The Project MAP D-PHASE

Introduction

In 2004, the MAP (Mesoscale Alpine Project) Steering Committee mandated a working group to explore the possibility and interest of a fourth phase, that of demonstration. From the many achievements of MAP, the following have been chosen as the topic for the MAP Forecast Demonstration Project (MAP FDP):

- Forecasting heavy precipitation and related flooding events in the Alpine region

- The associated issues of orographically enhanced precipitation.

- High-resolution numerical weather prediction and hydrological processes.

The project thereby addresses the entire forecasting chain ranging from observations, ensemble forecasting, high-resolution cloud-resolving atmospheric modelling (km-scale), hydrological modelling, and nowcasting to decision making by end users (civil protection authorities, water management and hydrological agencies, etc.), i.e., it sets up an end-to-end forecasting system.

To emphasize the main objective of the fourth phase of MAP, the MAP FDP is referred to as D-PHASE, which stands for Demonstration of Probabilistic Hydrological and Atmospheric Simulation of flood Events in the Alpine region. It is a Forecast Demonstration Project (FDP) of the WWRP (World Weather Research Programme of the WMO). The neighbouring Alpine countries have entered this project.

Objectives

The main objectives of the project are:

- Assessing the degree of predictability for precipitation and flood events as a function of event size, precipitation amount, event character (e.g. convective versus stratiform), and lead time;

- Demonstrating the potential of operational high-resolution atmospheric models in capturing the relevant processes responsible for heavy precipitation events in complex terrain;

- Demonstrating the ability of hydrological models to provide a timely and skilful forecast of runoff and water levels;

- Assessing the prospects of very short-term predictions of heavy precipitation and severe convection over orography, using tailored heuristic techniques and real-time observations from radar, automated surface networks, soundings, and satellites (nowcasting);

- Establishing a better link between atmospheric and hydrological scientists and the actual end users. This includes matching the improved possibilities from the hydro-meteorological models with the relevant needs of the end users.

MAP D-PHASE

The MAP D-PHASE project is the 4th and last phase of "MAP". It aims to demonstrate the benefits that MAP has brought to forecasting, in this case for heavy precipitation and associated flooding in the Alps. The demonstration has been carried out during the summer and autumn 2007. This project involves many meteorological and hydrological specialists at international and regional level.

A platform has been developed to visualize model generated alarms for different thresholds and accumulation times (3h, 6h, 12h, 24h, 48h and 72h) using approximately 24 models and 7 ensemble model products. The chosen areas represent a balance between meteorological and hydrological catchments. The 3 alert levels are determined according to return periods. The Platform allows visualisation of the meteorological model fields and meteograms, nowcasting tools (radar etc …) and hydrological information.

Every day the forecaster subjectively evaluates the quality of the guidance given by high resolution multi-models and ensemble approaches and also the utility of such a Platform (the model alarm approach). The importance of nowcasting tools versus models was also evaluated.

All the data, alerts and feedback are archived, mainly for verification purposes.

Finally, the feedback from the forecasters, hydrologists and end users will be analysed; meanwhile, the numerical models will be objectively evaluated.

The Visualisation Platform (VP)

The concept of the visualisation platform has been designed mainly by MeteoSwiss and realised by Next Generation Software (Salzburg, Austria); it allows the forecaster, the hydrologist and some end users to consult information such as deterministic and probabilistic models' alarm system, nowcasting tools, hydrological models etc. It is also through this platform that the users are able to submit their feedback.

