The European Forecaster

Newsletter
of the WGCEF

N°13
May 2008

Contents

Cover: High resolution image of the storm Johanna on 2008-03-10 and meteoalarm chart for the same day.

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 readers,

Being the new chairperson of the WGCEF these are my first introductive words for our newsletter. I feel very honoured to be chosen as the new chair person of the Working Group on Cooperation between European Forecasters. It will not be easy to compete with the former chair person Nick Grahame, but with the support from Herbert Gmoser (ZAMG) as the co-chairperson it should be possible to keep the high spirit up for the next four years.

This beautiful coloured edition of our 13th European Forecaster newsletter reflects again the great presentations we have seen during our last meeting in El Escorial in October 2007. Thanks to our hosts from INM we were able to have a very interesting meeting from which you will find the written report in this edition as well. All articles were reviewed by great help from Nick Grahame and Will Lang (both from UKMO). With the help from Bernard Roulet and his employer Météo France we are able to offer you again a high quality printed edition. Also gratitude should be paid at the address of our webmaster André-Charles Letestu (Météo Suisse). Visiting our website **www.euroforecaster.org** is really worthwhile. It offers you lots of additional information on the Working Group and many website links, the web archive will show you previous editions of the Newsletter.

Further on I would like to encourage any reader of the newsletter to contribute to future issues of our newsletter. During our El Escorial meeting we agreed to have presentations and intense discussion on the role of meteorologists issuing severe weather warnings at our upcoming meeting in 2008. From the psychological perspective the responsibility that comes together with this task can be quit heavy. We would like also to zoom in on this "human factor" during our next meeting in Copenhagen, Saturday 4th of October 2008. Any ideas and additional input on this topic from other European Forecasters is highly appreciated in advance. In Copenhagen we also welcome contributions on verification of severe weather warnings across WGCEF NMS's.

In the mean time I hope all of the articles in this newsletter will give you inspiring reading hours and will reflect the high level of discussions we have had during our meeting. It could be an invitation to representatives from other European countries, not already being presented within the WGCEF, to join during our next meeting.

Frank **Kroonenberg**
Chairperson of WGCEF

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

Euroforum, St Lorenzo de El Escorial, Spain, 5th October 2007

Introduction

The thirteenth annual meeting of the WGCEF was held on the afternoon of Friday 5th October 2007 in St Lorenzo de El Escorial, immediately following the end of the ECAM/EMS meeting. The meeting was opened by Nick Grahame (Chairperson, WGCEF) who welcomed everyone and then handed over to Fermin Elizaga who greeted the group on behalf of the INM. Nick Grahame expressed his gratitude to the INM for hosting the meeting and thanked Angel Alcazar and Martina Junge (EMS Secretary, not present) for helping to set up the meeting.

Copies of the agenda were circulated and a final agenda agreed. In total, there were 27 participants representing 18 Meteorological Services across Europe. Adamantia Vlassi was an invited guest whilst apologies and best wishes were read out from those who couldn't attend the meeting (e.g. Manfred Kurz)

Actions from last meeting

12.1 Polish Met Service to be contacted to see if they can be represented in WGCEF (Nick Grahame) – email sent but no reply. Will try again.

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) – Frank Kroonenberg has approached Serbia.

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

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

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

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

12.7 Updates to members on progress with EUMETNET proposal for common format of forecasts (Jean Quiby) – to follow after October 2007 meeting

12.8 Group members to provide user requirement for above proposal (All) – linked to above and ongoing

12.9 Exchange of AutoTAF software (Dirk Heizenreder/Antii Pelkonen) – contact to become close.

12.10 Propose topics on 'Probability Forecasting' and 'Forecasting Impacts' at the 2007 meeting (Nick Grahame) – complete.

Report of the chairperson of the WGCEF

The chairperson informed the group of past members who have stood down due to other commitments. These included Ana Casals (Spain), Dirk Heizenreder (Germany), Giuseppe Frustaci (Italy) and Branko Gregorcic (Slovenia). They have been replaced respectively by Angel Alcazar, Klaus Baehnke,Teodoro La Rocca and Janez Marosek. Sverker Hellstrom (Sweden) had also suggested that he might not be able to remain a member of the group but would be naming a successor if that were to be the case. Therefore the number of countries represented within the group remains at 32.

A text message had been received from Liisa Fredrikson saying that things were progressing well. Antii Pelkonen (Finland) added that he had been in contact with Liisa more recently and said that she sent her regards. The group reciprocated.

A major advance took place in Spring 2007 when Meteoalarm was launched officially (more details can be found later in this newsletter). Close liaison with WMO has also led to Meteoalarm being incorporated into the Severe Weather Information Centre (SWIC) on the WMO website. The chairperson also noted that Meteoalarm has been well received within the meteorological community based on comments during the ECAM meeting. Prior to the launch of Meteoalarm, a vicious wind storm affected large areas of northern Europe on 18 January. The Met Office contacted other European NMS's around this time to compare model output.

Jean Quiby (Eumetnet) had been asked to the meeting but had to decline because of an important forthcoming meeting on interoperability. He promised the chairperson to provide an update on this important Eumetnet sponsored activity.

Finally, Nick Grahame announced that the Met Office had appointed a new Chief Executive (John Hirst).

At this point, Aurora Stan-Sion (Romania) requested a short open debate on the importance of the human factor in the forecasting process and management of pressure and stresses. It was agreed by all that the forecaster is under greater pressure than ever before in terms of assimilating and interpretation of increasing amounts of information whilst delivering to higher levels of expectation. Nick Grahame mentioned that there had been a presentation at ECAM by Marco Gaia (Switzerland) that had raised this very issue. Marco's article appears later in this newsletter.

Aurora raised the importance of appropriate levels of training relating to decision-making and stress management in addition to the more traditional elements of meteorological theory. Essentially it is a plea to invest in the human factors involved in the forecasting process. Herbert Gmoser (Austria) suggested that the role of the forecaster should be focussed on 'adding value' in key situations with less involvement in routine tasks. Will Lang (United Kingdom) and Frank Kroonenberg (Netherlands) put forward a proposal to discuss and share experiences of the stresses of shift working. Michael Walsh (Ireland) suggested that the first step should be to see how each NMS deals with severe weather. It was agreed that actions would be put forward (see later). One other factor (raised by Herbert) is that forecaster 'added value' is difficult to assess and this needs to be addressed and acknowledged.

Discussion of Newsletter No.12 and WGCEF website

Nick Grahame mentioned that the articles had been sent in within the timescales requested and that Will Lang had helped in editing and proof-reading them. All contributions were sent to Bernard Roulet (France) by early June 2007 and many thanks once again go to Meteo-France for publishing the newsletter in time for the meeting. The front cover (chosen by Bernard) highlights the importance of the next-generation European satellite program. 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 and Nick Grahame thanked him for his hard work in maintaining up-to-date information.

Meteoalarm update

Frank Kroonenberg described developments since the much published official launch of Meteoalarm in March 2007. Visitor numbers peaked again in July 2007 with the enhanced interest in flooding across parts of the United Kingdom and the intense heatwave across eastern Europe. There are many challenges ahead in order to realise the full potential of Meteoalarm, including greater visibility within NMS websites and further integration with other agencies with environmental responsibilities. Merike Merilain (Estonia) announced that her country was the latest addition to the Meteoalarm consortium in September 2007.

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. Following action 12.10 (from the last meeting), the contributions were split into two topics

Forecasting Impacts:

Angel Alcazar (Spain) – Warning Statistics at the INM

Fracisco Martín (Spain) – Extratropical Transition of Tropical Storm Delta in the Canary Islands

Andre-Charles Letestu (Switzerland) – Forecasting heavy rain in the Alps (Project MAP-D phase)

Chryssoula Petrou (Greece) – The heat waves in Greece

Janez Markosek (Slovenia) – An extreme rainfall event in Slovenia

A break for coffee allowed the group photo to be taken outside the Euroforum building.

Probability Forecasting:

Carlos Santos (Spain) – Multi Model Short Range Ensemble Forecasting at INM

Benito Elvira (Spain) – Operational Use of EPS for Medium Range Forecasting in Spain

Herbert Gmoser (Austria) – Evaluation of seasonal forecasts at ZAMG

Bernard Roulet (France) – AROME: The new high resolution model of Meteo- France

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

Listed actions from this meeting

13.1 Investigate the current issues specific to shift-working forecasters in European NMS's (Aurora Stan-Sion, Frank Kroonenberg, Nick Grahame)

13.2 Set up a survey via e-mail or our website on perceived pressures in each European NMS, particularly in severe weather situations (Frank Kroonenberg, Nick Grahame)

13.3 Propose topic on 'Verification of warnings and feedback into best practice' at next meeting and send a questionnaire to forecasters (Herbert Gmoser, Aurora Stan-Sion)

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

Election of new Chairperson and Vice-chairperson

The group elects a new Chairperson and Vice-chairperson every four years. Nick Grahame proposed that Frank Kroonenberg should take on the role of Chairperson and this was passed on a unanimous vote. Frank thanked the outgoing Chairperson for his work in taking the WGCEF forward over the past four years and stated that the group has an important role to play in the future and he was proud to take up the challenge. Herbert Gmoser was proposed as the new Vice-chairperson and this was accepted. Nick Grahame announced that he would be happy to remain as editor of the newsletter (with Will Lang).

Plan of action for 2008

Nick Grahame highlighted the fact that forecasting has never had such a high profile as at present, mainly because of increased public awareness of climate change and extreme weather events. Thus, there is a real challenge for European forecasters to work more closely with researchers, other government organisations and of course, together (e.g. Meteoalarm, Windstorms etc) on timescales from nowcasting to seasonal forecasting. There is also a need for increased flexibility in exchanging forecast information for the common good. Such increased responsibility on the forecaster must however be recognised and the WGCEF should consider the best ways to take the 'human element' forward.

Date and place of next meeting

Nikolaj Weber (Denmark) kindly offered Copenhagen to host the 2008 meeting. This was to put to the vote and accepted. The group agreed that the optimum date would be on the Saturday immediately following eighth EMS meeting scheduled for Amsterdam. This would allow members to attend both meetings with minimal travel. Further details will be put on the website.

AOB (any other business) and closing of meeting

There was no other business so the Chairperson closed the meeting at 1915.

Other related events

A dinner had been arranged on the evening of 5th October by INM at the Meson La Cueva restaurant in the centre of St Lorenzo de El Escorial. The venue had a good deal of charm and the group enjoyed a typical tapas meal that was accompanied by traditional Spanish music. Frank Kroonenberg (Chairperson elect) once again thanked the members of INM for hosting the meeting and treating the group members to a 'taste of Spanish life'.

Nick Grahame
Chairperson WGCEF

Appendix 1

List of participants:

Bernard Roulet (France),
Antii Pelkonen (Finland),
Marta Sallai (Hungary),
Imra Bonte (Hungary),
Michael Walsh (Ireland),
Chryssoula Petrou (Greece),
Adamantia Vlassi (Greece),
Will Lang (United Kingdom),
Frank Kroonenberg (Netherlands),
Nick Grahame (United Kingdom),
Klaus Baehnke (Germany),
Herbert Gmoser (Austria),
Andre-Charles Letestu (Switzerland),
Claude Sales (Luxembourg),
Aurora Stan-Sion (Romania),
Jean Nemeghaire (Belgium),
Ole Kristensen (Denmark),
Nikolaj Weber (Denmark),
Janez Markosek (Slovenia),
Karen-Helen Doublet (Norway),
Merike Merilain (Estonia),
Taimi Paljak (Estonia),
Fermin Elizaga (Spain),
Angel Alcazar (Sapin),
Benito Elvira (Spain),
Carlos Santos (Spain),
Fracisco Martin (Spain)

Meteoalarm update

Historical Background

The concept of Meteoalarm was first discussed following the post-Christmas storms, "Lothar" (26 December) and "Martin" (27 and 28 December) in 1999. These devastating windstorms caused major losses.

The economic cost of "Lothar" and "Martin" was estimated at €5 billion and €2.7 billion respectively. The number of people that died as a result of these storms was around 140, of which almost 90 casualties occurred in France. There were also numerous injuries.

Within the meteorological community these storms provoked great interest and generated discussion on the use of conceptual models, such as Rapid Cyclogenesis, the apparent failure of numerical models to forecast these storms and inconsistencies in the way that warnings were issued across the affected areas of northern Europe.

During the October 2000 workshop on the post-Christmas storms (at Météo-France in Toulouse) meteorologists from all over Europe met to bring these discussions together and put forward proposals based on 'lessons learnt'. Météo-France announced their Vigilance system, designed to give all necessary meteorological warning information to French citizens in cases of severe weather. Also during this meeting the need was expressed by all European forecasters to establish a better international exchange of forecasts and warnings within Europe. The necessity to exchange ideas on the expected evolution of potential severe weather systems and more multi-national collaboration were the main reasons for this need.

