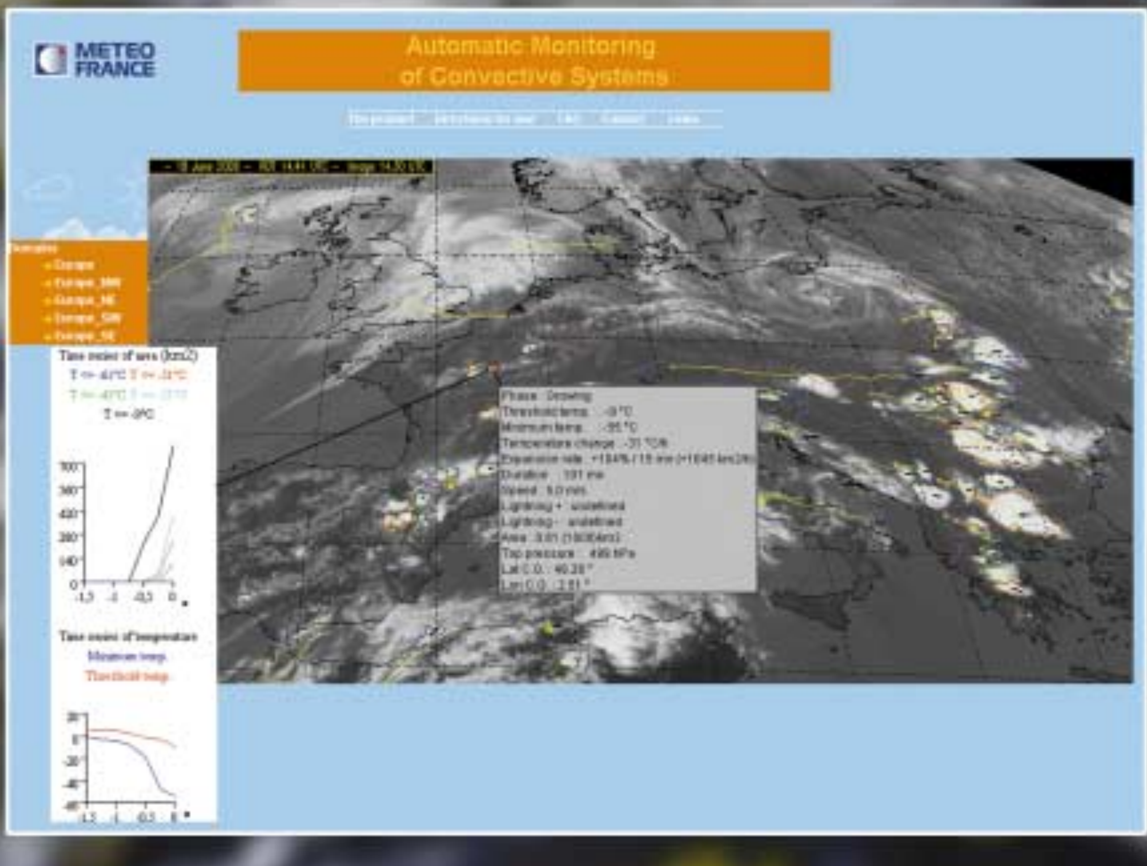
The European Forecaster



Newsletter of the WGCEF

N°11
May 2006

Contents

Cover: Example of MSG IR and RDT showing outlines and tracks of thunderstorms over Europe.
For the cell near Paris, various convective parameters are displayed.
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Introduction

Dear Reader,

Once again I welcome you to another issue of the *European Forecaster*, this being the eleventh newsletter of the Working Group on Cooperation between European Forecasters (WGCEF). All of the articles here were presented at the last meeting but we encourage any reader to contribute to future issues of the newsletter in the interests of sharing information and learning how others deal with something that affects us all and knows no borders – namely the weather. A list of contacts can be found at the back of the newsletter if you feel that you would like to get involved.

Our meeting at KNMI, De Bilt, followed the ECAM/EMS conference in September 2005 and was particularly special since we were celebrating ten years of the working group. It is good to reflect on the reasons as to why the group was first set up and where we have come since then. However, it is also important to look forward and concentrate on how the forecaster role will develop over the next ten years. This was a theme for the Round Table discussion at the ECAM conference.

The WGCEF website found at **http://www.euroforecaster.org** can provide you with extra information and includes links to future conferences. It also includes the announcement of our next meeting that will be held at the Hellenic National Meteorological Service in Athens, Greece at the end of September 2006.

Nick **Grahame**
Chairperson of WGCEF

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

KNMI, De Bilt, The Netherlands, 17th September 2005

Introduction

The eleventh annual meeting of the WGCEF took place at KNMI in De Bilt, The Netherlands on the Saturday following ECAM 2005. Nick Grahame (Chairperson, United Kingdom) opened the meeting, welcomed the participants and thanked Frank Kroonenberg (Vice Chairperson, The Netherlands) for hosting the meeting. Copies of the draft agenda were circulated and a final agenda agreed. In total, there were 24 participants representing 20 Meteorological Services (see Appendix I) and it was good to welcome back the founder member of the group, Manfred Kurz (Germany). This proves that meteorologists can never really retire completely. It was also pleasing to welcome representatives from Denmark and Cyprus for the first time.

Actions from last meeting

There were no direct actions on specific people but a lasting action on all members to promote the group and EMMA.

Report of the chairperson of the WGCEF

Nick Grahame stated that it had been a good year for co-operation. The storm on 7th/8th January 2005 caused concern for forecasters across northern Europe and the Met Office contacted DMI and Metno to pass on information about forecast winds from the UK 12km mesoscale model. The same storm hit the Baltic states on 9th Jan and we later found out from Merike Merilain that EMHI had received criticism following flooding in Estonia. Warnings of the storm had been issued well in advance by EMHI and it appeared that the criticisms were unfair. WGCEF members gave support to Merike via e-mail and we were told at the meeting that an apology had been sent to EMHI later.

Vida Raliene (Lithuania) visited the Met Office for the 2nd RSMC workshop in March 2005 (Vida sent her apologies for not being able to attend the meeting). Two Météo-France forecasters, Bernard Roulet and Jean-Marc Barrety, visited the Met Office in June 2005 and both gave presentations relating to their work. Links have been set up between Exeter and Rennes to allow discussion on mutually interesting weather events.

Dirk Heizenreder (Germany) also came to the Met Office in June to attend a NinJo workshop and this presented an opportunity for the Chairperson to introduce Dirk to the English seaside with fish and chips and English beer!

Following the visit of Robert Mureau (KNMI) to the Operations Centre in Exeter, an invitation to the Chairperson to take part in the ECAM Round Table discussion was accepted.

Nick Grahame then handed over to Frank Kroonenberg who provided an update on EMMA. Frank explained that the EUMETNET project had run into funding difficulties but a consortium comprising KNMI and ZAMG was planning to take it over and this was the proposal to be put forward to the EUMETNET council meeting in October 2005.

Discussion of Newsletter No.10 and WGCEF website

Nick Grahame mentioned that the articles had been sent in within the timescales requested but a lack of 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) then provided an update on the status of the WGCEF website. It was agreed at the last meeting that Andre-Charles would investigate if a more flexible arrangement could be achieved via a small payment to a private company. The new site **www.euroforecaster.org** 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.

Contributions from WGCEF members

Once again, it was pleasing that the request for short presentations was taken up in such an enthusiastic manner with a wide range of topics covered. The contributions before lunch were as follows:
Imre Bonta (Hungary) – Performance of the numerical models used at HMS in 2004
Bernard Roulet (France) – Analysis error, diagnostics and sensibility
Antii Pelkonen (Finland) – The Finnish boundary layer in winter
Thomas Krennert (Austria) – News from ZAMG, INCA and its application
Nick Grahame – Tornado in Birmingham, UK

The group broke for a tasty buffet lunch and the ‘official’ photograph then followed outside the entrance of KNMI (hastily arranged with a shower approaching!).

In the afternoon session, the following contributions were presented:
Dirk Heizenreder (Germany) – Application of PEPS
Kees Blom (The Netherlands) – Weather dependent shift strategy at KNMI
Ludo Van der Auwera (Belgium) – Experiments with EPS and EMMA output

To celebrate 10 years of WGCEF, the group welcomed Manfred Kurz who presented a short history of how WGCEF has developed between 1995 and 2005. This was followed by a celebratory drink and cake. Let us hope that we can do something similar in ten years time.

The details of each presentation can be found on the WGCEF website.

Plan of action for 2006

Nick Grahame reflected on the ECAM Round Table where some forecasters present expressed a feeling of disillusionment following the open discussion on ‘Re-engineering the Forecast Process’. However, he emphasised that there were many opportunities for forecasters to use their expertise in a proactive way to develop innovative ideas relating to the application of meteorology. Examples had been given in some of earlier contributions and the Chairperson looked at 2006 as being an exciting year. He also urged forecasters to share information. Links with the European Meteorological Society would also need to be developed further.

Date and place of next meeting

A proposal to hold the 2006 meeting in Athens was put forward by Chryssoula Petrou (Greece). The Chairperson mentioned that it might be possible to link it to the next EMS meeting in Slovenia and that a vote should be taken by members to decide. The Athens option was approved unanimously on this occasion (exact date to be confirmed but will be one weekend in September 2006).

AOB (any other business) and closing of meeting

The Chairperson reminded members that any contributions for the next newsletter would need to be received by 31st December 2005.

Concern was expressed about Liisa Fredrikson (former Chairperson) who had been suffering from bad health and did not attend the meeting. It was agreed that WGCEF members would send their best wishes on a card to be delivered to her by Antii Pelkonen.

Nick Grahame officially closed the meeting and the group proceeded on a tour of the forecast room and observational area on the roof of the KNMI building. A pleasant evening was then spent in the centre of Utrecht where the group met for a drink before taking up the invitation of dinner at the “Het Zuiden” restaurant where glasses were raised again to ten years of the WGCEF.

Nick **Grahame**
Chairperson WGCEF

Appendix 1

List of participants:
Giuseppe Frustaci (Italy),
Antii Pelkonen (Finland),
Nick Grahame (United Kingdom),
Imre Bonta (Hungary),
Sverker Hellström (Sweden),
Bernard Roulet (France),
Andre-Charles Letestu (Switzerland),
Frank Kroonenberg (Netherlands),
Dirk Heizenreder (Germany),
Thomas Krennert (Austria),
Chryssoula Petrou (Greece),
Norvald Bjergene (Norway),
Manfred Kurz (retired),
Ana Casals Carro (Spain),
Michael Walsh (Ireland),
Claude Sales (Luxembourg),
Tomas Halenka (Czech Republic),
Ludo Van der Auwera (Belgium),
Kees Blom (Netherlands),
Janez Markosek (Slovenia),
Merike Merilain (Estonia),
Teresa Abrantes (Portugal),
Silas Chr. Michaelides (Cyprus),
Nikolaj Weber (Denmark).

The EMMA Project - Operational Phase

Introduction

The main ideas of the EMMA (European Multiservice Meteorological Awareness) project have already been presented in the 2002 and 2004 issues of the European Forecaster. Graphical maps with awareness levels will be displayed on a common website to inform the public of imminent danger due to severe weather. Possible additional sources of information about mitigating risk will then be given by links to the websites of the National Meteorological Services.

The operational implementation of this project is expected by the end of 2006. The EMMA system by then will get its new operational name and will be baptised as "METEOALARM". However, several issues still need to be addressed with well worked solutions before the system becomes fully operational.

Figure 1. Example of Meteoalarm output.

Partners

The range of EMMA partners has been enlarged since the start of the project. At the 26th Eumetnet Council, the National Meteorological Services from the following countries agreed to participate and contribute to the EMMA system:

Austria	Finland	Hungary	Luxembourg	Spain
Belgium	France	Iceland	Netherlands	Sweden
Cyprus (1)	Germany	Ireland	Norway	Switzerland
Denmark	Greece	Italy	Portugal	UK

Visibility

This European map with integrated information on warnings and alert levels demonstrates the benefits of efficient and clearly visible co-operation between the National Meteorological Services involved, particularly in situations when significant media attention is focused on meteorological events.

The integration of the "vigilance map" into the French media has shown that there is a demand for standardised and consistent information particularly during extreme weather events. 'Standardised' in this sense means that key elements of the message should not change from one event to another and that the general public, relevant authorities and the media are all well informed in a clear way. Messages are well structured and can be understood without further explanation within seconds by the majority of people. Further information is conveniently accessible and provided for those customers/users who need more specific details.

In general terms, cases relating to extreme weather tend to be underestimated during the forecast period and overestimated in the reporting phase during and immediately after the event. There is then often less media interest in a later phase when damages have been assessed and measures are proposed to politicians. The storm that hit parts of northern Europe in December 1999 ('Lothar') is a prime example. Only a few hours before the event it was not possible to get the necessary attention of the public because the information did not contain easily understandable advice.

Impact – the hazard chain

In the last few years a general trend in research projects, risk management and new warning systems from the more advanced weather services has been observed. Pure warnings are related to a more integrated approach of impact related information systems.

