The operational convection-permitting ensemble COSMO-DE-EPS

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

COSMO-DE-EPS

COSMO-DE-EPS is a convection-permitting ensemble prediction system which is **in operational mode at DWD since 22nd May 2012**.

The 20 EPS members aim at quantifying forecast uncertainty resulting from uncertainties in initial and boundary conditions as well as in model physics.

COSMO-DE-EPS is runs eight times a day (00, 03,…, 18, 21 UTC) for 21 hours on the same grid as the deterministic run of COSMO-DE (~ 2.8 km mesh size, 50 layers). The explicit simulation of deep convection including its life cycle, the rapid update cycle and the incorporation of radar data via the operational COSMO-DE analysis make COSMO-DE-EPS a suitable tool to deal in a probabilistic way with convective processes which are relevant for warnings and risk assessment but have a very limited deterministic predictability.

A selection of probabilistic products is derived from the EPS members and visualized with an EPS-specific branch of the NinJo visualization tool.

REFERENCES

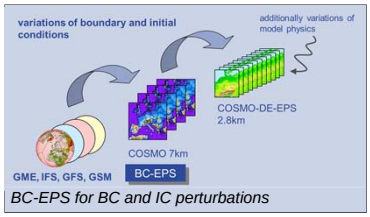
Gebhardt, C., Theis, S. E., Paulat, M., Ben Bouallegue, Z., 2011: Uncertainties in COSMO-DE precipitation forecasts introduced by model perturbations and variation of lateral boundaries, Atmos. Res.

Peralta, C. , Ben Bouallegue, Z., Theis, S. E., Gebhardt, C. 2012: Accounting for initial condition uncertainties in COSMO-DE-EPS, Journal of Geophysical Res.

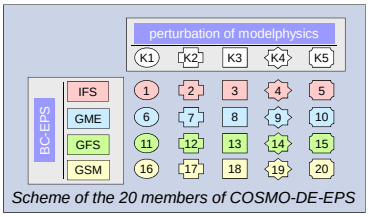
Ben Bouallègue, Z., 2012: Calibrated short-range ensemble precipitation forecasts using extended logistic regression with interaction terms, submitted to Wea. Forecasting

Generation of ensemble members and products

A four member EPS ('**BC-EPS**') dynamically downscales uncertainty from global scales providing **perturbations of initial and boundary conditions** for COSMO-DE-EPS.
Each member of BC-EPS is a 7km COSMO forecast which in turn is driven by forecasts of one of four global models (GME, IFS, GFS and GSM). BC-EPS provides boundary conditions for COSMO-DE-EPS as hourly updates.
Additionally, the BC-EPS forecasts are used to perturb the operational COSMO-DE analysis at the start time of COSMO-DE-EPS.
Model error is estimated by **five non-stochastic perturbations of key parameters of the COSMO-DE physics schemes**.
The symmetric combination of 4 BC-EPS perturbations with 5 physics perturbations leads to the 20 members of COSMO-DE-EPS. The IC and BC perturbations of different global models are not intermixed in this set up. Each physics perturbation is member-specific and the same for all forecast start and lead times.



BC-EPS for BC and IC perturbations

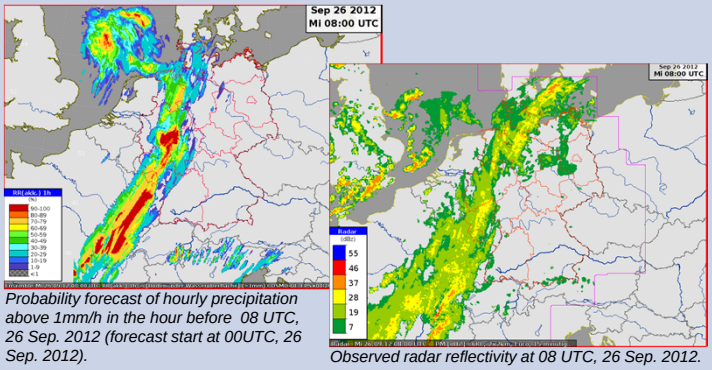


Scheme of the 20 members of COSMO-DE-EPS

Ensemble forecast products

The member forecasts of COSMO-DE-EPS are combined to **hourly probabilistic ensemble products** for precipitation, 10m wind gusts, 2m temperature and snowfall amount.
The types of EPS products are:

- probabilities for events defined by lower and upper thresholds,
- quantiles,
- spread measures (i.e. standard deviation or interquartile range),
- ensemble mean, ensemble maximum, and ensemble minimum.



