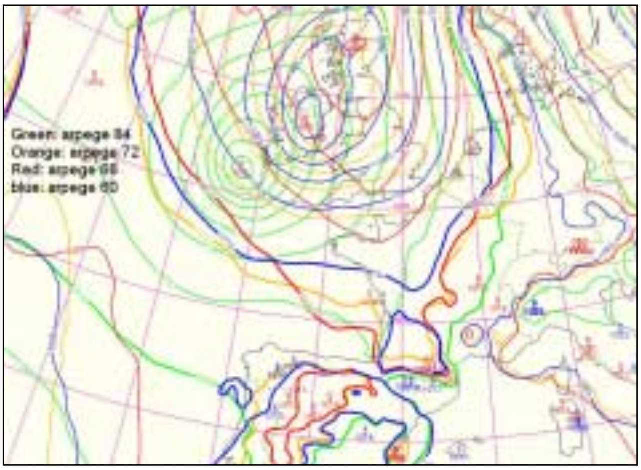


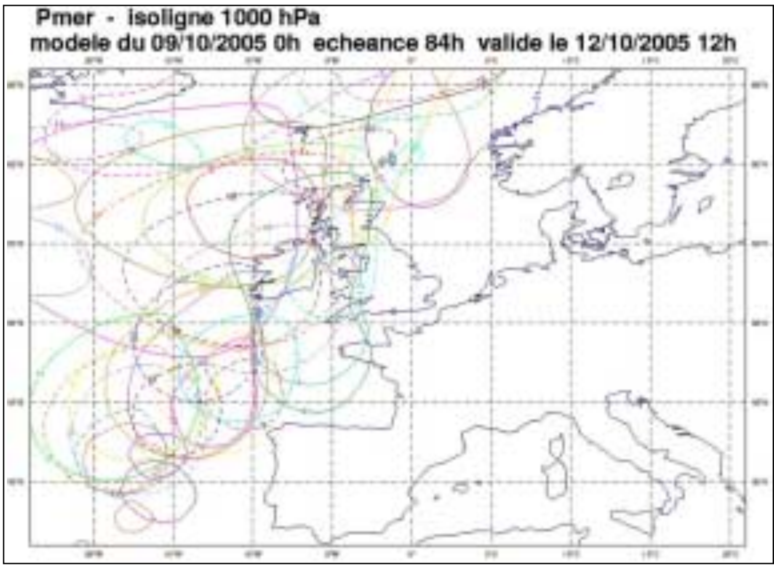
Figure 1: Positions of the storm on 12th Oct 2005 12 UTC based on successive ARPEGE runs

The spatial domain of PEARP covers the Northern Atlantic Ocean and Western Europe. The prime objective is to capture storm tracks but it is also used by forecasters on a day-to-day basis in conjunction with other available models.

In this article, two examples demonstrate how output from PEARP can be applied to typical forecast problems.

Example 1: risk of deep low over Western Europe at D+2, 10th Oct 2005

In a rapid southwesterly flow, all the deterministic models forecast an intense cyclogenesis event at D+2 near the British Isles but there was a large spread of solutions between successive model runs and different models.



The ECMWF ensemble forecast also gave an indication of great uncertainty. Figure 2 shows the 1000 hPa isobar plotted for each ensemble member with the cone of uncertainty ranging from north of the United Kingdom to west of Iberia.

Figure 2: Positions of the low in the 84 hour forecast for each of the 50 members of the ECMWF ensemble forecast (data time: 9th Oct 2005 00Z)

Verification of the initial conditions

In the initial conditions, the low did not exist. It developed as a secondary wave along a cold front to the southwest of Ireland. At upper levels, a rapid westerly jet stream extended from Newfoundland to the central Atlantic and then turned to the southwest towards Ireland. PV anomalies circulated along the polar side of the jet and initiated the early stages of deepening. A secondary northwesterly jet stream brought colder air from Labrador and probably played an important role in the subsequent deepening process. However the main source of uncertainty was the presence of a tropical storm named "Vince" in an unusual place near Madeira. The warm low-level air of the tropical storm was caught ahead of the cold front and helped to trigger the cyclogenesis process. There was no clear misfit between the model analysis and observations, water vapour and IR satellite imagery (see Figure 3).

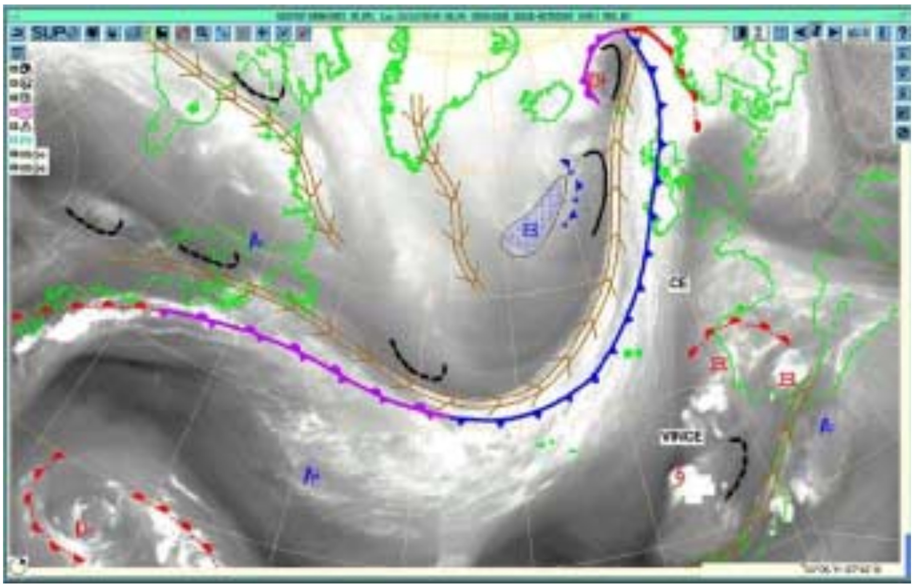


Figure 3: Water vapour imagery and synoptic features on 10th Oct 2005 06 UTC.

