

COSMO-DE EPS

construction, diagnosis and verification of a limited-area ensemble prediction system on the convective scale

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Michael Buchhold, Zied Ben Bouallègue**

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4th Verification Workshop, Helsinki

Overview

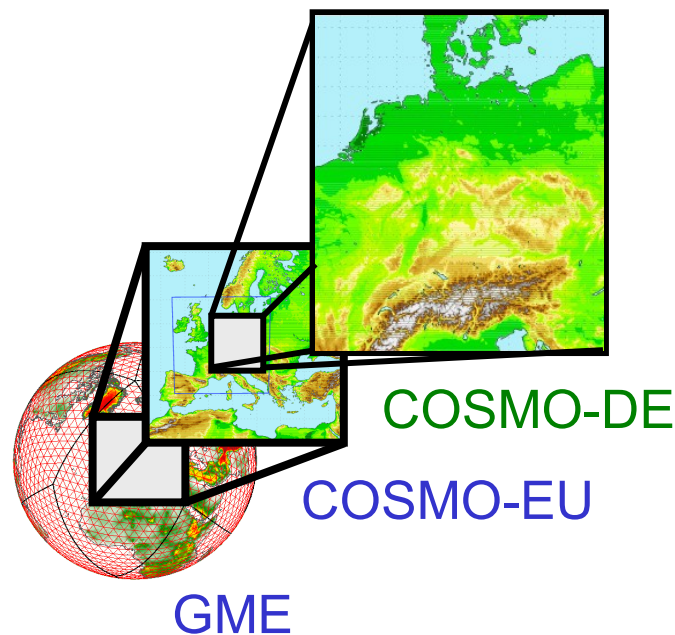
- construction and current status of COSMO-DE EPS
 - perturbation strategy

- results with focus on precipitation
 - diagnosis of different EPS experiments
 - verification of ensemble forecasts with “PACprove”

- summary and future work

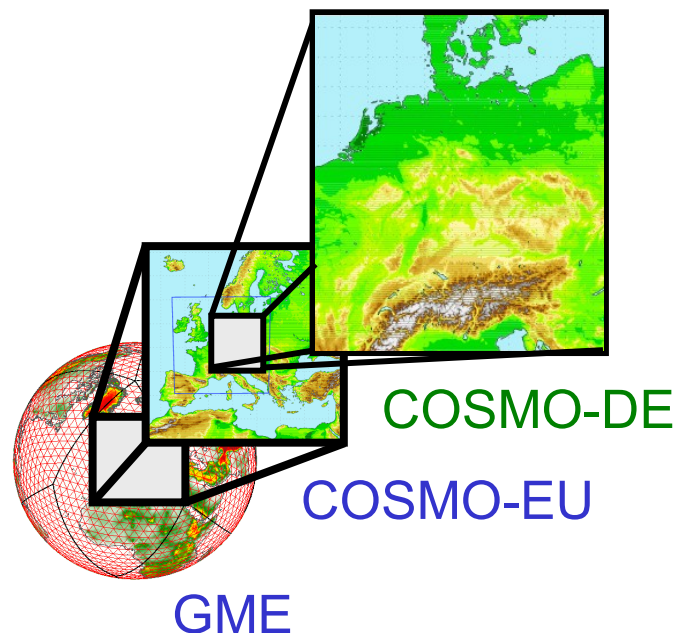
Model configuration of deterministic COSMO-DE

- grid-spacing: 2.8 km
→ convection permitting model
- forecast lead time: 0-21 hours
- model start: every 3 hours
- operational set-up at DWD



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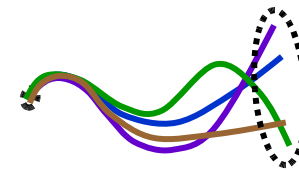
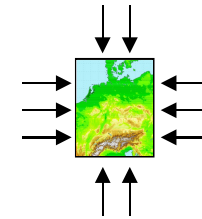


Ensembles based on high-resolution models are a new field of research!

→ Question: **Which perturbations have really an effect on the forecast?**

COSMO-DE EPS: general perturbation strategy

- perturbation of model physics
- perturbation of boundary conditions
- perturbation of initial conditions

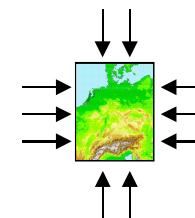


COSMO-DE EPS: general perturbation strategy

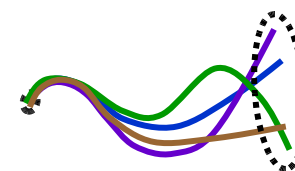
➤ perturbation of model physics



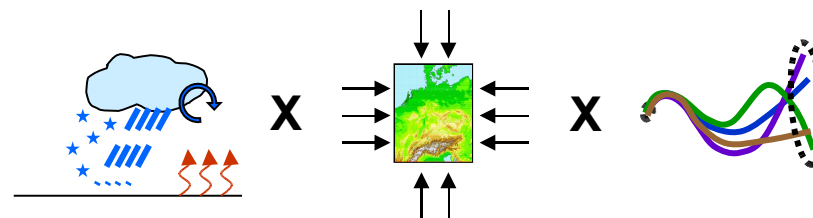
➤ perturbation of boundary conditions



➤ perturbation of initial conditions



➤ combination of perturbations

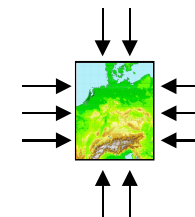


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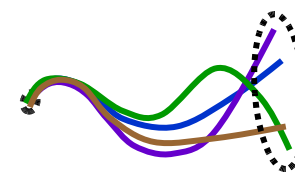
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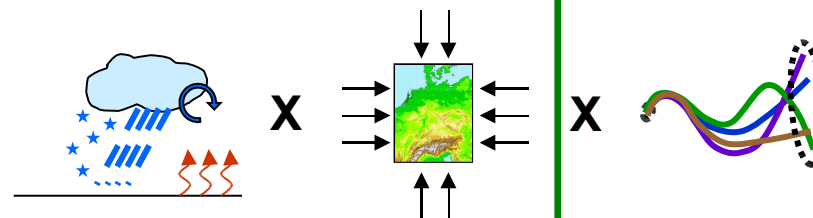
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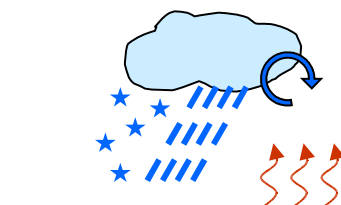


Perturbation of the model



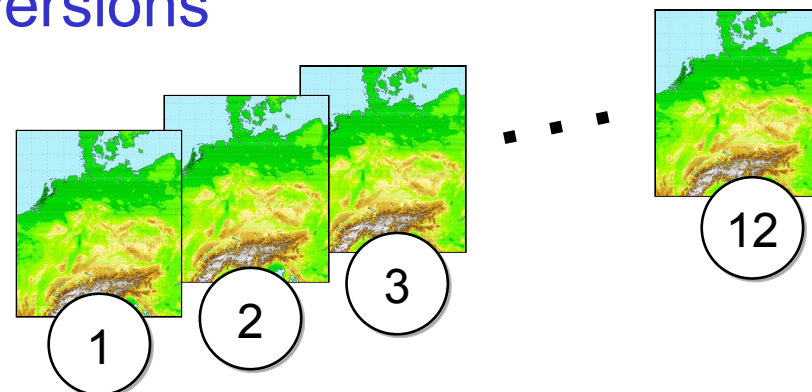
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 - alteration should lead to a different forecast
 - alteration should not deteriorate forecast quality (on average)

Perturbation of the model



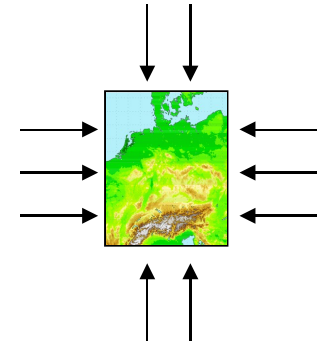
- alter parameters in parameterization schemes
 - alteration should lead to a different forecast
 - alteration should not deteriorate forecast quality (on average)
- 12 different fixed configurations of model physics
i.e. 12 slightly different model versions