Probability forecast of hourly precipitation above 1mm/h in the hour before 08 UTC, 26 Sep. 2012 (forecast start at 00UTC, 26 Sep. 2012).

Observed radar reflectivity at 08 UTC, 26 Sep. 2012.

Evaluation – Verification – Calibration

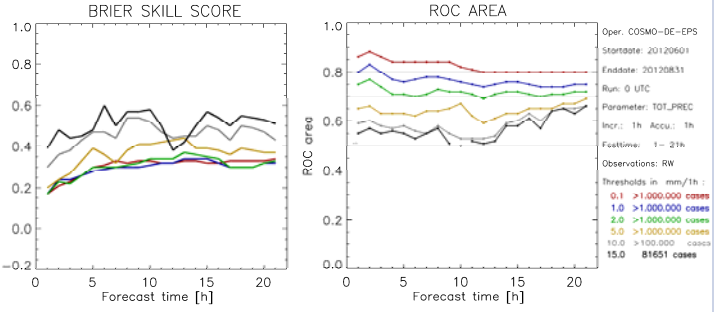
The **quality of COSMO-DE-EPS** is continuously monitored by forecasters' evaluation and objective verification.
The main advantages seen in the **evaluation** by the forecasters are:

- early signals for (severe) convective events as compared to the deterministic COSMO-DE,
- more robust forecasts, i.e. refusal of erroneous signal in the deterministic run,
- most advantageous for high precipitation thresholds and longer lead times.

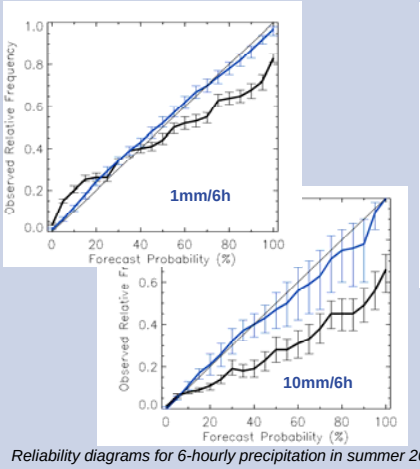
The essential results of **verification** are:

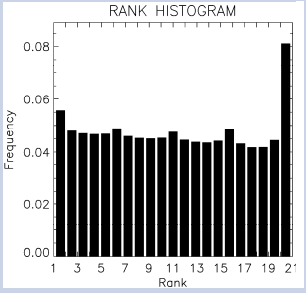
- probabilities for summer precipitation perform better than yes/no-decisions. This advantage increases with threshold and forecast lead time (see Brier skill score for hourly precipitation with deterministic run as reference),
- satisfactory discrimination between event and non-event (see ROC area for summer precipitation),
- slight underdispersion for precipitation (see rank histogram),
- reliability of precipitation forecasts for small amounts decreasing with increasing threshold (see reliability diagrams for precipitation),
- considerable to severe underdispersion for wind gusts and 2m temperature.

The deficiencies in dispersion and reliability of precipitation forecasts can be mitigated by **calibration**.
Current research focuses on the further development of a method for **extended logistic regression**.
This technique integrates the threshold of an event as predictor in the regression and furthermore takes into account **interactions between the predictors**.
Including the threshold as predictor allows for a consistent calibration of the full probability density.



Brier skill score (left, skill reference is the deterministic run) and ROC area (right) for hourly precipitation in summer 2012 for different thresholds. Observations are rain gauge-adjusted radar.





Rank histogram for hourly precipitation in summer 2012. Observations are rain gauge-adjusted radar.

Reliability diagrams for 6-hourly precipitation in summer 2012 for 1mm and 10mm threshold. Raw (black) and calibrated (blue) COSMO-DE-EPS. Observations are rain gauge-adjusted radar.

DWD – 4/2012