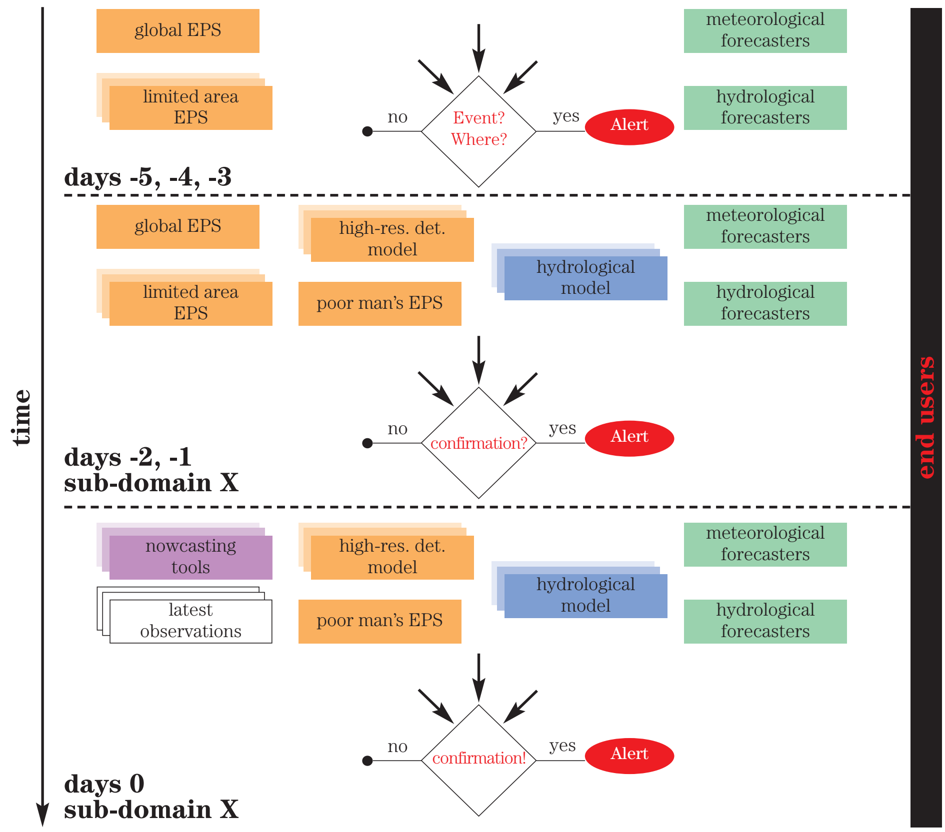


Figure 1: Conceptual sketch of the real-time end-to-end forecasting system for D-PHASE.

Forecasting Alarms

The diagram on fig 1 shows the decision process for issuing an alert. Between 3 and 5 days prior to the event, the forecaster analyses the ensemble forecast. The platform provides the average and the maximum precipitation of the ensemble. At this stage the forecaster can decide whether to issue a warning.

Between 1 and 2 days before the event, the fine mesh models are added to the diagnostic, each of them providing the maximum precipitation for a region. The alarm can be then confirmed or discarded. Meanwhile, hydrologists consult runoff models for various rivers.

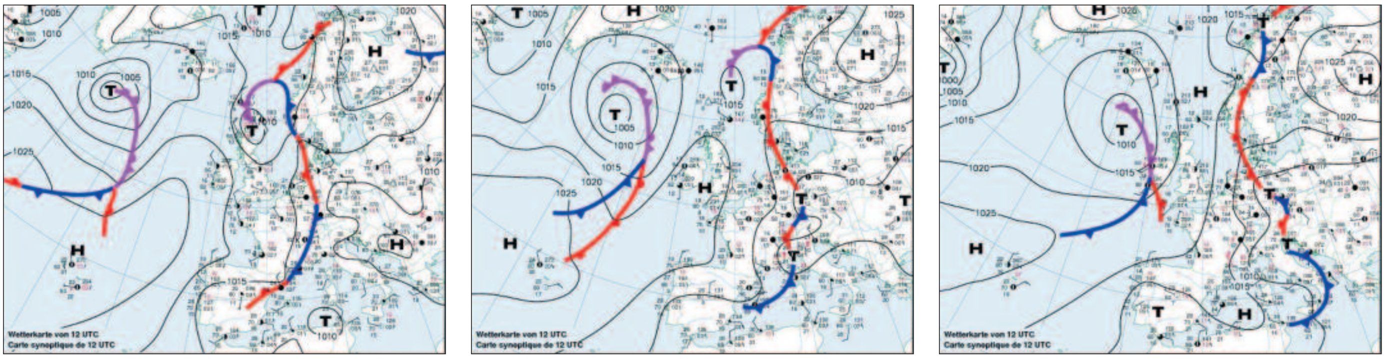
Finally, nowcasting tools are added to the analysis and help to localize and improve the forecast amount of rain.