Public authorities have been interacting more directly which each other on a more competent and higher level, thereby closing gaps in the chain comprising mitigation, prevention (e.g. land planning measures), forecast warnings and alerts, damage assessment and relief efforts. To make this chain work and to minimise damage with the most efficient use of public funds, each part of the chain has to interact with the other in an optimised way. Warning systems have to know about the impact of weather to be informative and relevant for practical measures to be put into place.

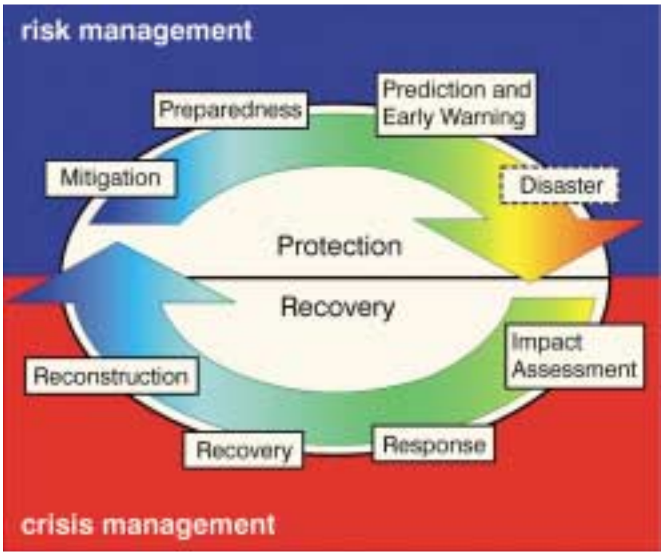


Figure 2. Integrated approach for warning systems.

Meteorological information and warnings have traditionally been based on fixed thresholds for one parameter, often with a fixed time scale, e.g. precipitation rate over 24 hours. This traditional approach makes evaluation of the quality of forecasts easy and homogenous for a given area with climatic homogenous conditions.

On the other hand, weather related damage and catastrophes are only indirectly dependent on parameter related thresholds. They are mostly linked to extreme values of a certain parameter in a given area or a critical combination of more than one parameter. By looking at area related occurrences, one comes to the conclusion that the impact of an extreme weather event is more important and relevant than references to fixed thresholds.

A good example is wind speed. In built-up areas away from coastlines, wind speeds are usually low and winds of 90 km/hr are likely to cause large amounts of damage. Over the exposed coasts of northwest France or in mountainous areas, winds of 90 km/hr would not usually result in any damage at all.

The same is true for precipitation or amounts of fresh snow. For areas in which large amounts of precipitation are common, the natural eroded landscape, architectural design, human behaviour and other damage related features are highly adapted to extreme precipitation events.

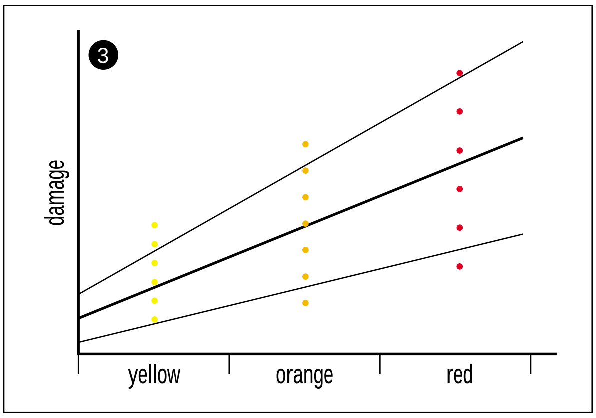


Figure 3. Schematic relationship between damage and warning levels for fixed threshold levels

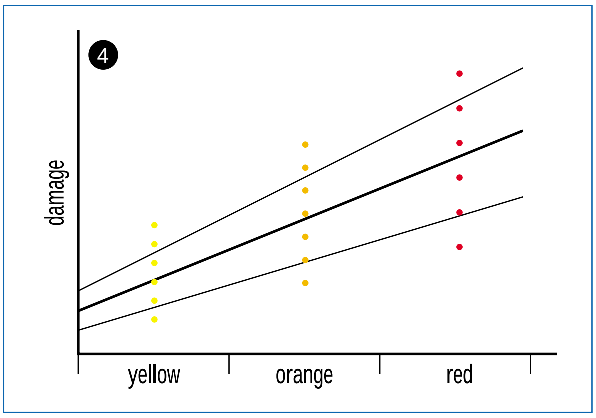


Figure 4. Schematic relationship between damage and warning levels for threshold levels dependent on return periods

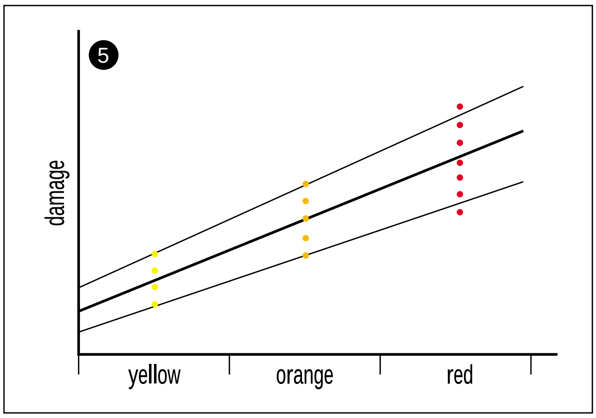


Figure 5. Schematic relationship between damage and warning levels for impact related threshold levels

It is suggested that return periods can provide a very good first guess for the choice of warning thresholds. A natural lower limit is a value that will not cause any damage. So would a well-sheltered area, for example, experience any damage at all if a 10-year event with wind speeds of 40 km/hr wind speed were to occur?

The principle of return periods can therefore be a very elegant and useful method to extend pure meteorology towards the impact of weather driven events and give at the same time, the needed flexibility to find thresholds for climatically very different areas.

If two adjacent but climatically different areas need to be warned with consistent information, the method of return periods allows the use of two different threshold values, relating to upper and lower limits of a precipitation event, to provide a comparison of warning levels for both areas. The advantage of this system is not only the much closer connection to the impact of the warning, but also the more direct connection to how this information is transmitted to the public by the media. A typical question from journalists after an extreme rainfall event is: When was the last time we had that amount of rain?

If values for meteorological parameters are static, the correlation between damage and warning level is weak, depending on climatic zones and preparedness for certain types of danger like wind for example.

Return periods used as a basis for the definition of warning levels give a closer correlation between warning situations and damage, as climatic features of an area are placed on a relative scale.

A foreseeable impact provides the best basis for warnings, but is the most difficult to assess. Basis for these calculations are the number of people exposed to a certain danger, the behaviour or the mitigation possibilities for certain damage types and the return periods of extreme meteorological events in a given area.

Finding thresholds

With journalists often directed towards the “interesting”, “other than normal” and the exaggerated, it is important that information related to extreme events is based on well established, reliable and easily understood concepts with quantitative elements available. The Richter scale for earthquakes provides a good example. Without any other additional information, the number on the Richter scale gives a clear first indication of the severity of an event and a first guess on the possible extent of damage.

In the case of meteorology, a similar system is still missing and the perception of the work of the Meteorological Services in the public domain suffers considerably from that fact. If warnings were correct, but recommendations have not been followed in cases of extensive damages, it is often the warning which is blamed after the event to have been unclear, incoherent or insufficient.

In many cases of very extreme events, users do not have a clear picture of how severe the event will be. Therefore the necessary measures of prevention or recommendations given do not have the impact that they should have.

Recommendations

The evolution from pure warnings towards a system that also incorporates impact related information has proceeded successfully within the more advanced weather services. However recommendations accepted by both sides are only slowly becoming part of the system.

It is an ongoing discussion with many questions still open between different meteorological services about how far meteorological services should go into providing advice or recommendations. In many cases clear legal implications are attributed to different warnings or alert levels. In some cases the National Meteorological Service is not allowed to give any behaviour advice by its ministers. In these situations perhaps stronger co-operation with other authorities at a national level should be established. These legal aspects very much depend on the local situation and the parameters concerned.

On the other hand if a given system is defined not only by weather driven impact parameters but also by certain types of recommendations, then this system would be more resilient in its practical usage as it can be read from different perspectives in a coherent and meaningful way.

The trick here lies in finding definitions for the different warning or alert states which are flexible enough to be employed in different legal environments and, at the same time, are sharp and concise enough to give clearly distinctive levels for the different types of response needed by the customers/public.

At the same time, the type of mitigation necessary can be a good starting point for the definition itself, when typical scenarios of the last few years are borne in mind. Another possible solution is to use types of recommendations for different warning levels internally as a definition aid at one Met Service, while the official wording is issued by the relevant authorities.

Take large events like Lothar (1999), the Oder floods (2002), the heat wave of 2003 or Hurricane Katrina (2005). In each case hundreds or thousands of casualties and/or billions of Euros in damage were caused in a very short time. In each of these cases recommendations issued by the responsible authorities were not understood and followed, or adequate structures in the hazard chain were not available.

It became clear to authorities, that the understanding of these warnings needed a certain education and training of the public prior to the events, as opposed to the moment when the warnings were issued.

Police officers in New Orleans were able to communicate the seriousness of the situation in 2005 after very time consuming discussions, only after they had asked people resisting evacuation to write their social security numbers on their arms in order to facilitate the identification of corpses.

In all of the cases mentioned above, the common theme was that such severe events had not been experienced within peoples short memory and therefore responses were inadequate. An optimised application of the hazard chain from mitigation to relief efforts may have considerably reduced the damage and loss of life.

The basic fact therefore is less about issuing actual warnings and recommendations, but much more about how these warnings and recommendations are understood according to the different elements in the hazard chain when delivered to the final customer, the individual and the general public.

Obviously a distinctive class for these very extreme events is needed in order to cope with events where the result of well understood warnings lead to optimum damage limitation.

Harmonisation across countries

The principle of subsidiary is one of the very successful and basic principles within in the EU and makes sense whenever local effects have to be dealt with by local means and the best decisions are linked to the needs of the basic citizen.

When it comes to large scale events like Lothar, the Oder floods, the heat waves or Katrina, local experience and local memories are less helpful because similar events have often occurred too far in the past to be used successfully in a rapidly changing world. The missing public awareness and preparedness was in all of these cases one of the most important factors relating to the amount of damage and the magnitude of the impact.

Public preparedness for such cases can only be achieved with the help of a media defined danger scale for severe weather events. Warning values could then repeated automatically for future events in the same way that the Richter scale is used for earthquakes, thereby indicating how really extreme and unusual the uppermost level will be.

The same regional and inter-regional scale applies for any relief efforts; in all of these cases, assistance and damage relief measures could only be coordinated with larger scale relief structures, either national or international.

It becomes clear then, that especially in the case of very extreme events, much can be learned from other relatively recent events in other parts of Europe or the world, as these events have received extensive media coverage and the losses (both financial and human) have been understood by all. Media coverage and experiences learned from Lothar for example, should help disaster prevention not only in the countries where the storm occurred, but in all countries where similar events are possible.

A meaningful harmonisation of warning thresholds across Europe should therefore be promoted so that all participants in the hazard chain gain a homogenous understanding. It is also essential to promote the ideas for outcomes at the upper end of the scale, which on a regional level in an individualised scale would be hard to communicate. Public preparedness for the very extreme events can only be achieved if the media are not seen as a predator who follows his own interests by generating sensationalist quotes at the cost of scientific truth, but rather as an strategic partner to combine images of extreme events in one area with recommendations and greater awareness for warning schemes in other areas of Europe.

The interest for the media in a homogenised warning scheme lies in the quality of a reference point which a Europe-wide or an international danger scale can provide; the physics and details of the Richter scale are not known to every journalist and TV consumer, but the value of such a scale can be clearly seen in terms of how difficult information is potrayed through its useage.

The results from the Salzburg meeting, November 2005

The experts at the Salzburg meeting felt it necessary to create a matrix wide enough to host the individual national legal concepts, but at the same time stringent and concise enough to transport the ideas and concepts we consider to be common sense in meteorological terms.

Considering all the efforts that had been made during the EMMA I phase and the collection of experiences during the events of the last year, a proposal was made to the Expert group at the EMMA meeting in Salzburg, November 2005. It contains the four different approaches which can be used to define a danger scale from either the side of the producer of warnings (i.e. the National Meteorological Services) or the people exposed to these events.

What had been said about the hazard chain as an visual expression of the individual needs and duties of the different actors in the public sector producing warnings and steering relief efforts is expressed in this matrix in a quantitative way (see Figure 6). The two left-hand columns are defined by the meteorology, the third one by the physical conditions of the environment where the event is happening and the fourth one is directed as advice to the general public. The way it is formulated should be general enough to accomodate individual and regional recommendations and legal procedures but sharp enough at the same time to contribute significantly to the definition of the different events.

If one starts in the bottom right-hand corner of the matrix (4th level of the 4th column) it becomes understandable as to what the system is aiming at: in very extreme events, very unusual measures suggested or imposed by the responsible authorities should be followed in order to save lives in situations rarely or never experienced before. Preparing for this moment is one of the main tasks of the whole scheme.

