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# Forecasting severe convection with a high-resolution local model ensemble

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## Motivation

Due to its spatial and temporal scale forecasting severe convection is a difficult task for models and forecasters. Improving the model and increasing its resolution creates better forecasts but cannot fully solve the problem. In consequence of the chaotic nature of small scale weather phenomena, one deterministic model run will always differ from another. To overcome this problem the operational work increasingly moves from deterministic to probabilistic approaches.

Two interesting case studies (23rd May & 30th June 2012) are used in this poster to carve out the advantages of a convection-permitting high resolution local model ensemble.

## COSMO-DE Ensemble

Since May 2012, DWD runs COSMO-DE Ensemble Prediction System (EPS) in operational mode. This forecast system bases on the deterministic and convection-permitting model COSMO-DE. The setup of both the deterministic and the ensemble model version is identical:

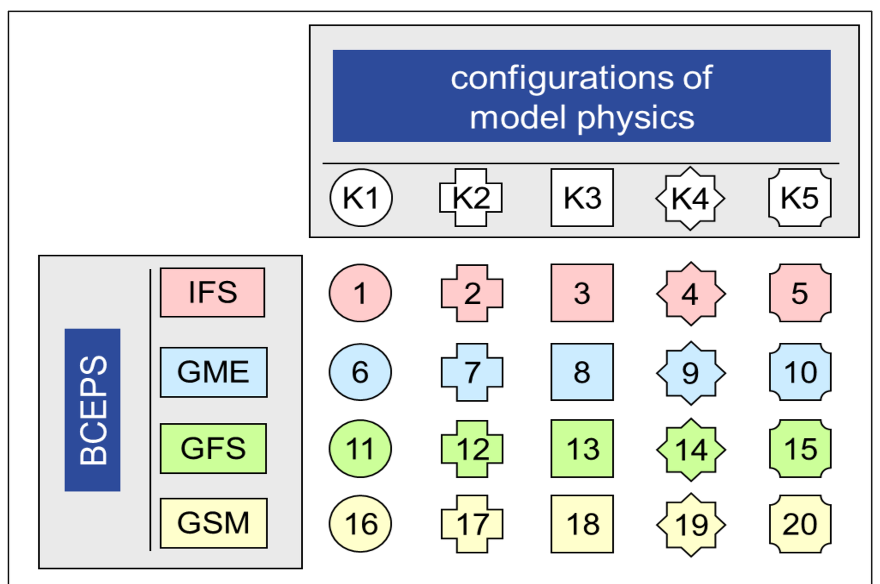



**FIG. 1:** Setup of the operational COSMO-DE EPS showing 20 members as a result of the combination of variations within the forecast system: four different global models for initial and boundary conditions (BCEPS), five different (non-stochastic) model physics configurations (Theis and Gebhardt, 2012).

- **2.8 km horizontal resolution**
- **model runs every 3 hours (00 UTC, 03 UTC, …, 21 UTC)**
- **forecast time up to 21 hours**

COSMO-DE EPS is a single model ensemble with 20 members and variations on initial conditions, boundary conditions and model physics (Theis and Gebhardt, 2012). The initial and boundary conditions are taken from four global models: IFS (ECMWF, Europe), GME (DWD, Germany), GFS (NCEP, USA), GSM (JMA, Japan). Each member is created combining global boundaries with a fixed (non-stochastic) model physics configurations (FIG. 1).