Feedback by the forecaster

Every day during the experiment period, the forecaster fills an evaluation form which consists of the following:

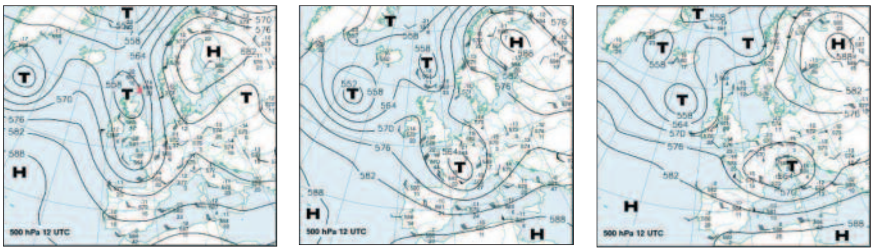
The description of the weather type, the type of event etc ….
Which model and data did the forecaster use for analysing the weather situation?
Which element supported the forecaster in his decision?

Similar feedback is provided by hydrologists and end users such as civil security officers.



▲ *Figure 2: a,b,c surface chart analysis on respectively the 7th, 8th and 9th at 12z.*

▶ *d,e,f 500 HPa chart on on respectively the 7th, 8th and 9th at 12z.*



Case Study: Heavy Rain Between the 7th and 9th August 2007

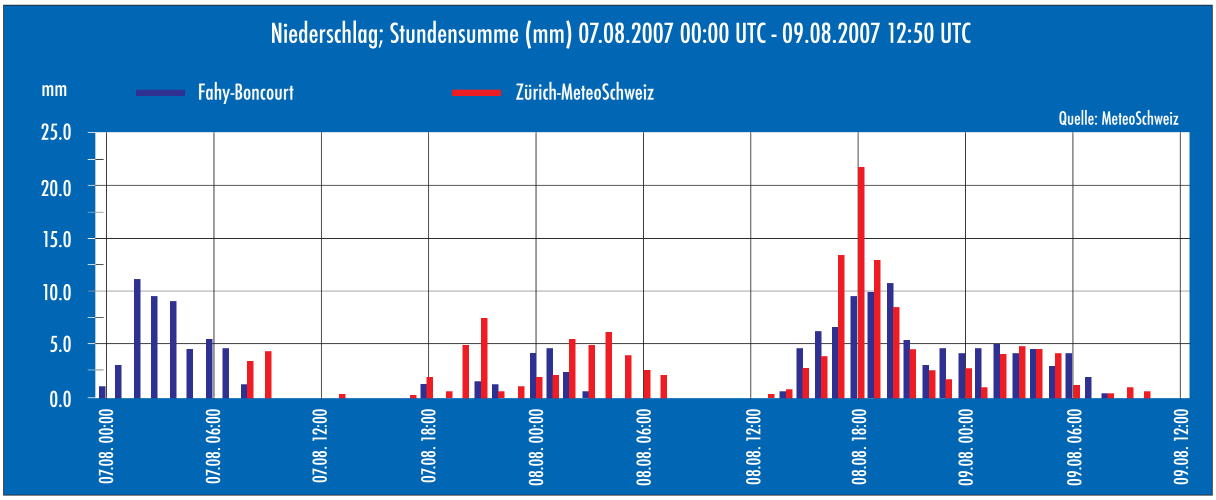
Many flood warnings were issued in Switzerland during the demonstration period; the most serious happened between the 7th and 9th August. Fig 2 shows the surface and the 500 HPa chart at 12z on the 7th, 8th and 9th August.

On the 7th, a front, associated with an upper trough, approached the western part of Switzerland. On the 8th, the trough created a cut-off centred over the “Massif Central” in France. The front started undulating and finally, on the 9th, the upper low moved eastward forcing the front to move backwards. These situations are known as “return from the east” and usually cause heavy precipitations in eastern Switzerland.

