Severe weather warnings at the German Weather Service – recent problems, developments and progress

Thomas Schumann, Deutscher Wetterdienst

Abstract

The prediction of severe weather and the issue of weather warnings are of vital importance in the DWD and has been fixed by the law of the Deutscher Wetterdienst. During the last years DWD's forecasts and warnings didn't always meet the users' expectations. The issue of warnings as early as possible has become a crucial topic. The warning strategy and some criteria have been changed; district-based warnings were introduced. Warnings, situation reports up to a week in advance and current weather data are now available on the web, updated frequently for free. Efficient tools were developed to maintain the content by the forecasters and for everyone to have access. Therefore, there is a need to improve observation and forecast methods. KONRAD, a radar-based system that allows a more reliable tracking of convective cells, was implemented. The COSMO-LEPS Model as a combination of the DWD's Local model and the ECMWF's EPS, is in experimental use. Preliminary results of the verification of COSMO-LEPS forecasts will be discussed.

1 Introduction

The preparation, transmission and the monitoring of early warnings, pre-warnings and severe weather warnings is the key tasks of the DWD. In 2002 the warning activity of the DWD has been heavily criticised by users, customers and the general public. The most spectacular cases are:

- 26 February 2002: An intense storm cyclone - a typical 2nd development storm - crossed the North Sea and Denmark. During the climax of the storm the maximum wind field passed northern Germany. Over widespread areas gusts above 120 kph were reported, gusts up to 180 kph at the North Sea coast caused severe damages of at least 25 M Euro. Three people were killed. The DWD's Global Model wasn't able to catch this rapid cyclogenesis.
- 10 July 2002: A thunderstorm squall line crossed Germany. Gusts up to 120 kph were observed, locally (Berlin area) gusts reached 150 kph. At least 10 people were killed. The synoptic situation was predicted by NWP models accurately. Warnings were already issued 6 hours in advance. Several customers and users were not able to use these warnings in a correct way.
- 12 / 13 August 2002: An intense cyclone, moving from the Adriatic Sea to Poland, caused extreme large scale precipitation, enhanced by embedded convection. Over wider areas in the Erzgebirge highlands and the Czech Republic precip totals exceeded 200mm within 72 hours. At the synoptic station Zinnwald, located in this area, were reported 312 mm – this was a record breaking 24-hour precip total. The resulting catastrophic flooding caused severe damages. 20 people were killed, approx 50,000 houses and flats destroyed. More than 1000 km of railway lines were out of service. NWP models had already shown a relevant signal 5 days in advance. The following NWP model(s) runs were inconsistent, the signal was gone. Predictions with a lead time of 48 hours or less were only useful. Further information is available in the ECMWF Newsletter No. 97, pp. 2-6.

For approximately 10 years, private weather companies have been active in the weather market. These companies require meteorological information, but they are not able to maintain NWP models. The company 'Meteomedia' has established their own (automatic) station network. Since January 2003, based on these observations Meteomedia has been providing area-district warnings. These companies are now on the offensive and attacking the DWD wherever it is possible.

Due to political reasons (reduction of official duties in Germany) the DWD has to cut its staff every year by 1.5 percent. In this sense the manned observation network has been reduced. Furthermore DWD is almost completely closing its commercial activities for the media during this year. Basic weather reports and essential weather information (warnings, current weather data) will be provided only. A serious fact is that the media are not treated by law to distribute severe weather warnings instantly. It depends from the tv or broadcast station and the moderator if, when and how a warning or weather report will be presented.

However an increasing number of the 'people on the street' are not able to understand warnings. Depending on their education level they are not interested in getting more comprehensive weather information and to understand the atmosphere's behavior. Severe weather risks will be neglected quite often.

Under these conditions – How should the DWD provide the general public with weather forecasts and reports, warnings etc. as has been fixed in the DWD's law? How could people be made aware of severe weather risks?

2 Modification of the DWD's warning procedure

During the last couple of years the world-wide-web has been penetrated completely by the public and private sectors in Germany, even the life of almost everyone. Companies, authorities, disaster protection staffs could access the web, more than 50 percent of all households in Germany are using the web. In this sense a huge gate has been opened for the DWD to reach 'the people on the street'.

So the DWD has changed its web policy dramatically and distributes forecasts, warnings and current weather data by itself for free. Almost everything of user relevant information is now available. The advantages are obvious:

- A direct way of weather information from the forecaster to the users
- No 'interpretation' by broadcast or TV moderators anymore, no loss of information caused by reduced presentation time or limited layout windows in papers etc.