The individual runs of PEARP show three different types of forecast but with an almost equal number of members. So it didn't really help the forecaster to make a choice.

Type 1: a deep low

Type 2: a moderate low

Type 3: a trough

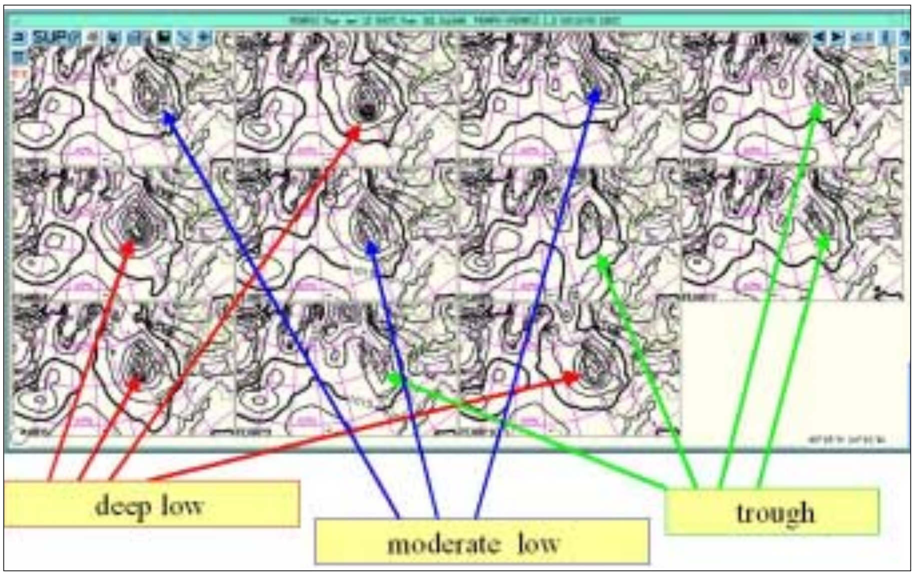


Figure 4: 54 hour forecast of MSLP from the 10 members of the Arpège ensemble.

Conclusion

In this case, the forecaster had no objective way to choose a scenario. The latest runs of models were chosen (a deep low) but it was a wrong choice: the resulting analysis showed a large and smooth trough.

Forecasters are still faced (very rarely hopefully) with such cases where everything is possible without solid arguments that allow a choice between different scenarios, either in the initial state, or in the model evolution.

Example 2: verification of the D+2 forecast for Saturday 15th April 2006

On 15th April 2006, a dynamic short wave trough crossed France with a band of heavy rain (see Figure 5).

The D+2 forecast for this day was based on ARPEGE rather than ECMWF because it gave more rain associated with the trough and indicated a faster movement. Furthermore, this scenario was supported by others models.

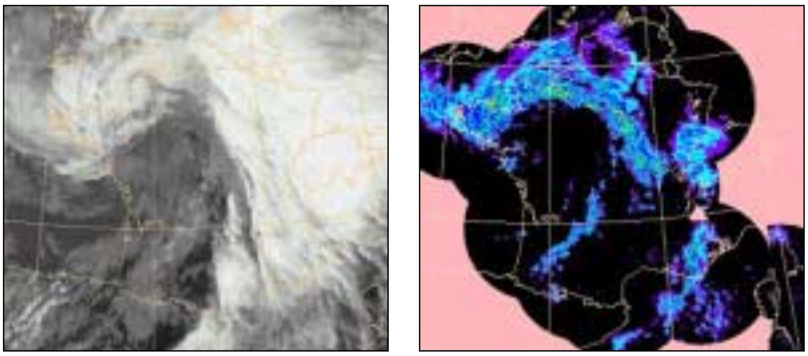


Figure 5: IR and radar images on Saturday15th April 2006 12 UTC

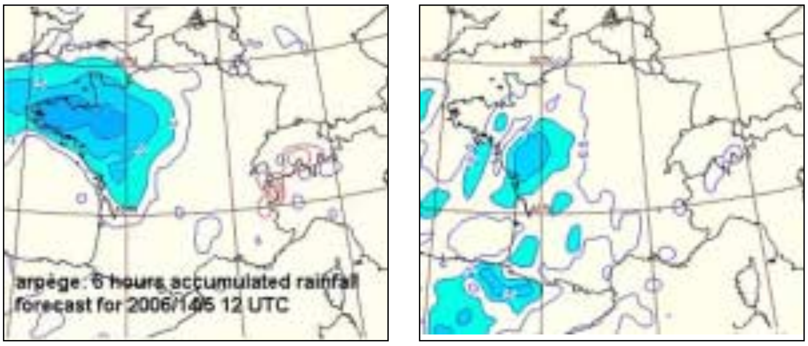


Figure 6: Comparison between Arpège and ECMWF 6 hours accumulated rainfall forecast for 15th April 2006 12 UTC.

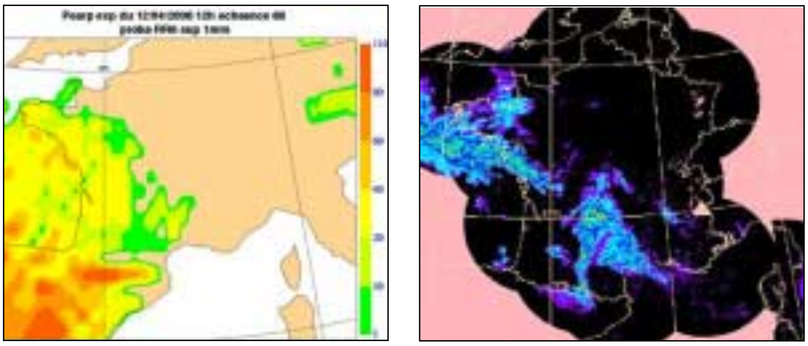


Figure 7: Comparison between the forecast probabilities of rain based on PEARP and the radar precipitation image.