Drastic events with casualties and general damage can also occur in the orange range, but they would be local and more regionally limited. In such cases, the best way to minimise damage would be to keep informed and act on the recommendations of the authorities.

In the yellow range, damage can be easily avoided by not pursuing dangerous activities like sailing, mountaineering or other selected outdoor activities.

Another way to define the different levels is via the frequency of occurrence of severe weather in the past and extrapolating the usage of the necessary warnings into the future. Seen from this perspective the scheme becomes based on meteorological events and is easier to grasp with data familiar to meteorologists. Lothar wind speeds in the hardest hit areas and the precipitation associated with the Oder floods would with no doubt fall into the “Red” category.

What is necessary here is a definition of the area where area related parameters are relevant. The size proposed and accepted at the Salzburg meeting was 300 000 km^2, (approx. half of France) covering thereby an area large enough to be responsible for the really large events. The area size does not imply that the event covers the whole area, but that this level would be used only once a year on a region of this size.

The meteorological thresholds are rather free for the different providers in the different climatic zones, as long as they fit with the other criteria and make sense in a warning context.

Common sense is a subjective measure, but a very helpful tool. Not every rare event is therefore worth a warning: very high temperatures, occurring only once in ten years in northern Scandinavia might be rare, but do not cause any damage and would not result in any warnings within such a scheme (although a warning service to specific customers could be employed).

Time scales of the events also define the way to incorporate them into the system. A storm lasting for only a few hours would count as one event and one usage of the warning level in the statistics. A heat wave lasting for more than ten days would need to count as one event, such as in 2003, with the necessary measures taken.

To further sharpen the ideas and mutual understanding of the usage of the warning levels it was proposed to prepare three cases of each partner from the last ten years, which would fit into the red category. These case studies and discussions about them could be the beginning of a long series of an extreme event catalogue helping to define commonly what we all want to achieve in the years to come.

The Future

The start of a new system like Meteoalarm offers Europe a unique chance to enter a new relationship with the public through the media. Several precautions have to be taken with similar steps: even if there is a high potential for large scale attention a new system needs a high degree of promotion at the beginning. The collaboration of the weather services could thereby be made visible in circumstances when meteorological information is essential and makes the news headlines.

	Thresholds (examples only, all values area related)	Used how often? per region (approx. 300 kkm²) for area related parameters	Damage	What to do?
Green			- - -	Usual phenomena
Yellow	> 60 km/h	> 30 per year	Exposed objects (avoidable)	Caution with exposed activities
Orange	> 90 km/h	1 to 30 per year	General damages (not avoidable)	Keep informed in detail
Red	> 130 km/h	Less then 1 year	Extreme damage on large areas (not avoidable, even in otherwise safe places)	Follow order of authorities under all circumstances Be prepared for extraordinary measures

Figure 6. Awareness level matrix

Special care should be given to the implementation phase and the period immediately after it. Any changes after the launch should be avoided, but there will inevitably be some very urgent ones that will need to be implemented with minimal delay. There will be a lot of information about the new warning system and this will need to be managed by the Meteoalarm consortium.

Michael **Staudinger,**
ZAMG

Frank **Kroonenberg,**
KNMI

The boundary layer in Finland during winter

Introduction

When high pressure is dominant across Finland in winter, the atmosphere is characterised by a near permanent temperature inversion. This regulates the exchange of fluxes between the boundary layer and the free atmosphere and influences the turbulent, radiative and cloud processes within the boundary layer. The low sun angle and short days do not allow enough heat to erode the inversion in Finland during the winter.

Stratus clouds are one of the most significant regional climatic features in Finland during winter. They play an important role in the vertical transfer of heat, moisture and momentum in the boundary layer. Numerical models such as ECMWF and HIRLAM quite often experience significant difficulties in reliably forecasting inversions and low cloud over Finland through the winter months.

Forecasts of inversions, fog and stratus during these events are always challenging for a forecaster and require careful inspection of numerical guidance, weather observations and the satellite data. Here is a short study of the Finland's climate and some of the boundary layer phenomena in winter.

Finland's climate

One important factor influencing Finland's climate is the country's geographical position between 60N and 70N within the Eurasian coastal zone. Characteristics of both a maritime and a continental climate are experienced, depending on the direction of the airflow. The mean temperature in Finland is several degrees higher (as much as 10°C in winter) than that of many other areas at these latitudes, e.g. Siberia and south Greenland.

Table 1. Monthly statistics for 1971-2000 in Sodankylä (67° 22`N 26° 37`E), located in the middle part of Northern Finland.

SODANKYLÄ 1971-2000											
	Lämpötila °C Temperature °C					**Lämpöt.päivät kpl/no** T-days		**SADE (mm)** Precip.		**LUMI (cm)** Snow	
Kk Month	**Keskimääräiset Mean**	**Max**	**Min**	**Abs. max**	**Abs. min**	**T max > 25°C**	**T min < 0°C**	**Keskim. Avg**	**Max** /month	**15.pvä 15 th**	**Viim.** Last
1	-14,1	-9,5	-19,6	6,5	-49,5		31	35	71	54	62
2	-12,7	-8,3	-18,2	6,5	-44,4		28	29	72	70	72
3	- 7,5	-2,6	-13,0	8,5	-42,7		31	29	66	76	79
4	- 2,0	2,6	- 7,4	14,6	-31,6		26	28	79	71	52
5	4,9	9,6	0,0	26,9	-17,8		15	35	79	14	
6	11,6	16,6	6,4	30,5	- 3,7	2	1	57	113		
7	14,3	19,4	9,1	30,9	- 0,6	3		63	128		
8	11,2	16,1	6,6	28,2	- 5,5	1	2	61	136		
9	5,8	9,8	2,1	23,0	-11,4		10	47	103		
10	- 0,6	2,3	- 3,7	13,5	-28,0		21	50	86	2	8
11	- 7,7	-4,3	-11,8	9,2	-34,5		28	40	70	16	26
12	-12,4	-7,9	-17,4	10,3	-41,0		31	35	77	34	44
Vuosi Year	**- 0,8**	**3,6**	**- 5,6**	**30,9**	**-49,5**	**6**	**224**	**507**			

Since Finland is located in the zone of prevailing westerlies where temperate and polar air masses meet, weather types can change quite rapidly, particularly in winter. The synoptic regimes known to influence Finnish weather are associated with the low-pressure systems usually found near Iceland and zones of high pressure over Siberia and the Azores. The position and strength of these systems vary, and any one of them can dominate the weather for considerable periods.

The coldest day of winter often occurs around the end of January, well after the winter solstice, except in the islands and coastal regions where the slower cooling of the sea delays the coldest period until the beginning of February (see Table 1). The lowest temperatures in winter range between -45°C to -50°C in Lapland and eastern Finland and -25°C to -35°C in the islands and coastal regions. The lowest temperature recorded at any weather station in Finland was -51.5°C in 1999.

The intensity of solar radiation

The intensity of solar radiation varies significantly over the course of a year ranging from zero during the polar winter to a maximum of 900-1000 watts per square meter (W/m^2) in the summer.

The maximum altitude of the sun depends of course on time of year and latitude. North of the Arctic Circle, part of the winter is the period known as the polar night, when the sun does not rise above the horizon at all. In the northernmost extremity of Finland, the polar night lasts for 51 days. Around midsummer, the sun changes little in altitude over the course of a day and there is daylight for 24 hours (Table 2).

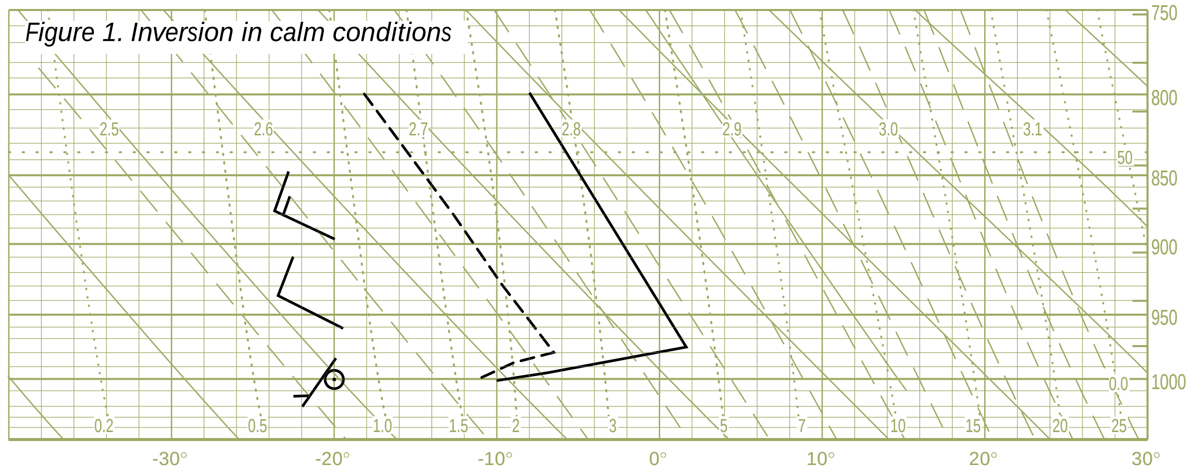
Month	Sunrise (local time)	Sunset (local time)	Length of day (hours)
1st January	11:31	13:04	1:33
1st February	9:25	15:30	6:05
1st March	7:32	17:21	9:49
1st April	6:26	20:12	13:46
1st May	4:19	22:06	17:47
1st June	-	-	**24:00**
1st July	-	-	**24:00**
1st August	3:37	22:59	19:22
1st September	5:41	20:44	15:03
1st October	7:25	18:40	11:15
1st November	8:18	15:35	7:17
1st December	10:31	13:34	3:03

Table 2. A length of a day in hours, time of sunrise and sunset in Sodankylä

Boundary layer in winter

In winter, Arctic weather is dominated by the frequent occurrence of inversions (when warm air lies above a colder air layer near the surface). The inversion layer decouples the surface wind from the stronger upper layer wind. For this reason, surface wind speeds tend to be lower in winter than one might expect (Figure 1).