To reach the 'people on the street' the DWD has had to change its language. Meteorology is not a subject matter at school, most of the people are not able to distinguish between a shower and large-scale rain - and they are not interested to in learning it. Warnings and weather reports have to be understandable by everyone. The DWD has replaced some units and is now using, for instance, to describe the wind speed in 'kilometers per hour' instead of 'magnitude in Beaufort'. 'Kilometers per hour' will be understood by almost everyone, whereas the Beaufort scale is only familiar to people near the sea. Additional information describing possible damages like 'Roofs will be removed, widespread destruction likely, roads are blocked, railway lines out of service ... if possible stay at home or inside of solid buildings.'

As a milestone on the way to improving its web content DWD has introduced in early 2003 district-based warnings. In opposition to the main private competitor – the company 'Meteomedia' which has started to display on the web district-based warnings a few weeks earlier – DWD is providing additional text information for free.

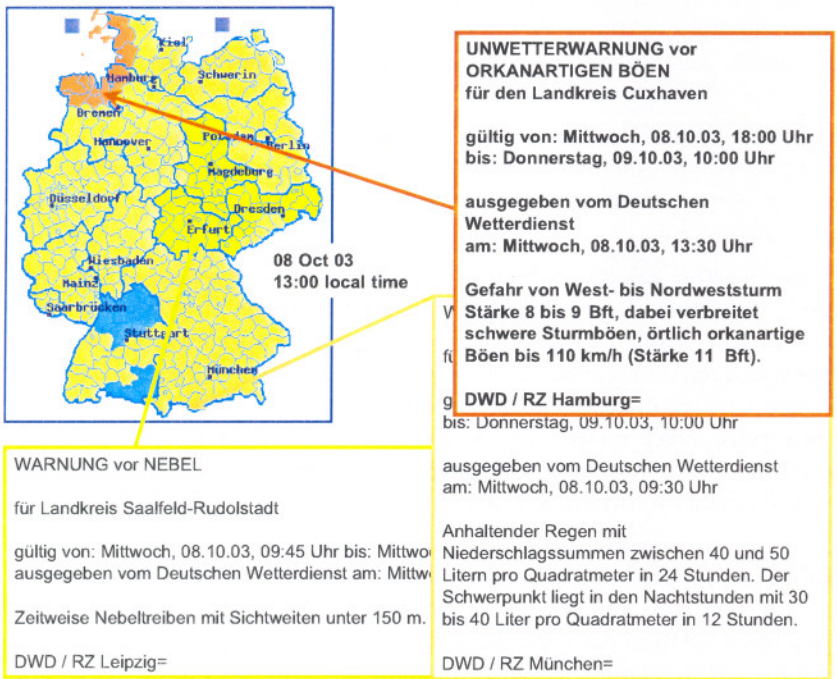

Fig. 1 District-based warnings of the DWD. After clicking the district the user is interested in, a pop-up windows appears providing warning text and additional information. The coloured areas indicate:
Blue: No warning active
Yellow: Weather warning
Ochre: Weather warning of a higher threshold, event could be dangerous (close to the threshold of severe weather)
Rose: Severe weather pre-warning
Red: Severe weather warning
Dark red: Extreme severe weather warning (new threshold)

Parameter	Old	New threshold	Extremely severe weather	Unit
Wind gust	> 104	> 104	> 140	km per hour
Heavy rain		> 25 mm		1 hour
		> 35 mm		6 hours
		> 40 mm	> 70 mm	12 hours
	> 15 mm	> 50 mm	> 80 mm	24 hours
	> 40 mm	> 60 mm	> 90 mm	48 hours
Snow		> 10 cm		6 hours
		> 15 cm	> 25 cm	12 hours
Above 800 metres	5 – 15 cm	> 30 cm	> 50 cm	12 hours

Tab. 1 Warning criteria, applied for severe weather warnings at the DWD.

Users may be confused: In the same area and at the same time different warnings active, generated by a different method, using discriminating warning criteria: At one web site the DWD's warnings and on the other web site the warnings generated by the Meteomedia company.

3 Improvements in remote sensing technologies

Political facts as mentioned above needs the introduction of improved remote sensing techniques suitable for small-scale regionalized predictions. A step in this direction was the pre-operational implementation of the system 'KONRAD'– KONvection in RADar. As a part of the German radar network covering Germany almost completely KONRAD provides radar scans every 5 minutes within a 100 km radius. This allows the tracking of convective cells.