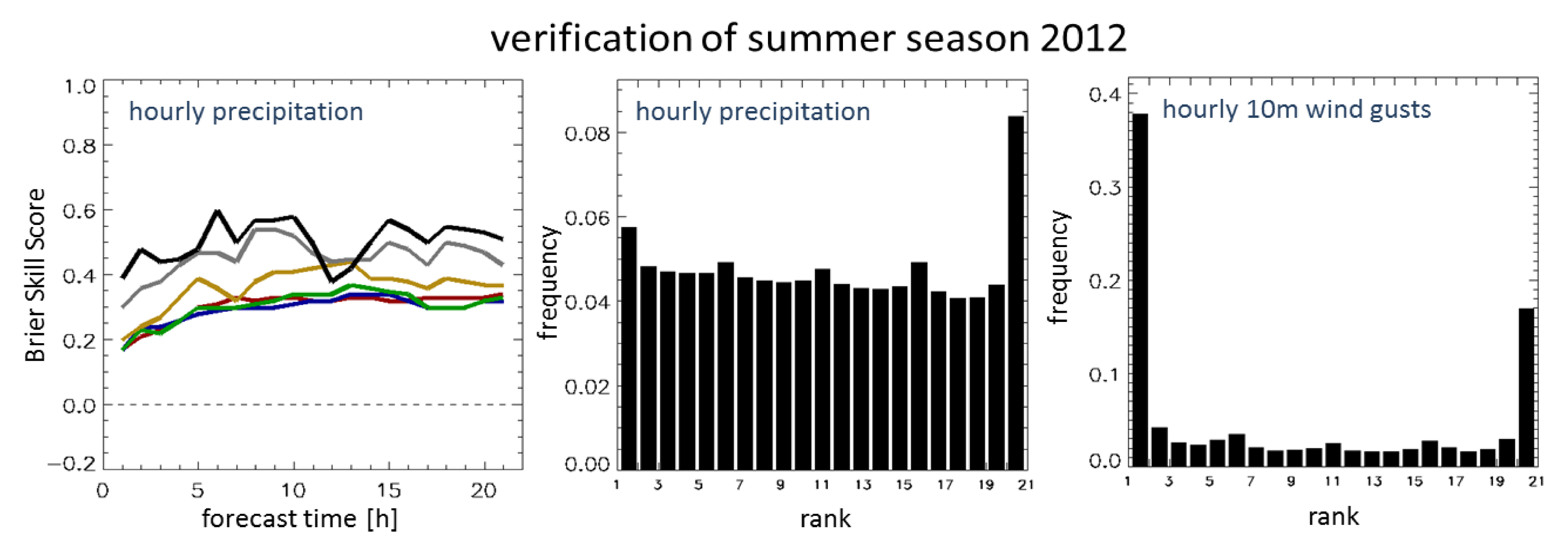


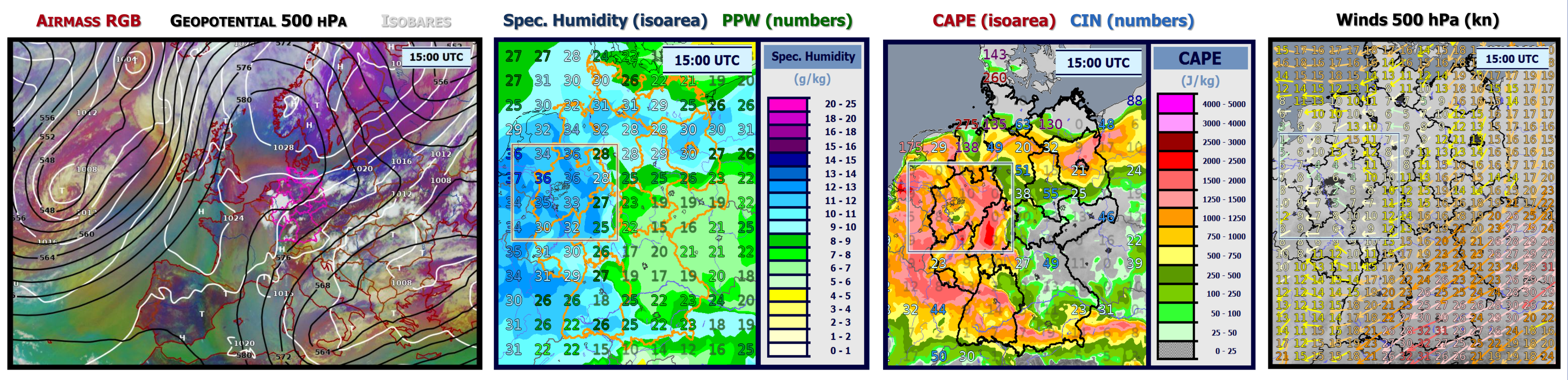

**FIG. 2**: Verification of COSMO-DE EPS forecasts for summer season 2012. **Left**: Brier Skill Score as function of forecast time (reference: deterministic COSMO-DE). Different lines mark different hourly precipitation thresholds: > 0.1 mm/h (red), > 1 mm/h (blue), > 2 mm/h (green), > 5 mm/h (yellow), > 10 mm/h (grey) and > 15 mm/h (black). **Middle:** rank histogram for hourly precipitation. **Right:** rank histogram for hourly 10 m wind gusts.