➔ “PHY” EPS

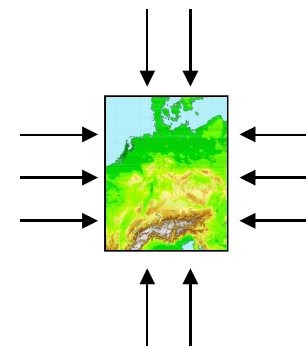
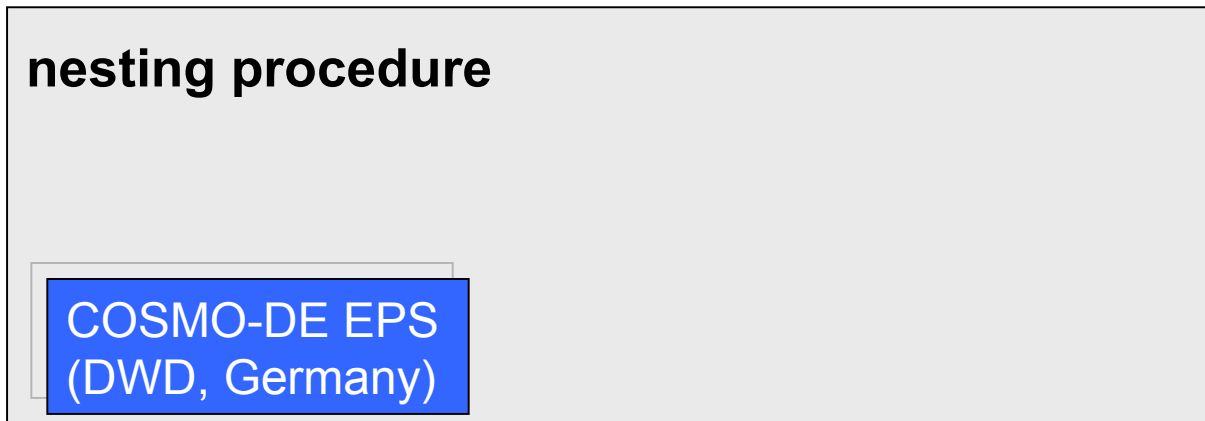


Perturbation of boundary conditions

nesting procedure



Perturbation of boundary conditions

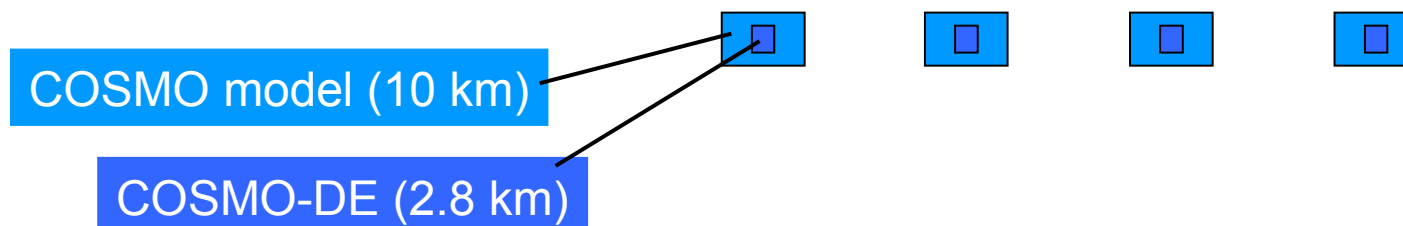
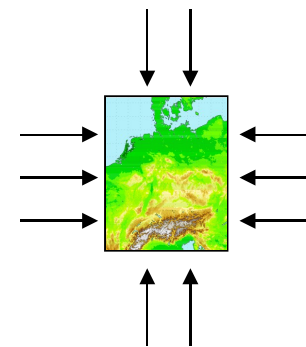
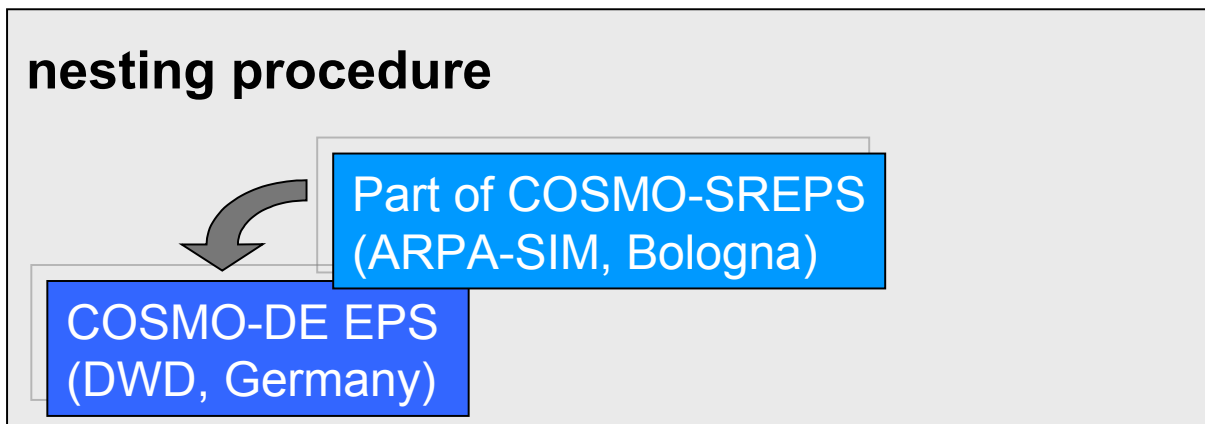


COSMO-DE (2.8 km)

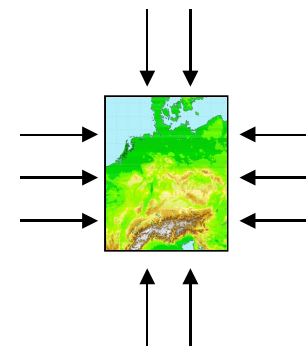
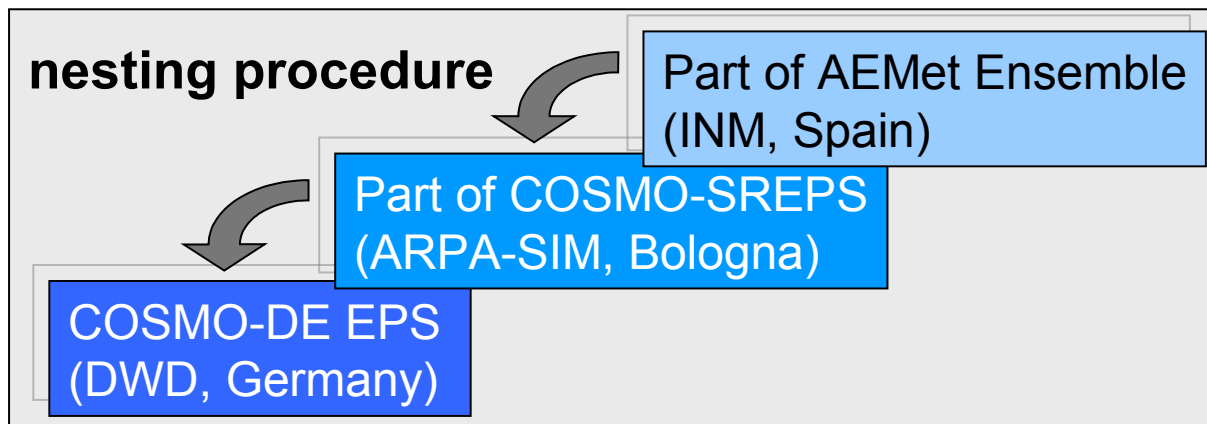


A blue rectangular box containing the text "COSMO-DE (2.8 km)". A black arrow originates from the top-right corner of this box and points towards the top-right corner of the "nesting procedure" diagram.