The comparison between the forecast and the analysis showed that it was a good choice. However the forecast was not perfect. The rain area in the southeastern part of France was not forecast correctly.

Would it be possible to improve the forecast with the use of PEARP, the ensemble model based on ARPEGE? In this case, the answer was 'yes' because the rainfall probabilities indicated clearly the possibility of rain in the south-eastern part of the rainfall band, and was therefore a better fit to the radar images relative to the rainfall forecast by ARPEGE.

General conclusion

In some cases, the ensemble forecast PEARP based on Arpège could provide a help to the forecaster by indicating other scenarios or alternative timings of synoptic features. That could happen not only in very active situations (for example in rapid cyclogenesis events) but also in the day-to-day forecasting of less active features.

However, the ensemble forecast PEARP should be improved to give a better spread of solutions. The area over which perturbations to the initial state are generated should be extended and, above all, the number of members in the ensemble should be increased.

Fabrice **Guillemot**
Bernard **Roulet**
Météo-France

Towards a new and better balanced system in assigning weather alarms in the Netherlands

Summary

Since summer 2005, KNMI have based their warning strategy for the highest level of warnings, the so-called "weather alarm", not solely on pure meteorological thresholds. A professional judgement on expected impact, due to the initial meteorological event, is also taken into account when issuing the weather alarm. In order to combine pure meteorological thresholds and the expected impact on society an expert team for weather alarms has been established.

The weather alarm assignment strategy (before July 2005)

Until July 2005, KNMI issued:

1. Weather alarms in a deterministic format, based solely on forecast parameters exceeding thresholds (intensities) over a minimum spatial scale, defined as either an area of 50 x 50 km or, for more geographically stretched phenomena (e.g. a coherent frontal band), at least 50 km in length. For coastal phenomena, the criterion for spatial scale was based on thresholds being exceeded at a minimum of 2 coastal observing stations. Lead times for weather alarms were 0 – 12 hrs in advance.
2. Early warnings of extreme weather based on the same criteria as above (intensity and minimum effected area) with a lead time of 12 – 24 hours in advance. This type of warning also had a deterministic format.

The problems:

KNMI realised that within the "old" system the level of responsibility for the Senior Meteorologist was too heavy and stressful. He/she was the only decision maker in issuing weather alarms.

- One of the reasons for this stress felt by the senior forecaster was that weather alarms implied the highest level of society awareness (orange or red).
- Also, for obvious reasons, there were hardly any "false alarms" issued, many of the weather alarms were issued quite late (almost without any useful lead time) or sometimes not at all (missed).
- Furthermore, hardly any use was made of the early warning. When senior forecasters were questioned about this, it became clear that they were only prepared to issue an early warning when being very sure the extreme event was going to happen (implying hardly any early warnings and quite often a belated weather alarm or a missed event).

The new weather alarm assignment strategy (from July 2005)

In order to optimise the system, many discussions took place between all groups of staff working at KNMI (including the forecasters). The outcome was a new decision making strategy with the establishment of a designated expert team. Within the strategy, the expected impact of an event would also be taken into account whilst the early warning would be changed towards a probabilistic format (explicitly mentioning the percentage risk for weather alarm conditions to occur).

1. The early warning, now probabilistic, is based on the same criteria as the weather alarm criteria. Lead time (unchanged) 12 – 24 hours. As soon as the risk of the extreme event is considered to be equal to or more than 50%, the early warning shall be issued.
2. Within the text of this early warning the percentage risk of weather alarm criteria for a certain parameter is explicitly mentioned for all users (general public, civil security and media).
3. The final decision on issuing this early warning for extreme weather is taken only by the senior meteorologist (the shift leader).
4. As soon as an early warning is issued, the so-called expert team on weather alarms at KNMI becomes operational. This team is intended to provide additional information on the vulnerability of society.
5. Bringing together this expert team does not only have to start after an early warning has been issued. It can also be initiated by one of the members of the expert team. This is in order to prevent missing a weather alarm on occasions when an early warning has not been raised. The chairperson of this expert team is the Head of Forecasting Division or his appointed deputy.
6. In a situation where the extreme weather is well foreseen, the expert team members will join the shift change briefing at 14.30 hours (early shift changing for late shift). During the shift change, all the meteorological information and details are exchanged.
7. During this shift change briefing, model and theoretical specialists from the R&D department are present to provide additional comments on initial model performance for certain critical parameters and forecasting methods if needed.
8. After the briefing the expert team meet outside the forecasting room, together with the senior forecasters from the incoming (late) and outgoing (early) shifts. During this meeting additional expert judgement on the initial vulnerability of society for the upcoming weather alarm event is discussed (see next section for more details).
9. Finally the expert team will take the decision to give a “yes or no” for issuing the weather alarm. The certainty of the event happening should be above 90% (though discussions are taking place to lower this towards 80%).
10. The format of the weather alarm is deterministic, so no risk percentage is mentioned in the text itself (though implicitly the risk is more than 90%).
11. When the decision to issue is difficult due to differences of opinion, the chairperson of the expert team will make the final decision. Details of the warning text will also be discussed together with the decision to ‘go’.
12. When a weather alarm situation occurs unexpectedly or outside regular office hours a special procedure to involve the expert team is available. Even a “high speed” procedure to bypass the expert team is available.
13. The chairperson always evaluates the expert team meetings and information is available to all involved.

The importance of the expert team judgement

Until now only meteorological criteria were triggering the weather alarms. KNMI strongly believe that weather alarms are not only meant to relate to meteorological criteria but also need to warn society of the potential impact and damage due to extreme weather.