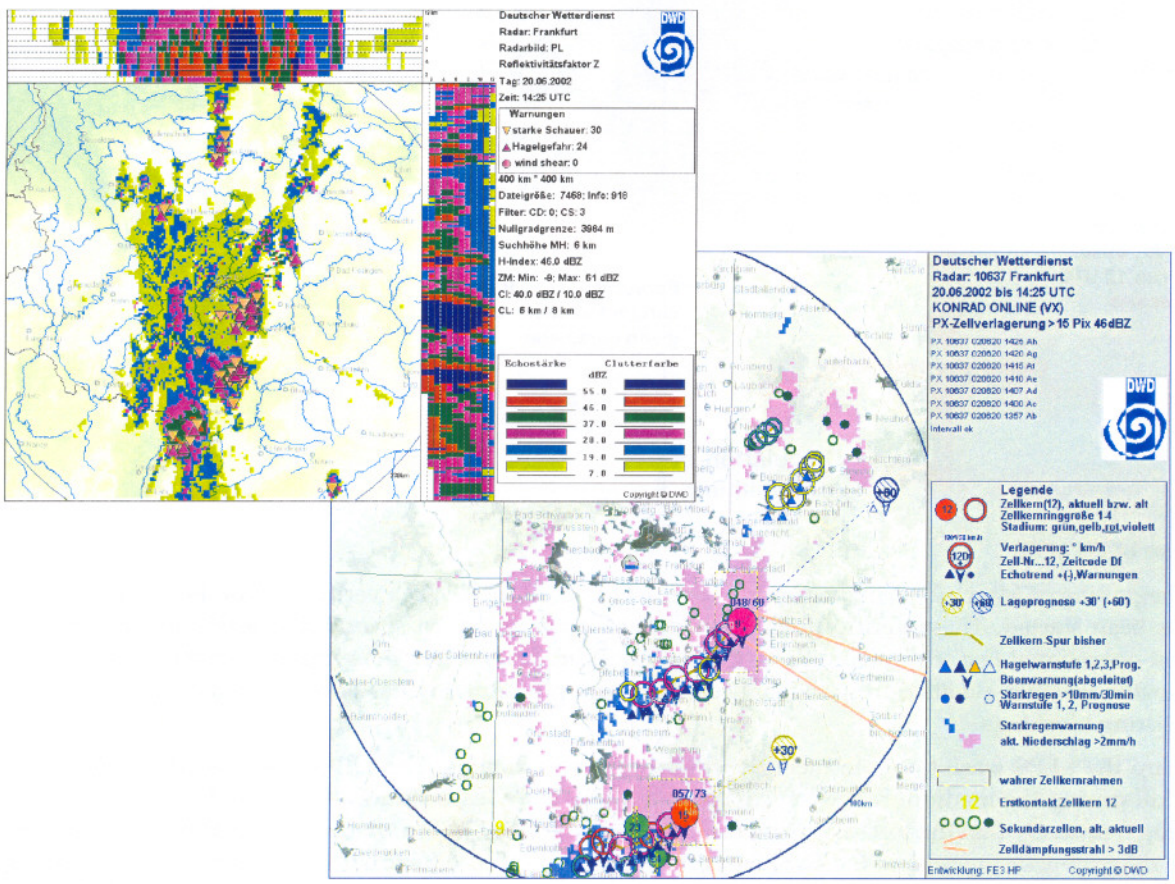

Fig. 2 KONRAD screenshot 20 June 2002, 14:25 UTC, the circle has been centered at the Frankfurt Rhein Main airport.
Top: Cross-section of convective cells showing the intensity.
Bottom right: Tracking of these cells during the last 30 minutes and extrapolation up to 60 minutes ahead

The prediction of severe convective events and especially the nowcasting of heavy showers, hail and thunderstorm is one of the most difficult tasks a forecaster is confrontated with. The development of severe convection hasn't been completely understood and still isn't parameterisized operationally by NWP models.

Using this extrapolation technique for thunderstorm nowcasting makes sense only if cells are moving driven by a mid-tropospheric flow. Best results will be shown if convective cells, well organized in squall lines, move across a 'flat orography'. The prediction of rapidly-developing convective cells, multi-cells and the genesis of mesoscale convective systems in a slow-moving tropospheric environment will not be improved considerably by KONRAD.

To monitor the development and the track of convective cells additionally to the German radar network a lightning registration system is operating. If a convective event produces lightning (it has to produce lightning otherwise it is not detectable) by a continuous registration and a resolution below 5 km the convective cell can be localized and monitored. Results will be visualized by workstations at 6 min up to 24 hour time steps.