**Main results from summer verification (FIG. 2):**

i.) Brier Skill Score
- gain in forecast quality using COSMO-DE EPS (reference: deterministic model)
- highest values for higher precipitation thresholds (extreme events)

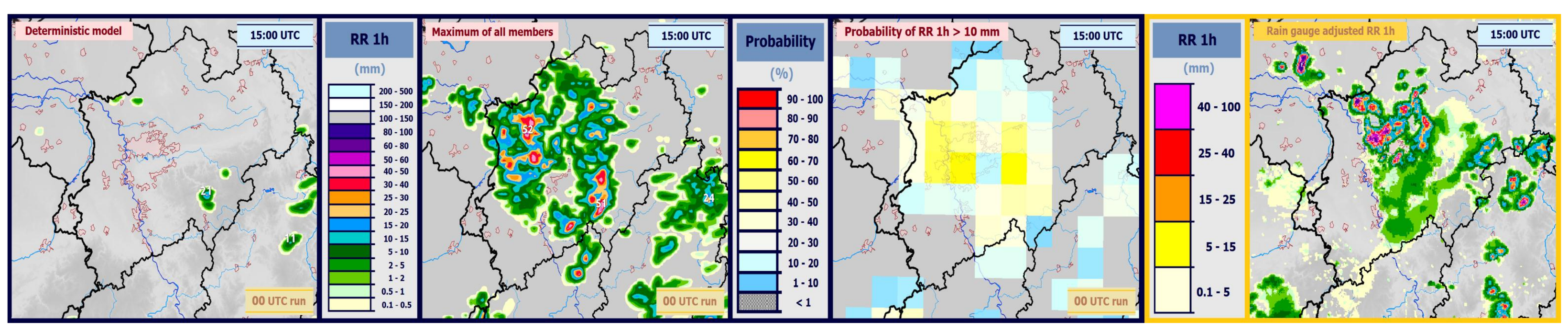
ii.) Rank histogram
- fairly good spread for precipitation
- but still biased (underforecasting)
- clear lack of spread concerning 10 m windgusts (underdispersive)

## Case I – 23.05.2012



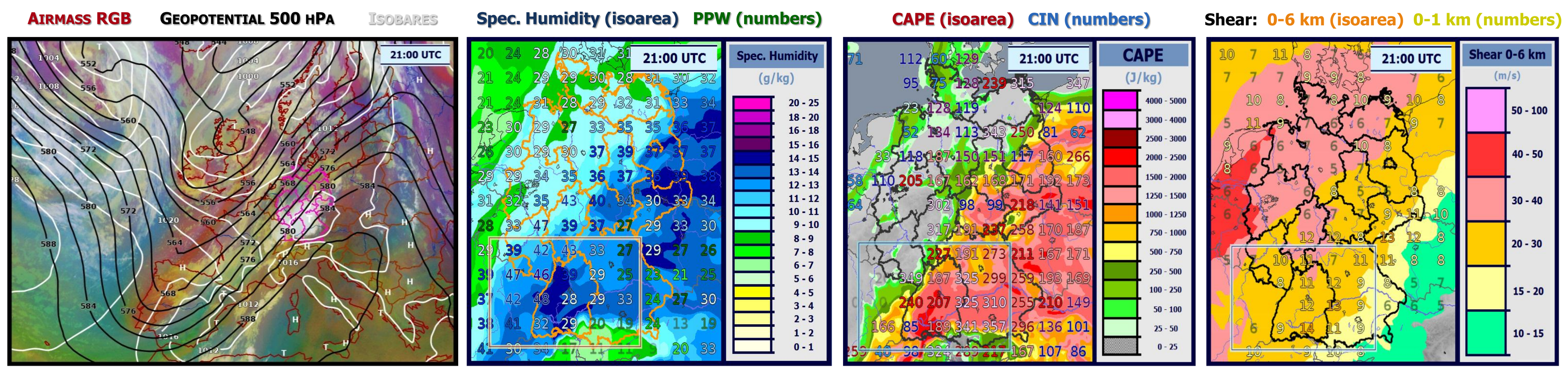

A weak flow regime between a ridge over western Europe and an upper level low over the Balkans was constitutive for central Europe with 500 hPa wind partly lower than 5 kn over the western parts of Germany. Convective instability and boundary layer moisture resulted in 1000 to 2000 J/kg that became mostly uncapped around noon. Only weak deep layer shear was present so that convection with pulsating character where outflow boundaries from dying convection triggered new thunderstorms were most probable.