Some general thoughts on initial impact:

- During certain periods, events or situations the country is more vulnerable to the impact of extreme weather.
- In general: on week days and especially during peak traffic times, society is more vulnerable than on sundays. Also during the summer season when people are camping outside, when many open air events are planned or during major pop concerts the impact may be higher even when the intensity of the weather might be a little below the formal thresholds for issuing the weather alarm.
- In this way during very vulnerable periods, one could decide to issue for high probability events that are not expected to fully reach the thresholds.
- During successive periods of extreme weather, issuing a weather alarm for a slightly less intense event shortly afterwards can sometimes be ridiculous in a strategic sense. In this case it would be prudent to warn at a lower level (by means of use specific warnings = yellow awareness).
- From an outside political perspective, the strategy might be a little bit more cautious for a “yes” or “no” decision at certain times.

Of course KNMI experts are not specialists in assessing the initial vulnerability of society. However, some common sense and feeling for this topic is adding a lot of information.

The expert team members and their typical value added input with respect to decision making on vulnerability:

1. The account managers for civil security at KNMI are well aware of special events. They are in possession of an events calendar and can get in touch directly with civil security to obtain additional information on large scale outside events.
2. Experts at KNMI know how extreme the expected event is from a climatological point of view. They also have additional information from insurance companies, for example, on the impact of comparable events in the past.
3. KNMI press officers understand or are able to foresee political sensitivities if a severe weather events are expected. They see the forecasts and other messages already issued by commercial meteorological companies in the country. They have a feeling for the impact of repeated extreme events over short periods of time and assign the best strategy to deal with that situation.
4. The KNMI Co-ordinating Officer is an expert in the official issuing of procedures and knows the best methods (or feasible alternative methods) to disseminate warning messages.
5. The shift leaders hold all the meteorological knowledge to provide input on expected intensities.
6. The Head of the forecasting division has overall responsibility.

Conclusions

- At first the operational meteorologists were quite reluctant to accept the decisive role of the expert team on weather alarms. Now it is well accepted because of the fact that the shift leader is member of the team. The decisions are also considered to be well-balanced.
- KNMI is strongly convinced that the weather alarms issued in the new set-up are more balanced and better linked to the needs of society.
- So far, strong and positive feedback has been received about these weather alarms from society, civil security and insurance companies.
- The new probabilistic method used for early warnings has demonstrated that the forecaster is more at ease and more likely to use the early warning for extreme weather. It seems to have made a major difference for the forecaster to be able to communicate and quantify explicitly the uncertainties.
- Since July 2005, the expert team on weather alarms has assembled eight times. There have been six occasions when weather alarms were issued. On one occasion, an early warning was raised and then withdrawn. There have been no missed events or any false alarms.

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The warning system of ZAMG for Austria – Concept and Applications

The warning of extreme meteorological events is a core task of ZAMG, the national weather service of Austria. Meteorological parameters such as windstorm, heavy rain, heavy snow, icing phenomena, thunderstorm and hail are covered by the highly sophisticated warning system of ZAMG. Warnings for thunderstorms and hail are also automatically transmitted to special clients by SMS. These warnings are based on a special technique detecting the 3-dimensional radar signal.

The operational warning system of ZAMG consists of 3 components

- Warnings for districts according to the federal alarm centres of Austria, public information transfer via internet portal
- Warnings for specified local areas, e.g. cities or industrial locations, special clients, information transfer via SMS
- Warnings for mobile local destinations, e.g. hikers in the mountains, information transfer via GPS (under development, project Galimet)

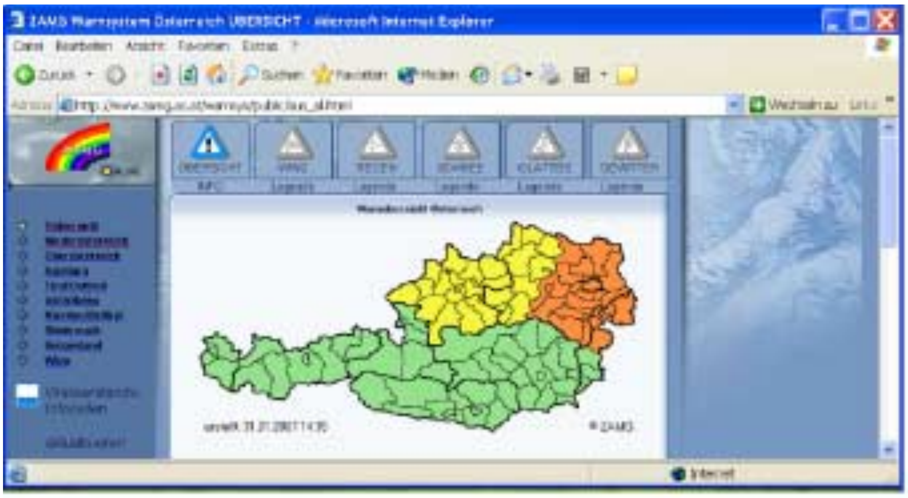
For warnings to the public and federal alarm centres, the responsibility lies with the forecasters at the headquarters of ZAMG and at the regional offices of ZAMG in Salzburg, Innsbruck, Graz and Klagenfurt. The warnings for specified local areas for heavy rain, snow and windstorm are based on forecaster information already in the warning system and on the predicted values of the combined mesoscale model system INCA-ALADIN (INCA = Integrated Nowcasting through Comprehensive Analysis, ALADIN = operational mesoscale forecasting model of se **http://www.zamg.ac.at/fix/INCA_system.doc**). The warnings for thunderstorm and hail for special clients are automatically generated. Warnings for mobile local destinations will be operated in conjunction with a telecommunication provider.