On 28 August 2002 the first of the Meteosat second Generation (MSG) satellites has been launched. MSG provides scans every 15 minutes in 12 spectral channels and of a horizontal resolution up to 1 km. Scans usable for cloud classification and the detection of fog. Applications at the DWD are still under development.

4 COSMO-LEPS

A pilot project generating regionalized severe weather forecasts has been started in October 2002 by COSMO-LEPS, the COnsortium of Small scale MOdelling using a Limited-area Ensemble Prediction System. Member states of COSMO are Italy, Switzerland, Poland, Greece and Germany. The results of the LEPS used at the DWD since March 2003 experimentally, the system has been developed and maintained at the ARPA-SMR, a regional Metservice in Bologna (Italy). LEPS is running at the ECMWF's supercomputer. By a combination of the ECMWF's EPS and a local model a 'Downscaling' of the EPS into the meso-scale will be carried out. A more realistic prediction of precipitation, gusts, temperature extrema and other parameters over a complex orography should be possible. The comprehensive description of COSMO-LEPS has been published in the ECMWF Newsletter No. 98, pp. 2 - 7.

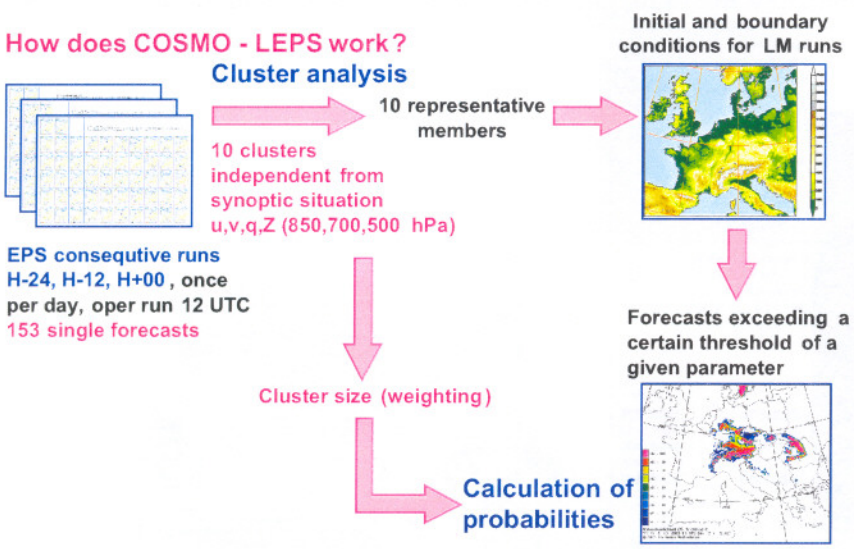

Fig. 3 Scheme of the LEPS

Since the beginning of March 2003 in the Central Forecast Office of the DWD a verification of the COSMO-LEPS products has been started. These verifications were realized subjectively by several forecasters in combination with the semi-operational use of these products. Case studies didn't represent the synoptic variability because of the lack of severe weather events during the last year. The synoptic situation has been characterized repeatingly by long persisting blockings.

To sum it up the LEPS wasn't able to meet the forecasters expectations. The LEPS products has been shown mostly no skill during the medium range forecast period. Preliminary case studies using rare (no severe) events demonstrating frequently that the forecasts from the Global Model (the DWD's Global and Local model as well as the ECMWF deterministic model and the EPS) outperforming LEPS. These forecasts are not able to add value for severe weather forecasts and therefore LEPS is not accepted by the forecasters. It seems to be that the LEPS combines the weaknesses of the German local model and the ECMWF's EPS.

Parameter	Result	Comments
Minimum temperature / since autumn 2003	No signal or incorrect position	The use of LEPS is not recommended! Prefer other methods!
maximum temperature	Sometimes useful	Realistic regional assignment of the signals; poor for extreme events.
Wind gusts (non-convective gusts)	Fair, useful	Gusts sometimes overestimated. Realistic presentation of orographic effects; **without skill in medium-range.** No skill for convective gusts!
Snow	Not very well	Realistic presentation of orographic effects; one case study only.
Large-scale precipitation	Fair, useful	Realistic regional assignment of the signals; **without skill in medium-range.**
Convective precipitation	Mostly no signal	The use of LEPS is not recommended!

Table 2 Preliminary results of the LEPS verification.

References

Moltani, A. et al.: Operational limited-area ensemble forecasts based on the 'Lokal Modell'. *ECMWF Newsletter* No. **98**, Summer 2003, 2–7.

Sopko, F.: Model predictions of the floods in the Czech Republic during august 2002: The forecaster's perspective. *ECMWF Newsletter* No. **97**, spring 2003, pp. 2–6.