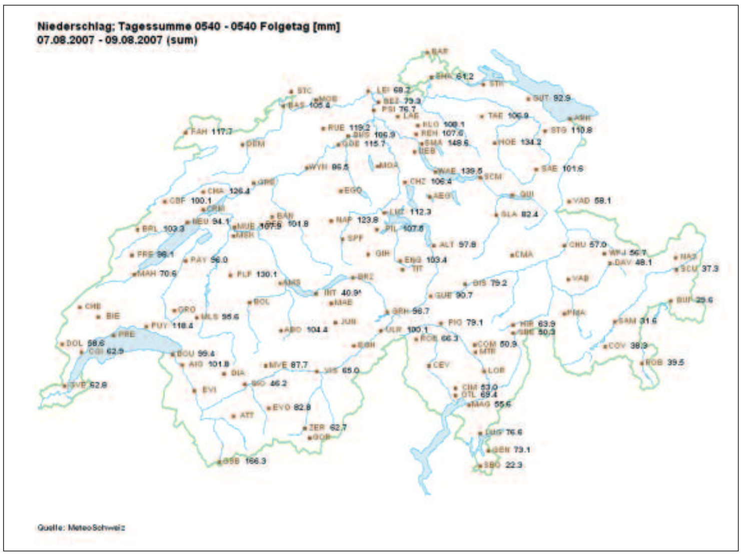
Figure 3 shows the hourly precipitation at Zurich and Fahy (50 km south west of Basel).

On the 7th, most of the precipitation was associated with pre-frontal instability, as a convergence zone moved eastward. On the 8th, the front produced moderate rain whilst crossing Switzerland and during the night of the 8th and the morning of the 9th; the heaviest precipitation was associated with the moist flow from the Mediterranean Sea.

The 72-hour total precipitation over Switzerland is shown in figure 4. The heaviest rain was recorded near Zurich, Basel and along the northern foothills of the Alps.



▲ *Figure 3: hourly precipitation at Zurich and Fahy.*

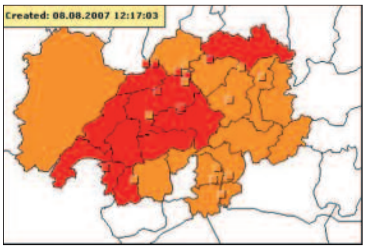


◀ *Figure 4: 72 hours precipitation from 6z on the 7th to 6z on the 10th.*

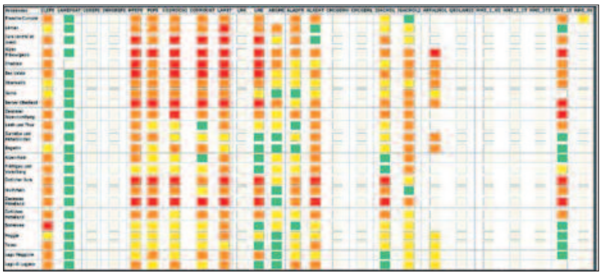
MAP D-PHASE platform

The visualization platform contains 3 levels; the maps shown here are as seen on the 8th August 2007 at midday. At level 1 (figure 5a) the map shows the regions coloured according to the degree of warning. The squares correspond to locations on rivers where runoff is measured. By selecting a square the hydrologist can access the model's runoff forecast. Since the data of many models are used in the platform, the alerts shown in this map correspond to the highest grid point value of precipitation of all models.

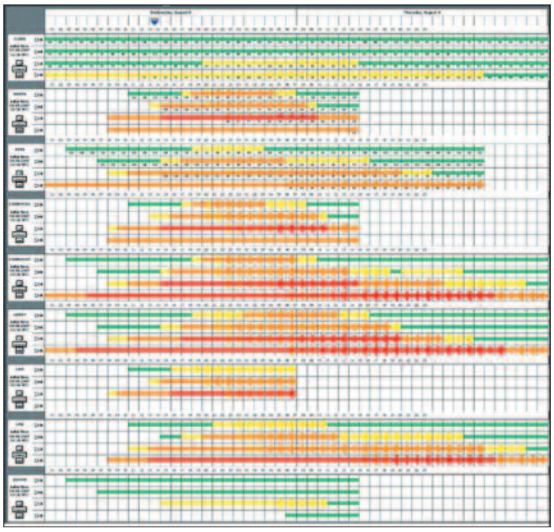
Level 2 (figure 5b) is reached by clicking on the map. It shows, for each region and each model, the highest degree of alert for each model. Finally, by selecting a region, the forecaster can reach level 3 (figure 6) which provides details on the duration of the alarm, the quantities of precipitation and when the threshold would be reached for which time-lag (3, 6, 12, 24, 48 and 72 hours). The triangle indicates the end of the alarm period. The colours, green, yellow, orange and red correspond to different alarm levels (green means no alarm). The levels are different for each region and fixed according to the return periods, respectively 60 days, 180 days and 10 years. The amounts of precipitation forecast by the deterministic and ensemble models are available on this level.