Figure 1. Inversion in calm conditions



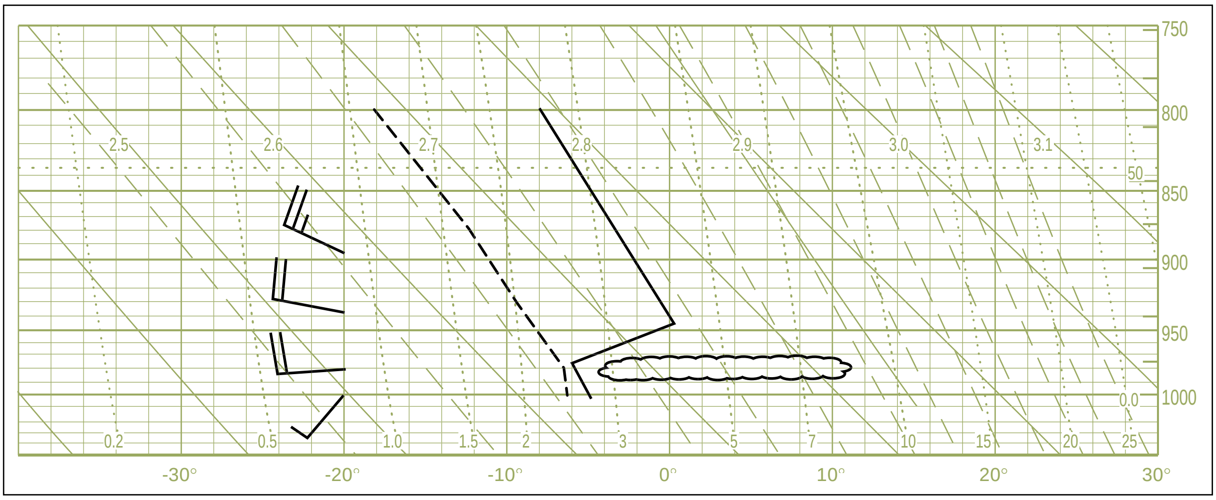


Figure 2. Inversion in a weak wind regime

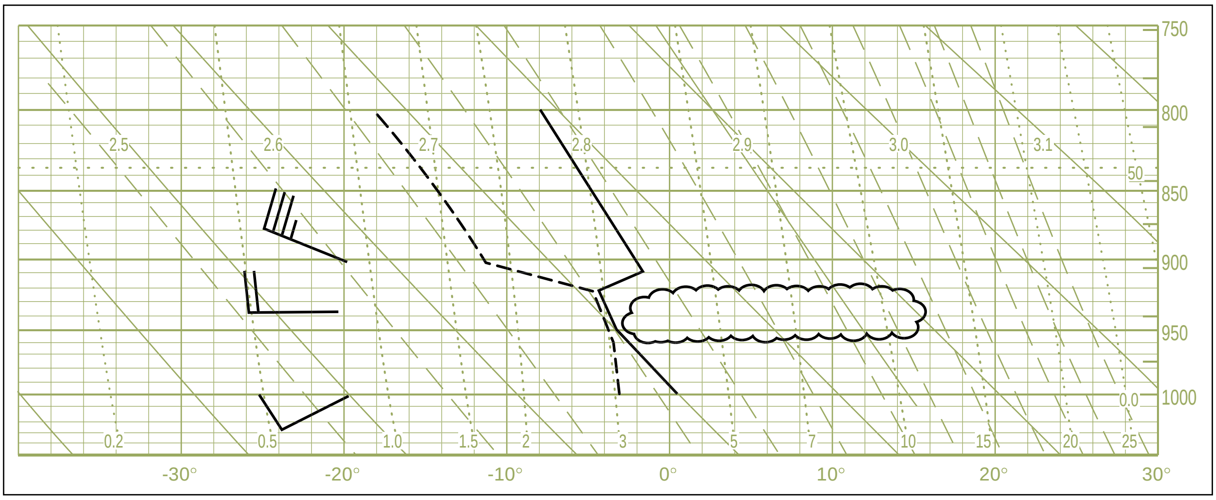
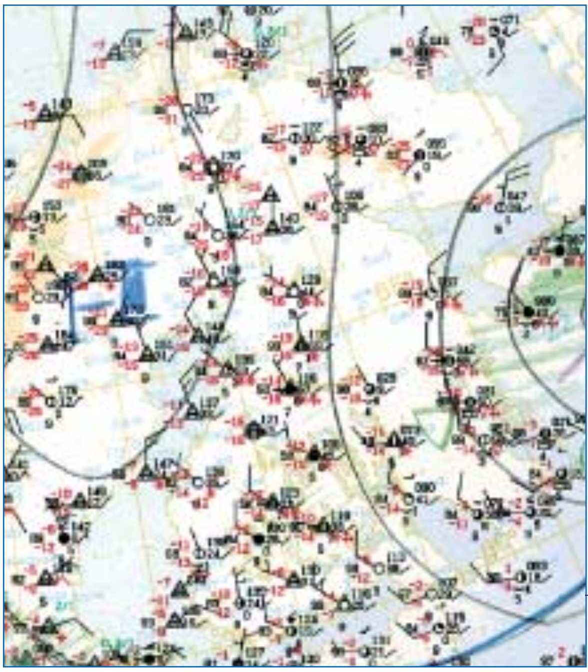


Figure 3. Inversion in a moderate wind regime



Boundary layer (mixed layer) height is an important meteorological parameter for aviation, for instance. The temporal evolution and spatial distribution of boundary layer height depends on many factors, including the synoptic conditions, local circulation patterns, cloud cover, and surface characteristics (Figures 2 and 3).

Case study of a strong surface based inversion and ice fog

A cold air outbreak affected the northern part of Finland on 20th January 2003. After this occurred, a strong surface based inversion formed with local ice fog. Here is a short synoptic study of the meteorological situation.

Figure 4. Surface analysis, 20.1.2003 at 00 UTC with fronts, isobars (in hPa) and plotted observations.

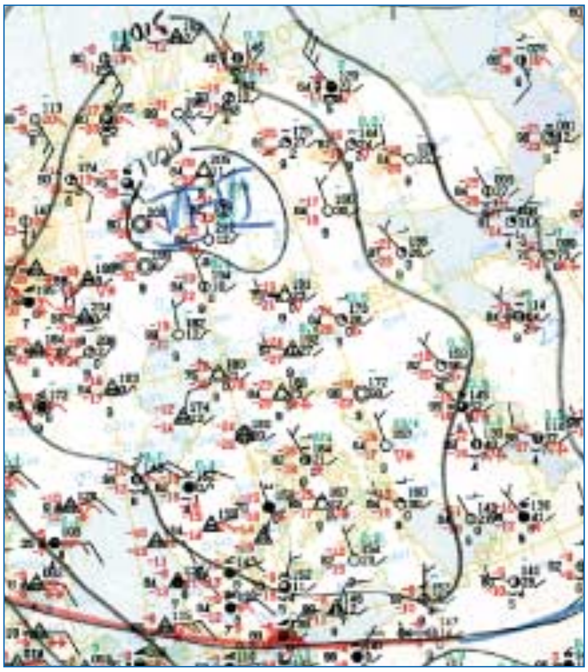


Figure 5. Surface analysis, 20.1.2003 at 06 UTC with fronts, isobars (in hPa) and plotted observations.

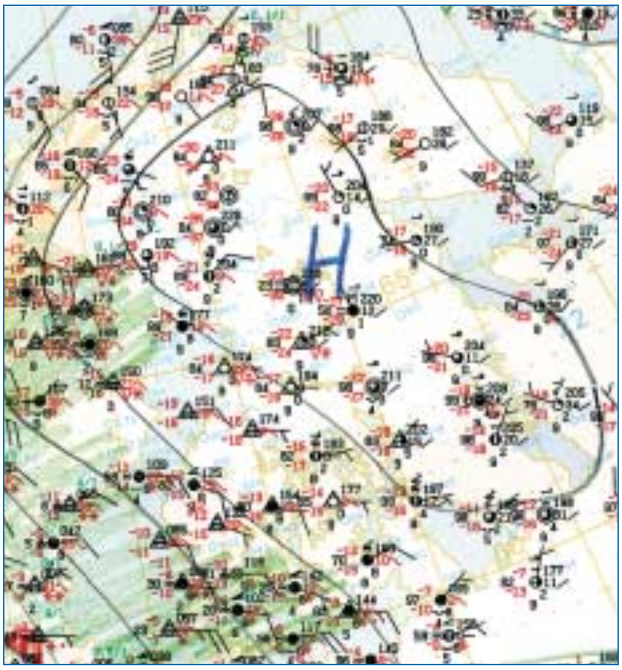
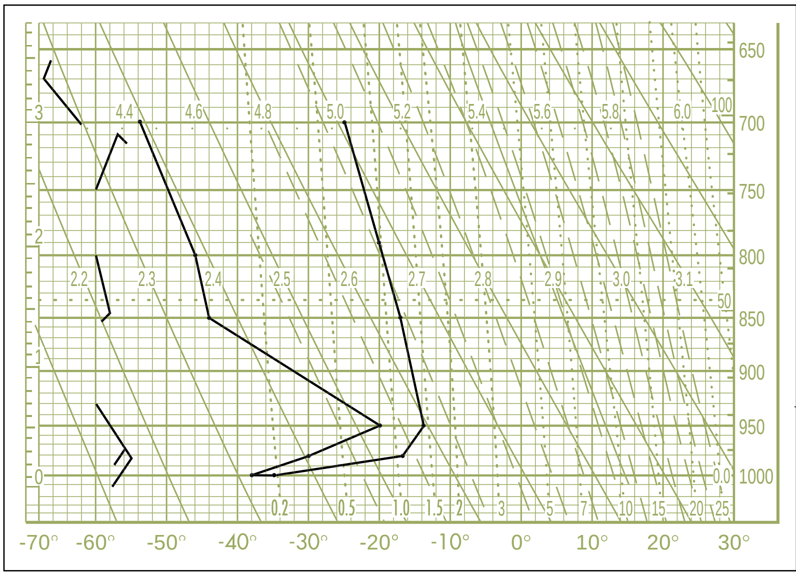


Figure 6. Surface analysis, 20.1.2003 at 12 UTC with fronts, isobars (in hPa) and plotted observations.

The synoptic situation is relatively classical for this type of cold air outbreak over the northern part of Finland in winter. A low pressure centre moved across the northern part of Finland from west to east. Following the passage of the low, the wind turned to the north and cold advection occurred with pressure then building across the northern part of Finland (Figures 4 and 5). An upper ridge at 300 and 500 hPa extended from Russia to Finland.

A discrete surface high pressure centre developed over the northern part of Finland within 12 hours (Figure 6). The sky was clear in many places and a strong surface based inversion developed. The temperature at the 950hPa level was -15°C but -35°C at the surface (a temperature difference of 20°C between the two levels - Figure 7). This is typical in Finland during the winter for this kind of meteorological situation. The strong surface based inversion was a direct consequence of the high pressure centre with calm winds, a cold air mass and the clear sky.



At low temperatures the air may become full of ice crystals with serious limitations in visibility near the surface. Ice fog occurs when the air near surface becomes saturated with respect to ice and crystals form on condensation nuclei. Visibilities of less then 1 000 metres are common and local ice fog was observed in this case.

Figure 7. Atmospheric temperature and dewpoint profile, 20.1.2003 at 12 UTC for Sodankylä upper-air sounding station.

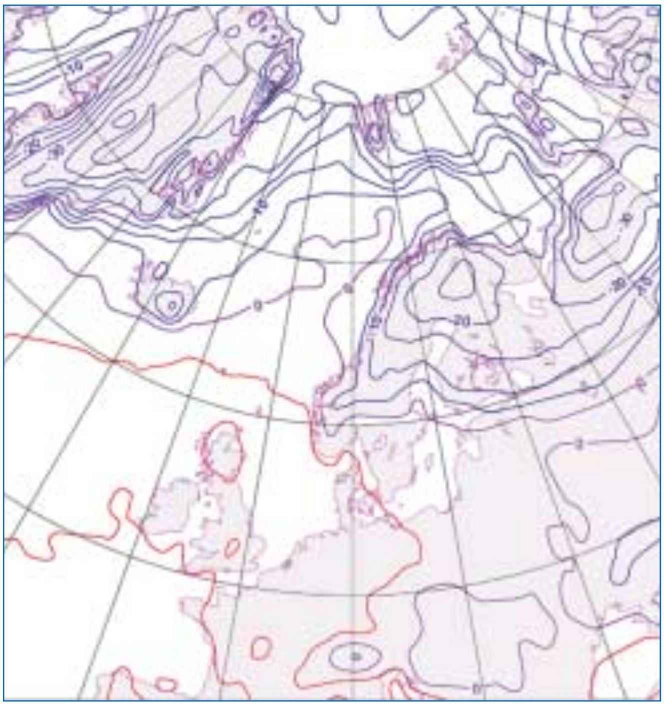


Figure 8. ECMWF 12-hour forecast of 2 meter temperature (in º C) valid for 20.1.2003 at 12 UTC.

Northern winter problem in the ECMWF model

It is typical that predicted near-surface temperatures associated with a stable boundary layer within an Arctic airmass are too warm (e.g. in ECMWF). The difference between observed and forecast 2 m temperatures over Lapland was about 10°C at 12 UTC on 20th January 2003 (Figure 8). Such differences between observations and forecast values are common. In reality, clear sky, no significant short wave radiation, a strong surface inversion over a snow covered surface all contribute to the suppressed temperature values.

Ed – It will be interesting to see results from the higher resolution ECMWF operational model for the 2005-2006 winter over Finland.

Antii **Pelkonen,**
FMI

Diagnostics of first guess errors and sensitivity to provide help to forecasters

First Guess error diagnostic

The aim of the analysis is to minimise the difference between the first guess and the observations. To do that, the model uses a matrix of variance and covariance of forecast errors and observational errors. These quantities are related to the statistical confidence in both the numerical model and observations, and the finalised analysis is weighted towards one or the other. However, the forecaster has no clear idea of what the model really does with the analysis. To resolve this problem, the forecast laboratory at Météo-France have developed two charts of first guess error diagnostics, one for low levels (surface-700 hPa) and the other one for upper levels (400-200 hPa).

What is the principle of these charts?

The variance of the difference between the first guess and the observations is calculated and then the ratio between this calculated error and the climatological error is plotted.

If this ratio is near 1.0, the forecast error of the model is acceptable; the analysis is an optimal minimisation between the first guess and the observations.

If this ratio is clearly lower than 1.0, the real variance is weaker than the climatological one and the analysis will tend to move away from the first guess and draw towards the observations.

If the ratio is clearly higher than 1.0, the real variance is more important than climatological one and the analysis will tend to draw too much towards the first guess to the detriment of the observations.

A colour coded identification scheme is used to separate two kinds of observations: crosses and lines when the assimilation draws towards the observations and red, grey and yellow when the assimilation draws towards the first guess.

Examples of these charts are shown in Figures 1 and 2 below.

The weakness in surface pressure to the southwest of Ireland as analysed by Arpège at 1800 UTC and 0000 UTC generates strong winds in the respective forecasts. However, confidence in the analysis is low because the assimilation has drawn towards the first guess (red and yellow points).