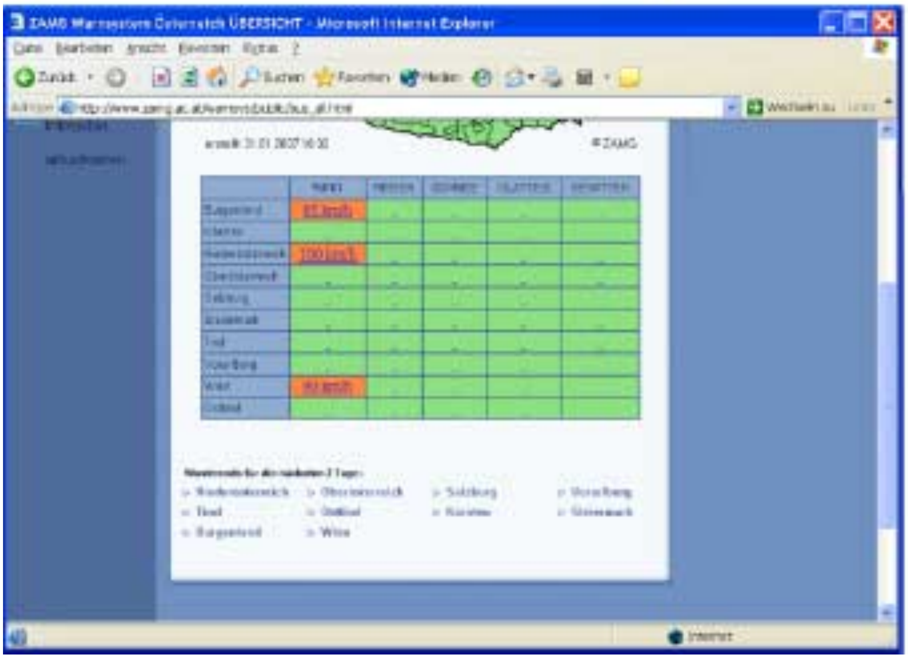
The general warnings are presented in the public domain on the homepage of ZAMG (**www.zamg.ac.at**)

The warnings areas relate to the political districts over the territory of Austria.

By clicking on a district where a warning is in force, a popup specifies the warning period and contains further information within a detailed short text. The warning period for the public lasts no more than 24 hours. This page also contains a trend warning for the next two days.

The warning system of ZAMG has utilised some ideas from the French vigilance system, especially the colour definitions: green, yellow, orange and red. **The Austrian philosophy in distributing a warning is determined by the principles in standardisation of alarm levels in relation to climatological data and areas. The colour of the warnings for the public represent how often the warning parameters of wind, rain and snow occur per year in each district. Green** represents no warning, **yellow** less than 18 times per year, **orange** less than 4 times per year and **red** less than 2 times per 3 years. For thunderstorms, hail and icing phenomena, the colour is linked to the magnitude of the event. The Austrian warning tool of ZAMG runs operationally but further developments are planned. It is also compatible and integrated into the **E**uropean **M**ulti-service **M**eteorological **A**wareness system (EMMA), operating formally as METEOALARM.





What does that mean for a risk management strategy to public authorities?

Yellow means **damage is possible to exposed objects, orange represents frequent damage and red identifies large scale damage**.

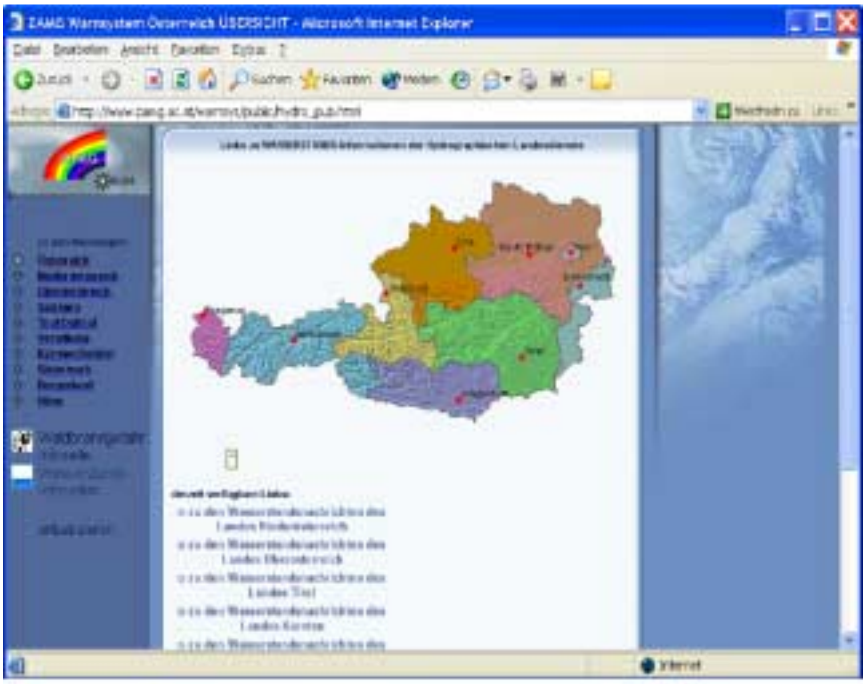
What does that mean to the public?