◀ *Figure 5a: Platform MAP D-PHASE, level 1; map of the alarms region.*



▲ *Figure 5b: Platform MAP D-PHASE, level2; details of the model alerts.*



◀ *Figure 6: Platform MAP D-PHASE, level 3; periods of thealerts.*

This example shows the benefit of such a platform Most of the models showed an alarm during this event, and moreover, it is possible to visualize the precipitation distribution for all models on the same format.

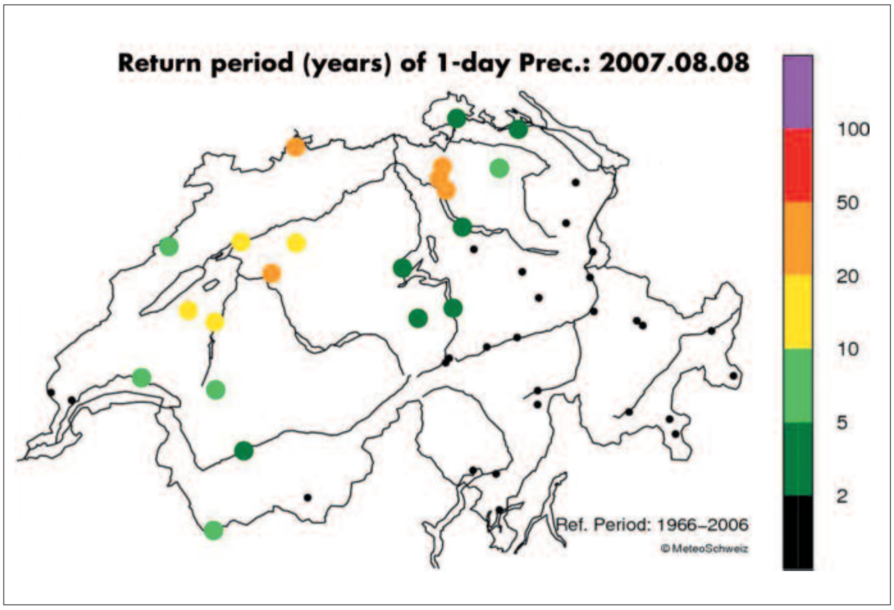


Figure 7: One day precipitation according to the return period.

Finally, figure 7 shows one day's precipitation (on the 8th August) according to the return period. The alarms issued during this event have been fully justified; the MAP D-PHASE platform has proved to be a valuable aid.

Conclusion

The demonstration period finished in November 2007. The feedback so far has been very positive, mainly concerning the visualisation platform. Its main benefit was to have all the model's alarms readily available on the same screen and on the same format. The strength of the platform is to be able to see the sum of the precipitation for different accumulation time and threshold. Usually, models provide precipitation accumulation over a fixed length of time.

Some informal contacts with hydrologists and end users have enhanced the usefulness of such systems. A large number of end users have been involved in this project; it contributed in bringing together the meteorological and hydrological communities.

The models verification will provide a feedback to the forecaster about its quality during the events. The forecasters have requested to include large-scale models such as ECMWF into such a platform, in order to monitor warnings 3 or 5 days prior the event.

Hopefully, WGCEF's web site would benefit from the visualization platform of MAP D-PHASE to construct a tool which will display different output models on the same format.

More details about this project are available at:
http://www.map.meteoswiss.ch/map-doc/dphase/dphase_info.htm

References

P.Ambrosetti, U.Germann, A.Hering, L.Fontannaz, M.Stoll (2007): MAP D-PHASE SEVERE CONVECTION FORECASTS. 4th European Conference on Severe Storms, 10 - 14 September 2007, Trieste (ITALY). http://www.essl.org/ECSS/2007/abs/06-Forecasts/ambrosetti-1177421726.pdf

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