Perturbation of boundary conditions



Perturbation of boundary conditions



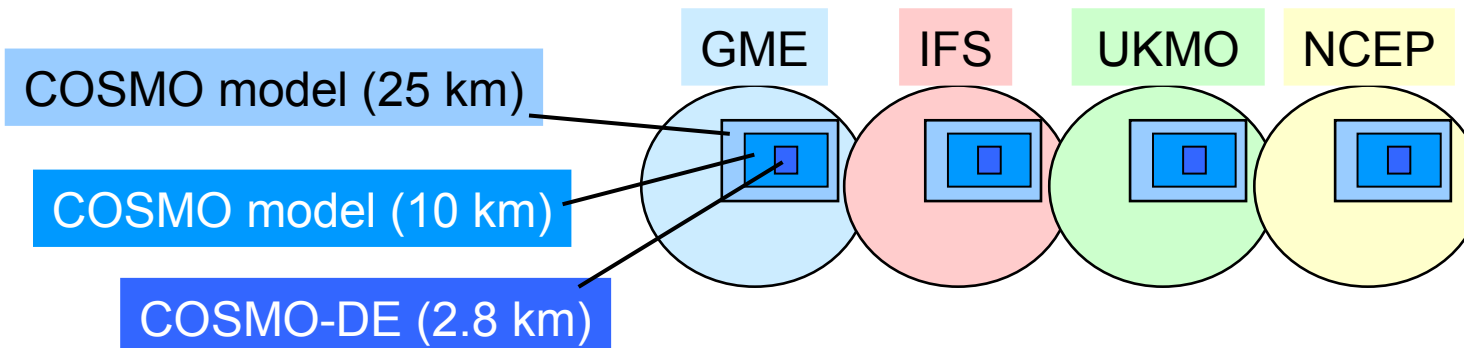
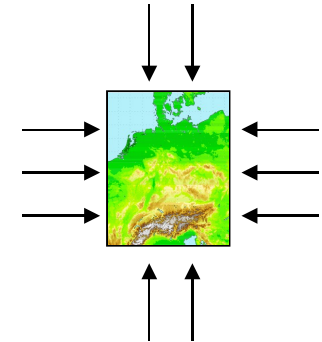
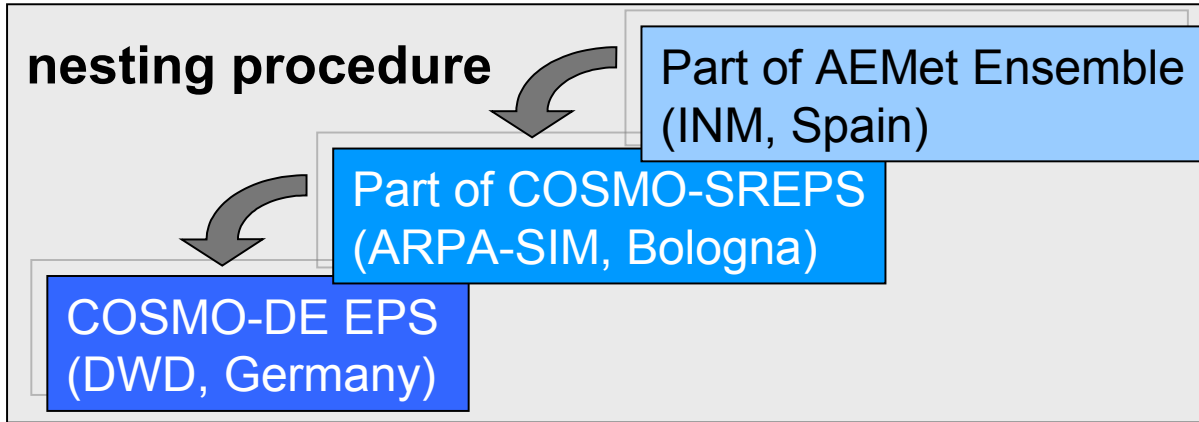
COSMO model (25 km)

COSMO model (10 km)

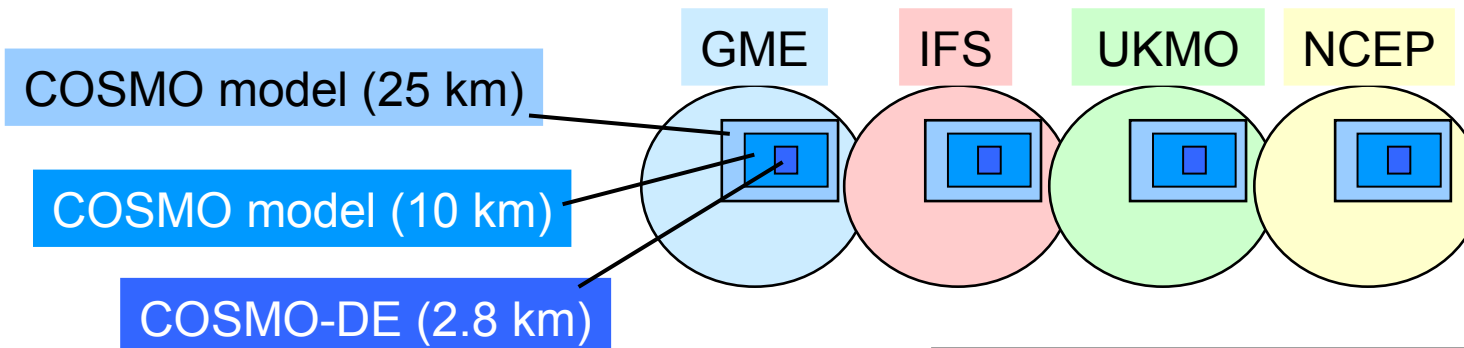
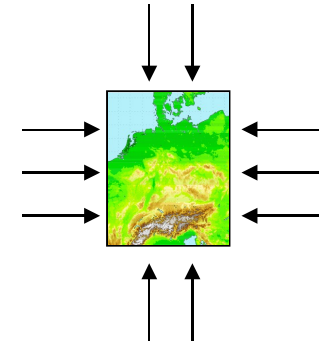
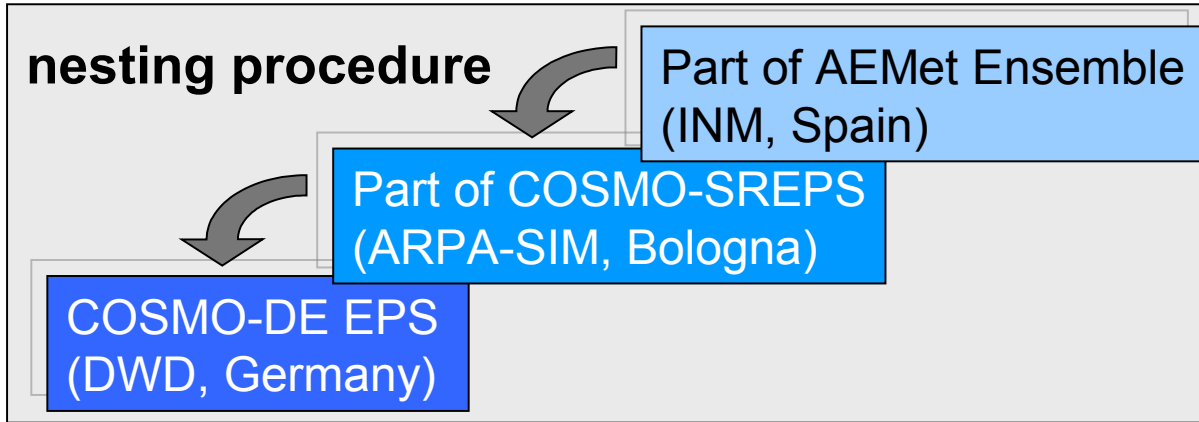
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Perturbation of boundary conditions



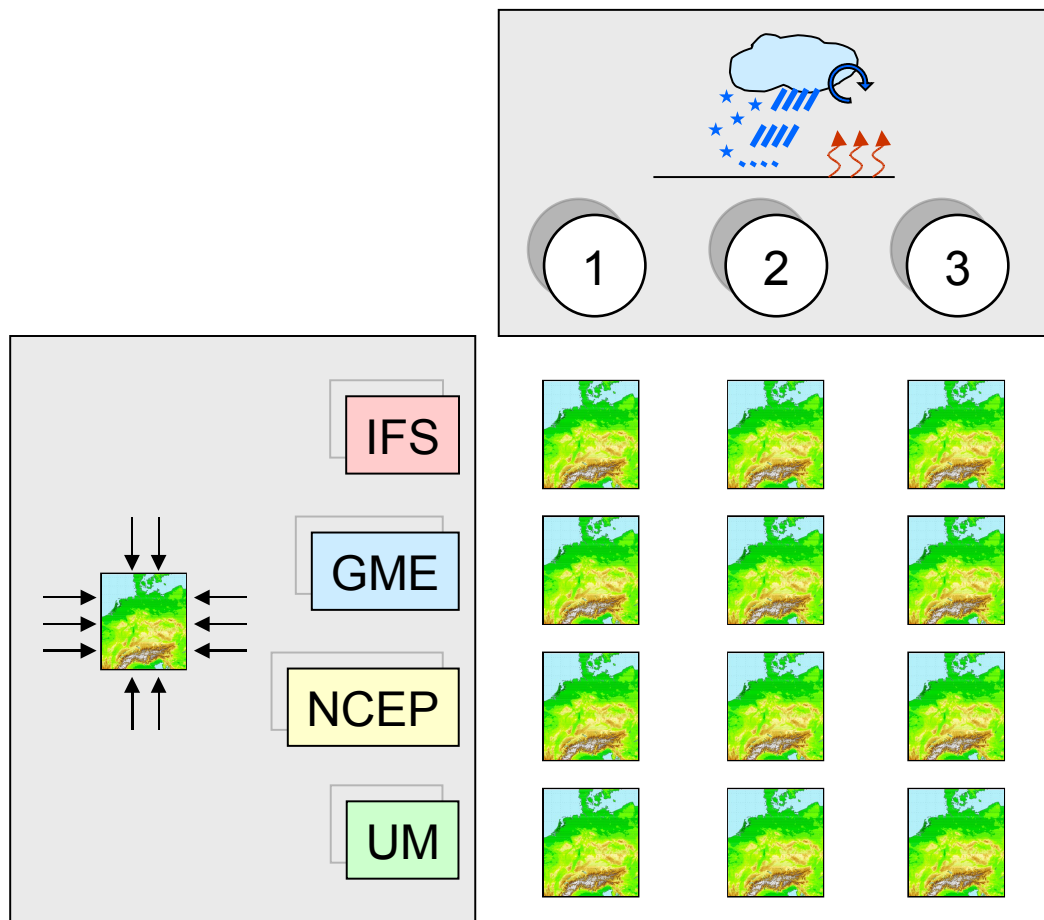
Perturbation of boundary conditions



physics variations in COSMO-SREPS leads to 12 members (in this study)