Working Group on Cooperation between European Forecasters

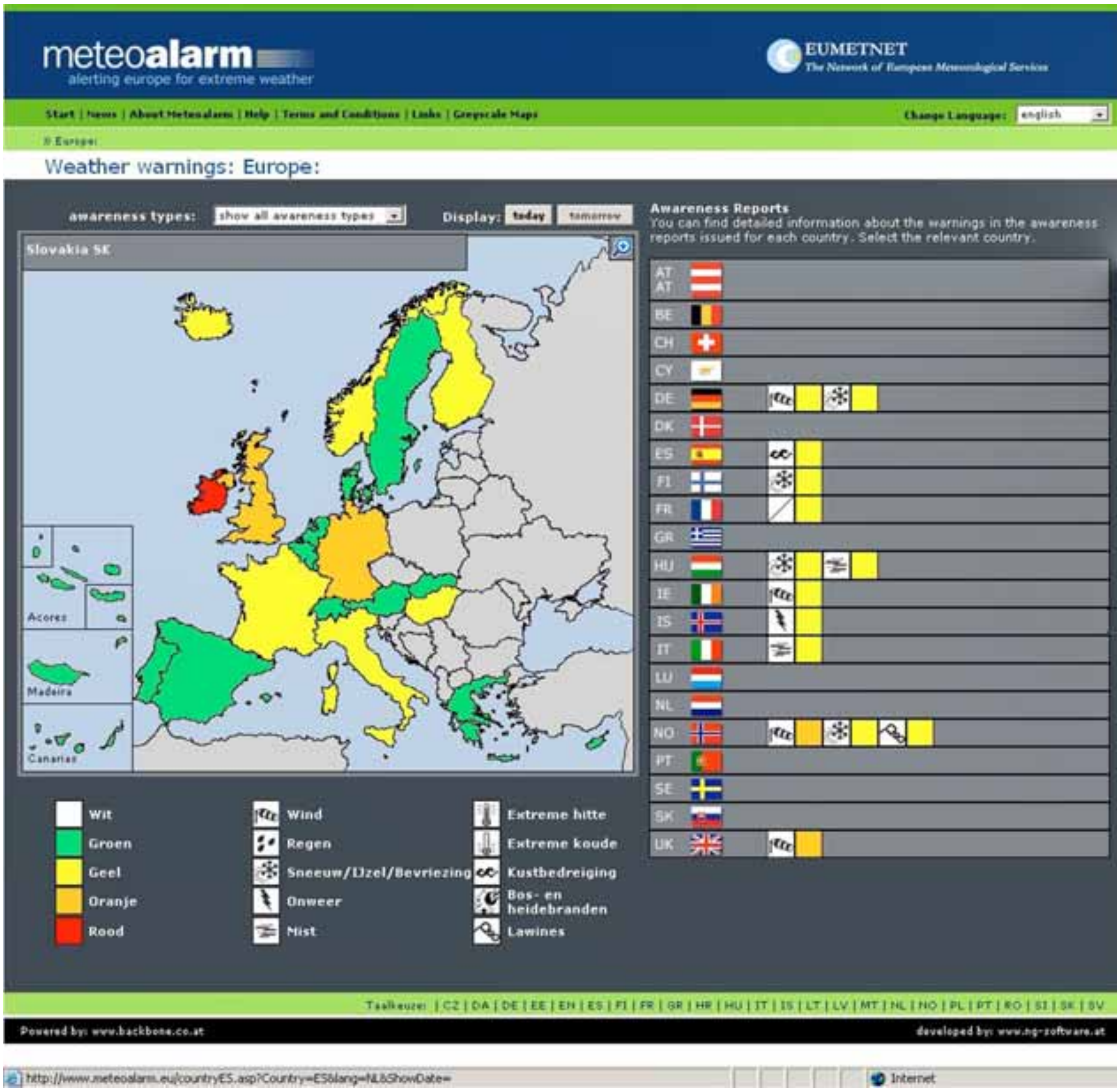
After the above workshop took place, the Working Group on Cooperation between European Forecasters (WGCEF) developed the initiative to establish this exchange platform. By late 2001 the

EUMETNET sponsored EMMA (European Multiservice Meteorological Awareness system) programme was underway and being managed by Météo-France. The French Vigilance system stood as an example for EMMA. The programme resulted in prototyping a European awareness website, developed together by 21 National Meteorological Services (NMS's) within EUMETNET.

After the EMMA programme, EUMETNET approved the EMMA Phase II programme that aimed to get the prototype into operation. This three year programme, scheduled to end in late 2008, has been managed by the Austrian Meteorological Service (ZAMG) and KNMI together with a growing number of participating NMS's, over 25 at the time of writing. Within a year of the Phase II programme, EMMA had been renamed Meteoalarm and the website became a fully operational system.

The Meteoalarm website

On World Meteorological Day, 23rd March 2007, Meteoalarm was launched officially in St. Lorenzo de El Escorial in Spain. In preparation for this event lots of attention was given by Press Officers at European NMS's to promote awareness of this new website towards the media. This approach turned out to be very successful! The launch was attended by many people and well represented by the



media. During the press conference many questions from the media were answered and there were numerous interviews given to international radio and television. In addition, the general public seemed to be very well informed on this occasion. On the launch day itself, there were 12 million hits on the website. The extremely high hit rate stressed, even at this early stage, the high potential of Meteoalarm for the external users (e.g. European citizens).

The meteoalarm intranet forecasters forum

The website is meant primarily to serve external users, by giving them all the necessary information about meteorological awareness within Europe in an easily accessible and understandable format (colour coding countries and regions and using simple symbols and graphics).

The second goal within the Meteoalarm concept is to serve the need of the professional meteorologist, as expressed during the workshop in Toulouse. To complement the fact that operational forecasters will benefit fully from all awareness and warning information on the website, the intranet part of the site (accessible to all forecasters across Europe) is offering some useful features to give additional information during the onset phase of an extreme weather event.

The forecasters forum on the intranet is designed to promote on-line discussions and contains additional facilities to add relevant attachments for guidance purposes. In this way forecasters have the ability to exchange important information on upstream weather events and can assimilate second opinions and judgements by other experts within their own warning and colour assignment strategies.

Such strategies will allow the content of warnings across Europe and also the colour assignments, to raise awareness for the general public, to become more coherent and consistent within the Meteoalarm domain.

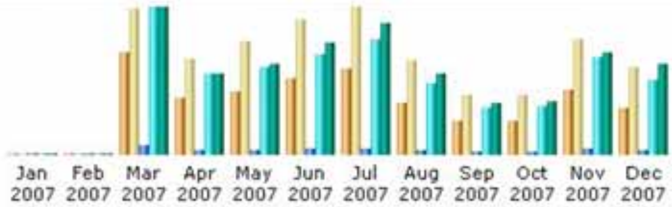
Meteoalarm hit scores – April to December 2007

In general we see 1 to 3 million hits during “regular” weather days but this rises towards 6 million hits per day during periods with high impact weather. According to web statistics the number of visitors has tended to be at its highest during the summer holiday season and slows down a little during autumn. September and October have been the quietest months, but attention increased again in November and December.

The total number of hits in 2007 (since 23rd March) has been around 372 million. Most of the hits originate from the Netherlands, but Germany, Greece, Belgium, France, Austria, Sweden, Hungary and Finland are also high in the user rankings.

As soon as extreme weather is expected to hit a certain part of Europe, hit rates tend to rise in that area. We do see that additional media attention, raised for the website by NMS press officers, does lead to an immediate increase in hit scores. For this reason all the press officers at NMS’s receive an attention e-mail from the Meteoalarm programme team as soon as at least three countries have assigned an orange and/or red awareness level, within a geographically coherent area, In this way additional attention for Meteoalarm on NMS websites and media releases is encouraged.

Monthly history



Month	Unique visitors	Number of visits	Pages	Hits	Bandwidth
Jan 2007	0	0	0	0	0
Feb 2007	0	0	0	0	0
Mar 2007	335723	479773	3630806	62941574	173.89 GB
Apr 2007	182933	312795	1702390	34546610	96.55 GB
May 2007	209453	371910	1855121	37331032	107.97 GB
Jun 2007	249776	441642	2226609	43106582	132.98 GB
Jul 2007	282256	483477	2566269	49202906	155.26 GB
Aug 2007	171037	307369	1523146	30759659	96.48 GB
Sep 2007	109579	195651	1114627	20135784	61.39 GB
Oct 2007	111045	197908	1032300	20843626	63.59 GB
Nov 2007	209747	376733	2182713	41278442	120.09 GB
Dec 2007	150946	286361	1923816	31522560	107.49 GB
Total	2012495	3453619	19757797	371668775	1115.69 GB

Challenges within the programme

Harmonising

Since the start of the EMMA phase II programme many successful efforts have been made to harmonise colour assignment schemes throughout Europe. Awareness colours within Meteoalarm are assigned according to impact and damage. In this way meteorological thresholds triggering a certain awareness colour may differ from one country and/or region to another, whilst a certain awareness colour will still have the same meaning all over the Meteoalarm domain.

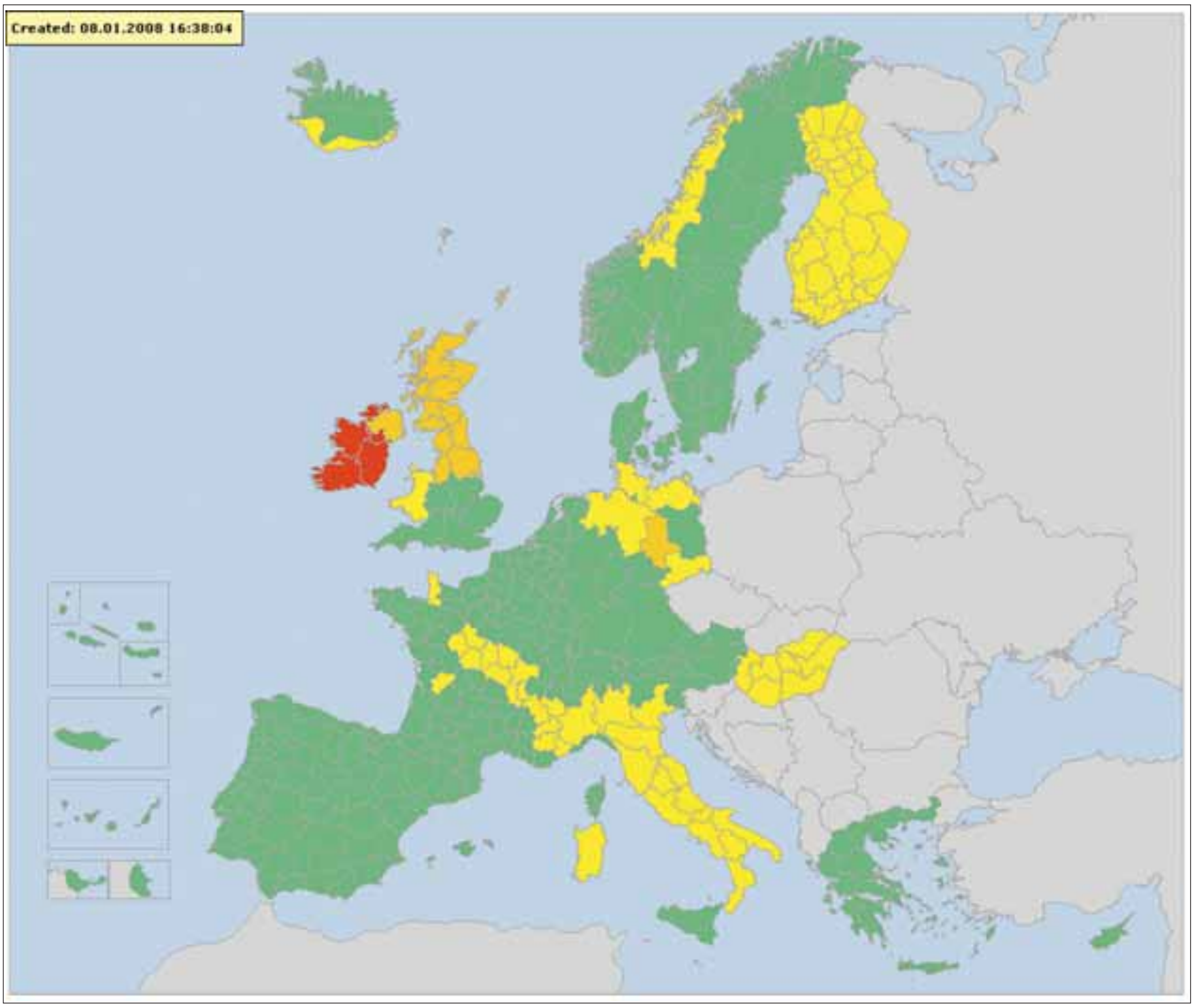
At this moment in time we are tending to adapt colour assignment strategies more towards return periods for events. In this way, only those very high impact events that occur very seldom (i.e. once in two years) will be coloured as “red”. The theory behind this is that society will adapt to very intense meteorological events if these events occur more often. People will anticipate their behaviour and infrastructure will be upgraded towards these more frequent intense events. Thus if climate change would induce more intense meteorological events in the UK, parameter thresholds for a certain colour assignment will rise.

Non-homogeneity in the use of parameters

Meteoalarm deals with obligatory and additional weather parameters. Some intense events, such as the forest fires in south-eastern Europe during summer 2007, raised a great deal of public interest and media attention but were not covered by some of the affected countries at the time (forest fire is not a mandatory parameter). In such cases there is a risk that Meteoalarm visitors might be mislead or at least confused by seeing Greece on “green” while the country is burning. The programme team is busy trying to solve this problem and one solution could be to perhaps separate the so called additional parameters from the obligatory ones.

Coastal warnings

Possibilities for a new "coastal warning" parameter will be investigated. This parameter will integrate several meteorological events such as high wind speed, sea ice, large waves and/or swell extending over coastal waters (defined as 12 nautical miles offshore). This new parameter should not be confused with the already existing "coastal events" parameter that is mainly used for storm surge (high tides) linked directly to coastal areas. The Finnish Meteorological Service (FMI) is leading the project to introduce the coastal warning within Meteoalarrm.



Encouraging the use of the intranet forum for operational forecasters

Since Meteoalarm was also meant to serve the European forecasters we will encourage intranet forum discussion between meteorologists during the onset phase of an intense event. At this moment the number of forum discussions between NMS's is growing, but should still be improved to create an appropriate medium for routine discussion during pan-European severe weather events.