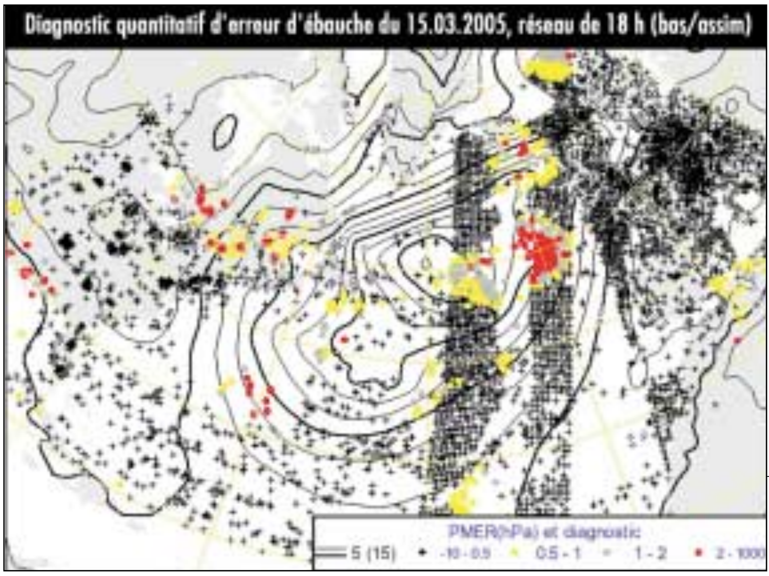


Figure 1. Mean sea level pressure on 2005/03/15 18 UTC with guess error diagnostic

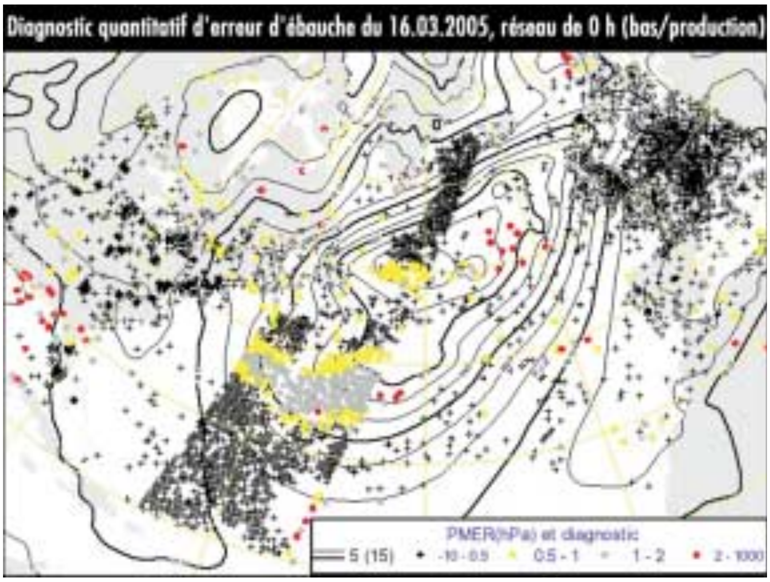


Figure 2. Idem figure 1 for 2005/03/16 00 UTC

In conclusion, this diagnostic brings more transparency to the assimilation. The forecaster can visualise areas where there is a potential conflict between the first guess and observations and make subjective assessments on the model analysis. However, although it is useful to identify problems in the analysis, the forecaster also needs to assess the potential consequences on the forecast. There is a need for a diagnostic tool of foreseeability.

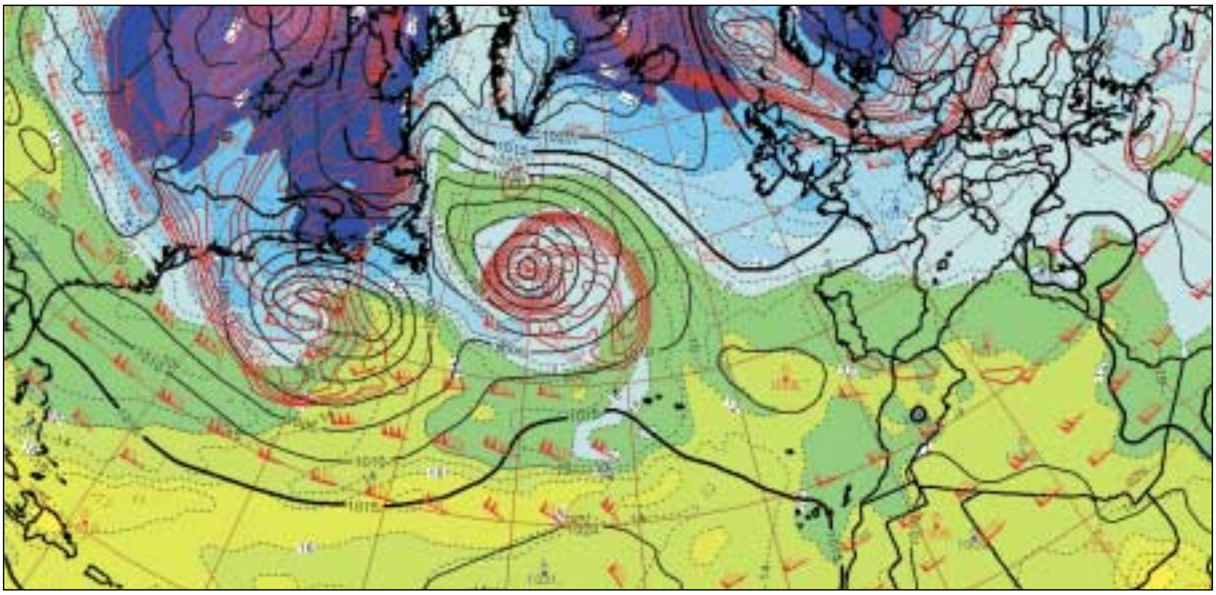
Progress in foreseeability

A parallel process within Arpège allows the forecaster to identify the sensitive areas for the forecast. This tool is based on an explicit diagnostic calculated on the first four singular vectors. After each run of Arpège, four charts of sensitive areas are provided, two for H+30 (lower levels and upper levels) and two for H+48. The use of these charts will be illustrated with an example: The situation of 13th March 2005.

Fields on these composite charts are surface pressure, 850 hPa wet-bulb potential temperature (shaded colours), height of the 1.5 PVU surface and winds at 1.5 PVU level.

We focus on the warm front, depicted by the 850 hPa wbpt gradient, which lies across Spain on the analysis and reaches the southwest of France on the 30 hour forecast. We could imagine that the main feature controlling the evolution is the frontal system in the middle of the Atlantic Ocean associated with a deep low. However, the area of sensitivity at upper levels is situated between Greenland and Iceland on the analysis (see figure 5 below).

Figure 3. 2005-03-13 00 UTC analysis



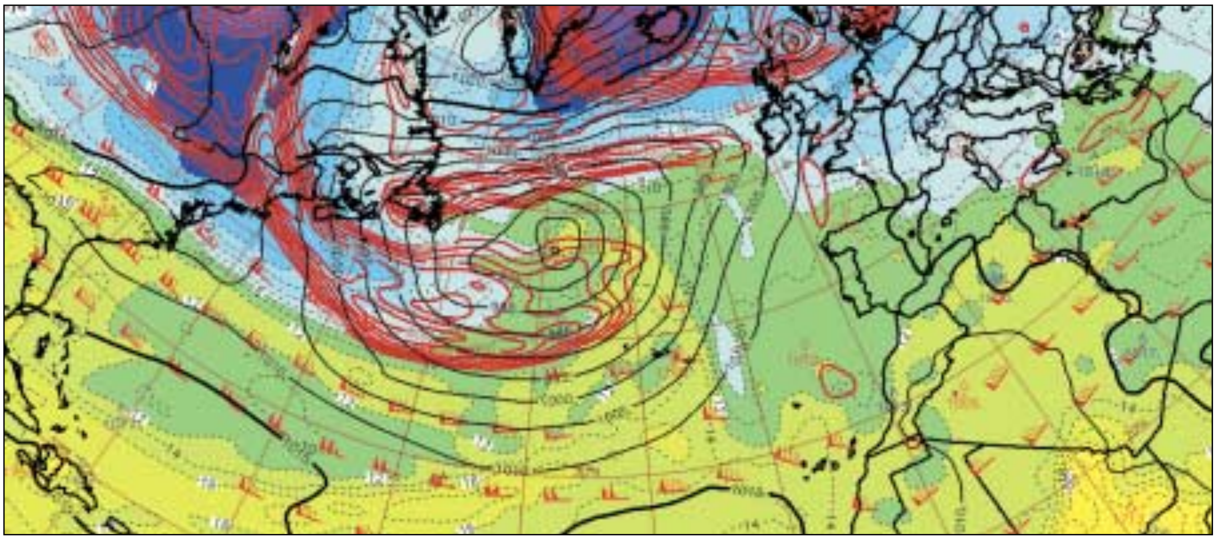


Figure 4. 30 hours forecast for 2005-03-14 06 UTC

In this area, the comparison between the water vapour imagery and the height of the 1.5 PVU surface suggests some problems in the model analysis. In order to obtain a better fit with the water vapour pattern, the forecaster makes some adjustments to the PV fields associated with the trough approaching Iceland in the strong north westerly flow aloft.

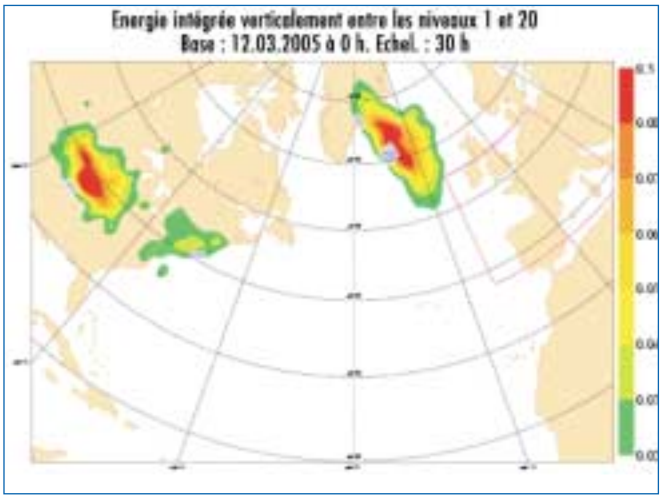


Figure 5. Area of sensibility in altitude for the 30 hours forecast over France

Figure 6 shows the differences between Arpège and the modified 0000 UTC analysis for the height of the 1.5 PVU surface. In blue, the positive difference near Iceland means that the forecaster has enhanced the trough. Note that there is no difference to the large-scale low system in mid-Atlantic and only minor differences on the trough over central Europe.

The next step is then to rerun the model and monitor the evolution of the difference between the previous model and the new run with the modified analysis.

At H+12 (see figure 7), the initial differences weaken between Iceland and Scotland but others appear on the trough over the Atlantic Ocean, as if there were interactions between these two main features of the circulation.

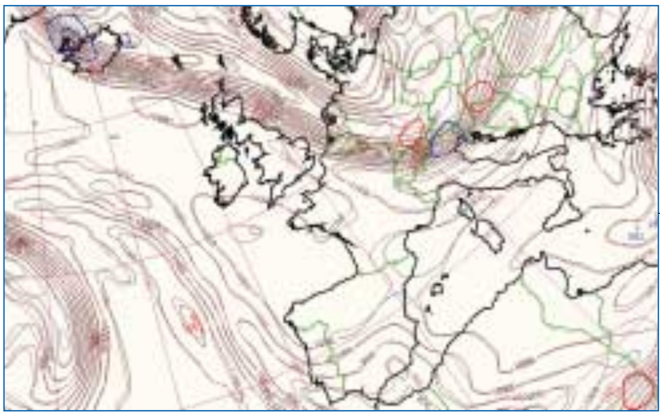


Figure 6. 2003/03/13 00 UTC analysis of Z = 1.5 PVU. In blue, positive differences of the altitude of the 1.5 PVU surface at 00 UTC between Arpège and the modified model by the forecaster. In red, negative differences.

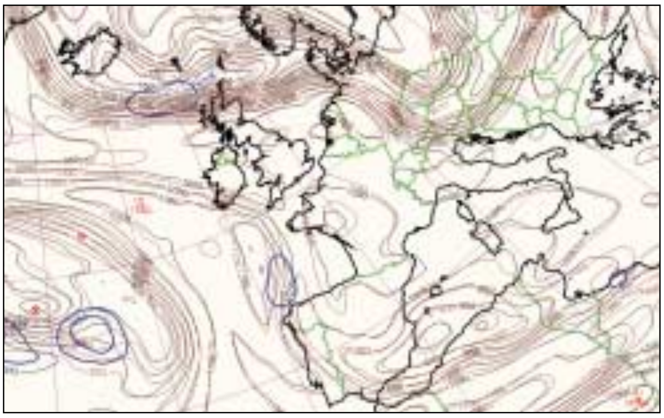


Figure 7. Same as figure 6 but for T+12 forecast

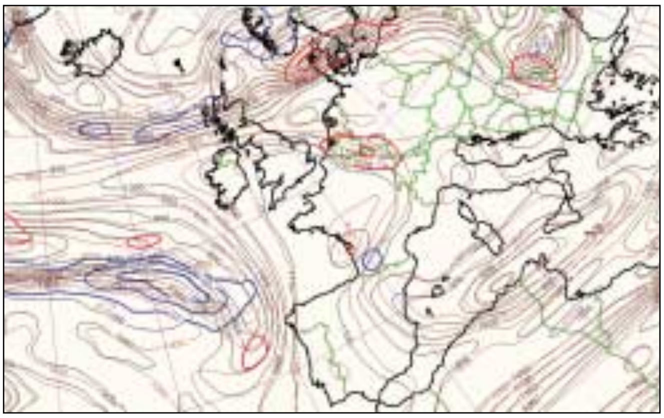


Figure 8. Same as figure 6 but for T+24

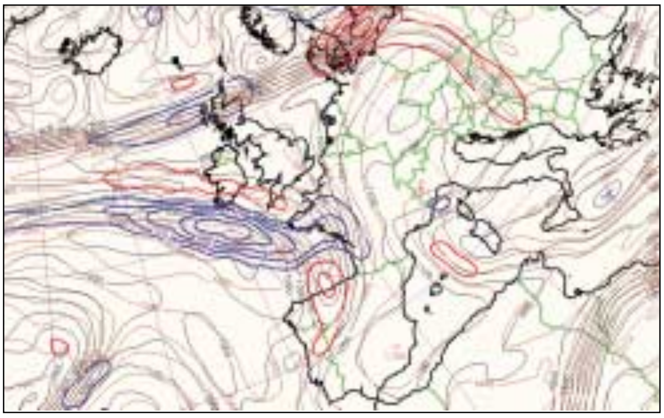


Figure 9. Same as figure 6 but for T+36 forecast

At H+24 (see figure 8), the differences over the Atlantic, to the northwest of Spain, are growing. The positives differences mean that the trough moves more slowly to the east in the modified Arpège run.