➔ **“LBC” EPS**

Combination of physics and boundary perturbations



- all global models should be included

- 3 physics perturbations with highest impact on spread are chosen

➔ **“COMB” EPS**

Results with focus on precipitation

- time period: 15 days of August 2007
- 3 EPSs with 12 members: PHY, LBC, COMB
- starting point: 00 UTC, lead time 0-24 hours
- ensemble diagnoses
 - Normalized Variance Difference
- ensemble verification: „PACprove“
 - quality of single members
 - probabilistic verification

Ensemble diagnoses: Normalized Variance Difference

- investigation of the impact of different EPSs on the spread.

$$\text{NVD} = \frac{\text{Var}(\text{EPS1}) - \text{Var}(\text{EPS2})}{\text{Var}(\text{EPS1}) + \text{Var}(\text{EPS2})}$$

$$-1 \leq \text{NVD} \leq +1$$

Ensemble diagnoses: Normalized Variance Difference

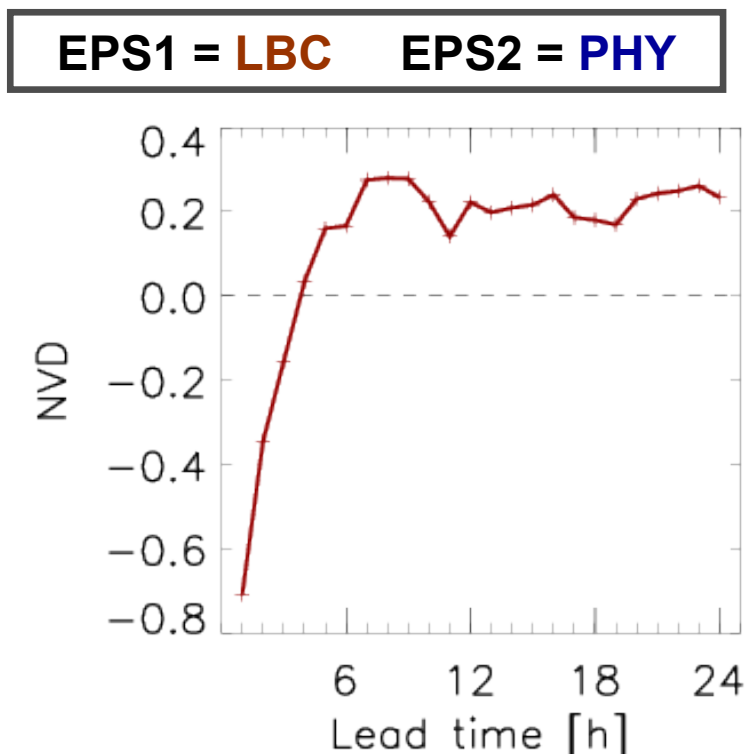
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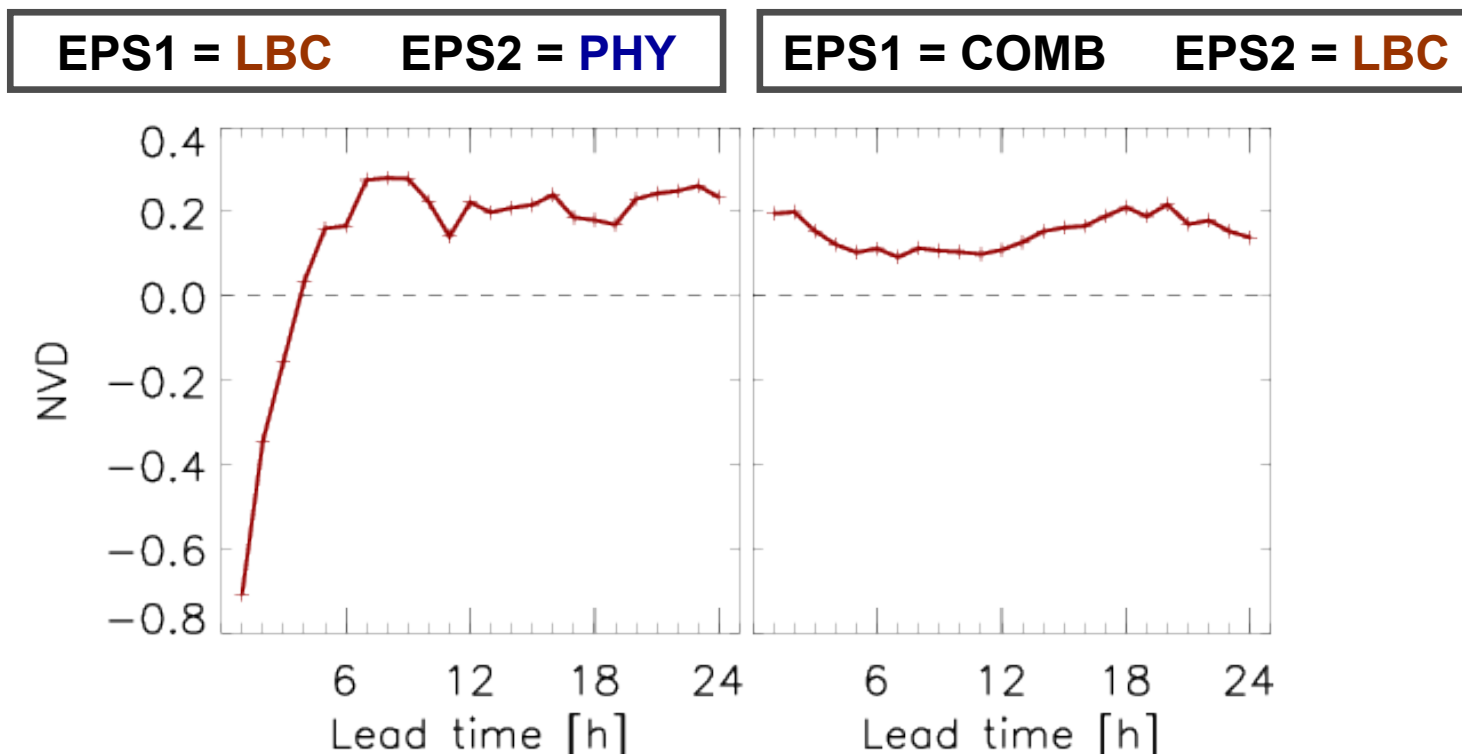
$$\mathbf{-1 \leq NVD \leq +1}$$

$$\mathbf{NVD} \left\{ \begin{array}{l} > 0 \rightarrow \text{higher impact of EPS1} \\ = 0 \rightarrow \text{equal impact of both EPSs} \\ < 0 \rightarrow \text{higher impact of EPS2} \end{array} \right.$$

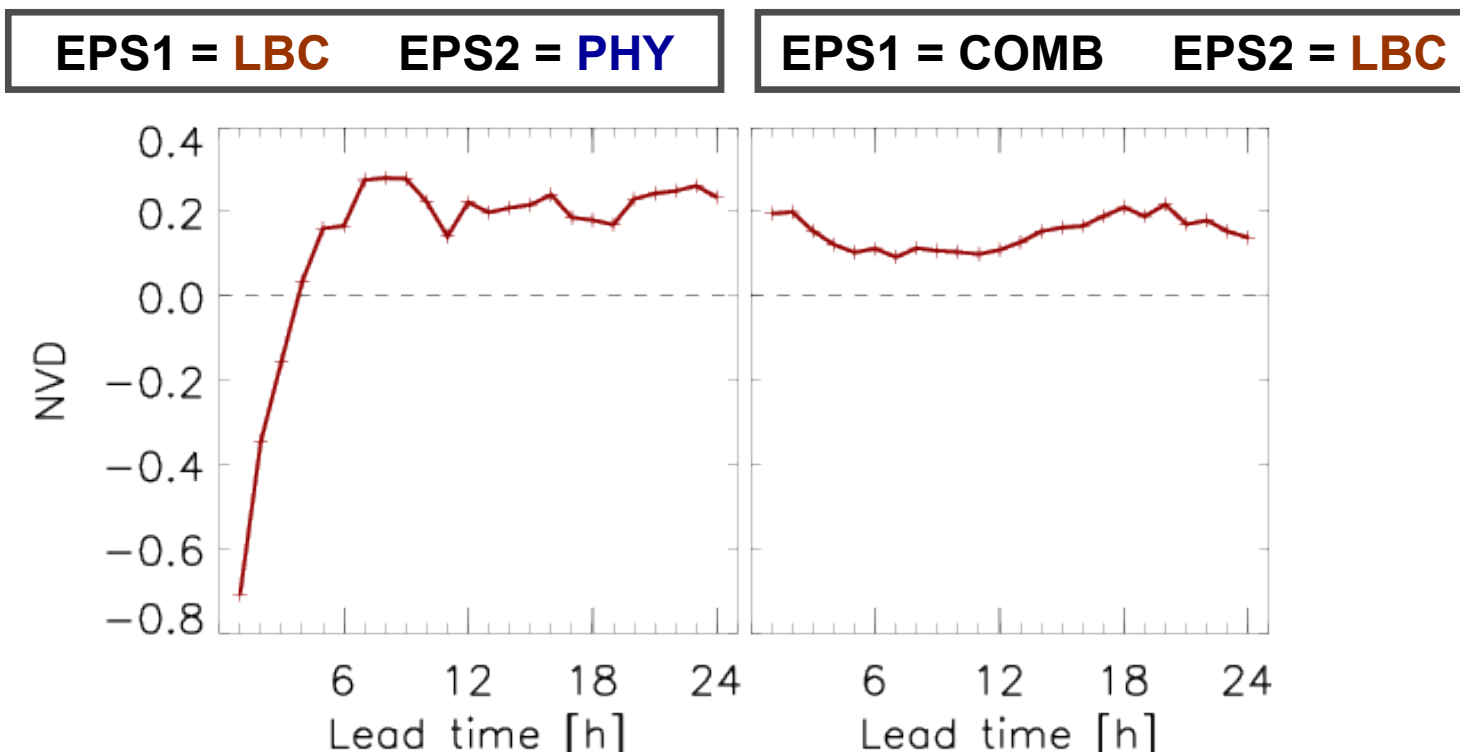
Ensemble diagnoses: Normalized Variance Difference