New developments

• New countries entering soon: Croatia, Slovakia, Slovenia, Latvia.

• More cooperation will be developed with civil protection agencies, both National and European (e.g. Monitoring and Information Centre "MIC", operated by the European Commission).

• A combined “rain and/or flood” parameter will be introduced, that will replace the present “rain” parameter. In many countries meteorological and hydrological experts work together to produce flood forecasts. This combined parameter will give the possibility to include hydrological flood warnings within Meteoalarm. In general more cooperation between meteorological and hydrological services across Europe will be strongly encouraged to create these flood warnings across the European domain. Also the EC MIC is strongly supportive of such activities.

• Website resilience has been improved 40 times (towards 40 million hits per day).

• A regional European map, which will show all the coloured regions within one European map without frontiers, is expected to be introduced before the end of 2008.

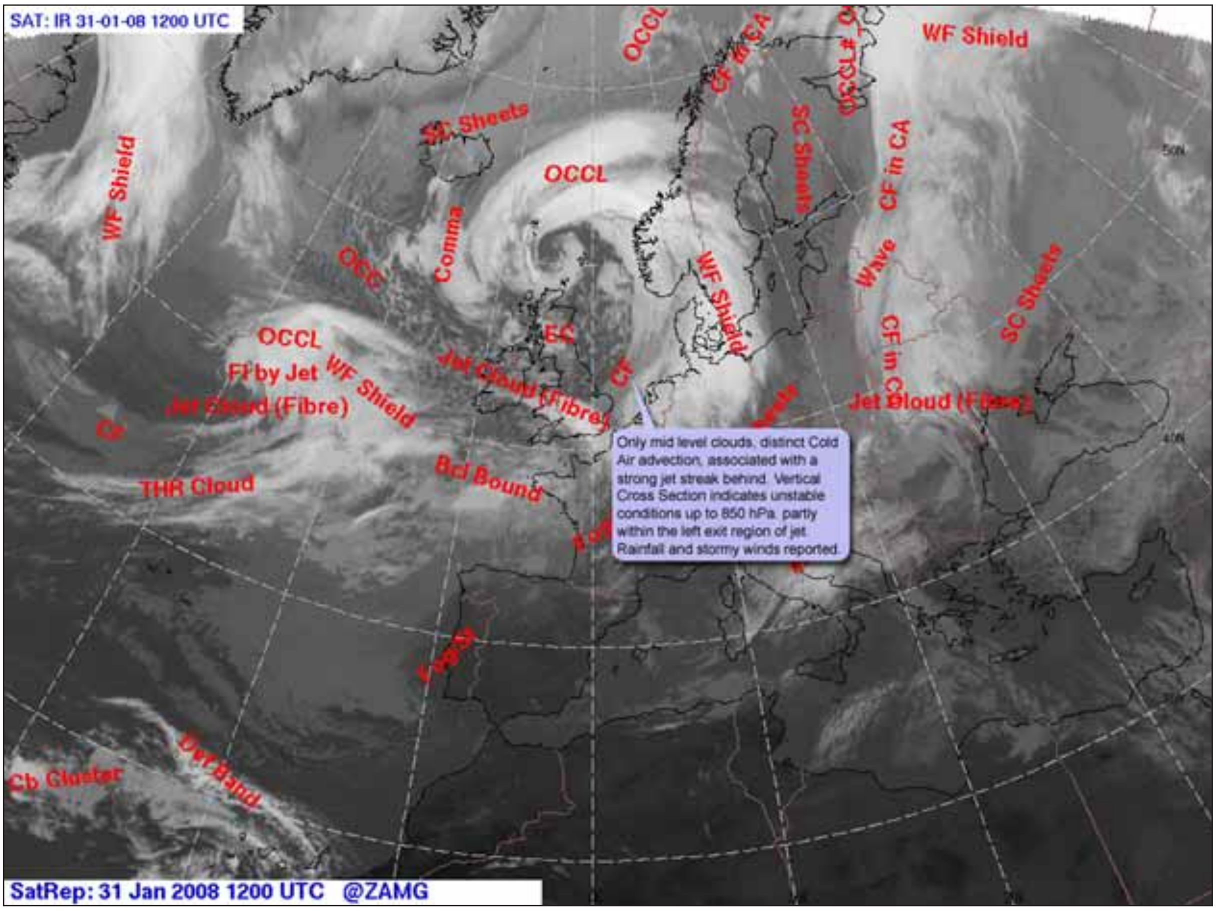
Frank **Kroonenberg**,
(KNMI)

SatRep.
A new Eumetnet Project

In January 2008 the new Eumetnet project SatRep (Satellite Report) started.

SatRep is a diagnostic tool that has existed for many years and displays a 6-hourly manual diagnosis of the Meteosat satellite image in terms of conceptual models. It is currently produced by 3 NMS's (ZAMG, KNMI, FMI) and is available through the SatRep home page (http://www.knmi.nl/satrep). In addition to the manual 6-hourly diagnosis, a 15-minute automatic SatRep diagnosis is available as well. From all products there is also an online archive that includes data back to 2003.

The image below shows a SatRep example from 31 January 2008:

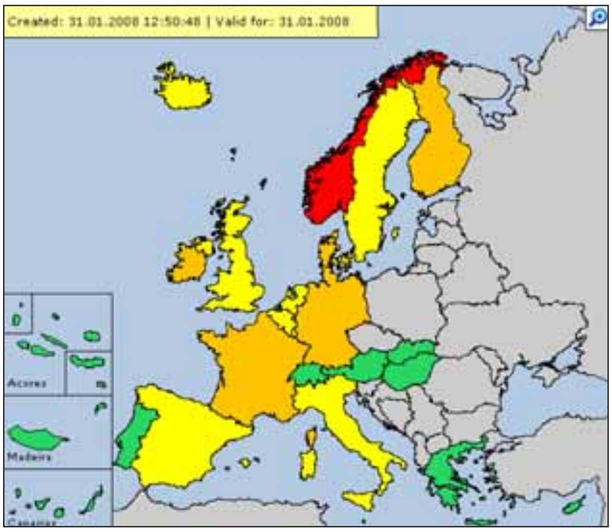


As there is already an operationally working SatRep procedure – why is there a necessity to upgrade it to a Eumetnet project?

There is a psychological reason:

To acknowledge that this project, originally developed among three smaller weather services, is of benefit for the whole of Europe and deserves the status of a European project.

*According to Meteoalarm,
this weather situation led
to the generation of numerous
warnings of severe weather
in Western, North-western
and Central European Countries*



And there are several scientific reasons:

• To raise the quality of the diagnosis by including an expanded set of experts across Europe which will have more skills in the analysis and interpretation of locally specific conceptual models

• To raise the 'know-how' in conceptual model recognition through mutual training

• To find new additional partners who have the skill to make SatReps for their own region ("Regional SatRep") and to put all these diagnoses together to produce a "Mosaic SatRep".

A combination of these topics decreases the work load of today's SatRep producers and at the same time increases the know-how of new volunteering NMS's which will lead to a distinct increase in the quality of a new "Mosaic SatRep".

The following countries are contributing directly to this Eumetnet project:

Austria, Belgium, Croatia, Finland, Ireland, Italy, Latvia, Netherlands, Norway, Portugal and Spain.

After a kick-off Meeting in Vienna early in 2008, there was a general outcome that the International SatRep at the end of the project should be:

A tool for every interested user (every NMS) to provide:

• A quick overview for diagnosis, manual analysis and nowcast interpretation

• Model error indication (preferably ECMWF) – based on an objective method which combines the model forecast output with the current satellite diagnosis

The Eumetnet SatRep Programme Advisory Board is very interested in obtaining input from all NMS's who want to take part in training as well as in development. For ideas and contributions please contact: **zwatz-meise@zamg.ac.at**

Jarno **Schipper**, Andreas **Wirth**
and Veronika **Zwatz-Meise**
ZAMB, Austria

The human side of weather forecasting

Introduction

Some years ago, during the introductory session of the Initial Forecasting Course at the Met Office College, the lecturer described the job of the weather forecaster with more or less the following words: *"As a weather forecaster you will be asked to make decisions in situations where you will be under tight time constraints and face uncertainty, you will have huge amounts of data available, some of it contradictory and most of it not really of significance to you, and you will be constantly looking for the correct data, which will not normally be at your disposal".*

After some years, I'm now convinced that "to be able to decide" is one of the key competences of a weather forecaster. And it is still not always a simple task, despite the improvement in the tools and systems at our disposal.

An example of a bad decision

On the 3rd October 2006, flash flooding occurred in the central part of Ticino (Switzerland), on the southern slopes of the Swiss Alps. This resulted in damage within a number of valleys, disruption to communication links and a fatality. The exceptional rainfall was caused by the passage of an intense cold front, combined with the movement of a small low-pressure system, which crossed the alpine barrier during the late afternoon. The potential for such a frontal system was identified some days in advance by synoptic considerations and by the numerical weather prediction models as well. Unfortunately, no warnings were issued by the regional forecasting centre and the civil authorities and rescue teams were partially taken by surprise.

The post-event analysis of the flash flooding provided some interesting results about how decisions were taken in the forecaster team and on the thought processes that led to the decision not to send out any warnings. It was clearly recognised that in this case the "human side" of the decision-making process was the critical point. Indeed the forecaster on duty, despite having recognised the dangerous potential of the approaching frontal system, was confronted with opposing signals between the high-resolution model solution and the ensemble models. With these contradicting indications, the final decision was strongly influenced by a "short term experience". Two weeks before, the same forecaster was faced with a similar severe weather situation and the warning he issued turned out subsequently to be a false alarm. The conclusions drawn from a post-event analysis of that event were effectively translated and applied two weeks later to the new situation and led to a missed warning.

The human side of weather forecasting: the decision-making process

Taking decisions has always been one of the central points of the forecasters job. Understanding how weather forecasters make their decisions means understanding the cognitive processes of the human forecaster to enable sensible interpretation of data and added value to a forecast. Consider the following questions:

• How do humans use weather information to produce forecasts?

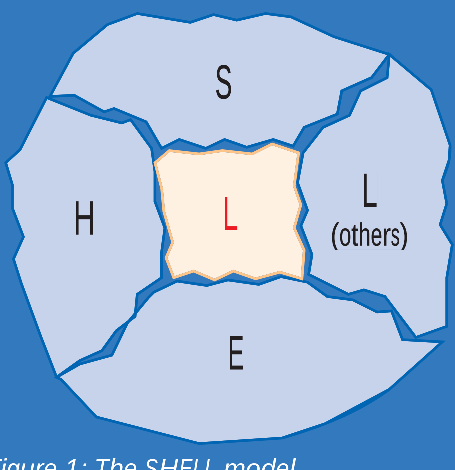
• What expertise does a forecaster apply to allow him/her to make the judgment that a weather event could be extreme?

• How can a forecaster pick out the important signals in model guidance or in observational data amongst large volumes of less relevant information?

These are the types of questions that have been at the centre of interest for some researchers for many years and, in some cases, they are still waiting for an answer. Providing answers to these questions is equivalent to trying to understand the nature of expertise in assessing weather situations and forecasting their development.

Despite a lot of research in other fields where people take decisions normally under time constraints or in stress situations (e.g. fire fighters, police, medical teams, army etc.) it seems that up to now, less knowledge has been gained in the understanding of cognitive tasks and the nature of expertise in weather forecasting. Over the last few years the necessity of increasing our knowledge about the cognitive process in weather forecasting has been recognised. Some research has been done ([1,2]) and some workshops and conferences have been organized ([3,4]). The first results of this research have shown some peculiarities in the decision- making processes of experienced weather forecasters ([5]). Because of the huge amounts of data that forecasters face, analytical decision-making processes are limited by time constrains. Therefore heuristics (i.e. intuitive) approaches are virtually mandatory. Klein ([6]) describes the decision-making process of the experienced weather forecaster with a recognition-primed decision model, which combines both analysis and intuition. Also the differences between experienced (expert) and inexperienced (novice) forecasters have been studied. It seems that experts and novices use very similar types of reasoning strategies but experts have a larger repertoire of routine and thus a larger range of ways to size up situations; experts are more likely to question the data and are more effective in data analysis, recognising better patterns and key factors. They use a lot of intuition, are able to manage uncertainty and risk, and have the ability to recover from errors.

We cannot forget that, since all the activities are performed in the forecast room, each decision-making process is strong influenced by the interaction of the human forecaster with the technical systems (software and hardware) at his/her disposal and is constantly subjected to external influences (coming from the work environment in a general sense). It is possible to describe these interactions with a simplified SHELL model (see Fig. 1), which group the different sources of interaction into classes (designed as “blocks”)[7]. The results of the actions of the operator can only be maximised if the contact surfaces between the different “blocks” are good and smooth. Therefore it is possible to seek a wide variety of ways to improve results relating to the decisions made by the forecaster. In very general terms, we can summarise all the interactions between the Liveware-block of the operator and all other blocks with the term “human factors”.



S: Software: guidelines, routine and emergency procedures, …

H: Hardware: all the technology tools used in the forecast room (for meteorological analysis, for communication, for production, …).

E: Environment: the ergonomics of the hardware, the “climate” and the social culture of the office, the family, the friends, …

L (others): Liveware: people around the operator (‡ forecaster colleagues, users, authorities, journalists, etc.).

L: Liveware, the operator (‡ in our case: the weather forecaster).

Figure 1: The SHELL model

The technology challenge

Over the last few years a lot of research has been done to improve numerical weather prediction (NWP) whilst new tools have been developed for much improved analysis and visualisation of the meteorological data. However in some cases the introduction of these new technological systems into the regular daily forecasting process has been not so straightforward because forecasters were not always enthusiastic to adopt the new tools and models. Moreover, even when the systems were well integrated into forecaster practice, an improvement in the quality of weather forecasting was not always as expected.