### Comparison of deterministic and probabilistic output with observations



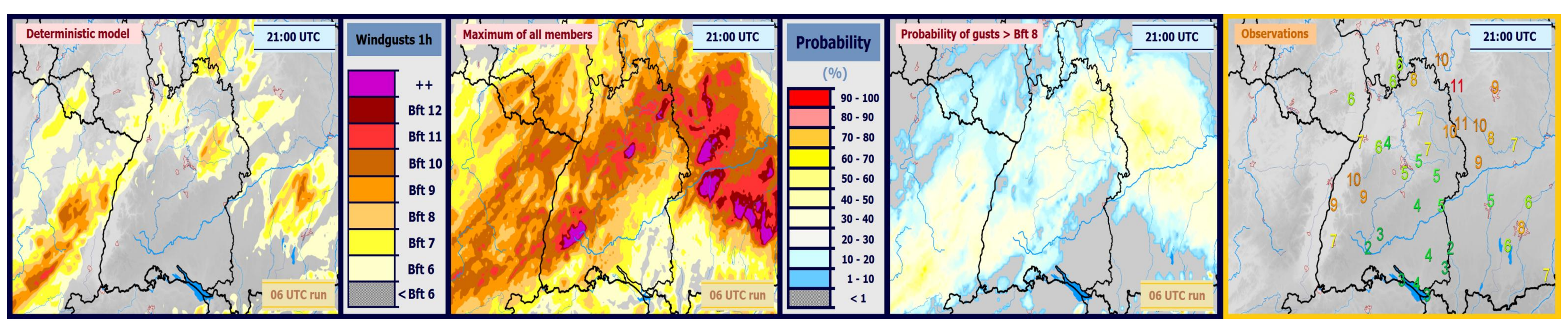
The COSMO-DE model run from 00 UTC showed only weak signals for strong convection and heavy rain events. When taking the 20 members of the COSMO-DE ensemble the potential for severe weather becomes better visible. Taking the maximum of all EPS members the area of interest could be clearly pointed out. In addition, probability products showed values higher than 60 % for more than 10 mm. With the help of these products the region where heavy rain events were most probable could be clearly localized at least 15 hours in advance.

## Case II – 30.06.2012




Central Europe was lying on the forward flank of a highly amplified long wave trough. Strong advection of warm and humid air was present in the area of interest. High values of boundary layer moisture and convective instability resulted in CAPE values between 2000 and 2500 J/kg. Since the atmosphere was capped only a few but long-living supercells developed during the afternoon. In the evening a mesoscale convective system evolved in Switzerland and travelled northeastward upstream of the long wave trough.

### Comparison of deterministic and probabilistic output with observations



The deterministic model run of COSMO-DE from 06 UTC indicated the possibility of gusts up to Bft 10. The strength and especially the regional placement were not in a good agreement with the observations. Taking the maximum of the ensemble, it is clearly visible that Bft 12 existed within the 20 members. Also the probability products were of a great help to identify the regions of interest. The highest probabilities of wind gusts in excess of Bft 8 could be found in the region were the strongest gusts were observed. The same could be found for gusts > Bft 10.

## Conclusion

COSMO-DE EPS is an ensemble system on the convective scale developed at DWD with focus on precipitation. Verification results show the benefit compared to one single model run especially in summer season.

The two case studies illustrated that the use of an ensemble can help to improve the forecast of convection and its accompaniments like heavy rain and severe wind gusts. While the deterministic model run sometimes gives only weak or wrongly placed hints on the regional scale for a severe weather event, the ensemble expands the forecaster's horizon and draws the attention to an area of interest by providing a certain degree of confidence with the help of probabilities.

## Source

Theis, S. and C. Gebhardt, 2012: COSMO-DE-EPS: Das konvektionserlaubende" Ensemble des DWD. *Promet*, Jahrgang **37**, Nr. 3/4, 53-61.

Peralta, C., et al., 2012: Accounting for initial condition uncertainties in COSMO-DE-EPS. *Journal of Geophysical Research*, **117**, D07108, doi:10.1029/2011JD016581.

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