At H+36 (see figure 9), the differences on the trough reaching the Bay of Biscay continue to grow. As a consequence, the forecast over France is different between the initial and modified Arpège runs, especially with respect to the position of the warm front.

The sensitivity diagnostic has therefore allowed the identification of the areas where modifications will have a significant effect on the forecast.

Conclusion

Two new tools for the forecaster have been presented. The first guess error diagnostic provides more transparency on the assimilation and highlights areas where the bias towards the observations is weak. The sensitivity diagnostic provides a better understanding of the main synoptic features. It also allows the forecaster to monitor the critical areas where observations could be important and where field modifications (using PV inversion techniques) will have a marked effect when the model is rerun.

Hubert **Dreveton,**
Bernard **Roulet**
Météo-France

Weather dependent shift strategy at KNMI

History

During the 1980's and 1990's, KNMI (Royal Netherlands Meteorological Institute) consisted of three main forecast offices, and another three secondary ones. The main Offices were in Zierikzee (later Hoek van Holland) where maritime forecasting was based, Schiphol airport for aviation forecasting and De Bilt for general forecasting. Furthermore there were forecast/briefing offices at three regional international airports. This set-up caused an enormous amount of duplication, with each office drawing its own charts, producing its own forecasts almost from scratch etc.

Centralisation, first step

After lengthy discussions, KNMI decided to centralise forecasting (at least partially), and in November 2001 the Central Forecasting Office (CFO) in De Bilt became operational. The maritime office was completely closed and the aviation station at Schiphol was reduced to only one forecaster per shift, responsible only for Schiphol itself, while the Meteorological Watch Office and forecasting for other airports and general aviation was transferred to the CFO.

Centralisation, second step

At the end of March 2003, services at Schiphol (apart from observations) ended rather abruptly due to staffing problems, and the last forecasters where also withdrawn from the site.

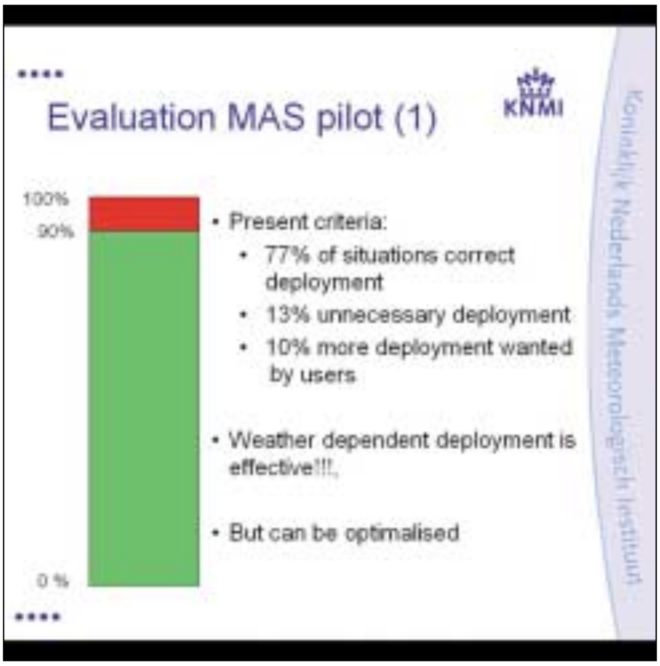
Users in the aviation community in The Netherlands were not pleased at all and feared that there would be a significant effect on quality and service. By the end of 2002 there had been a study by one of the senior aviation forecasters at Schiphol on the possibilities and advantages of having an experienced forecaster on site at the Air Traffic Control (ATC) Approach facilities at Schiphol. The results of this study were quite promising and proved that having such a Meteorological Advisor on site would have great advantages in trying to reduce costs due to suboptimal use of the limited capacity of the airport.

Advantages of Meteorological Advisor on site

In addition to the cost reductions mentioned above, ATC realised that there were other advantages in having their advisor next to them and "live". Face to face contact was seen as providing greater trust in the forecasting and nowcasting qualities of these advisors. On the other hand, forecasters were happy to be “there where the real action is” and felt much more appreciated whilst gaining a greater understanding of the decision making processes within ATC.

Pilot scheme for the MAS (Meteorological Advisor Schiphol)

The combination of factors mentioned above led to a pilot study from October 2003 extending into spring 2004. A preliminary working desk was installed in the ATC Approach site but forecasters only went on duty under certain (weather) conditions. The procedure is as follows: Each evening around 2000 local time, the aviation forecaster in De Bilt and the Supervisor Approach at Schiphol talk to each other by telephone and based on the forecast weather conditions for the next morning (visibility, cloud ceiling, severe weather, cross/tail wind), the decision is made whether or not to deploy the forecaster to Schiphol. The MAS would only be available for the morning shift, normally 0500-1300 local time. This is the period when the first morning peak occurs in terms of air traffic and delays cause maximal impact due to so-called snowballing (effects that can be felt throughout the whole day and sometimes even longer). In prolonged extreme weather situations KNMI will try to have a second MAS available for a late shift. The period of presence can also be changed when adverse weather is forecast during any other specific period of the day (e.g severe thunderstorms in late afternoon during summer)



Evaluation

Evaluation of the pilot scheme showed that in 77% of cases the deployment of the MAS was useful to very useful, in 13% of cases it was deemed to be not necessary and in 10% of cases necessary but not deployed. Furthermore Air Traffic Controllers were appreciative of the presence of the MAS very much, awarding their ability over the whole period with 8 or above (on a scale of 1-10).

According to what was expected from climatology, the MAS was sent to the airport on 55-60% of the days during winter.

Conclusion

The main conclusion was to implement the deployment of a weather dependent MAS following the successful trial provided by the pilot scheme. It was decided to refine the criteria/thresholds on which the decision to deploy or not would be based. To facilitate face to face contact with other users (such as Schiphol Airport Authorities), a video conference system would be put in place.

Kess **Blom,** *KNMI-Netherlands*

1995-2005: Ten Years of WG CEF
How the story began!

Weather does not know any border, and if you intend to make weather forecasts for more than a few hours, you have to look beyond the borders of your country. This was well known from the very beginning and therefore international co-operation was immediately organised after the build-up of the National Meteorological Services (NMS's) in the developed States – within IMO at first and WMO now.

This co-operation not only includes the exchange of data and products and maintenance of the relevant infrastructure, but also conferences and meetings of the representatives of the NMS's. The latter often involve Directors and experts in their respective subjects, but rather seldom people involved in operational weather forecasting. That is also due to the fact that after the advent of the first NWP-models, the focus of interest was shifted more from the manual work of forecasters towards computing and modelling. With advanced progress in this field, the impression was given that the problem of weather forecasting was generally solved and that contributions by forecasters to that cause were less and less important. The perception was that operational forecasting was and is of general interest only when the forecasts dramatically failed or a warning was missing in the case of a significant weather event! In these cases, however, it was often only the forecasters that were accused to be responsible for the failure.

One of these events was the storm in October 1987 that hit southern England and was poorly predicted by forecasters at the Met Office, with their short-term model guidance providing misleading signals. In this case, Météo-France provided a better solution and the Director of the Met Office, Prof Julian Hunt, concluded that direct contact between both Met Services could have been highly beneficial. He subsequently proposed the development of a well organised bi-or multi-lateral co-operation between forecasters of the European NMS's and promoted this idea in the early 1990's.

In other parts of Europe also, there were very few direct contacts between forecasters beyond national borders at this time. One of the few exceptions (and a good example of effective co-operation for a special purpose) was the Warning Service for Lake Constance in central Europe, carried out jointly by the forecasters of Deutscher Wetterdienst (DWD) and Meteo-Swiss. This was developed with the aid of mutual contacts and the need of an agreement before the warnings were issued. The service remains to this day.

In the early 1990's there were some other important developments that influenced the idea to create an organ for the co-operation between the forecasters of the different NMS's. After the end of the "Cold war", contacts between western and eastern Europe increased dramatically. This was also true for the respective NMS's and as one of the follow-up actions, forecasters from eastern Europe got the first chance to visit their colleagues in the west. I remember some events in Offenbach, organised by DWD, to which forecasters from the NMS's in eastern Europe were particularly invited and at which were demonstrated the methods of work and the products provided by RSMC Offenbach following a relevant recommendation of WMO. Contacts with our westerly neighbours were also enhanced in this time. Twice a year, the Directors of Météo-France and DWD met and agreed upon measures for better co-operation between both Services. One of the actions was that mutual visits of forecasters should be organised and that was done – at first between the Central Offices at Toulouse and Offenbach and later between the neighbouring Regional Offices at Strasbourg and Stuttgart. Jean Coiffier who formulated concrete ideas for the co-operation between forecasters in subsequent years, was one of the colleagues responsible for these contacts from the French side.

Another activity of great influence was the creation of the series of European Conferences on Applications of Meteorology (ECAM), with the first one held at Oxford in 1993 and the second one at Toulouse in 1995. Since weather forecasting is surely the most important application of the science of meteorology, it was clear that contributions from forecasters also had to be considered and included in the Conference programme of these Conferences. They indeed provide one of the rare occasions to speak on actual forecast problems or new methods, e.g. for nowcasting and very-short-range forecasting.

During preparations for the second ECAM, a proposal was made by Prof Hunt and others to establish a working group to deal with the possibilities of organised co-operation between forecasters of the NMS's in Europe. I was asked to act as convenor for this group.

As a first action, I sent a letter to all European NMS's asking for their opinion and proposed concrete ideas for a closer co-operation formulated by Jean Coiffier. Twenty-one of the thirty-five services to which the letter was sent responded positively. That meant that the majority of the European Met Services were in favour of the proposal to improve co-operation between the forecasters.

A first meeting of the contact persons appointed by the NMS's was organised during ECAM 95 in Toulouse. Representatives from the Meteorological Services of Belgium, Finland, France, Hungary, Netherlands, Norway, Portugal, Slovenia, Sweden, Switzerland and United Kingdom participated in the meeting and discussed a working paper prepared by the convenor who, of course, also represented DWD. Other already appointed members were unable to attend due to lack of resources.

The main question of the discussion was focussed on what were the real benefits of the proposed co-operation. It was agreed that the expected main advantages should be:

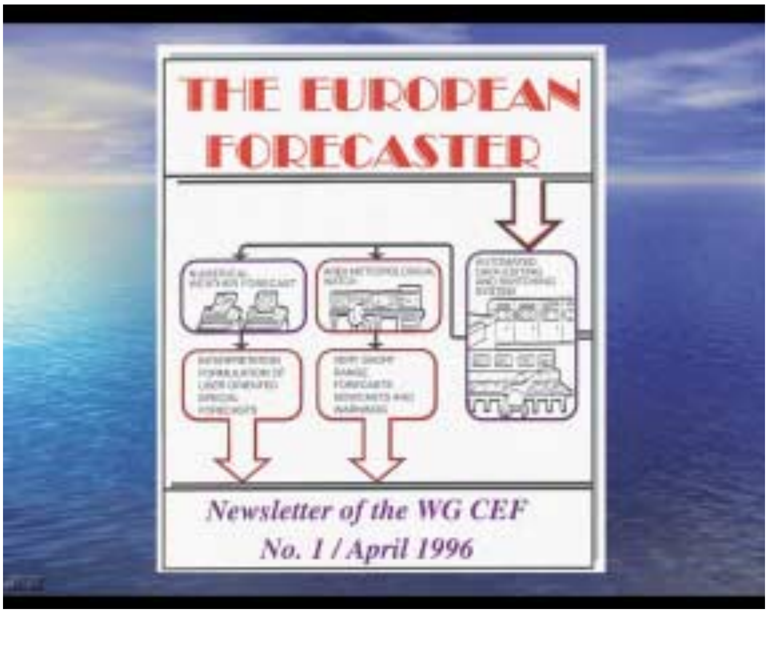
- **A direct improvement of operational forecasting in specific weather situations i.e. through direct contacts or exchange of warnings;**
- **An increase of personal knowledge and performance, through exchange of information, visits and training events.**

The aim of the working group was defined to promote, encourage and monitor activities in these directions.