I think that a possible explanation can be found in a lack of consideration of what I have called "the human factors" during the development and introduction of the new systems. With respect to the SHELL model, it is possible that we have concentrated our efforts too much in improving the single blocks (especially the "hardware" and the "software" blocks) whilst neglecting the contact surfaces between the blocks. Indeed we cannot forget that each change in the forecasters work environment has an effect on the human, especially when we make a technological change or introduce a new tool. There is a cognitive dimension in the use of each technology that must not be neglected. Experts recognise patterns, identify key issues from the data, build mental models and take an active stance. However, if inappropriately developed technology presents too much data it can disconnect the human from the process and weaken the mental models of the human forecaster, making them less adaptive and more passive. This is the so-called *technology challenge*: new technology can hinder greatly the forecast process if used incorrectly.

Sometimes experienced forecasters can be stimulated by the introduction of new technology, which gives them the opportunity to analyse meteorological data in new and creative ways. There can be negative aspects, however, when the introduction of new technologies meets strong resistance among the forecasters because they are obliged to change their preferred ways of working. This can interfere with the cognitive processes that enable forecasters to interpret the data correctly to aid their decision-making.

The future role of the human in the weather forecasting process

As in previous years, I think it is certain that technical developments will continue at a rapid pace. New tools will be introduced and NWP will improve further. I am convinced that if we want to maximise the benefits of these new systems, we cannot forget the "human side" of the technology. As technical and scientific solutions are developed, we must ensure that the new tools take account of the cognitive dimension. An awareness of the cognitive processes present in weather forecasting can:

- help to improve the design of new technical tools
- develop more efficient training courses to learn how to use these tools
- reorganise the work of the forecasting team with respect to the new tools
- improve the quality of the entire weather service
- avoid, or at least minimise, the "bad decisions".

Recent discussions about the future role of the human have demonstrated clearly that he/she will only be able to maintain that role if there is an ability to add value to NWP models and automatically generated forecasts. Situations in which I believe the human forecaster has the skills and competences to maintain a role are those involving severe weather. In the case of Switzerland, where there are regions of complex topography, numerical models still have some problems in forecasting severe weather events despite the improvements of recent years (e.g. higher resolution). It is in these situations that experienced human forecasters can potentially add important value to NWP models and automatically generated forecasts now and in the future as their role in the forecast and decision-making process evolves.

During severe weather situations the human decision-making process is put under a lot of pressure and taking the right decision can become very difficult and require a lot of experience. Therefore we can maintain and reinforce the role of the human forecaster if we are able to give the forecaster the opportunity to find ways to continue to gain expertise in a rapidly changing technological environment. This is possible only if we devote more effort, time and research in order to better understand the cognitive process of weather forecasting and - more important - if we are able to translate our knowledge into best practice. For example, education and training courses (basic, continuing professional development and on-the-job experience as well) should be designed to build on quality experience. Also new technical tools, which are expected to change the work practices of the forecaster, should be developed and introduced in such a way that they really respect the human cognitive processes.

Conclusion

The "human side" is an important component in weather forecasting, as the case study of 3rd October 2006 has demonstrated. This component should be considered seriously if we want to maintain a role for the human in the forecasting process for the future and if we want to enhance quality within the National Meteorological Services across Europe.

References:

[1] Doswell C. A. III, 2004, Weather Forecasting by Humans - Heuristics and Decision Making, *Wea. Forecasting*, 19, 1115-1126

[2] Klein, G., 2005. The cognitive dimension of weather forecasting, *21st Conference of Weather Analysis and Forecasting*. Washington, D.C.

[3] Stuart N. A. and Coauthors, 2006, The future role of the human in an increasingly automated forecast process, *Bull. Amer. Meteor. Soc.*, **87**, 1497-1502

[4] Stuart N. A., Schultz D. M., Klein G., 2007, Maintaining the Role of Humans in the Forecast Process, *Bull. Amer. Meteor. Soc.*, **88**, 1893-1898

[5] G. Klein, B. Moon, and R.R. Hoffman, "Making Sense of Sensemaking 2: A Macrocognitive Model," *Intelligent Systems*, vol. 21, no. 5, 2006, pp. 88–92.

[6] G. Klein, Sources of Power: *How People Make Decisions*, 1998, MIT Press, 330 pp.

[7] Adapted from the Workshop: *Supporting Expertise in Weather Forecasting A Human Factors Workshop (with a cognitive spin)* organized by MSC Canada, Toronto, 23 – 25 May 2007

Marco **Gaia** and Lionel **Fontannaz**
MeteoSwiss

A case-study of an extreme rainfall event in NW Slovenia

Introduction

On 18 September 2007 heavy precipitation occurred in some parts of western and northern Slovenia. Bands of quasi-stationary convection were responsible for extreme amounts of rain causing destructive river floods and flash flooding in two narrow valleys – Selška dolina (valley) and Kropa. The Bohinj valley was also badly affected. More than 300 mm of rain was measured locally in less than 12 hours. The town of Železniki experienced a huge volume of water as the river Sora, which flows through the town, rose rapidly over a period of 30 minutes to 1 hour. More than 100 cars were swept away and many landslides and debris flows occurred. Heavy precipitation was also observed in some other parts in northern Slovenia, causing landslides and local floods. Six lives were lost and the total damage across all of the affected areas was estimated as around 200 million €.

The orographic characteristics of Slovenia

In Figure 1 the relief map of Slovenia is presented, with some places of interest also indicated. The northwest part of the country is characterised by a region of high mountains – an extension of the Julian Alps with many peaks above 2000 metres. To the southwest lies the lower terrain of the north Italian plain. As a result, the highest precipitation intensities in the mountainous region of NW Slovenia

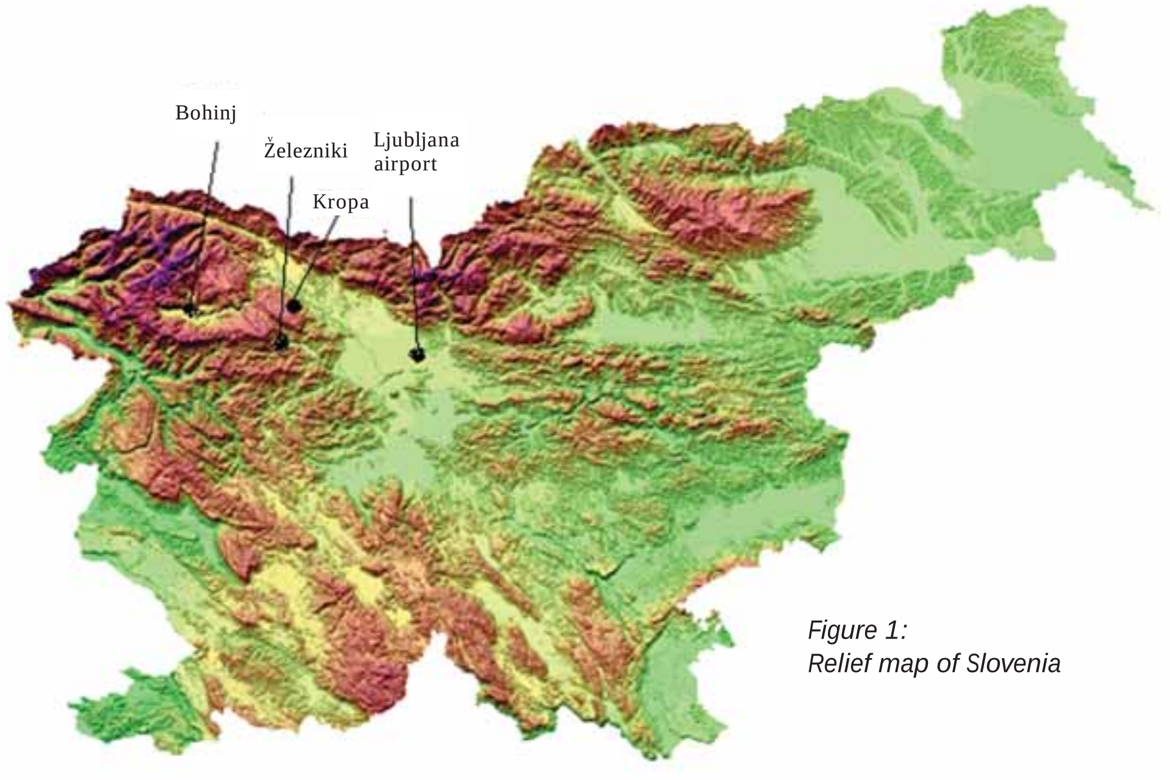


Figure 1: Relief map of Slovenia

tend to occur when moist air approaches on southwesterly winds. The orographic barrier leads to lifting of the airflow and precipitation can be persistent and intensive. In the case of unstable airmasses, the orography can also trigger convection.

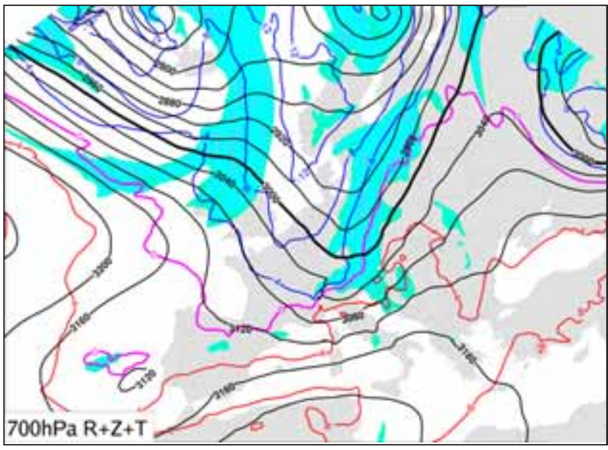


Figure 2a: Analysis of 700hPa height, temperature and relative humidity over Europe (18 Sep.2007 12 UTC)

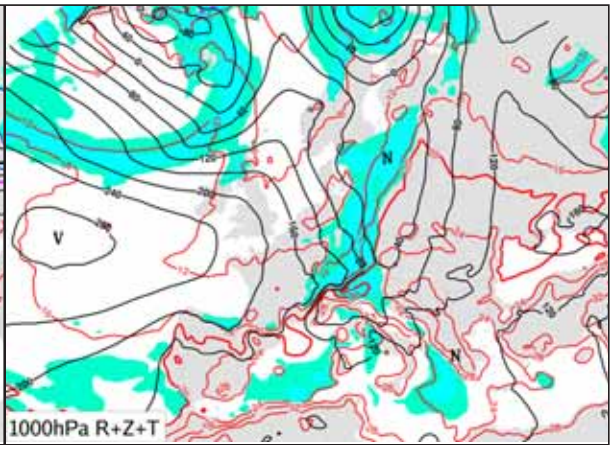


Figure 2b: Analysis of 1000hPa height, temperature and relative humidity over Europe (18 Sep. 2007 12 UTC)

Brief description of the synoptic situation and model behavior for this case

A surface low was present over northern Europe with a cold front approaching the Alps from the northwest. At the same time, an upper trough was moving from west to east with strengthening southwesterly flow over Slovenia, reaching speeds of 20 – 30 m/s above 1500m.

The approaching air mass was very unstable and there was also strong wind shear between the surface and 6000m.

The day before, on 17 September, the limited area models (Aladin/Si, LM of DWD) and the ECMWF global model (all 00 UTC runs) predicted a high amount of precipitation over parts of western Slovenia with values of 100 – 150 mm in 24 hours on 18 September. The forecast maximum was located more to the west towards the border with Italy. The main trend from successive model runs was that predicted precipitation amounts in the region of interest were diminishing. Despite these signals, the meteorologist on duty decided to issue a heavy precipitation warning for the civil protection authorities during the afternoon of 17 September. Following the protocols, a warning is issued when the expected amount of rain exceeds 100 mm in 24 hours in the western part of Slovenia and 50 mm in 24 hours elsewhere. In this case, an extreme weather warning of more than 100 mm of rain in 24 hours was predicted in western parts of Slovenia in the period from 18 September 00 UTC. Local thunderstorms with heavy rain were also mentioned.

