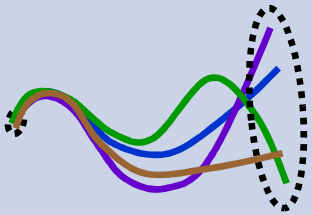
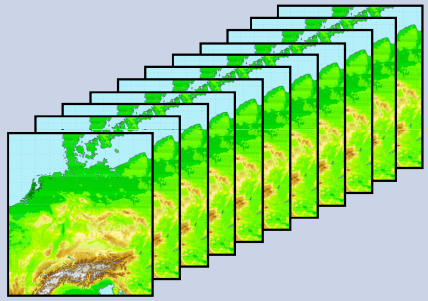
Deutscher Wetterdienst
Wetter und Klima aus einer Hand





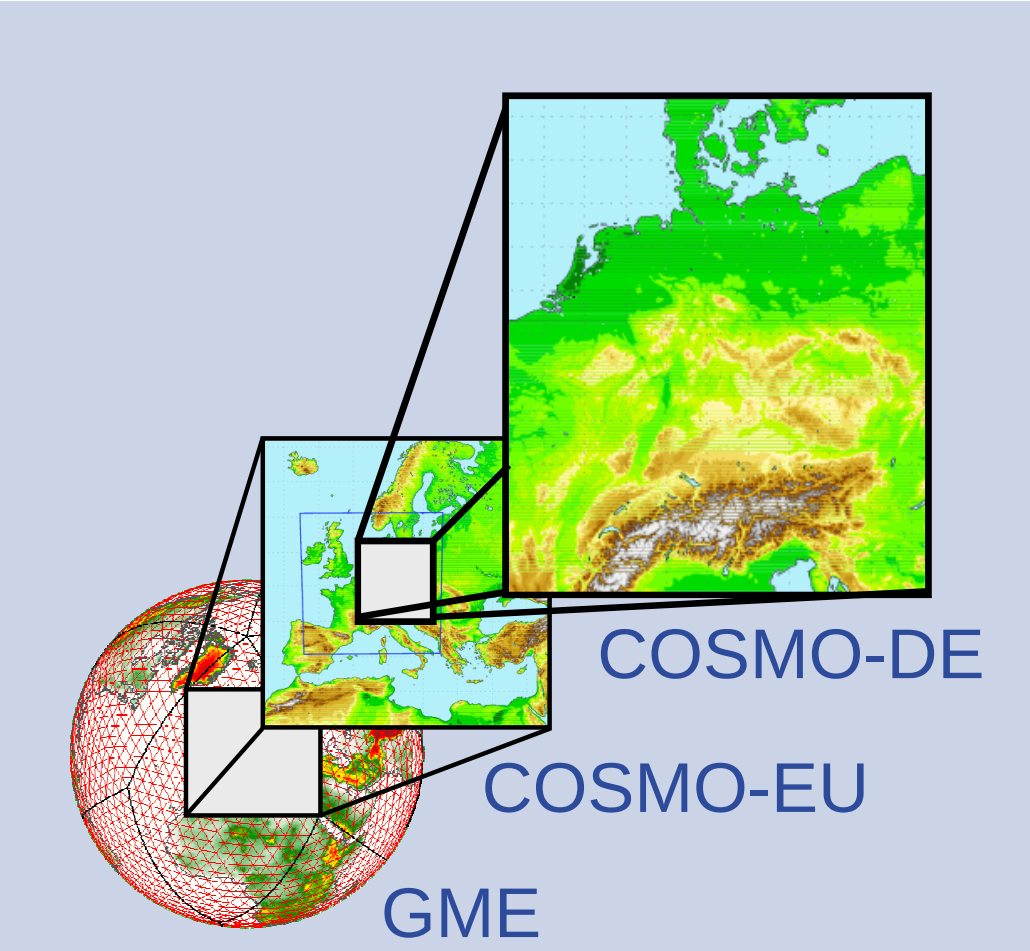
Current Status of COSMO-DE-EPS

Susanne Theis, Christoph Gebhardt, Michael Buchhold,
Zied Ben Bouallègue, Roland Ohl, Marcus Paulat, Carlos Peralta

with support by: Helmut Frank, Thomas Hanisch, Ulrich Schättler, etc

NWP Model COSMO-DE

- ➔ grid size 2.8 km
- ➔ without parametrization of deep convection ***(convection-permitting)***
- ➔ lead time 0-21 hours
- ➔ operational since April 2007



