An Ensemble Prediction System based on COSMO-DE

Status & Plans – development stage

S. Theis, C. Gebhardt, M. Paulat, M. Buchhold, R. Ohl, Z. Ben Bouallègue, C. Peralta
Deutscher Wetterdienst (DWD), Offenbach, Germany

Motivation & Aims

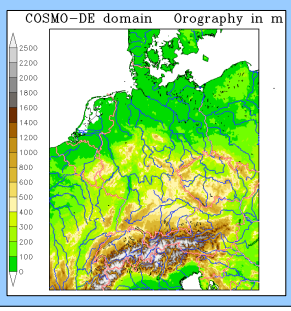
- small scales are especially limited in predictability
- take a probabilistic forecast approach when using the convection-permitting model COSMO-DE

→ develop an Ensemble Prediction System "COSMO-DE-EPS" (operational: 2011)

The project is part of the DWD Innovation Programme.

Atmospheric model: COSMO-DE

- convection-permitting
- 2.8 km grid spacing
- 50 vertical levels
- very short-range forecasts up to 24 hours
- assimilation of radar data
- cloud microphysics include graupel, snow and rain



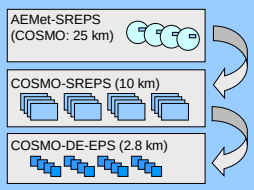
Ensemble generation

1. Model uncertainty

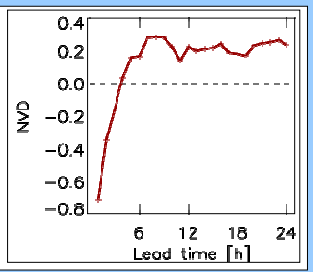
- non-stochastic multi-parameter approach
- perturb parameters of cloud microphysics, turbulence, and boundary layer parameterizations
- perturbations are kept constant during the forecast

2. Uncertainty introduced by lateral boundaries

- transfer of uncertainty across scales in an 'ensemble chain'
- COSMO-DE-EPS is nested in COSMO-SREPS which itself is nested in AEMet-SREPS
- *PLAN*: nest COSMO-DE-EPS in ICON-EPS (to be developed at DWD/MPI)



The Normalized Variance Difference compares the impact of different ensemble set ups on the spread. This figure compares the precipitation spread of an ensemble with only physics perturbations to one with variations only at the lateral boundaries depending on lead time.
NVD > 0 : higher impact of bound.
NVD < 0 : higher impact of physics



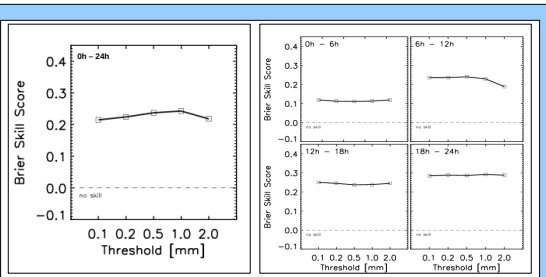
3. Uncertainty of initial conditions (*PLANS*)

- perturb parameters of the operational nudging assimilation
- use differences between COSMO-DE and COSMO-SREPS as perturbation of initial conditions
- long-term plan: Ensemble Transform Kalman filter (COSMO priority project KENDA)
- not yet implemented (see verification results below)

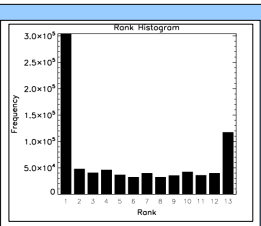
Ensemble verification – PACprove

Within the project, a package for probabilistic verification has been developed: PACprove

- deterministic scores for the evaluation of single members (ETS, FBI, …)
- probabilistic scores and measures for the evaluation of the full ensemble (Brier-Skill-Score, ROC-curve, reliability diagram, rank histogram…)
- can handle huge data amounts



Brier-Skill-Score for 24 hrs (left) and 6 hrs (right) accumulated precipitation for 15 days in August 2007. Reference is the unperturbed COSMO-DE forecast.



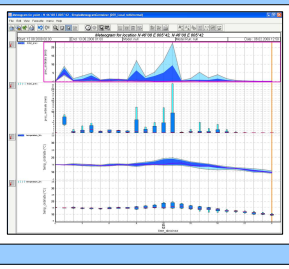
Rank-histogram of 24 hrs accumulated precipitation for 15 days in August 2007.

Ensemble calibration (*PLANS*)

- first step: logistic regression
- research project with Univ. of Bonn: Bayesian approach

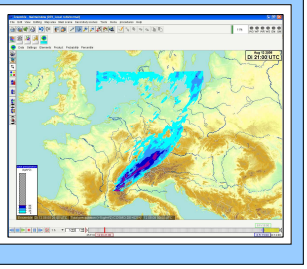
Ensemble visualization

- visualization with NinJo for the operational use of ensemble results is an essential part of the project
- visualization has to handle huge data amounts and has to communicate complex contents



NinJo screen shot of an EPS meteogram for hourly precipitation and 2m-temperature (left).

NinJo screen shot of a probability map for hourly precipitation forecasts (right).



Feedback and further information

susanne.theis@dwd.de
christoph.gebhardt@dwd.de