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Ensemble diagnoses: Normalized Variance Difference



→ Following verification results focussing on the **COMB** experiment



Ensemble verification with „PACprove“

- PACprove = Package for probabilistic verification
- Why we are developing our own Package and not „R“ for example?
 - actually, the R-package is not officially supported at DWD
 - main work has to be done on data handling (outside „R“)
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 - deterministic: standard error scores like FBI, ETS, ...
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Keep in mind: development stage → How far we get with our perturbations?





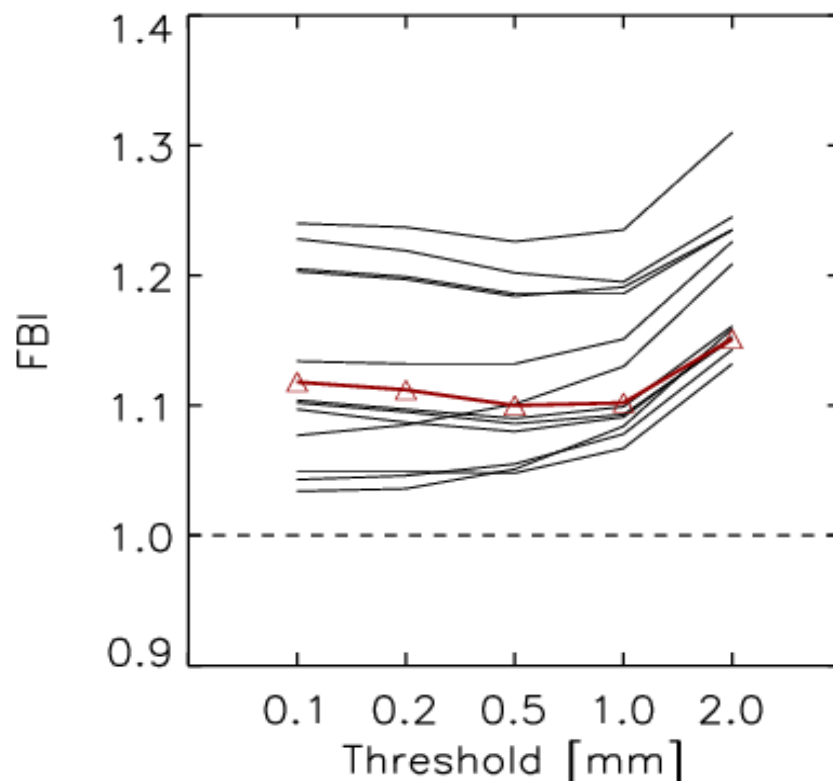
Verification results: single member quality check

Is our perturbation strategy the right way?



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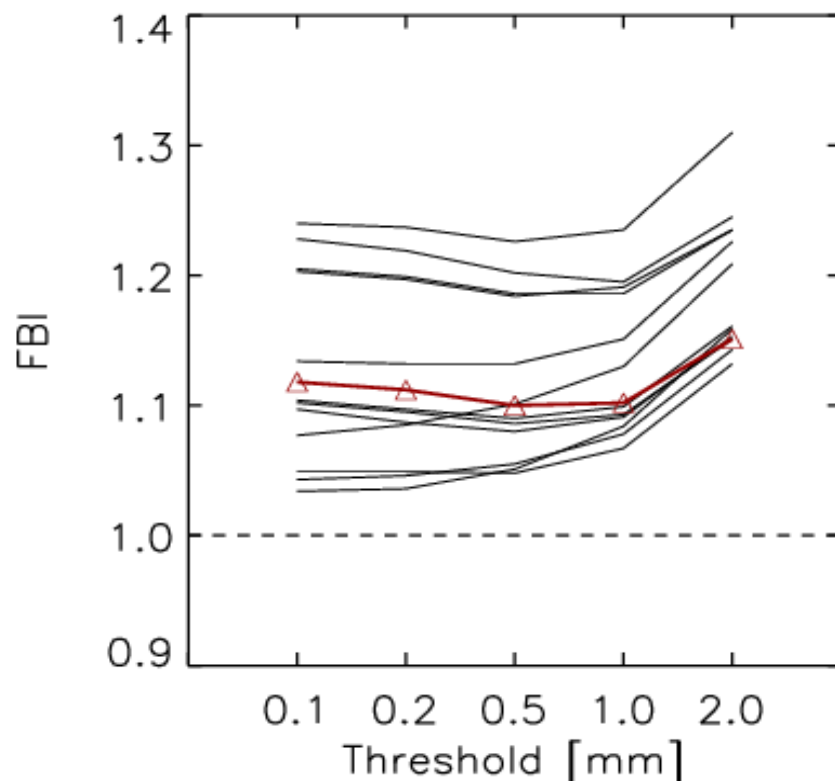
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- Frequency Bias Index
- **24 hours** accumulated precipitation
- red line shows the **deterministic COSMO-DE**

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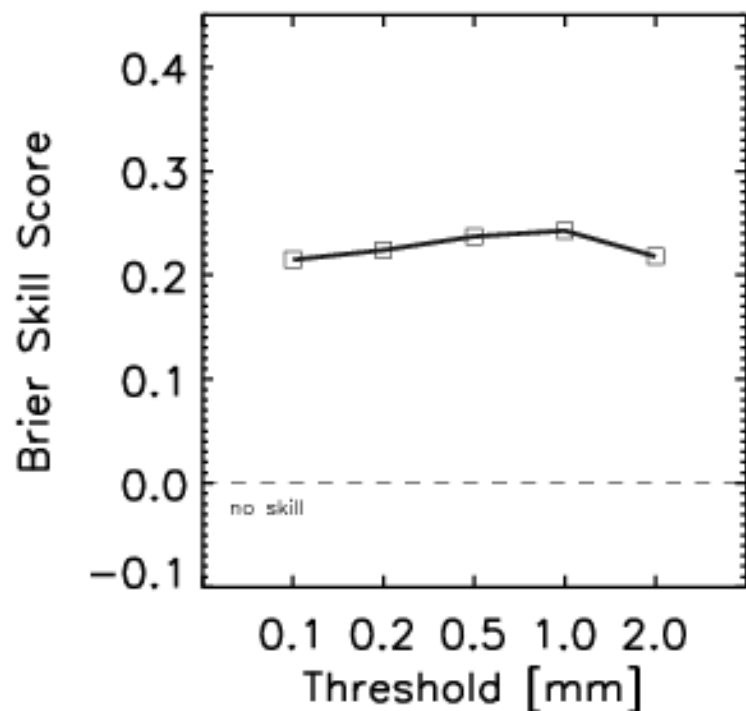


- Frequency Bias Index
- **24 hours** accumulated precipitation
- red line shows the **deterministic COSMO-DE**
- all members are within a reasonable range
- we are on the right way!