In the framework of improved co-operation special proposals were formulated. The following proposals are compared with the actions taken subsequently and the situation we have today:

Exchange of information about the Forecast Offices of the European NMS's:

This was done with aid of a Newsletter, in which a description of the structure and organisation of the relevant parts of the Services was given together with names and addresses of responsible colleagues.



Since that was published roughly ten years ago, the question arises as to whether this information is still valid. Therefore an update is strongly recommended.

Production of a Newsletter issued twice a year containing interesting and useful information for forecasters:

This was produced once a year with a lot of useful information. Besides the information on the Forecast Offices just mentioned, there were articles describing examples of successful co-operation between forecasters, new tools for forecasters and special weather situations of general interest. Other contributions were devoted to important topics like "The present and future role of the forecaster", "Warnings and the exchange of warnings, "Tools for manual diagnosis and forecasting", "Education and Training in WMO RA VI" and others. The publication of the Newsletter must therefore be continued. However, the question remains as to whether all forecasters have access to it. This should be and must be addressed by the appointed members of the Working Group.

Promotion of visits and exchange of forecasters:

Mutual visits were organised and also individual forecasters got the chance to work at an Office of a neighbouring Met Service. This was done, however, only by few Services and on an irregular basis, obviously due to lack of resources.

Exchange of information during hazardous weather conditions and in the case of major nuclear or chemical accidents:

This very important proposal was indeed taken up by many Services and a bi-or multi-lateral exchange of warnings was partly realised. Meanwhile the EUMETNET project EMMA (European Multiservice Meteorological Awareness system) was created. It is described in issue N°.9 of the Newsletter.

Promotion of special conferences suited for forecasters as part of other conferences or as a special event:

That is especially true of the European Conferences on Applications of Meteorology (ECAM) and the International Conferences of Alpine Meteorology (ICAM). Many of the meetings of the WG CEF therefore took place in conjunction with these Conferences. A very special event was the Conference on the December storms of 1999 proposed by the former French member of the Working Group, Brigitte Benech, and organized by Météo-France in October 2000 at Toulouse. Reports on this Conference can be found in N°.6 of the Newsletter.

The participants of the WG CEF meeting at the lake of Bled from left to right: H. Gmoser, I. Fredrikson, P. Rauh, V. Pastirčák, M. Kurz, H. Ottoy, C. Ajello, B. Benech, Marta H. Bona, B. Gregorčič, M. Dutton, I. Karro, L. Lombroso

The realisation of the proposed actions implied the agreement of the participating NMS's and the willingness of volunteers to take over the responsibilities for the different tasks or to contribute to them. In order to organise this work, it was proposed to retain the Working Group as a permanent organ for forecasters of the European Meteorological Services. This was agreed by the NMS's involved and the WG CEF started its fruitful work.

Manfred **Kurz,**
Former staff member of DWD and first chairperson of the WGCEF

SRNWP-PEPS
A regional multi-model ensemble in Europe

Summary

The promising results of the EUMETNET PEPS project are presented. The paper describes the method and representative evaluation results. It ends with the suggestion that PEPS products should be used operationally by all participating EUMETNET members.

Introduction

One of the most important challenges the operational forecaster is faced with is the effective usage of the existing variety of operational numerical weather forecasts. There is the feeling that joining these operational forecasts in a multi-model ensemble could lead to better results within the forecast and warning process.

Regional Modelling in Europe is organised in 4 consortia: HIRLAM, ALADIN, COSMO and the UK Met Office, each of them having their own regional model. A reasonable variety of operational forecasts exist, which are produced on different domains with different grid reso-lutions and use different model parametrizations and data assimilation techniques.

In 2002, DWD had the idea of bringing together all available high resolution numerical fore-casts in a **P**oor Man's **E**nsemble **P**rediction **S**ystem (PEPS). It was suggested at a EUMETNET Council meeting that a project should be started under the umbrella of EUMETNET.

The EUMETNET PEPS Project

In June 2003 the director of the SRNWP EUMETNET Program, Jean Quiby, started the project by asking the European National Meteorological Services to participate. At the time of writing, 20 Weather Services had joined the project, providing 23 forecast models (Table 1). As a result, 40 deter-ministic and probabilistic forecast products are distributed to the contributing members on an opera-tional basis. One of the main goals of the project has been the evaluation of PEPS to decide whether it provides a significant support and improvement of the warning process.

Methodology within PEPS

The single model forecasts are interpolated onto a reference grid, the PEPS grid. It has a grid spacing of 0.0625° (~7 km) like the DWD Lokal Modell, covering Europe from 30°W to 30°E and 35°N to 70°N. Exceedance probabilities are calculated at each PEPS grid point from the ensemble members using a nearest neighbour approach. Because the individual members have different resolutions and integra-tion areas, the ensemble size depends on location. At the moment all ensemble members are equally weighted and the probability P of forecast value x exceeding threshold T at location i is calculated according to:

Table 1: Contributing European Weather Forecast Models (Dec. 2005)

Meteorological Service	Regional Model	Coupling Model	Resolution (km)	Forecast Period (h)	Time Interval (h)	Main Run (UTC)
Belgium	ALADIN	ARPEGE	15	+60	1	0, 12
France	ALADIN	ARPEGE	11	+48	3	0, 12
Austria	ALADIN-AUSTRIA	ARPEGE	9.6	+48	1	0, 12
Croatia	ALADIN	ARPEGE	9	+48	3	0, 12
Czech. Repub.	ALADIN-LACE	ARPEGE	9	+48	3	0, 6, 12, 18
Hungary	ALADIN-LACE	ARPEGE	11	+48	1	0, 12
Slovakia	ALADIN-LACE	ARPEGE	11	+48	3	0, 12
Slovenia	ALADIN-LACE	ARPEGE	9.5	+48	3	0, 12
Denmark	HIRLAM	ECMWF	16	+60	1	0, 6, 12, 18
Finland	HIRLAM	ECMWF	22	+54	1	0, 6, 12, 18
Spain	HIRLAM	ECMWF	22	+24	1	0, 6, 12, 18
Netherlands	HIRLAM	ECMWF	22	+48	1	0, 6, 12, 18
Ireland	HIRLAM	ECMWF	16	+48	3	0, 6, 12, 18
Norway I	HIRLAM	ECMWF	11	+30	1	0, 12
Norway II	HIRLAM	ECMWF	22	+30	1	0, 12
Sweden I	HIRLAM	ECMWF	11	+48	3	0, 6, 12, 18
Sweden II	HIRLAM	ECMWF	22	+48	3	0, 6, 12, 18
Germany	LME	GME	7	+78	1	0, 12, 18
Switzerland	aLMo	ECMWF	7	+72	1	0, 12
Italy	EuroLM	EuroHRM	7	+60	3	0
Poland	LM	GME	14	+72	3	0, 12
United Kingdom I	UKMO-Meso	UM NAE	12	+48	3	0, 6, 12, 18
United Kingdom II	UKMO-NAE	UM global	12	+48	3	0, 6, 12, 18

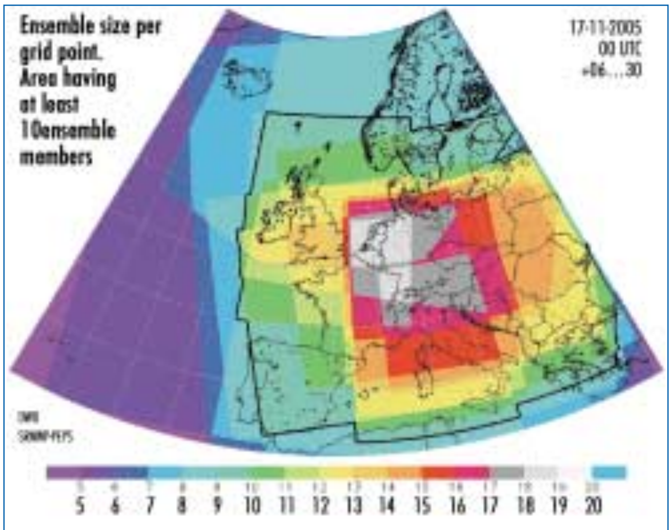


Figure 2: Number of ensemble members in the SRNWP-PEPS. The area having at least 10 ensemble members is enclosed by the black line.

$$P_i(x > T) = \frac{\sum_{k=1}^{N_i} H(x_k - T)}{N_i}$$

where N_i is the total number of forecasts at grid point i and $H(\theta)$ is the Heaviside function ($H = 1$, if $\theta \geq 0$; $H = 0$, if $\theta < 0$). Figure 2 shows an example of the variation of ensemble size with location.

Operational Suite

At the end of 2004 an operational suite was established at DWD. The ensemble products are calculated four times a day according to the cut-off times noted in Table 2:

Ensemble forecasts are calculated for the meteorological parameters

- Accumulated total precipitation
- Accumulated total snow fall
- Maximum 10 m wind speed
- Maximum 10 m gust speed
- Maximum and minimum 2 m temperature

Ensemble product	Cut-off time
00 UTC	05:30 UTC
06 UTC	11:30 UTC
12 UTC	17:30 UTC
18 UTC	23:30 UTC

Table 2: SRNWP-PEPS data cut-off times

Ensemble means and medians (precipitation and total snow) as well as probabilistic products are calculated. According to the requirements of operational forecasting, a 24h accumulation period was defined lasting from +06h to +30h relative to the 00 and 12 UTC runs. Additionally, 12h forecast products from +06h to +18h and from +18h to +30h are derived from the 0, 6, 12, and 18 UTC runs with slightly different thresholds for the prob-abilities.

As shown in Table 1, only the 00 UTC run incorporates the maximum number of model forecasts. Moreover, the ensemble size varies with parameter (Table 3) because not every model provides every forecast parameter, e.g. only some of the ALADIN and COSMO countries operate empirical parametrizations of wind gusts within their modelling environment. An ensemble size per grid point of at least 3 has to be reached to activate the calculation of the probabilistic products.

Model Lead Time	Total Precipitation	Total Snow	Wind Speed	Gust Speed	Temperature
00 UTC	23	22	23	9	23
06 UTC	10	9	10	1	10
12 UTC	22	21	22	9	22
18 UTC	11	10	11	2	11

Table 3. Maximum ensemble size depending on model lead time and on meteorological parameter

Visualisation

The forecasts are provided in a password protected area of the official SRNWP-PEPS web site for evaluation purposes. This site is updated every 6 hours. In addition to the European size standard products, plots of a smaller domain focused on Germany are made. These are available to the forecasters at DWD only and allow them to analyse the products in more detail. In the near future the PEPS products will be made available to the NinJo workstation system. Using NinJo it will be possible to combine the PEPS products with any other meteorological information available such as synoptic observations, radar products, satellite images or numerical models. The NinJo system was introduced in WGCEF Newsletter N° 10 (Heizenreder, Koppert 2005).

Evaluation results

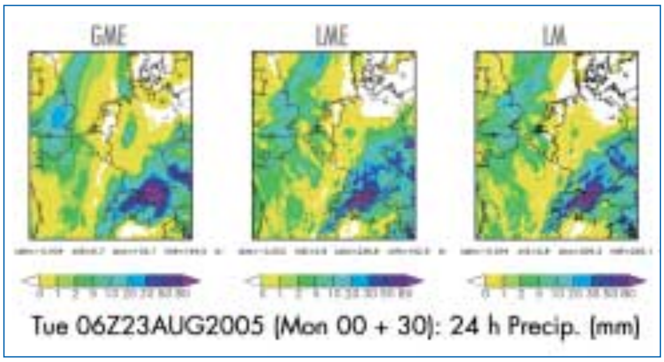
At the Central Forecast Office of DWD the pre-operational SRNWP-PEPS products were evaluated on a daily basis. First evaluation results were presented at the 11th Meeting of the WGCEF in De Bilt, September 2005. The results are promising and suggest that operational usage of the PEPS products will be useful, especially for short range forecasting and in the warning decision process.

The issue of severe weather warnings is often a very difficult matter due to the uncertainty in predicting the location, timing and intensity of extreme events. To quantify the forecast un-certainty in a reliable way a variety of different numerical models with slightly different analyses or physical parametrizations should be available. These are provided by the SRNWP-PEPS, incorporating the most sophisticated high-resolution numerical weather prediction models of Europe.

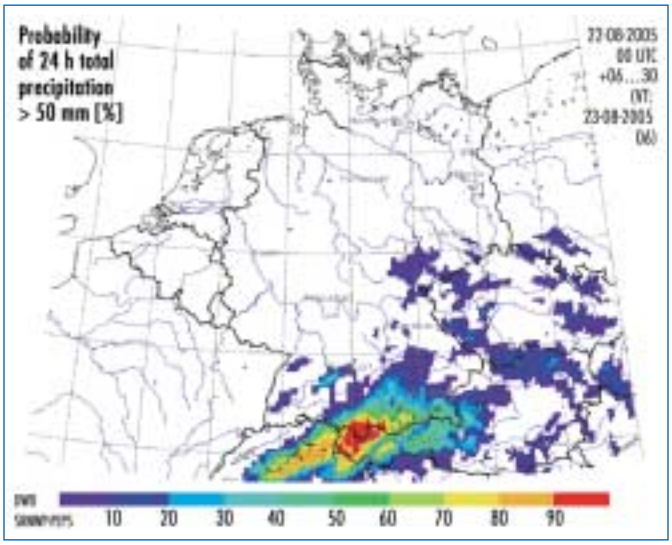
Representative example of evaluation results – synoptic scale situation

The PEPS products supported the signal of the deterministic forecasts for the 23rd August 2005 in Figure 4 relating to the location and the extreme values of the expected precipitation.