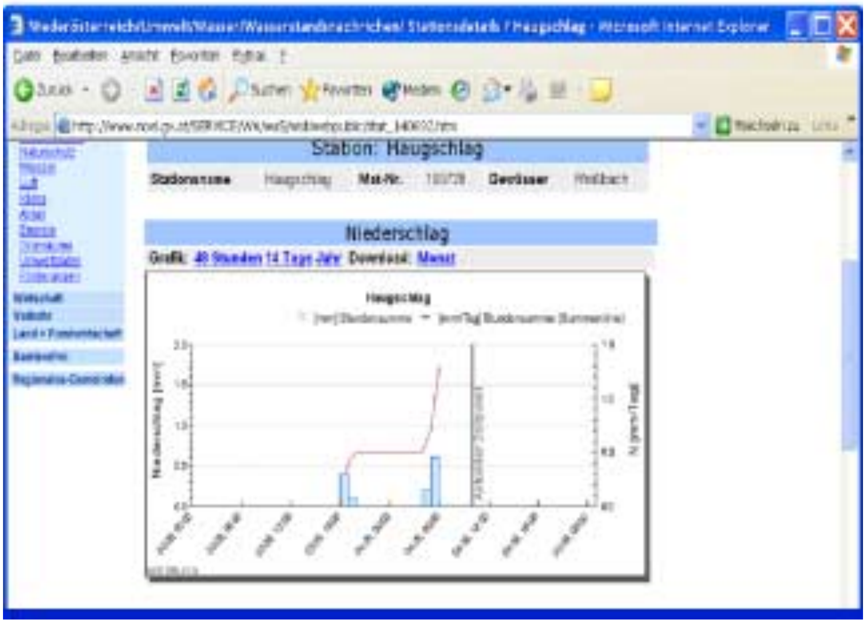
Yellow informs the public to **be alert**, orange to **be very alert** and red to **follow the advice of the public authorities**. Identified special clients do not need to constantly monitor their screen with this integrated internet portal. They are informed by SMS, email or fax if there is a change on the warning system.

At ZAMG a crucial verification method has been developed in order to evaluate the warnings in space and time. An example for wind in shown below for the period May 2005 – July 2006 over the counties of Lower Austria, Vienna and Burgenland:

Not detected: 13 %, false alarm rate (overwarning): 30%, preliminary warning time: 6,5 hours. The detection rate and false alarm rate are dependent on the frequency of warnings, density of the observation network and the orography of Austria. Links to flood information operated by the hydrological services of each county are included on the ZAMG homepage.

Special warnings for heat waves, drifting snow and snow load are inserted in the warning pages by an '*attention pictogram*'. The warnings for forest fire are provided in a special page on ZAMG homepage. Warnings for avalanches are not operated by ZAMG. A link to this service is in preparation.





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Exploiting ensemble members: forecaster-driven EPS applications at the met office

Introduction

Ensemble Prediction Systems (EPSs) have assumed a central role in the forecast process in recent years. The challenge is to allow forecasters to exploit fully the rapidly growing quantity of EPS data within the timescales of an operational environment.

As part of an ongoing review of usage of NWP products within the Met Office, new presentational techniques and automated analysis methods are being developed for use with model data. There is also a need to rationalise and unify EPS products used in the Met Office, thus simplifying usage and empowering the forecaster and other customers.

Uses of ECMWF data

Operations Centre Forecasters routinely access standard ECMWF EPS products such as 'postage stamps' and the Extreme Forecast Index (EFI) via the ECMWF website. Additionally, forecasters may make use of the 'in-house' suite of ensemble products derived from raw ECMWF data (accessed via a system known as PREVIN). Products from PREVIN include alternative clustering methods, meteograms, and a wide-range of probability charts for specific weather events affecting the UK. For example, an invaluable element of PREVIN is the First Guess Early Warning (FGEW) system, which uses the ECMWF EPS to automatically alert forecasters of upcoming potentially severe weather affecting the UK.

MOGREPS

In the last year, extensive trials have taken place using an EPS developed within the Met Office, known as MOGREPS (Met Office Global and Regional Ensemble Prediction System). MOGREPS uses an Ensemble Transform Kalman Filter (ETKF) to generate perturbations in initial conditions. Model physics perturbations are also introduced via random variation over time of key parameters within each EPS member.

	MOGREPS-G	MOGREPS-R
Model	UM6.1 (G38)	UM6.1 (E11)
Resolution	N144 (90km), 38 levels	24km, 38 levels
Run Times	00 and 12 UTC	06 and 18 UTC
Run Length	72 hrs	54 hrs
Availability Times	07:30 and 19:30 UTC	13:00 and 01:00 UTC
Ensemble Size	24 (CNTRL+23 perturbed)	24 (CNTRL+23 perturbed)

Table 1: MOGREPS configurations

MOGREPS runs in two main configurations (Table 1) based on the Met Office Global (GM) and North Atlantic & European (NAE) model domains respectively. An additional version of MOGREPS-G is run out to 15-days at ECMWF as a component of the THORPEX multi-model ensemble, TIGGE.

A wide variety of products are routinely generated using the MOGREPS output. As with PREVIN, these are accessed via the Met Office intranet. The website makes full use of web technology developed since PREVIN was originally implemented, displaying clickable and animated sequences of each EPS member, or products derived from them such as event probabilities and clusters.

Close liaison between forecasters and developers has resulted in a system with a high degree of flexibility: certain products or combinations of model fields have been requested depending on the synoptic situation, and developers can respond quickly to these requests. More formally, forecasters have been asked to evaluate the usefulness of each MOGREPS product via questionnaires, enabling developers to ascertain product priorities and to alter product generation schedules accordingly. Further surveys will be conducted, and continuous feedback encouraged, until an optimum set of forecast products is achieved.

New EPS applications

The Cyclone Database

PREVIN includes facilities for the tracking of extra-tropical cyclones based on matching and tracking MSLP minima. However these systems are often of limited use in identifying and tracking the precursors of cyclogenesis, prior to formation of well-defined low centres.

The Met Office Cyclone Database, CDB, (Hewson, 2007) has been running in real time on UK Global Model data for several years. This attempts to identify and display features using automated, objective techniques based on standard conceptual models of fronts and of cyclone development (Figure 1).

Having identified objective features at a given time, an attempt can be made to automatically identify the same features at later times. An important aspect of this tracking scheme is the consideration that an object may evolve into another type of object. For this type of transition, the probabilities have been derived empirically from historical data. Hence, for example, the natural development of a minor baroclinic feature into a frontal wave and finally a barotropic low can be tracked throughout its lifecycle using this system.