Weather developments on 18 September 2007

Outbreaks of rain first occurred in the area of interest between 05:00 and 07:00 local time (UTC +2 hours). A short drier period followed before further rain moved in around 08:00, with a line of thunderstorms passing through between 09:20 and 10:00. Less intense rain occurred over the following 40 minutes but further bands of convection developed and became quasi-stationary across the area of interest between 10:40 and 13:00. As a consequence were many landslides and flash flooding in Kropa valley and in the town of Železniki. During the remainder of the afternoon, further thunderstorms and

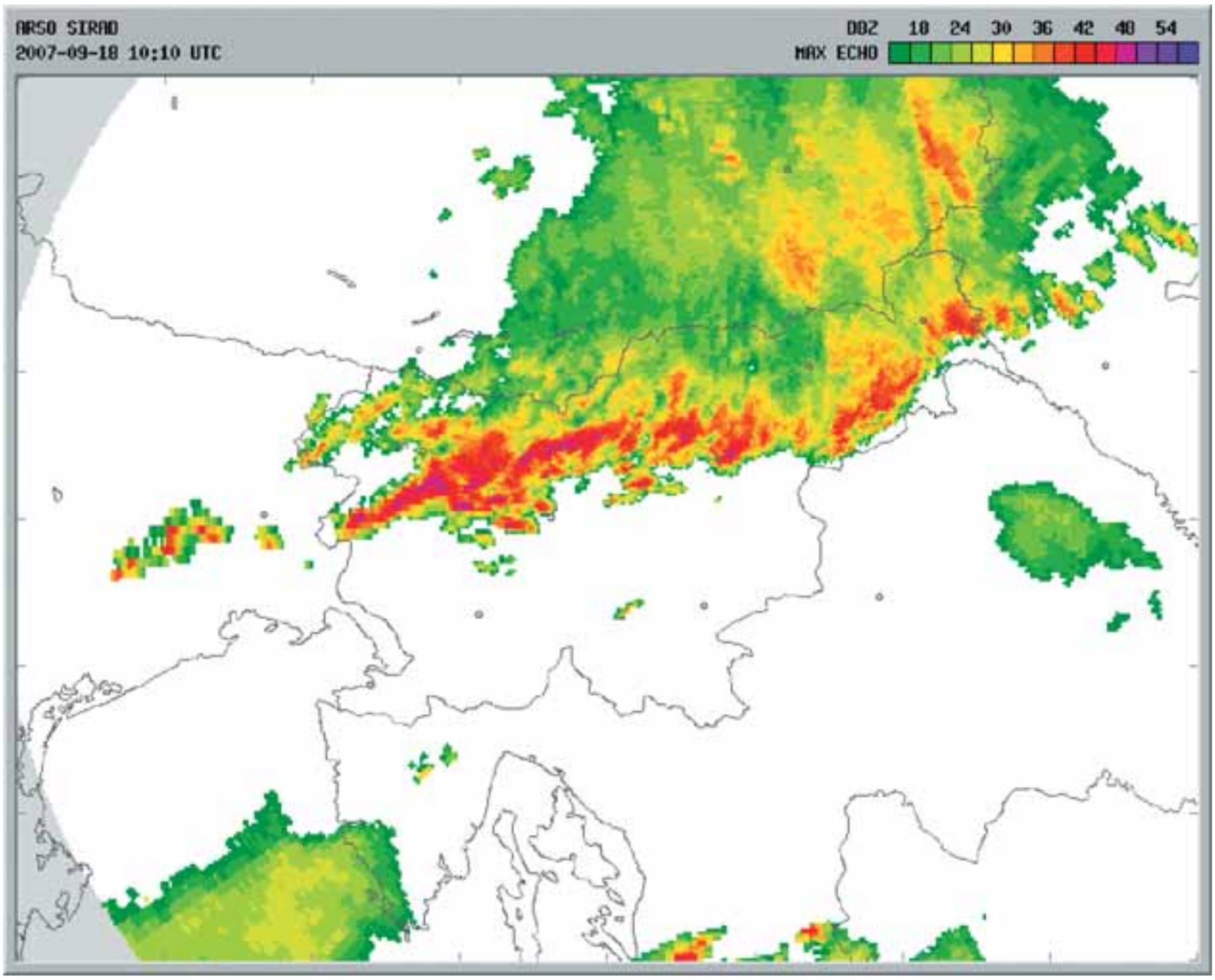


Figure 3: Radar image at 12:10 local time

heavy rain developed across the northern half of the country with the surface cold front clearing during the evening hours. Rain finally ceased at around 22:00 in the worst affected area.

Spatial and temporal distribution of precipitation

Most of the precipitation was recorded in a time period of 6 to 12 hours, within which the greatest return periods were calculated. In some places the return period exceeded 250 years. In Table 1 the highest 6 and 12 hour rainfall accumulations with return periods are presented whilst Table 2 shows some daily (18 Sep. 08:00 – 19 Sep. 08:00) amounts also with return periods.

	Highest 6-hour accumulations		Highest 12-hour accumulations		Daily (24 h) accumulation
Location	Precipitation (mm)	Return period (years)	Precipitation (mm)	Return period (years)	Precipitation (mm)
Lesce	145	> 250	176	> 250	180
Rudno Polje (1250m)	125	10	203	15	214
Ljubljana airport	115	> 250	176	> 250	181
Krvavec (1700m)	91	10	145	20	151
Gorenja vas	43	1	78	5	82

Table 1: The highest 6 and 12-hour precipitation accumulations measured at automatic weather stations with return periods. The data are presented for the affected region.

Stations	Precipitation amount	Return period (years)
Bukovo	224	25
Cerkno	140	25
Davša	230	250
Kneške Ravne	304	10
Naklo	135	10
Zgornja Sorica	233	50
Zgornje Bitnje	187	100

Table 2: 24 hour precipitation accumulations measured manually at 08:00 on 19 Sep. with estimated return periods. The data are presented for the affected region.

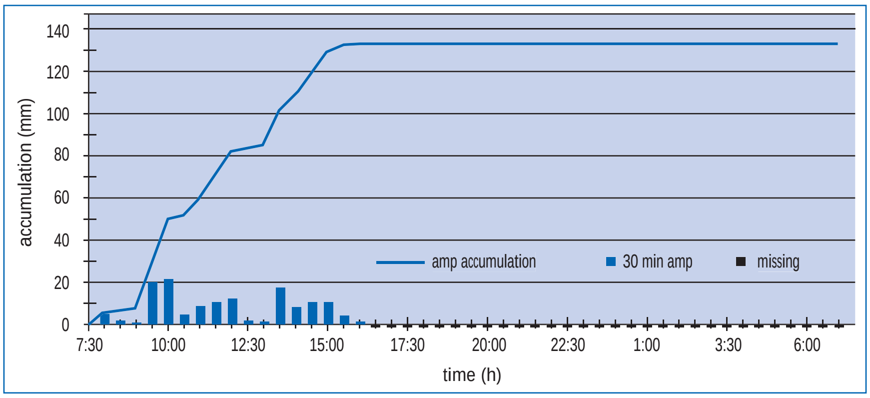
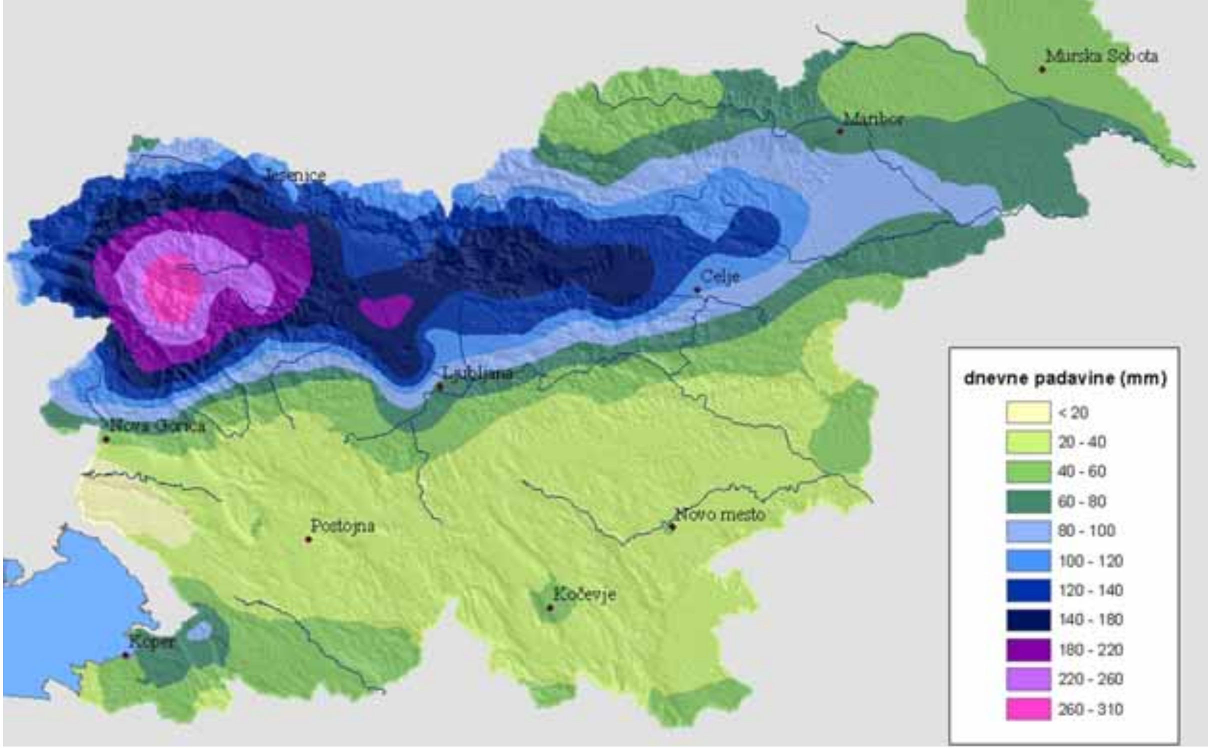


Figure 4: Accumulated precipitation in Suha

The intensity of rainfall can also be seen graphically in Figure 4 (below). The station is located in Suha, some 20km downstream from the worst affected town of Železniki. Rainfall intensities upstream of Železniki were estimated to have been even greater.

Figure 5 (below) shows the spatial distribution of rainfall accumulations in the 24 hour period from 08:00 on 18 Sep. 08:00 to 08:00 on 19 Sep. Note that more than 100 mm of rain was measured across the northern half of the country except in the lowlands of NE Slovenia. Peaks of more than 200 mm appeared in the region of the Julian Alps, where amounts of more than 300 mm were measured in some places.

Figure 5: 24 hour rainfall accumulation from 08:00 18 Sep. to 08:00 19 Sep.



The impact of heavy precipitation in Selška dolina (valley)

The worst affected place was the town of Železniki, a rural community with 7000 inhabitants situated in Selška dolina (valley). It is estimated that almost half of the population were affected by the rising floodwaters. The river Sora flows through the town and has many tributaries upstream that flow down steep terrain. Due to heavy rainfall in that region during morning between 09:00 and 10:00, the rivers and torrents began to rise. Intense rainfall continued and between 13:00 and 14:00, the discharge rates of the river Sora upstream of Železniki increased dramatically. The river burst its banks within 30 minutes. In Železniki the peak was reached at 14:00 when the water level was 370 cm above normal with a discharge rate of around 170 m^3/s. This represents a discharge rate with a return period of 50 to 100 years. The river was in a state of severe flood for only 1 to 2 hours and subsided very rapidly. Figure 6 shows the discharge of the Sora at the flow gauge in Suha, 20km downstream of Železniki.

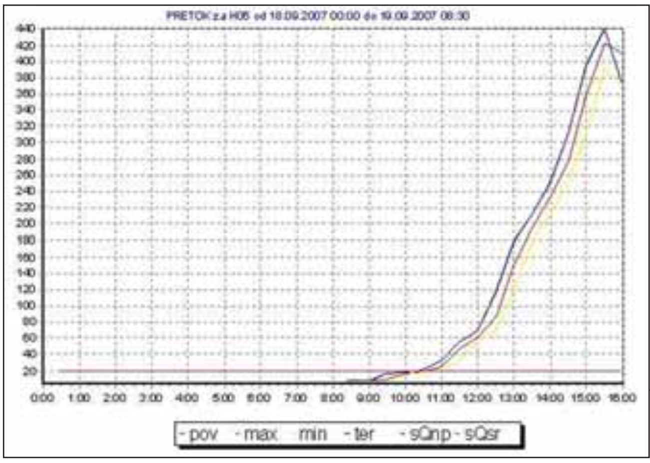


Figure 6: Discharge of the river Sora at Suha on 18 Sep.

The speed at which river levels rose and discharge rates were exceptional. The re-sulting floodwaters caused a lot of damage to buildings, factories, traffic routes and the local infrastructure and also resulted in the loss of personal belongings. The estimated damage in Železniki alone was around 70 million €. The reason for such a destructive situation was due to the intensity of rainfall over a very complex terrain, with rapidly responding river systems.

Was there any pressure on the forecaster?

The answer to this question is partly yes and partly no. First of all, the forecaster reacted correctly on 17 September when the warning was issued and sent to the civil protection authorities 20 hours before the event. Of course, the extreme rainfall amounts were underestimated but locally heavy rain was forecasted for western parts of Slovenia. A post-event analysis of the situation has showed that with existing tools, the prediction of the exact location and duration of the heavy precipitation was not possible. As a result there was no blame on the forecaster and in this case no pressure was applied. However, a week after the event another active frontal system was forecast to affect the same region. The pressure rose from day to day, particularly with increased interest from the media who wanted to

Figure 7: Destruction in Železniki from floodwaters.

know if the impacts would be the same in the town of Železniki. The forecaster on duty was also under pressure to issue a new warning, although he thought that the amount of precipitation would not be so high and a warning would not be necessary. No formal warning was issued but the civil protection authorities were kept informed twice a day with the forecasts for the amount of rain expected in that region. Due to the vulnerability of the terrain and because the river banks were damaged, the fear of the people was understandable. The second case passed without any floods and no additional damage occurred.

Conclusion

Bands of quasi-stationary convection were responsible for high amounts of rain which caused flash flood. A warning had been issued but the extreme amounts of rain were underestimated. The forecaster was not able to predict the exact location and the duration of heavy precipitation with existing tools. In future the improvement of predictability of locally heavy rain could be reached by a better description of the initial state of numerical models (assimilation of more qualitative data) and by objective diagnostics of NWP outputs (could be realised by implementing the INCA system). In further work, existing methods for extreme precipitation diagnosis should be investigated and implemented into operational work. Some adaptation to the complex terrain of northwestern Slovenia would be necessary. The studies of comparable extreme events in alpine regions within international projects such as MAP or ESTOFEX will contribute to a better understanding and predictability of such extreme events.

Janez **Markošek**,
EARS, Ljubljana, Slovenia

Arome, the new high resolution model of Météo-France

Introduction

In 2007, the numerical forecast system of Meteo-France was based on a global model, Arpège and a limited area model, Aladin. This operational system will be complemented in 2008 by a new high-resolution model named Arome.

The characteristics of Arome will be presented, as well as some preliminary results of its potential capability and skill through a selection of model fields.