▲ *Figure 3. Impact of the flooding situation, 23.08.2005 in southern Germany* ▶

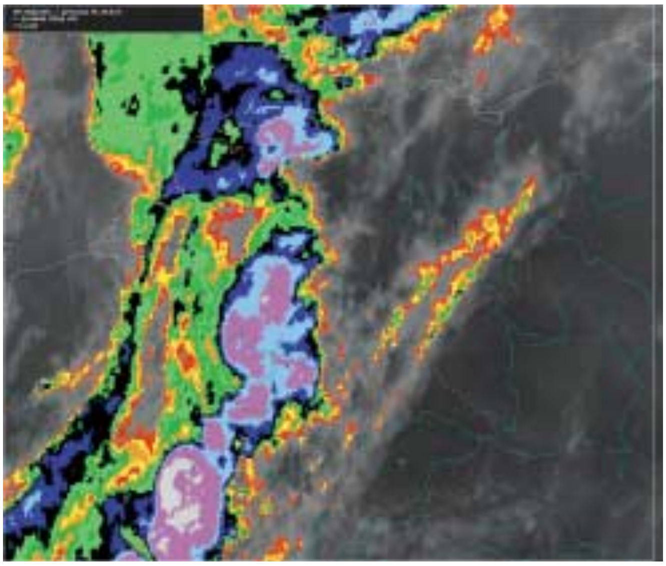


▲ *Figure 4. Deterministic model forecasts – Global Model and Local Model of DWD*



◀ *Figure 5. PEPS Products - taking all available high-resolution models into account.*

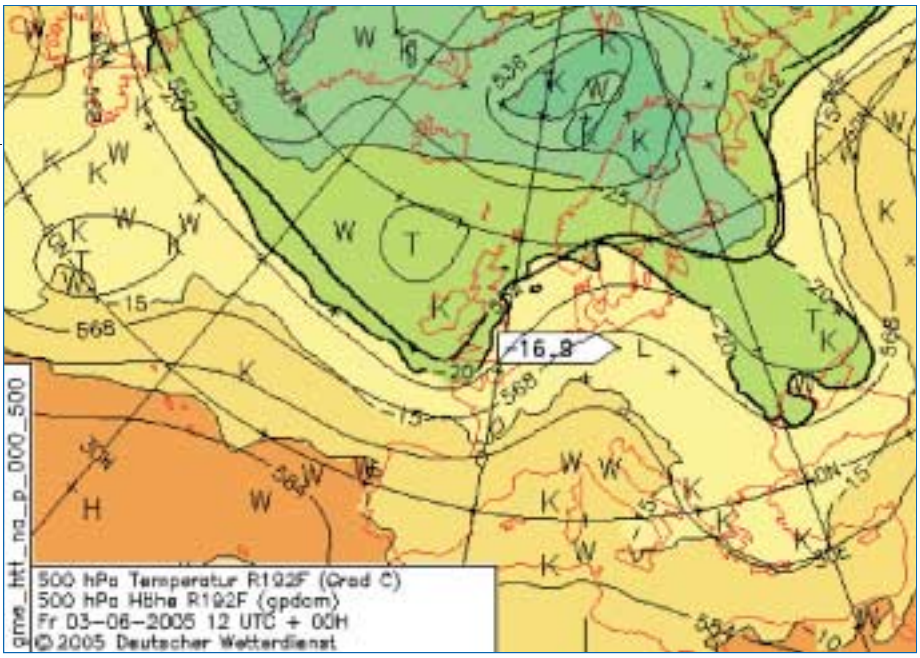
Representative example of evaluation results – convective events



◀ *Figure 6. Satellite data, 03.06.2005, 18 UTC*

◀ *Figure 7. Damage caused by gusts of more than 130 km/hr.*

Figure 8. Geopotential height 500 hPa, 03.06.2005, 12 UTC



The most critical time span of the warning process is 24 to 48 hours before an expected severe weather event occurs. The evaluation of SRNWP-PEPS products at the Central Forecast Office of DWD has shown that, **for synoptic-scale events**, these products provide a very useful aid to the forecaster's decision-making process. There appears to be a clear correlation between PEPS forecast probability and frequency of occurrence of an appropriate event.

The examples above (Figure 4 – 14) show 2 representative cases demonstrating some strengths and weaknesses of the SRNWP-PEPS system. One particular weakness is the inability of the available current mesoscale models to predict convective events reliably. In the case of the severe thunderstorms over Germany on 3rd June 2005, model soundings and nowcasting products formed the basis of the issued severe weather warnings. PEPS products did not show an appropriate signal.

One strength of PEPS is related to the ability of its constituent mesoscale models to simulate synoptic-scale events reliably.

Figure 9. Severe weather warnings from DWD, 03.06.2005 (www.wettergefahren.de)

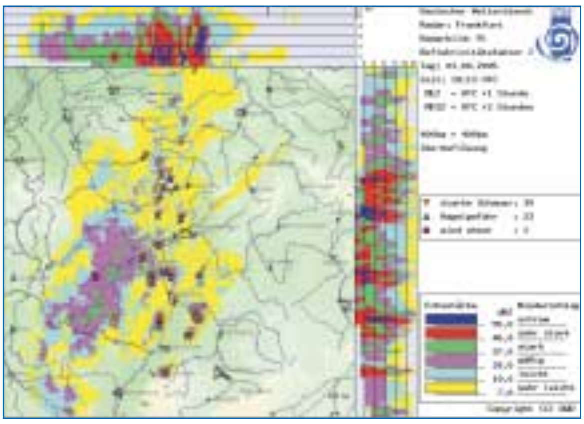


Figure 10. Radar data, 03.06.05, 18:13 UTC

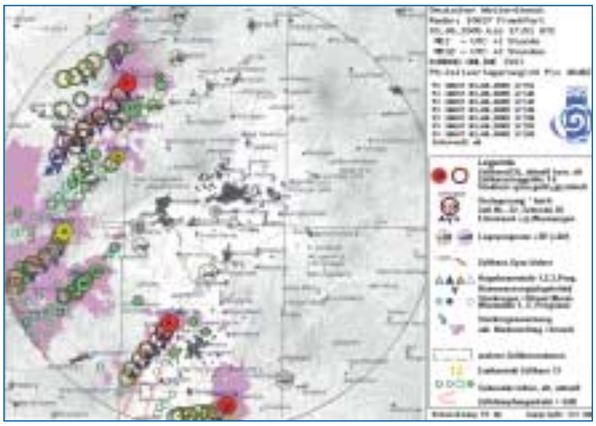


Figure 11. KONRAD, 03.06.05, 17:51 UTC

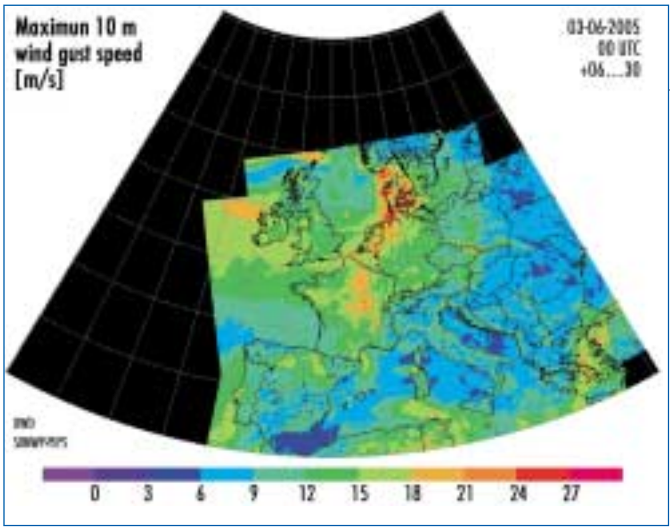


Figure 12. PEPS Forecast Product, 03.06.05, 00 UTC T+06...T+30

Several severe weather situations have supported this conclusion during the evaluation phase at the Central Forecast Office of DWD.

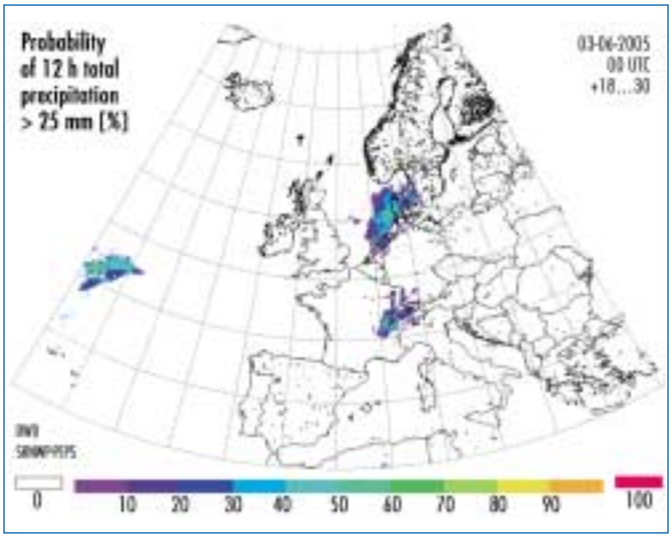


Figure 13. PEPS Forecast Product, 03.06.05, 00 UTC T+18...T+30

Outlook

The first evaluation of the SRNWP-PEPS is promising, though many questions still remain open. These concern for example, the simple assumption of giving equal weights to the individual ensemble members and using the total number of forecasts as a proxy of the actual probability of an event. Furthermore, it can be seen from Figure 15 that the system is biased and uncalibrated. To tackle these problems we will continue to verify the SRNWP-PEPS in a systematic way and we will implement a statistical post-processing package to calibrate the ensemble based on Bayesian Model Averaging (BMA).

From the results presented here we want to encourage the European weather services to start their own evaluation processes. We are very optimistic that the SRNWP-PEPS will provide reliable estimates of forecast uncertainty and enhance the quality of severe weather warnings. The question of using SRNWP-PEPS products for operational purposes will appear on the agenda of the next SRNWP ensemble meeting. Commercial applications will be discussed under the umbrella of ECOMET.

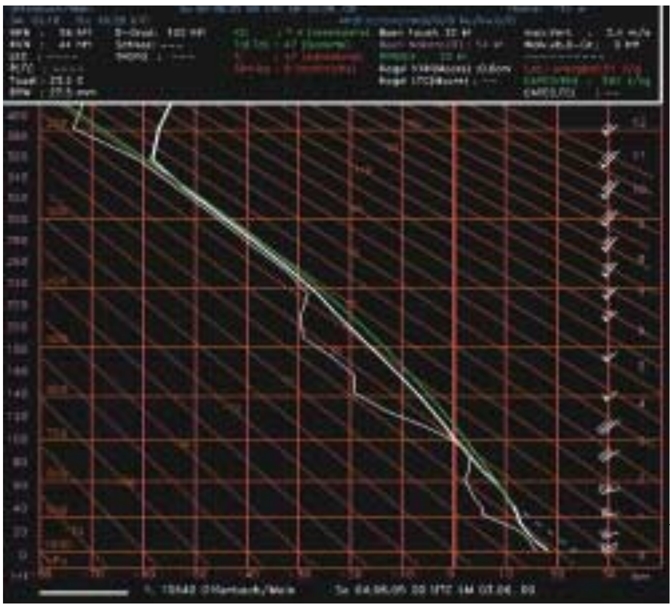


Figure 14. LM-Forecast Sounding used for warnings, 03.06.05, 00 UTC T+24

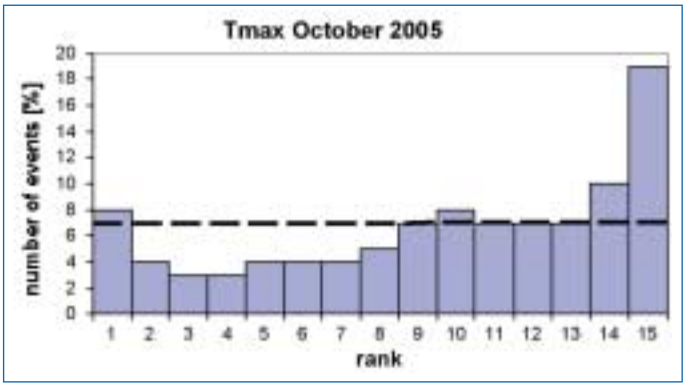


Figure 15. Rank histogram of maximum temperature in October 2005. The expected distribution of an unbiased and calibrated system is indicated by the dashed line. The SRNWP-PEPS underestimates the maximum temperature and the forecast uncertainty.

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http://www.dwd.de/PEPS,
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