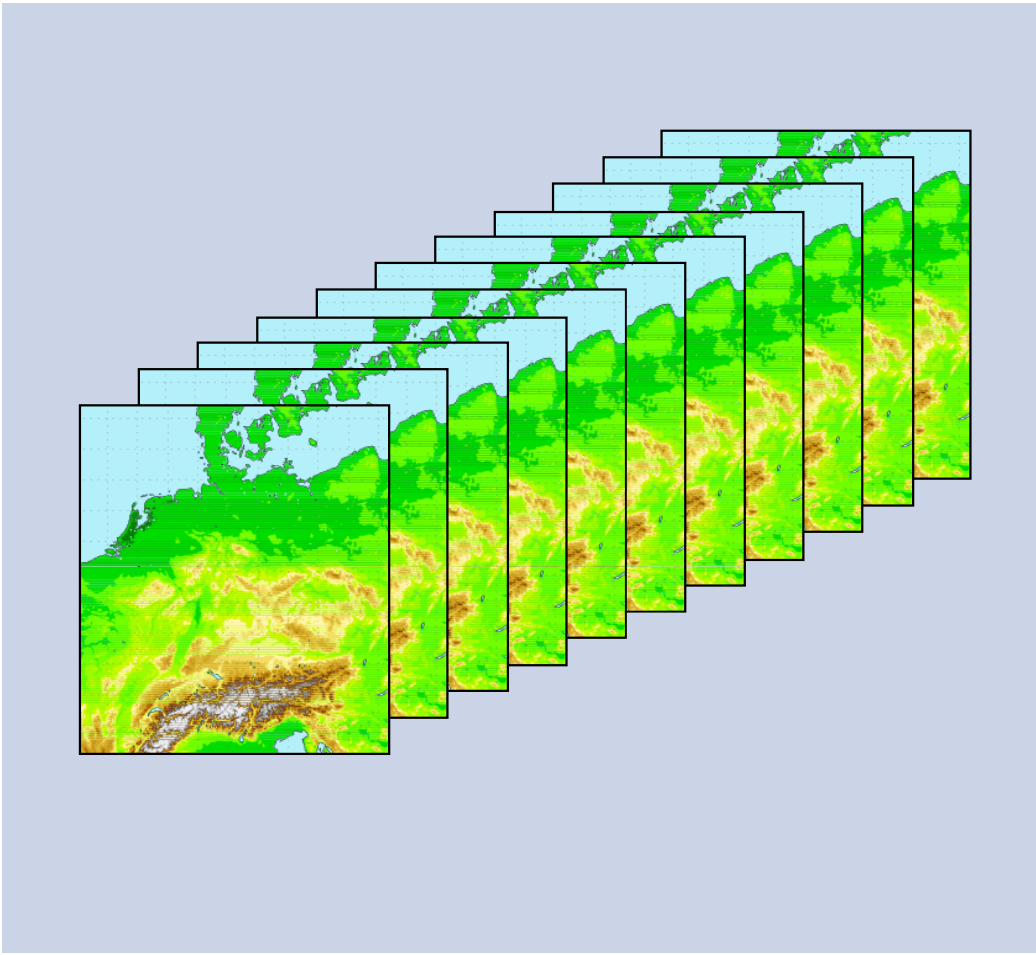
Plans for a COSMO-DE Ensemble

How many ensemble members?

- ➔ preoperational: 20 members
- ➔ operational: 40 members

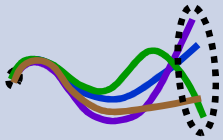
When?

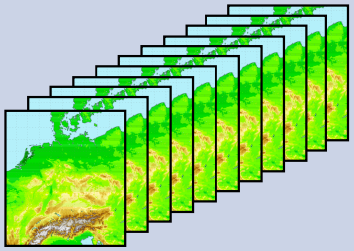
- ➔ preoperational: 2010
- ➔ operational: 2012



COSMO-DE-EPS production steps

„variations“ within forecast system





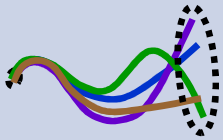
ensemble members

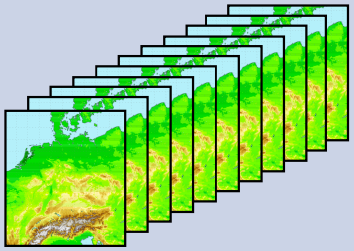
Ensemble products:

- mean
- spread
- probabilities
- quantiles
- ...