Characteristics

The aim of the Arome project is to improve local forecasts, especially for dangerous convective phenomena (thunderstorms, flood risk, heavy precipitation) and low-level conditions (wind, temperature, ground state, fog, heat islands, etc). The tool used is the Arome software, based on a new model with its own data assimilation.

Model features

- Fine horizontal grid of 2.5 km for a better surface description (see Fig 1)
- Non-hydrostatic model with prognostic cloud representation (clouds with ice and hail/graupel phase, 3D advected hydrometeors)
- Prognostic turbulent mixing
- Sub-gridscale shallow convection
- The physical model for surface/atmosphere interaction is named Surfex. It uses a high resolution land database over Europe to represent detailed geographical features such as vegetation, soil types, seas, lakes, cities, snow, ice, etc.

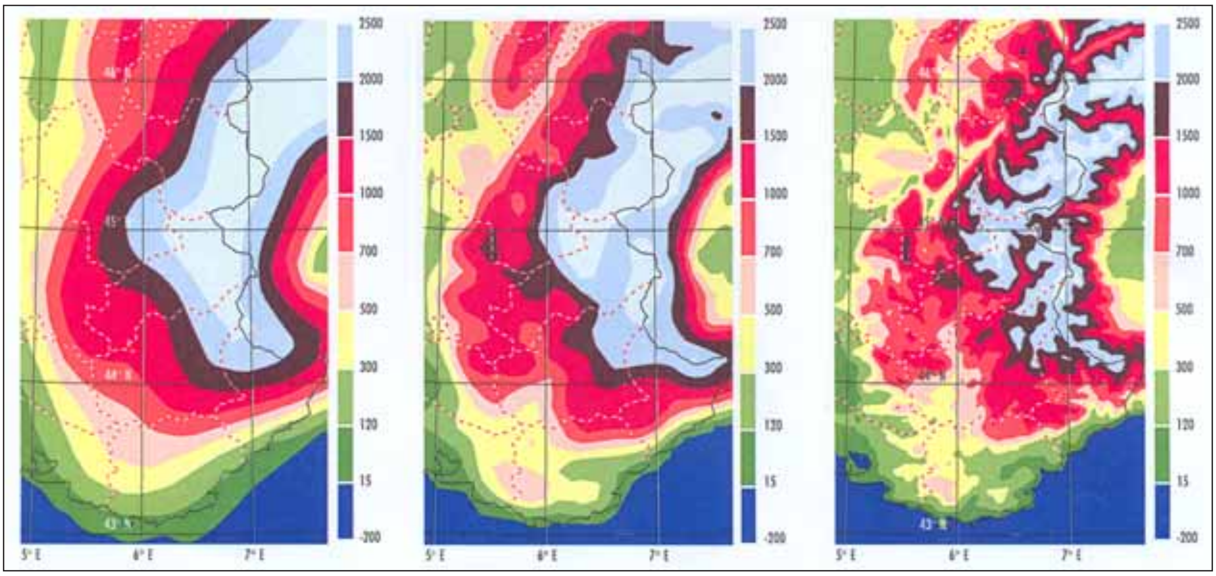


Figure 1: Orography in the Alpine region - Arpège (left), Aladin (middle), Arome (right).

Assimilation

The analysis is based on a 3DVAR assimilation process similar to Aladin but with a higher density selection of observations over France. One of the most interesting features is that Arome will assimilate radar data (Doppler winds and 3D reflectivities) and satellite radiances.

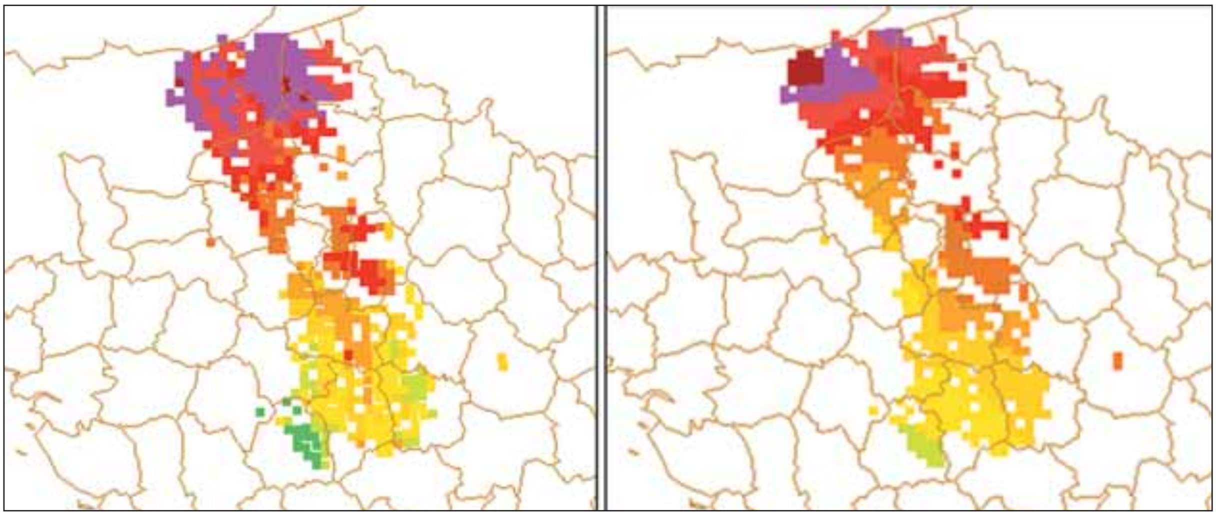
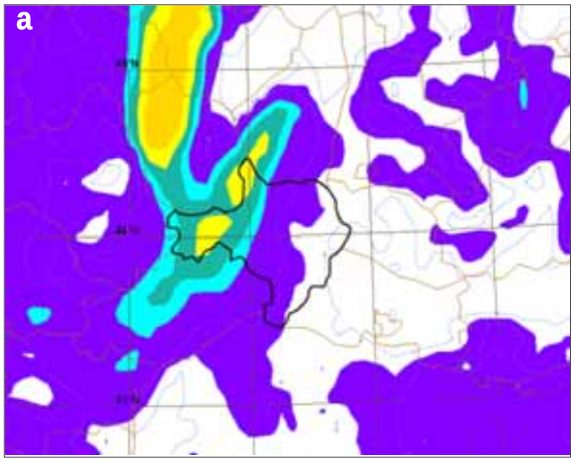


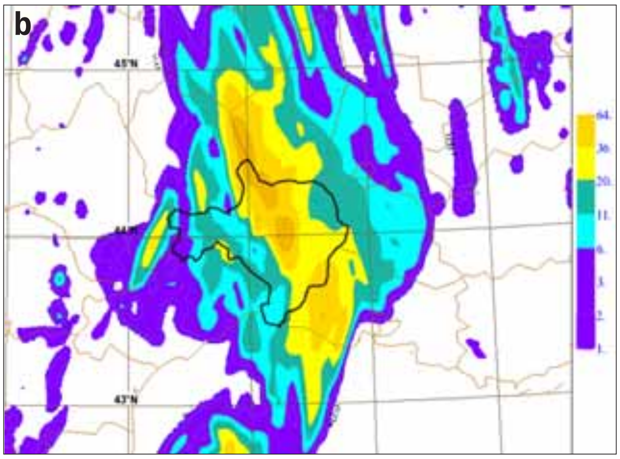
Figure 2: Radial Doppler winds observed by the meteorological radar in Trappes (top) compared to winds simulated by a model (bottom). These data are interpolated at the same spatial resolution, 10 km. (Doppler radar information can be ambiguous and is difficult to interpret directly. However, it can be easily incorporated into the 3DVAR assimilation to improve the wind field analysis).

First results

Heavy precipitation events

The most anticipated contribution of Arome is its ability to forecast heavy rain especially during Mediterranean events named “Cevenol events”, in





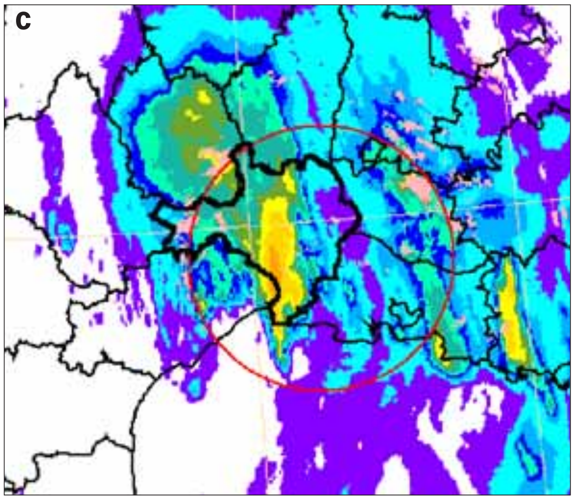


Figure 3: 3-hour rainfall accumulation during the flooding episode of September 6th, 2005.

Top: Forecast by Aladin;
Middle: Forecast by Arome without own assimilation;
Bottom: Analysis based on observations (radar adjusted by observed data).
Arome is better than Aladin although its initial conditions and boundaries are provided by Aladin

reference to the Cevennes mountains on the southern side of the Massif central where heavy rains occur during southerly flow, especially in autumn. Although the assimilation system is not yet complete, initial tests have shown that Arome forecasts are much more realistic than those given by Aladin and Arpege in terms of timing and rainfall distribution, especially during intense events, although the precise location of the rainfall features is not always accurate. Furthermore, the initial tests were carried out using a direct coupling of Arome to Aladin without high-resolution assimilation. Some additional improvement has already been shown when high-resolution assimilation has been used in other experiments.

Heavy convective features

Arome is able to forecast isolated heavy thunderstorm cells and their associated gust fronts. Intense line convection and banded structures within frontal systems are also well predicted by the model. One key point of Arome is the good forecast of squall lines forced by orography and convergence.

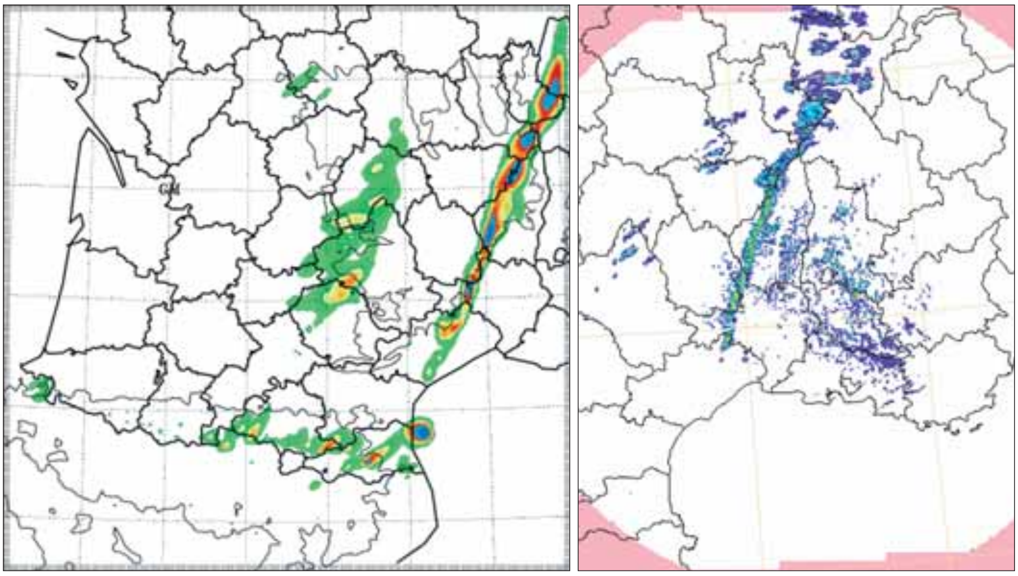


Figure 4: Example of a squall line associated with low-level convergence forced the combined orographic effects of the Pyrenees and Massif central. Left: Rainfall forecast by Arome; Right: rainfall observed by radar.

Fog

Features in Arome such as explicit boundary layer forcing and fine scale humidity analysis seem to have the potential to improve the forecasting of fog development and dispersal.