Verification results: Brier Skill Score

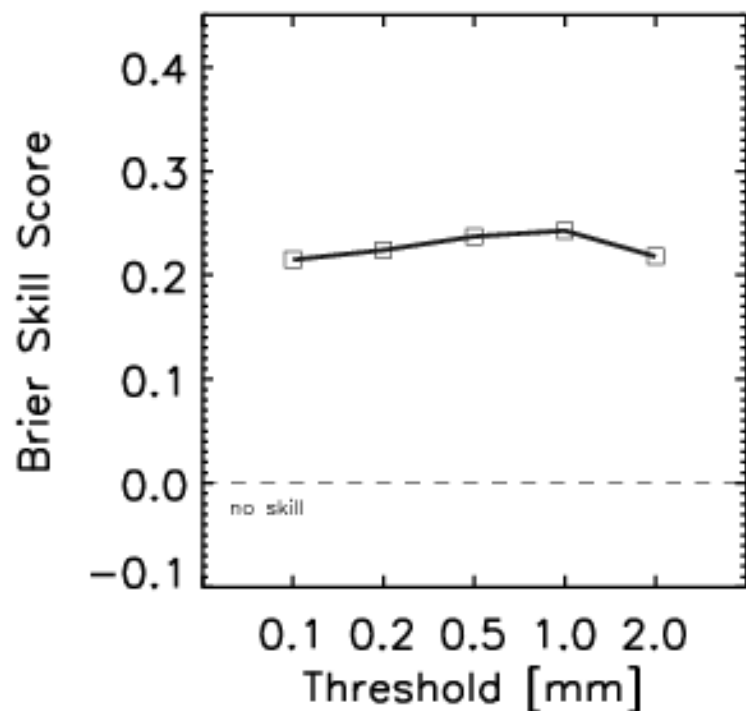
24 hours accumulated precipitation

reference: deterministic COSMO-DE

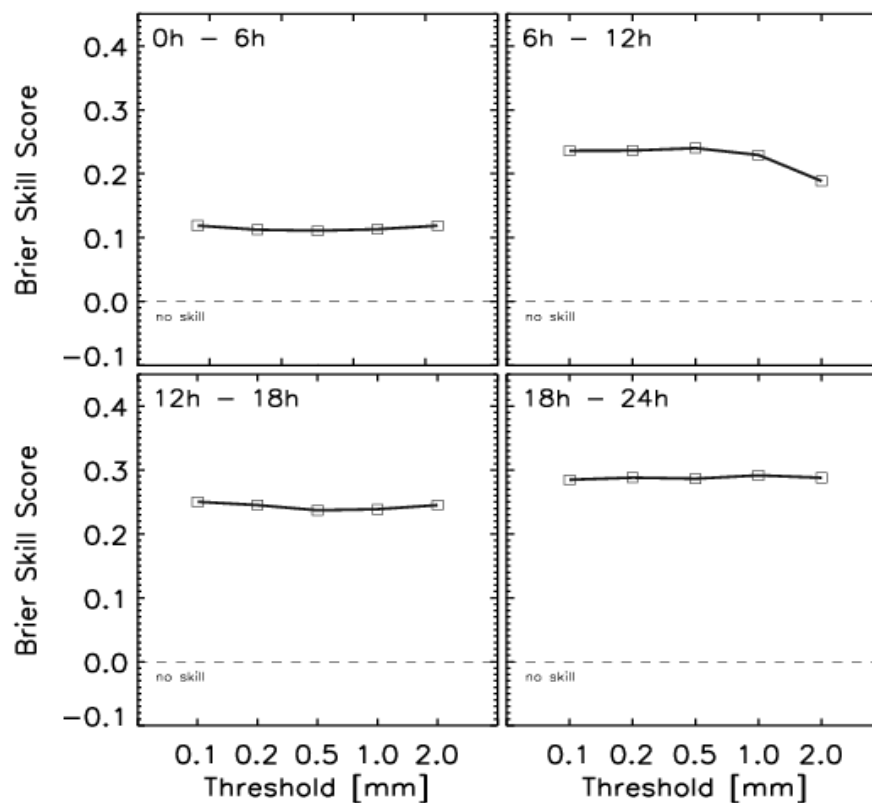


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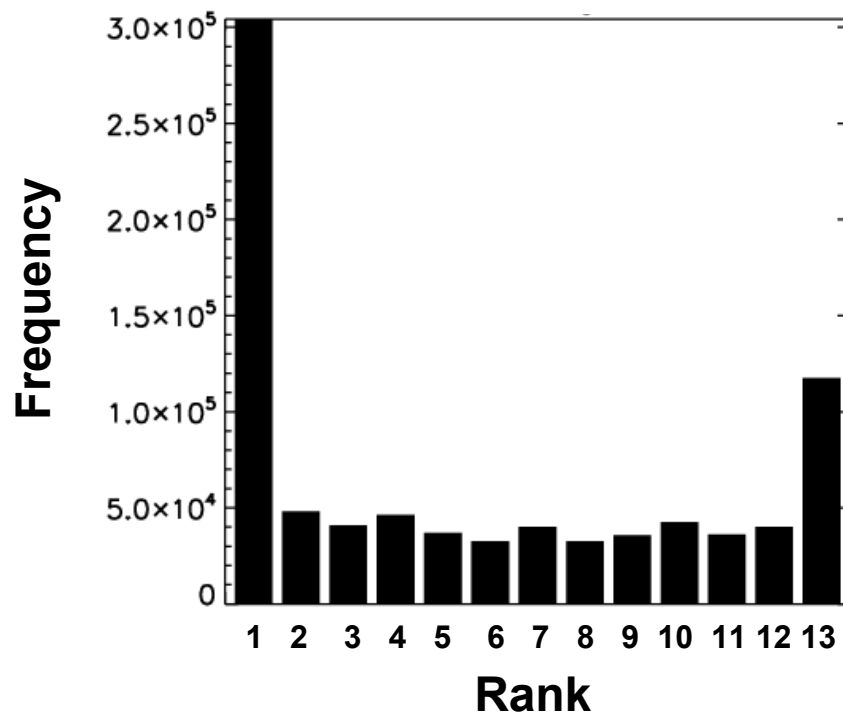


6 hours accumulated precipitation



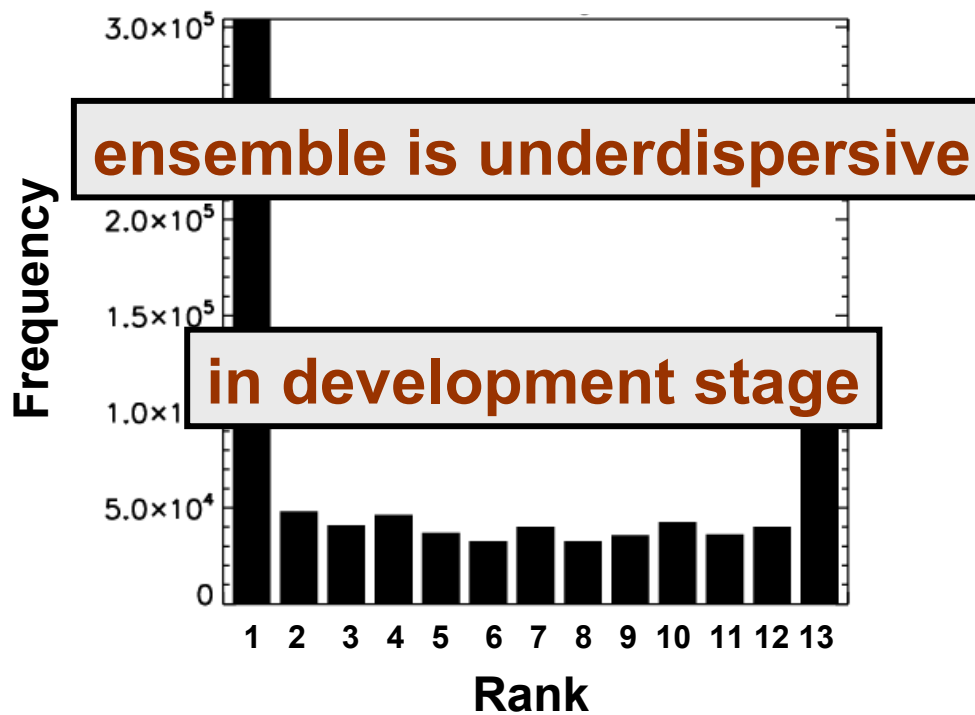
Verification results: rank histogram

24 hours accumulated precipitation



Verification results: rank histogram

24 hours accumulated precipitation





Summary

- construction of 3 different EPS experiments based on COSMO-DE
 - perturbations in physics and boundaries
 - perturbations of initial conditions is work in progress





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- verification of the COMB ensemble (for precipitation) with PACprove
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- most of these results are presented in an article (submitted to Atmos. Res.)