COSMO-DE-EPS production steps

„variations“ within forecast system





ensemble members

Ensemble products:

- mean
- spread
- probabilities
- quantiles
- ...

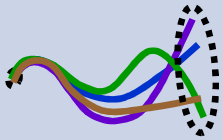
+ verification

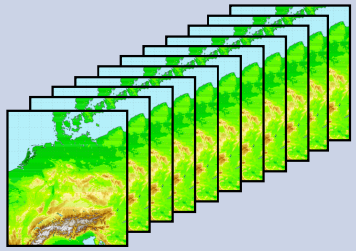
+ postprocessing

COSMO-DE-EPS production steps

„variations“ within forecast system

1





ensemble members

Ensemble products:

- mean
- spread
- probabilities
- quantiles
- ...

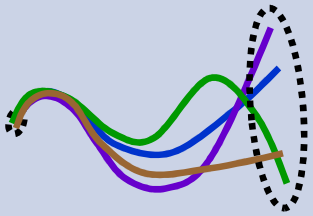
next slides:
step 1, production of members

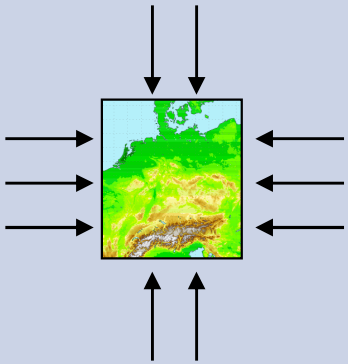
Generation of Ensemble Members

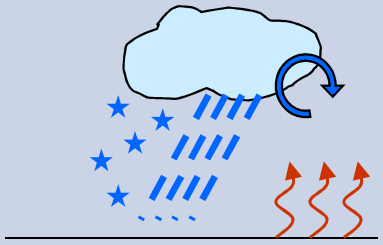
Variations in Forecast System

for the Representation of Forecast Uncertainty

Initial Conditions	Boundaries	Model Physics



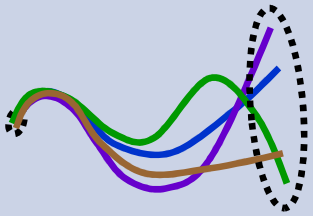
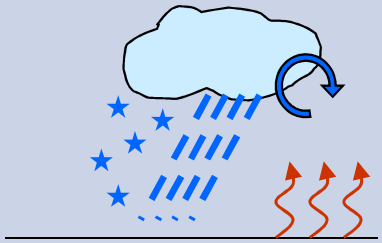




Generation of Ensemble Members

Variations in Forecast System

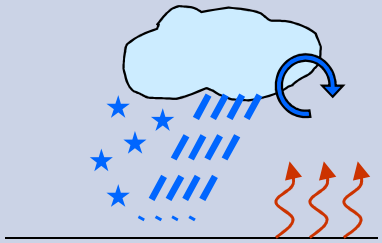
for the Representation of Forecast Uncertainty

Initial Conditions	Boundaries	Model Physics
	**“multi-model”** driven by different global models	

Generation of Ensemble Members

Variations in Forecast System

for the Representation of Forecast Uncertainty

Initial Conditions	Boundaries	Model Physics
“multi-model” different global models are used to modify COSMO-DE initial conditions	**“multi-model”** driven by different global models	

Generation of Ensemble Members

Variations in Forecast System

for the Representation of Forecast Uncertainty

Initial Conditions	Boundaries	Model Physics
“multi-model”	**“multi-model”**	**“multi-configuration”**
different global models are used to modify COSMO-DE initial conditions	driven by different global models	different configurations of the COSMO-DE model