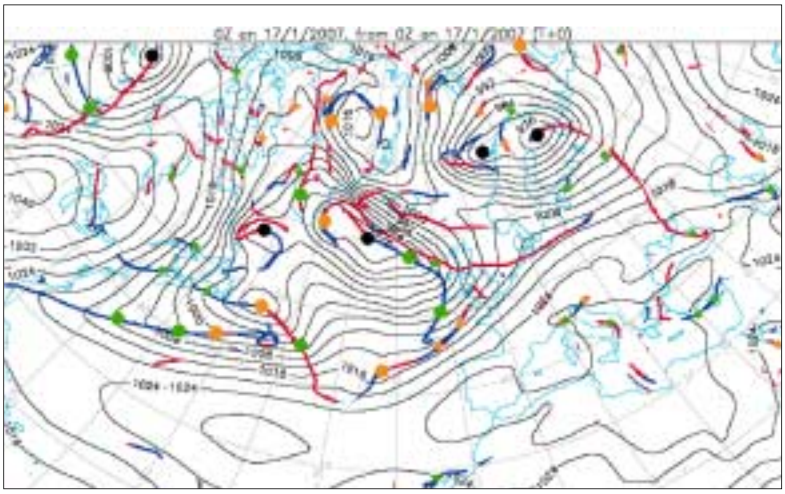

Figure 1: Example CDB analysis of UKMO Global Model T+0. Labelled features are Diminutive Waves (Green), Frontal Waves (Amber), and Barotropic Lows (Black) along with Warm (Red) and Cold (Blue) Fronts.

This formulation proves to be an excellent means of analysing large EPS datasets. The MOGREPS version of the CDB (adapted for THORPEX by Helen Watkin, Met Office) matches features in the MOGREPS-G CNTRL member at T+0 with the other ensemble members. Once common objects are identified, their tracks can be plotted, along with various other useful properties such as minimum MSLP and maximum wind at certain heights (Figure 2). Tracking plots for each object are displayed by clicking on the appropriate object in the T+0 CNTRL analysis (as in Figure 1).

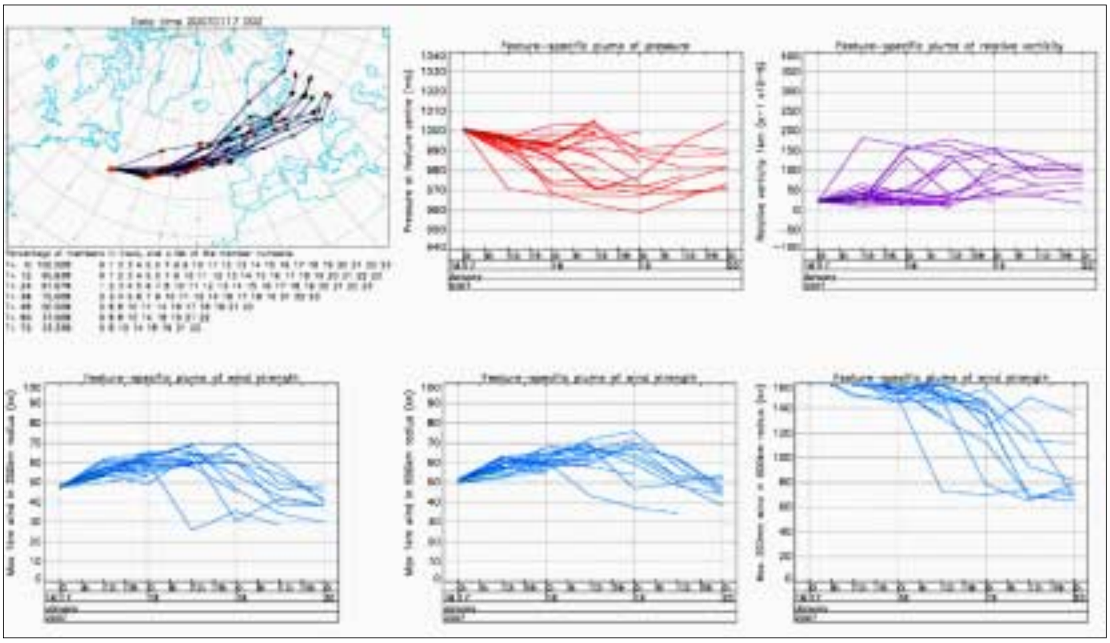

Figure 2: MOGREPS CDB plumes displayed by clicking on a given object identified in the CNTRL member at T+0

Objective-GWL: Synoptic Regime Analysis

As part of the THORPEX project, Paul James (of the Met Office's Hadley Centre) has developed applications to classify EPS members by synoptic type. Members of a MOGREPS-THORPEX dataset on a given day are clustered according to Grosswetterlagen (GWL) synoptic types over northwest Europe. The results are displayed in order to indicate quickly to the forecaster the dominant regimes in the medium-range period (see Figure 3 and Figure 4).

The analysis can also be performed on either ECMWF or GFS ensemble data. Additionally, the data can also be classified by Lamb Synoptic Type, which is perhaps more familiar to UK forecasters.

Figure 3: MOGREPS-THORPEX Objective-GWL output displaying the number of EPS members of each GWL synoptic type on a given day.

Figure 4: Objective GWL clustering. Cluster 1 represents the most probable GWL regime sequence. Cluster 2 is the next most probable sequence, having removed the first set of regimes, and so on.

These products have recently become widely used by the Medium Range forecasters in the Met Office. In the past, forecasters have derived similar results subjectively, usually by inspection 'by eye' of EPS 'postage stamps'. Anecdotal evidence already suggests that such automated output is extremely useful, and is already saving considerable time and effort.

Future Projects

Though ensembles are in continuous use by forecasters, the recent survey of their usage has highlighted a need for consistent methodology and for standard working practices. At present, each forecaster relies on the particular products with which they have become familiar, and the very large amount of data available can make it difficult to assimilate additional information on the timescales required operationally.