Future work

- the COSMO-DE ensemble needs further developments
 - include the initial conditions (increase of the spread) → promising ideas
 - increase duration of experiments → more data





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 - running a high resolution ensemble needs large computer resources
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 - running a high resolution ensemble needs large computer resources
 - handling of large data amount
- COSMO-DE EPS is planned to be operational in 2011



COSMO-DE EPS: construction, diagnosis and verification of a limited-area ensemble prediction system on the convective scale



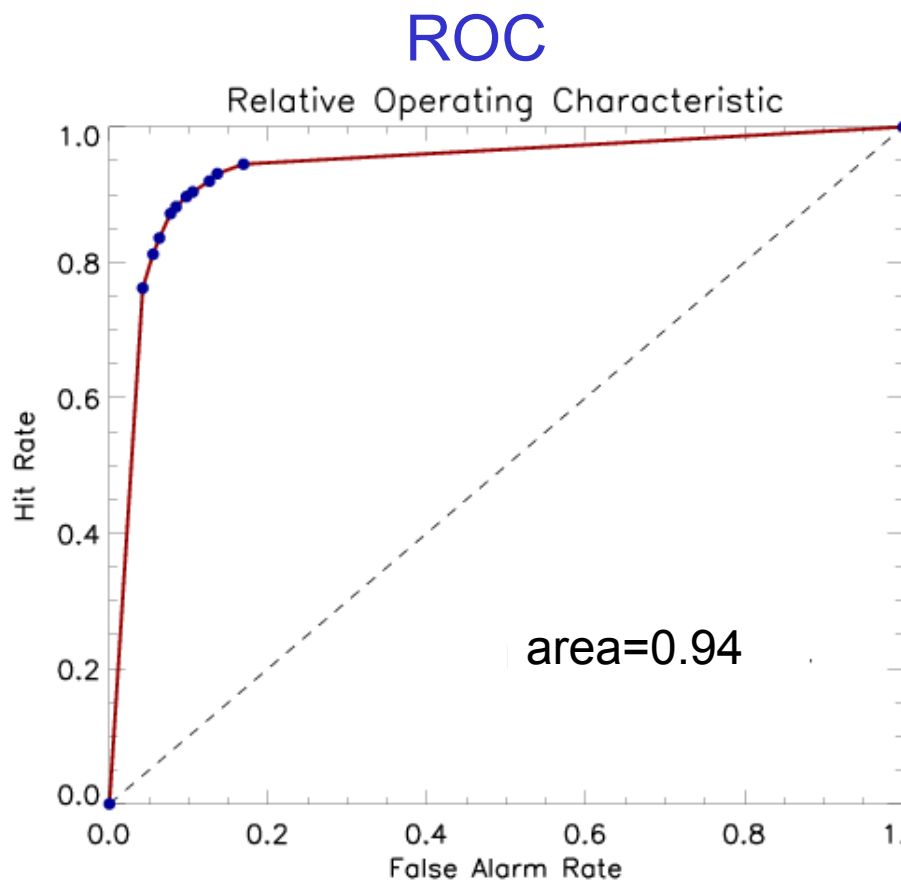


Extra Slides

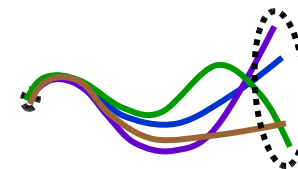


Verification results for 2m-temperature 12UTC

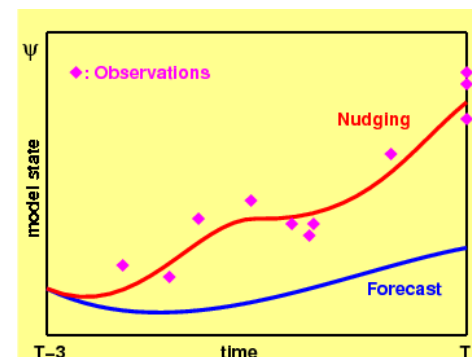
threshold: 25°C



Perturbation of initial conditions



- first experiments: perturb “nudgecast”
 - correlation length of observation increments
 - geostrophic balance
 - divergent flow correlations



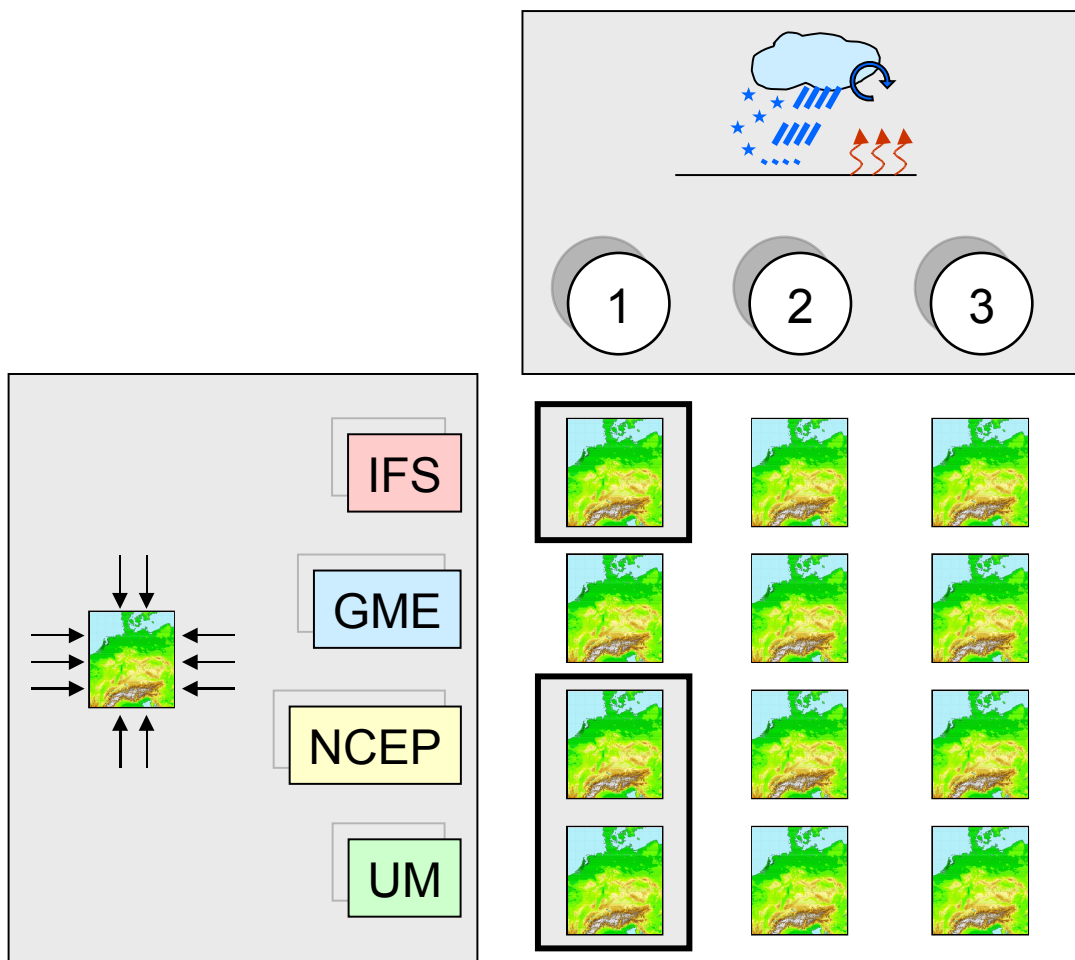
- **current work:**

use differences between control and COSMO-SREPS as IC perturbations

- long-term plan:

Ensemble Transform Kalman Filter (COSMO project KENDA)

Experiments – physics and boundary perturbations



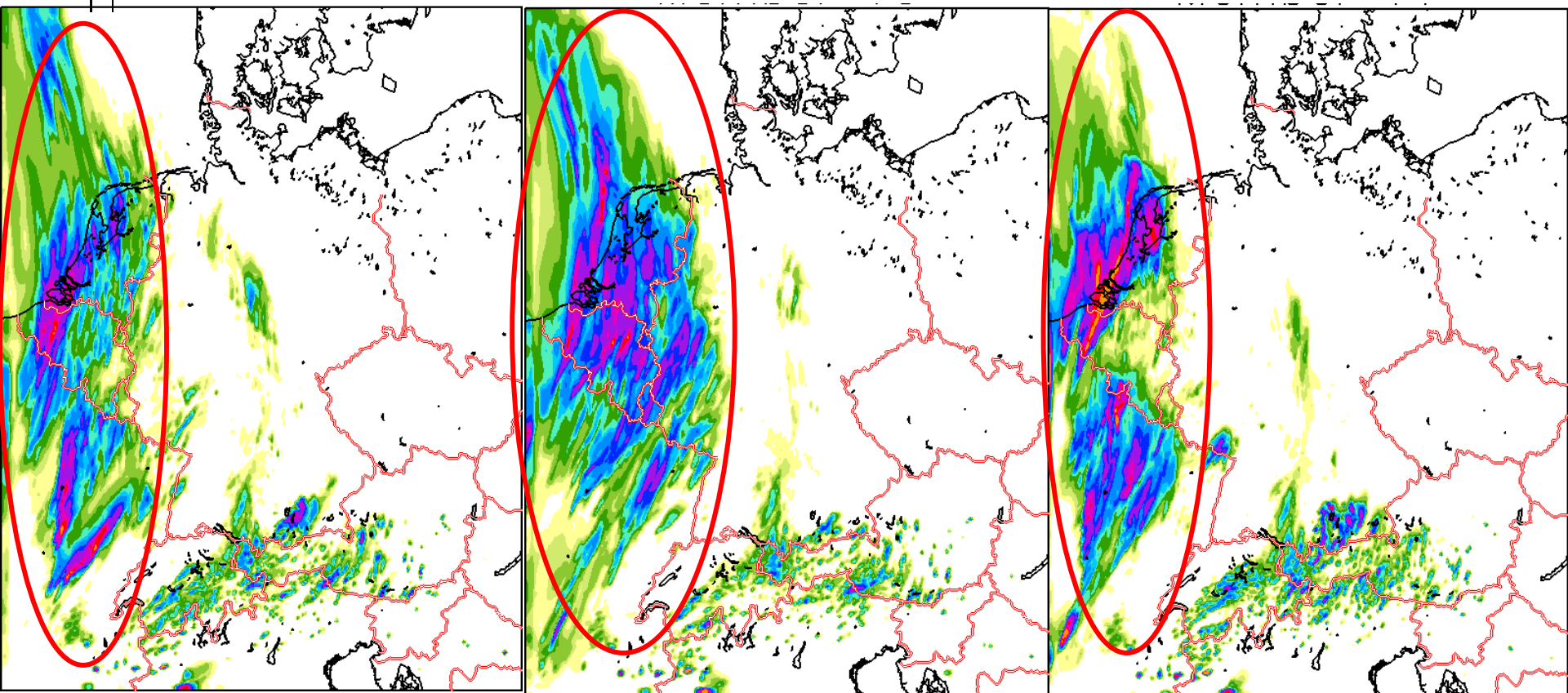
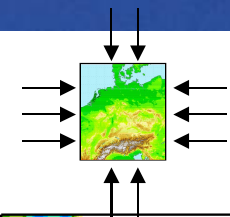
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COSMO-DE EPS: construction, diagnosis and verification of a limited-area ensemble prediction system on the convective scale