Generation of Ensemble Members

Variations in Forecast System

for the Representation of Forecast Uncertainty

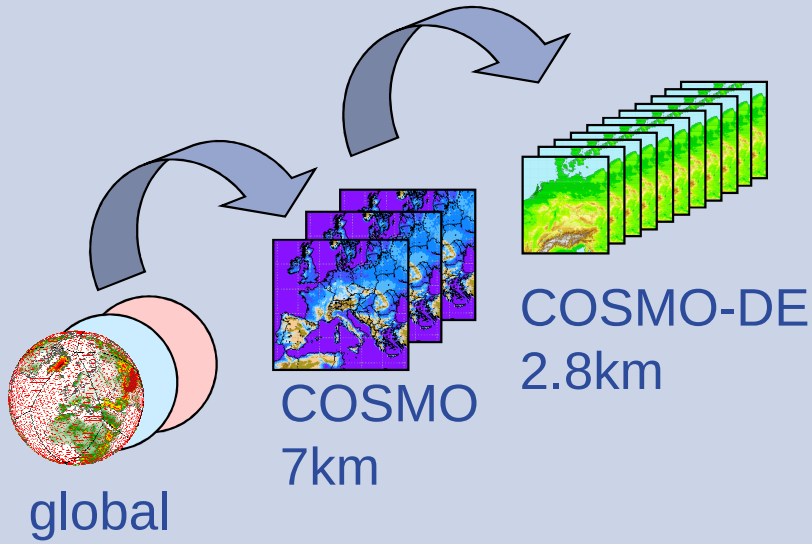
Initial Conditions	Boundaries	Model Physics
“multi-model”	**“multi-model”**	**“multi-configuration”**
different global models are used to modify COSMO-DE initial conditions	driven by different global models	different configurations of the COSMO-DE model

