The COSMO-DE Ensemble Prediction System – Strategies and First Results

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INTRODUCTION

The German Weather Service (DWD) has recently started the development of an ensemble prediction system based on the model COSMO-DE.
The project explores a new field of research:

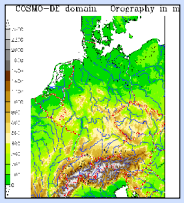
Ensembles for very short range forecasts on the convection-permitting scale.

As a first step, the project studies the effect of different sources of uncertainty on the COSMO-DE simulation.

1. The Ensemble 'PHY' represents model uncertainties.
2. The Ensemble 'LBC' represents uncertainties from the lateral boundary conditions.

The Model COSMO-DE (Doms and Förstner, 2004)

- convection-permitting
- 2.8 km grid spacing
- 50 vertical levels
- very short-range forecasts
- assimilation of radar data
- cloud microphysics including graupel, snow, and rain
- operational at DWD since April 2007



MODEL UNCERTAINTY (Ensemble 'PHY')

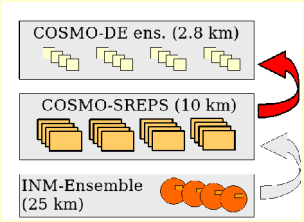
- perturbation of model physics
- perturb parameters of cloud microphysics, turbulence, boundary layer processes, and vegetation
- each ensemble member is defined by one perturbed parameter
- perturbation is kept constant during the forecast
- 12 members in total (1 default and 11 perturbed)

CASE STUDY

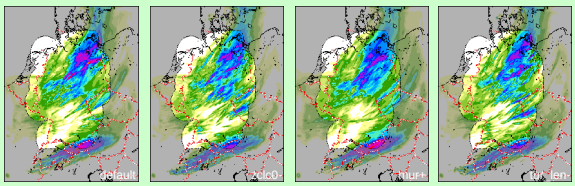
- August 2nd 2007
- precipitation accumulated over 12-24 UTC (forecast starts at 00 UTC)

UNCERTAINTY INTRODUCED BY LATERAL BOUNDARIES (Ensemble 'LBC')

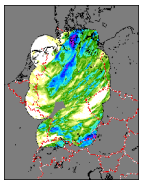
- transfer of uncertainty across scales in an 'ensemble chain'
- COSMO-DE is nested into the COSMO-SREPS (16 members, ARPA-SIM, Bologna)
- COSMO-SREPS uses a COSMO model version with 10km grid spacing and perturbed physics
- COSMO-SREPS is nested into the INM ensemble (INM, Spain)
- 16 members in total



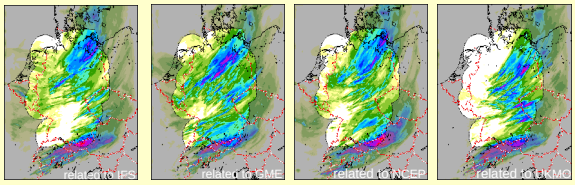
4 selected members of Ensemble PHY



Radar (RY)



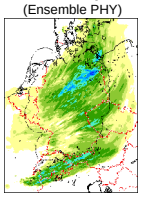
4 selected members of Ensemble LBC



Ensemble PHY

- generally lower spread than Ensemble LBC
- fairly low spread in Alpine region
- high spread in other regions of intense precipitation
- differences between individual members appear on smaller scales

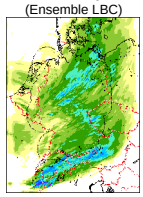
Ensemble Spread
(Ensemble PHY)



GENERAL RESULTS

- systematic differences between ensemble members
- differences in structure, intensity, and location

Ensemble Spread
(Ensemble LBC)



Ensemble LBC

- generally higher spread than Ensemble PHY
- high spread in Alpine region
- larger area with considerable spread
- differences between individual members appear on larger scales

VERIFICATION

Talagrand Diagram

- measures ensemble spread and bias
- considers all precipitation forecasts > 1.0 mm/12h
- U-form indicates insufficient spread
- spread is higher in Ensemble LBC than in Ensemble PHY
- 4 groups of ensemble members are visible in Ensemble LBC

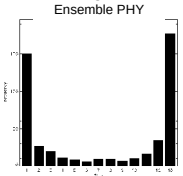
Relative Value

- measures economic value for all cost/loss ratios
- evaluated for dichotomous precipitation forecasts, threshold: > 1.0 mm/12h
- envelope (red) indicates potential economic value
- potential economic value of ensemble significantly enhanced compared to deterministic forecast (blue) represented by one member
- Ensemble LBC has higher potential economic value than Ensemble PHY

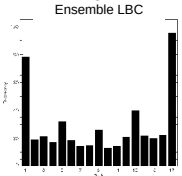
Data

- Case study: August 2nd 2007, 12-24 UTC
- Model forecasts based on 16 and 12 ensemble members, respectively
- Observations: Radar precipitation scan (RY)
- 12-hours-precipitation, mean over 10x10 grid boxes

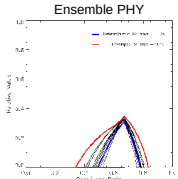
Talagrand
Ensemble PHY



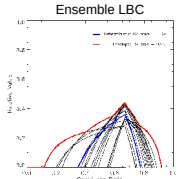
Talagrand
Ensemble LBC



Relative Value
Ensemble PHY



Relative Value
Ensemble LBC



OUTLOOK

- more case studies
- enlarge data basis for verification
- more profound analysis of Ensembles PHY and LBC
- combine perturbations of model and lateral boundaries
- perturb initial conditions
- long-term aim: operational ensembles based on COSMO-DE

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- **Susanne.Theis@dwd.de**

Doms, G. and Förstner, J. 2004:
Development of a kilometer-scale NWP-system: LMK.
In G. Doms, U. Schättler, and A. Montani, eds.,
COSMO Newsletter No.4, pp. 168-176.

Gebhardt, C., Theis, S., Krahe, P., and Renner, V. 2007: Experimental Ensemble Forecasts of Precipitation based on a Convection-Resolving Model. In J. Thielen, J. Bartholmes, and J. Schaake, eds. *3rd HEPEX workshop, Book of Abstracts*, pp. 40-44.