2 July 2007, 00 UTC + 24h

24h accumulations of precipitation [mm]

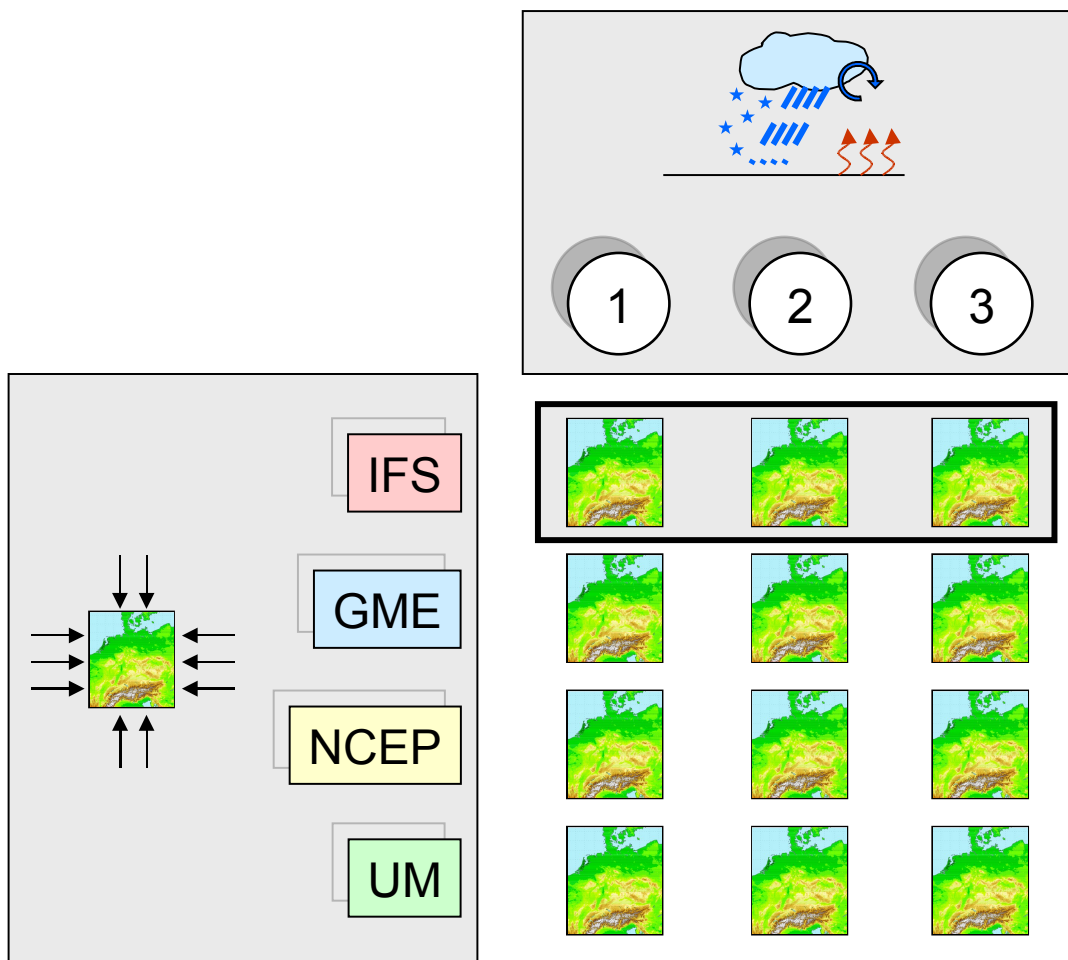


0.1 0.5 1 2.5 5 7.5 10 15 20 30 40 50

mm/24h



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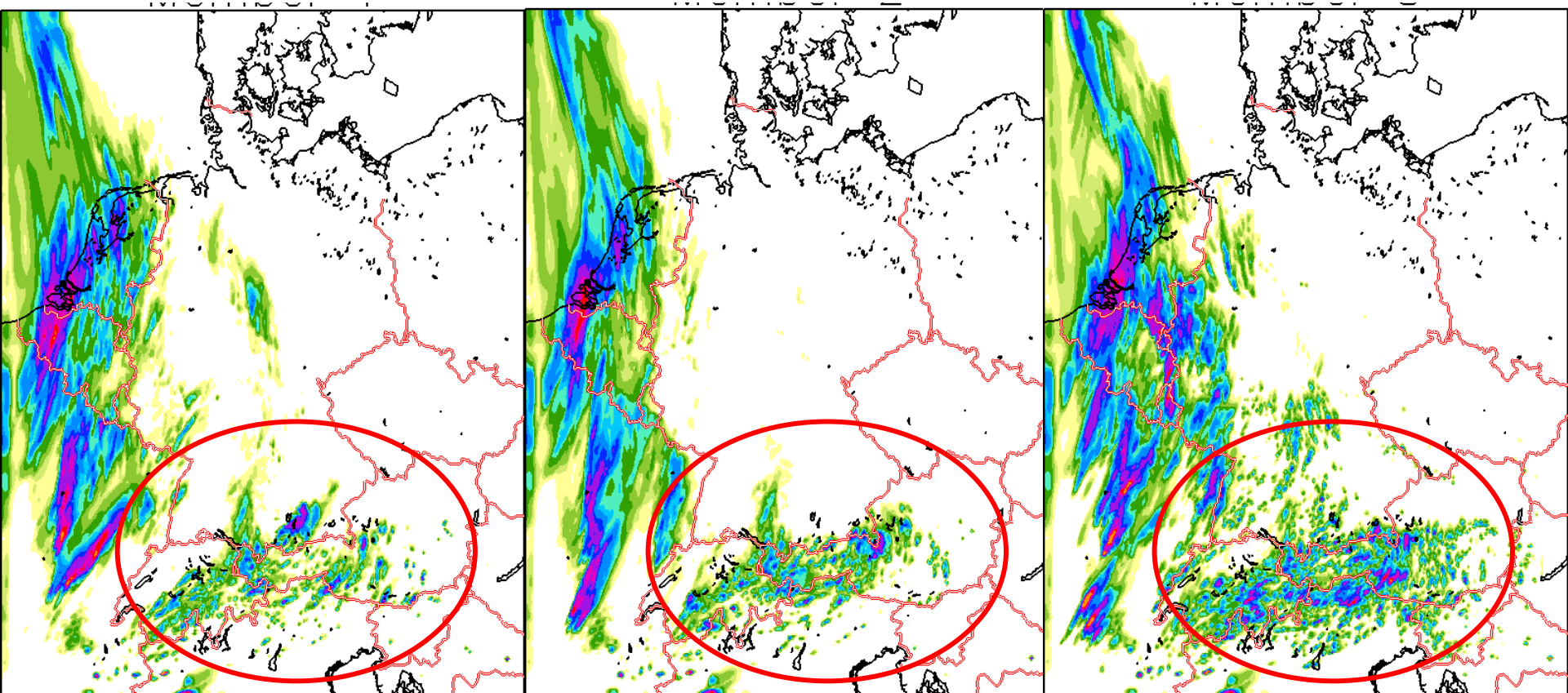
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