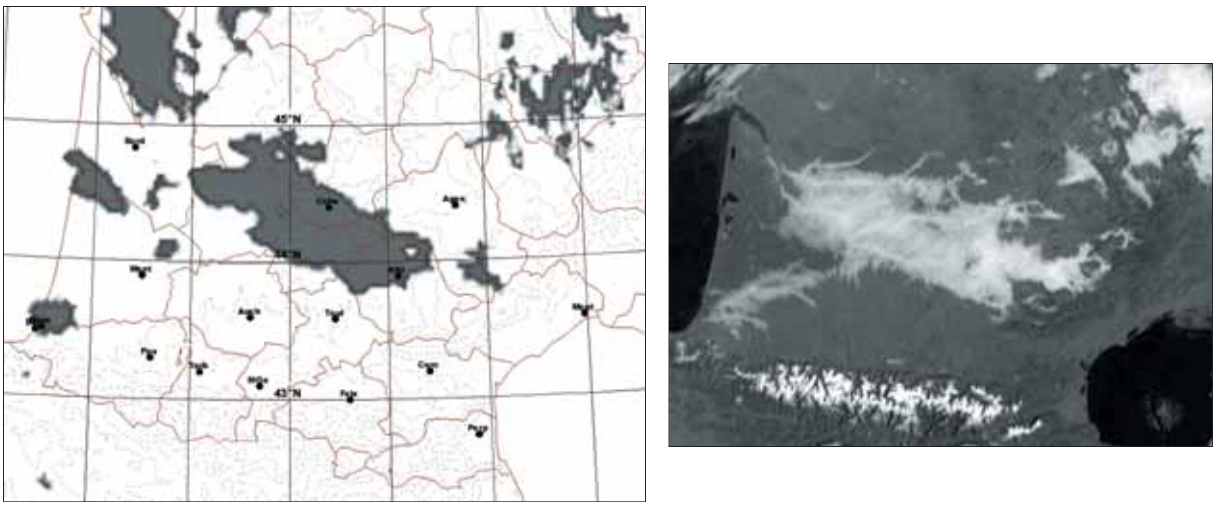
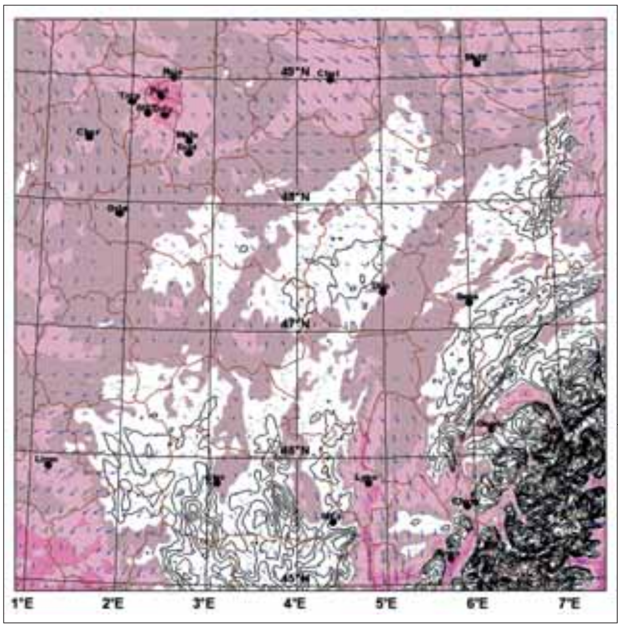


Figure 5: Example of a fog forecast by Arome (fog forecast is in grey on the left map) with observed fog distribution on the right (based on the Meteosat visible image, the area of fog over southwest France appears in light grey).



Impact of finer grid resolution

The higher resolution of the model improves the meteorological impact of geography in a spectacular way. For instance, the meteorological effects of cities, coasts and large valleys are well represented: urban heat islands, diurnal cycle of sea breezes and valley breezes, frost zones, local winds forced by orography etc.

Figure 6: Arome simulation of 2m temperature on February 10th 2006 over north-eastern France. Note in pink the 'hot' spots in the big cities (Paris, Lyon) and the relative mildness of Lake Leman. The white areas indicate frost on higher ground and in mountainous areas.

Conclusion

Arome is being tested in close co-operation with forecasters during autumn and winter 2007-2008. Continuous improvements are being made by researchers with particular attention towards stratiform clouds and light precipitatio.

A fully operational system should be implemented in autumn 2008. It will be a great challenge to forecasters to use this model in the appropriate way. To do that, forecasters must have the best possible knowledge of mesoscale meteorological features in order to interpret the model fields.

Like any other numerical forecasting system, Arome is intended to improve and diversify towards new applications. Amongst these, the following are likely:

• Very short range forecasts with frequent updates of the model run

• Introduction of a high resolution ensemble forecast system

• Evolution of a very high resolution system for local applications (factories, airports, big cities, etc.) thanks to an integrated approach to the modelling of the environment.

François **Bouttier** et Bernard **Roulet**,
Météo-France

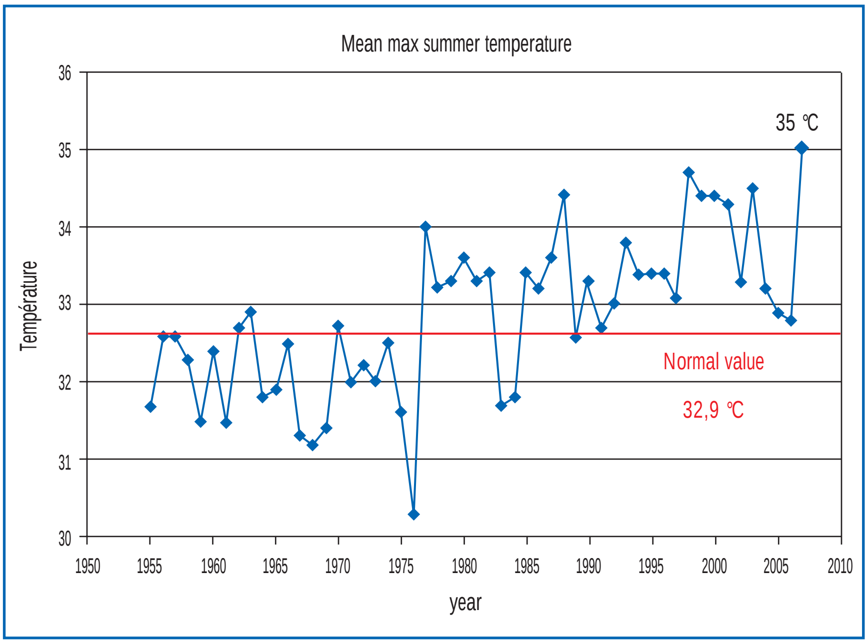
Heat waves in Hellas, summer 2007

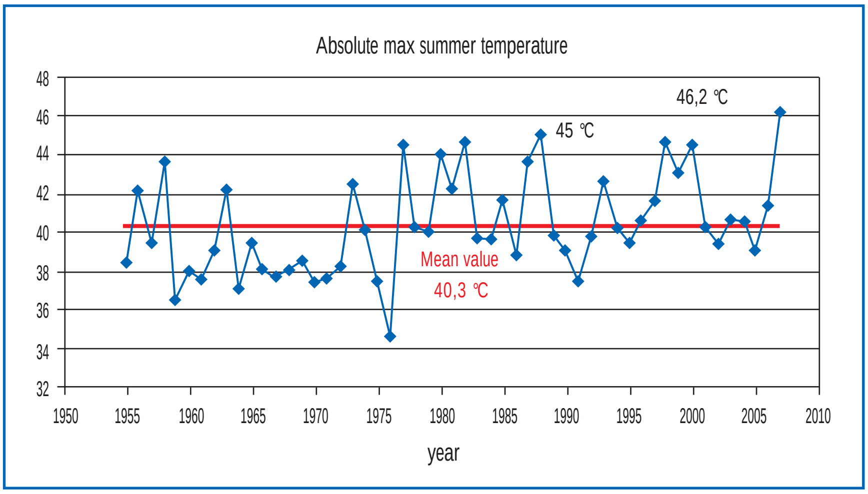
Introduction

Summer 2007 was characterised as the hottest period for at least fifty years as three records were broken: (i) the absolute maximum summer temperature reached 46.2 °C (ii) the number of days with T_{max}>=36.5 °C was 30 and (iii) three intense heat waves of long duration occurred for the first time in various regions.

Background

Summer in Greece is usually “hot”. The climatological mean maximum summer temperature, over the time period under examination, is 32.9 °C and the mean of the absolute max temperature for the same time period is 40.3 °C. On the other hand the number of days with T_{max}>=36.5 °C varies from 0 to 30 and the number of days with T_{max}>=39.5 °C varies from 0 to 10. These facts are shown graphically in the following diagrams.





Data and Methodology

The number of days during the summer period in Athens with maximum temperature above two thresholds, 36.5 °C and 39.5 °C has been analysed. Moreover the heat waves which occurred during summer 2007 and their characteristics are also presented.

Observational data from an urban station in the Attica region and a semi-urban station in the central mainland of Greece, for the period 1955-2007, have been used to form the basis for the study.

Analysis and Discussion

Based on an analysis of the above data series we see that:

• Both the mean maximum and the absolute maximum temperature show a significant increasing trend over the last 30 years

• Both the number of days with T_{max}>=36.5 °C and the number with T_{max}>=39.5 °C also show a significant increasing trend as shown in the following diagrams.

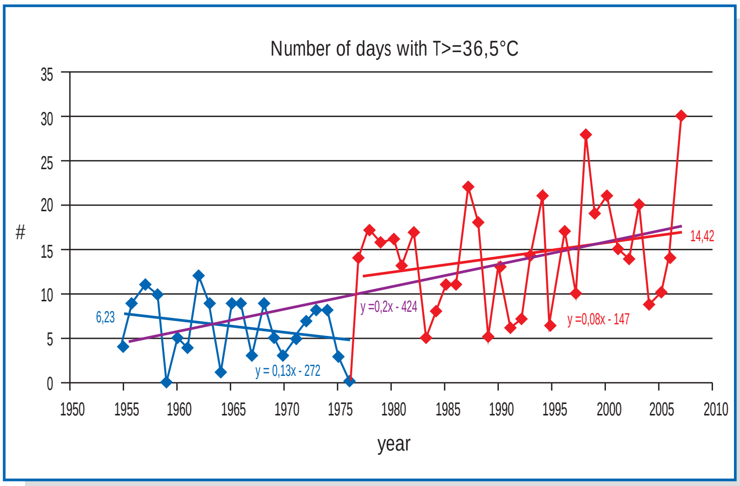
It is however remarkable that:

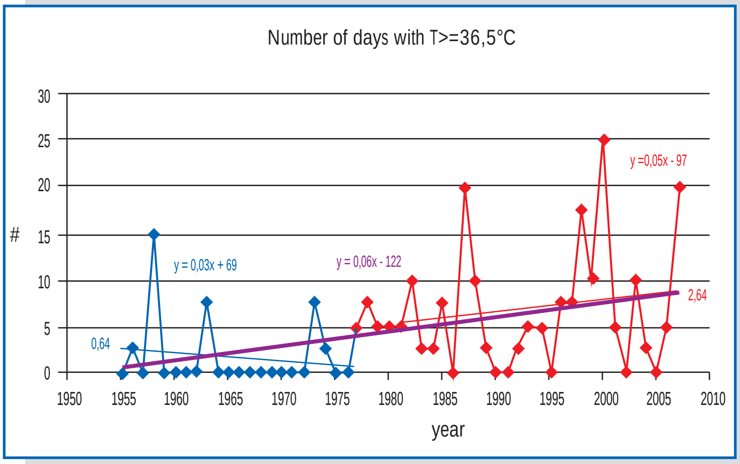
The time period can be divided in two sub-periods (i) from 1955-1976 and (ii) 1977-2007 as far as their characteristics are concerned.

• In the first sub-period almost all mean maximum summer temperatures are lower than the normal value whilst during the second almost all mean maximum summer temperatures are higher than the normal value.

• The same is true for the absolute maximum summer temperatures with almost all values lower than the mean value in the first sub-period but during the second sub-period almost all absolute maximum summer temperatures are higher .

• The average number of days per each summer with T_{max}>=36.5 °C is around six (6) during the first sub-period with a decreasing trend, and more than double (14) during the second sub-period which, on the contrary, exhibits an increasing trend.





• The average number of days per each summer with T_{max}>=39.5 °C is 0.64 during the first sub-period but this is more than quadrupled (2.64) during the second sub-period which again shows an increasing trend.

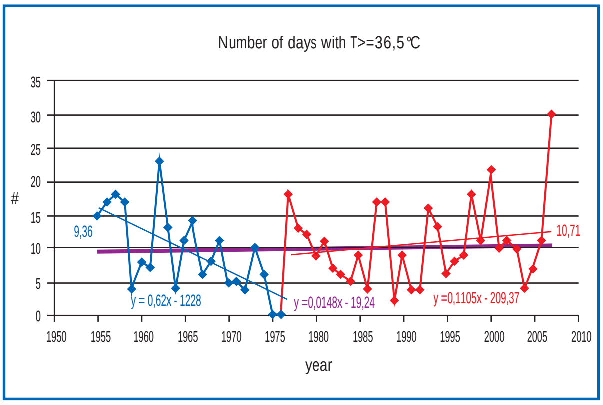
Why is there a “gap” observed between the two sub-periods?

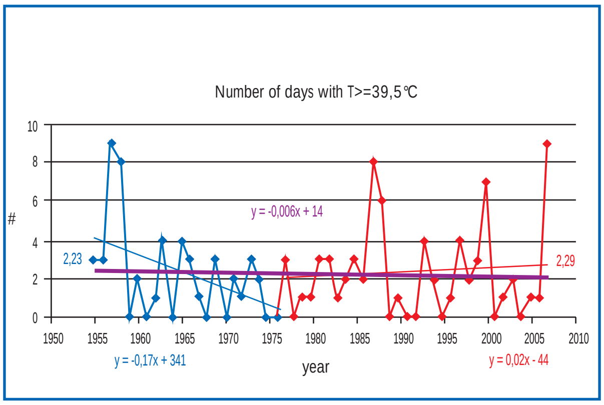
The answer may be either due to the heat island phenomenon or climatic change or even linked to human activities in the broader area around the station site (urbanisation, land use, etc.). In an attempt to attribute one of these three possible factors to the “gap”, data from another semi-urban station (Larissa) was selected for additional analysis. The station positions are shown on the map below.