The amount of available EPS data has increased substantially in recent years. Clearly it is advantageous to have access to a wide range of products, and also a range of different models, each with known characteristics. However, this profusion of data from different sources (often in different formats and available at different times) makes objective and quantitative comparison difficult for the operational forecaster. At present, much of this evaluation is made subjectively after examination of a combination of screen-displayed and printed charts.

It is hoped that, by developing standardised products and procedures, the comparison of data may be made more rigourous and more objective, and considerable time and effort can be saved during the forecast process. There is already work underway within the Met Office to attempt to standardise the presentation of 'in-house' EPS output: PREVIN products are soon to be accessed via the MOGREPS webpages and displayed in a similar format. New products, such as those described above, show the merits of developing automated analysis and comparison techniques, and will be absorbed by the unified display system. In addition, EPS products will be incorporated into the new Met Office forecaster workstation, SWIFT, further enabling detailed analysis of Ensemble data.

Having established standardised display formats, the next logical step is to enable quantitative comparison between the different models themselves. For example, the behaviour of an EPS relative to its 'parent' deterministic model can be an important indicator of forecast confidence if correctly interpreted. Work at ECMWF (the 'Combined Prediction System') suggests that statistically, the ECMWF operational deterministic model has very high average weighting at short lead-times, if considered as a member of its own ensemble. It is expected that these results can be generalised, enabling forecasters to quantitatively assess the most probable solution via comparison of all the models.

Some PREVIN and MOGREPS products (such as meteograms) are generated on demand, and as computing power increases, it is anticipated that many other EPS products may be created in this way. The development of an interactive EPS system would also allow the forecaster to specify key parameters for various analysis techniques. At present, the full power of clustering is rarely demonstrated. However, by letting the forecaster specify the domain, time and fields over which to cluster the data according to the synoptic situation, a powerful tool could be generated. This flexibility is far more important than the actual clustering methods used, which can be made as simple as possible in order to minimise computing time.

Best member selection

A standard method of model verification is by subjective comparison of appropriate fields with observational data, most notably with IR or WV satellite imagery. Evaluation of a model's handling of upstream features at, say, T+6 (see Fig 5) provides a key measure of confidence in its later performance.

We can also use this idea to assess performance of each EPS member, thus identifying the current 'Best' and 'Worst' performers in the ensemble. As with the products above, it is essential to automate the process of comparison in order to examine the large EPS datasets on operational timescales. Comparison techniques in this case will be similar to those used in the CDB matching algorithms.

Initial efforts will focus on identifying 'Worst Members' – poor performers – which may be discarded from the ensemble. This is a much simpler process, as often model deviations from reality are clear from comparison of single model fields with imagery. The Best Member could then be obtained by process of elimination, or a set of updated probabilities could be calculated based on the remaining members. Though lacking the statistical rigour of the probabilities derived from the full sample, these recalculated probabilities would help forecasters assess weightings of particular members or clusters given recent observations.

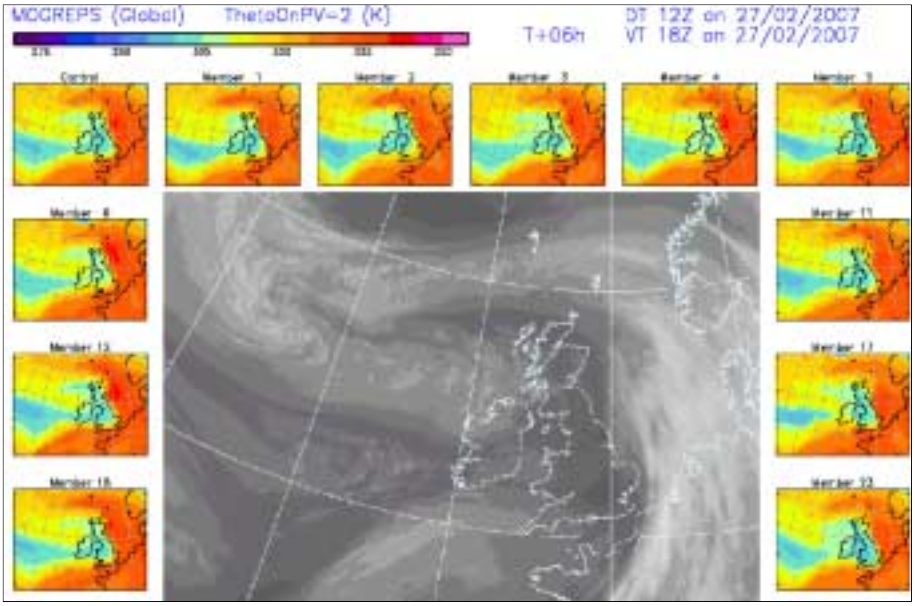

Figure 5: Example comparison between MSG WV imagery and MOGREPS fields. Comparison can be automated, and used in Best/Worst Member selection scheme.

In the future, it is anticipated that the configuration (eg. resolution and physics schemes) of EPS members will be equivalent to their 'deterministic' parent model. This may open up a scenario whereby a Best Member could be chosen to drive products further down the forecast chain if deemed likely to perform better than the parent model run. This option is being considered as an alternative to complex field modification techniques that are currently being used when larger-scale errors are anticipated in the parent model run.

Summary

The proliferation of EPS data requires that new presentation and analysis techniques are developed in order to keep full data comparison viable on operational timescales.

The Met Office is moving to standardise its EPS output as new ensemble products become operational.

It is hoped that these developments will be the first steps towards a unified and interactive system for quantitative comparison between observations and both EPS and deterministic model data. This will allow EPS data to play an increasingly pivotal role in the everyday forecast process.

References

Hewson, T. 2007. "Objective Identification of Cyclonic Features, from Initiation Through to Decay". To be submitted to Meteorological Applications.

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