For Larissa, it is found that:

• No significant trend is observed in either the number of days with Tmax>=36.5 °C or with T_{max}>=39.5 °C, as shown in the following diagrams

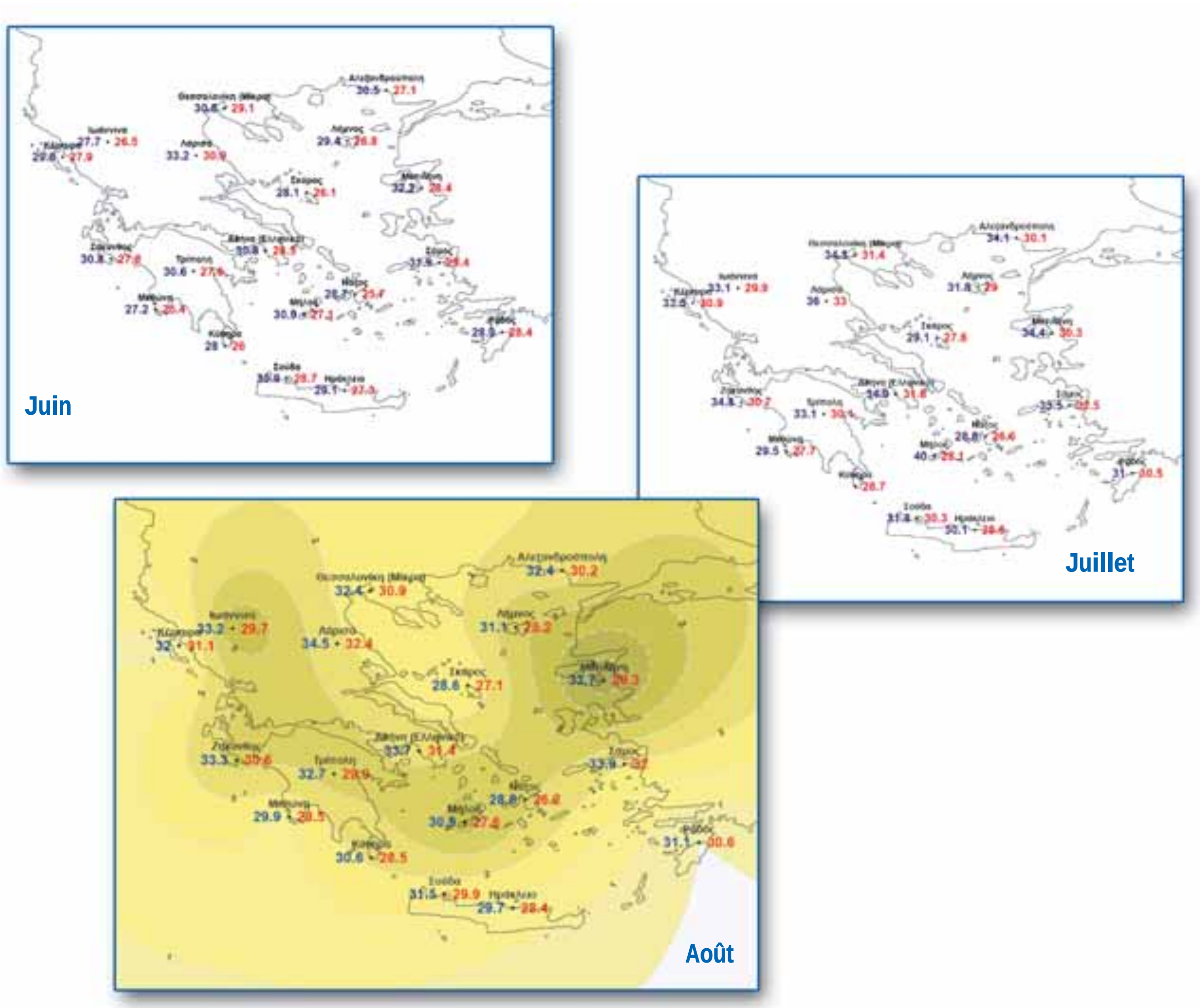
• No significant “gap” is observed between the two sub-periods.





Summer 2007

The characteristics of summer 2007 have already been mentioned in the introduction. In the maps below the climatological (1961-1990) temperature values (in red) and those observed during summer 2007 (in blue) are shown at a selected number of sites across Greece.



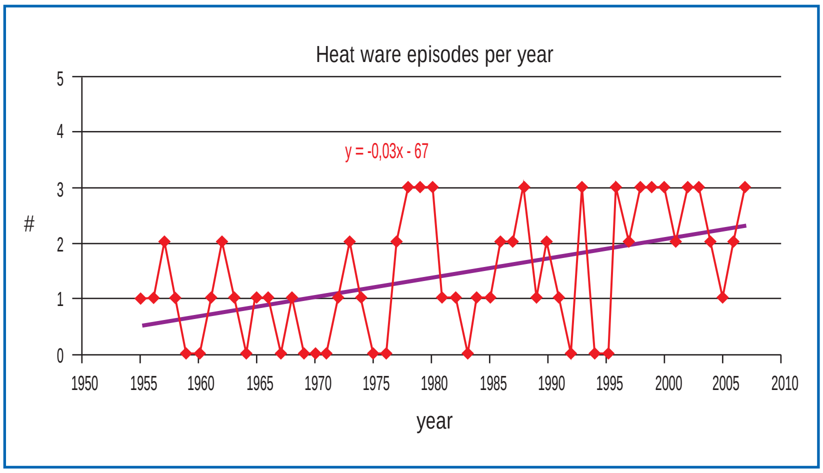
Heat waves

Research has been focused further on heat waves, since they can be related to the large-scale atmospheric circulation. The definition criteria for a heat wave in Athens are:

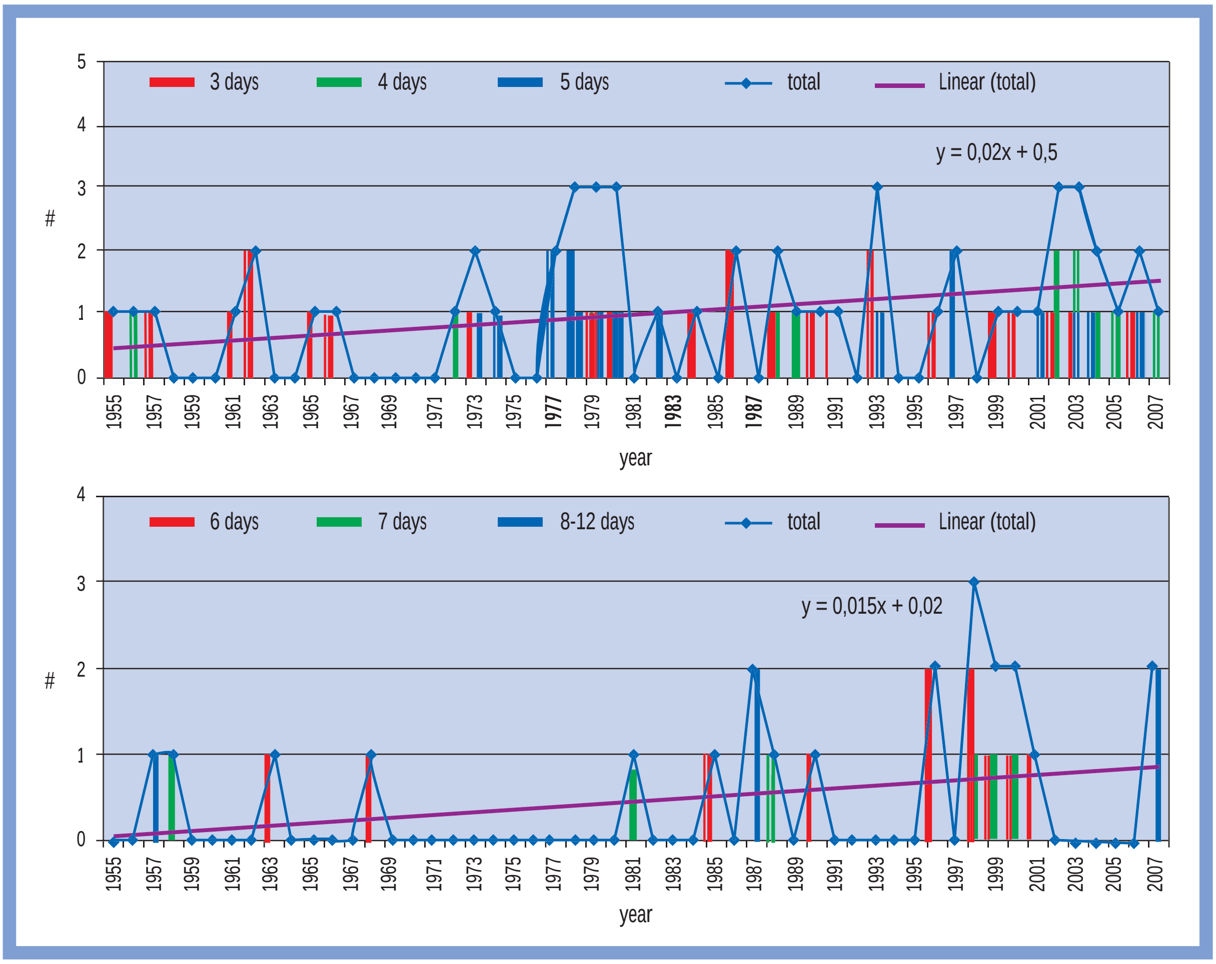
- at least 3 consecutive days with max air temperature >= 38 °C
- light winds
- sunshine

The above criteria are also used for the issue of warnings.

The following diagram shows that there is a clear increasing trend in the number of heat wave episodes in Athens over the last 50 years.



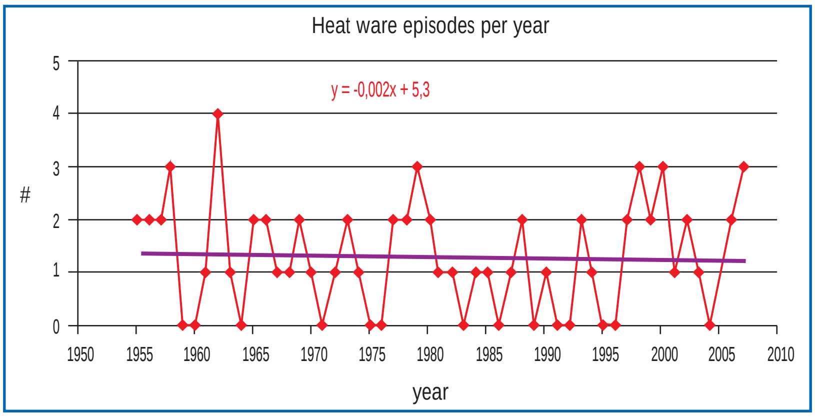
Given that this trend has been identified, heat waves in Athens were divided further into two categories relating to their duration: in the first group heat wave episodes of 3,4 and 5 days were included and in the second heat wave episodes of 6, 7 and 8-12 days were taken into account. The analysis is shown in the figures below.

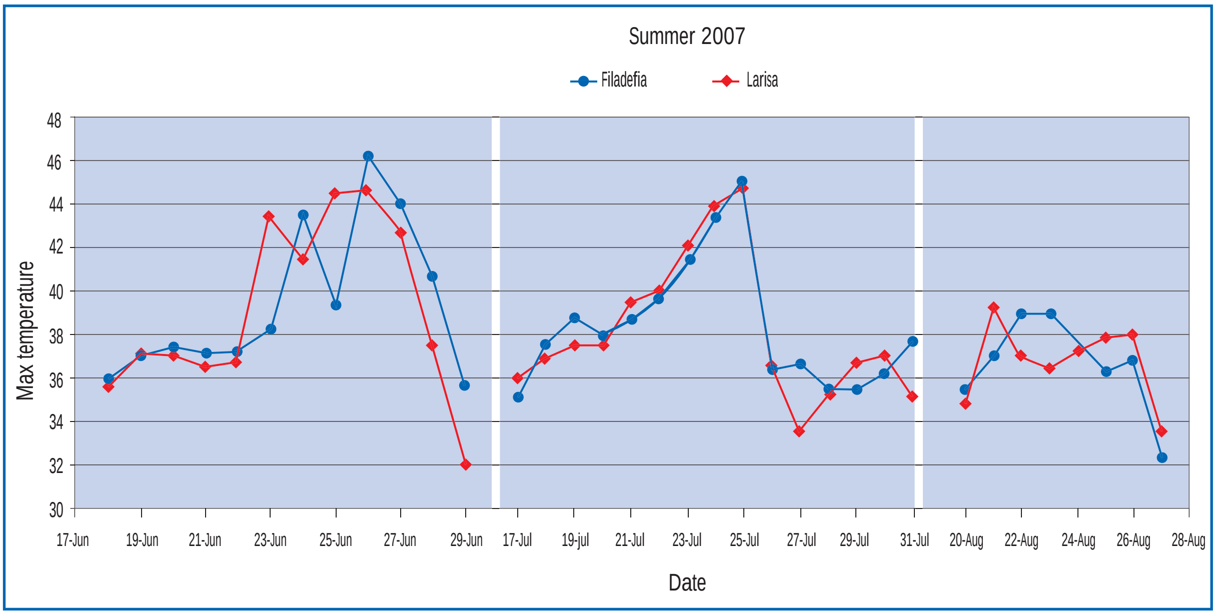


It is particularly interesting to note the increasing number of heat waves lasting at least 6 days, a factor that could be potentially related to climatic change. However, the situation in Larissa is quite different from that in Athens since no trend in the number of heat waves has been observed there (shown in the next diagram).

During summer 2007 however, three intense and long lasting heat waves were recorded for the first time in both Athens-Filadelfia (June 10 days, July 8 days, August 4 days) and Larissa (June 7 days, July 7 days, August 3 days).

It has to be mentioned though that, based on 10-day analyses (not presented here), the number of heat wave incidents recorded is a maximum during the first 10 days of both July and August with lower numbers in-between. This is most probably because of the increased activity of the Etesian winds.





Conclusion

Summer 2007 produced the hottest period in Greece for at least 50 years. For the broader area in and around Athens there is no doubt that the increasing trend in the number of heat waves and the high temperatures observed is mainly due to the heat island phenomenon and urban activities. Over the rest of the country, using many representative stations in both rural and urban areas, it was found that similar behavior can be observed in other cities as well, both in the northern and central mainland. For coastal and island stations no trend is observed as they are influenced primarily by the sea and the prevalence of the Etesian winds.

Chryssoula **Petrou**,
NHMS, Hellas