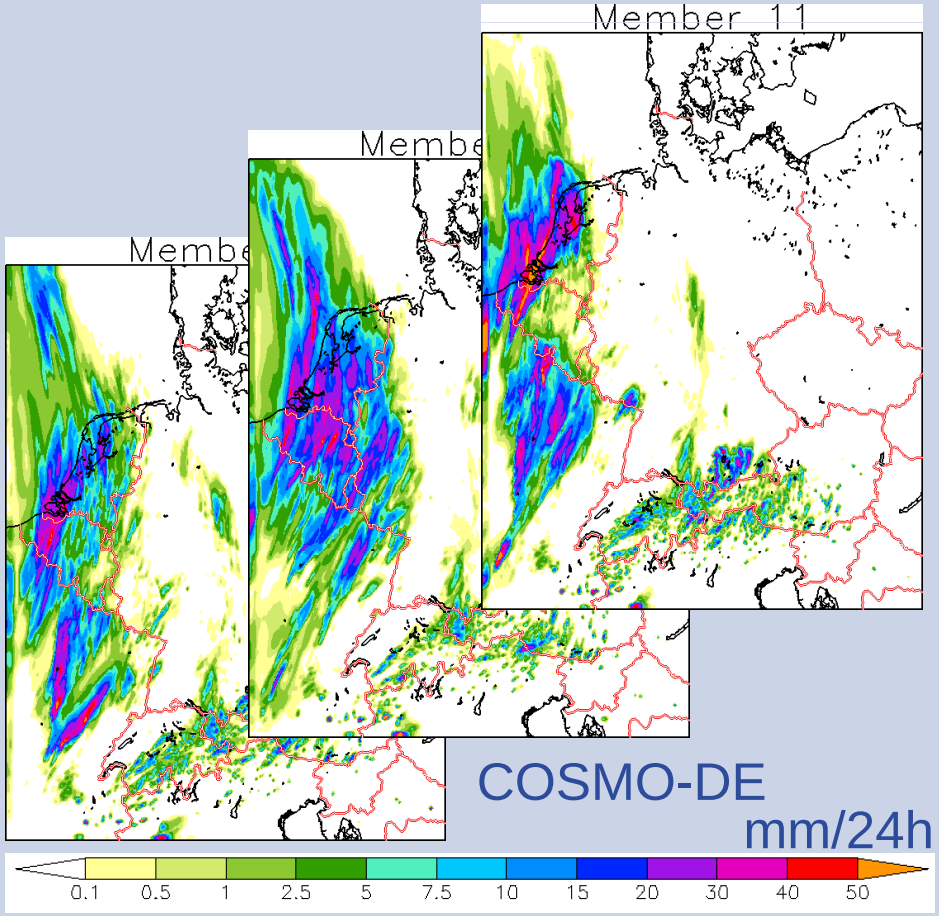
new

new suite

Generation of Ensemble Members

The Ensemble Chain

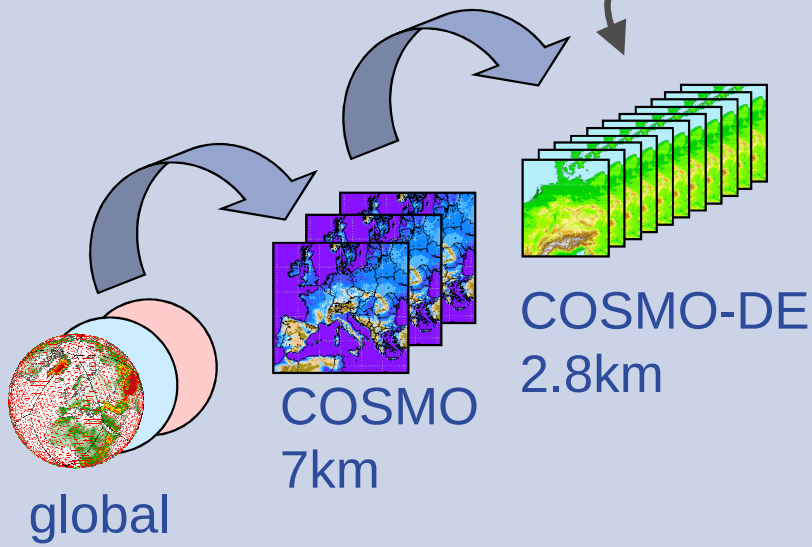


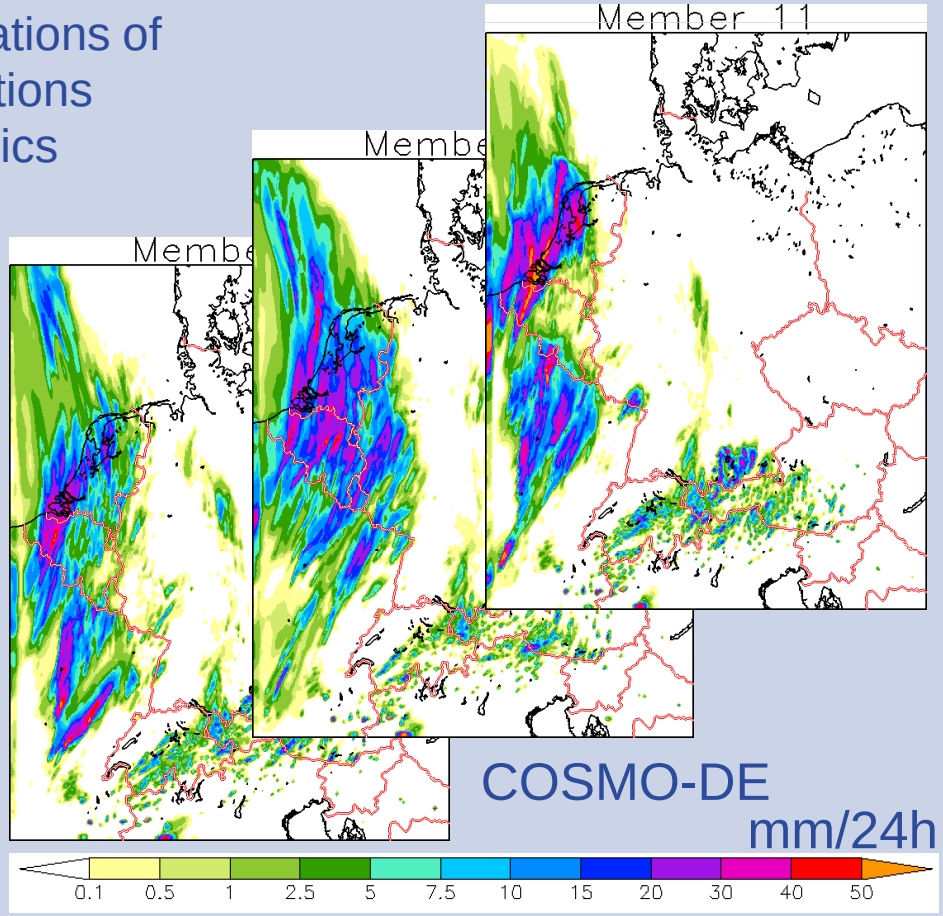


Generation of Ensemble Members

The Ensemble Chain

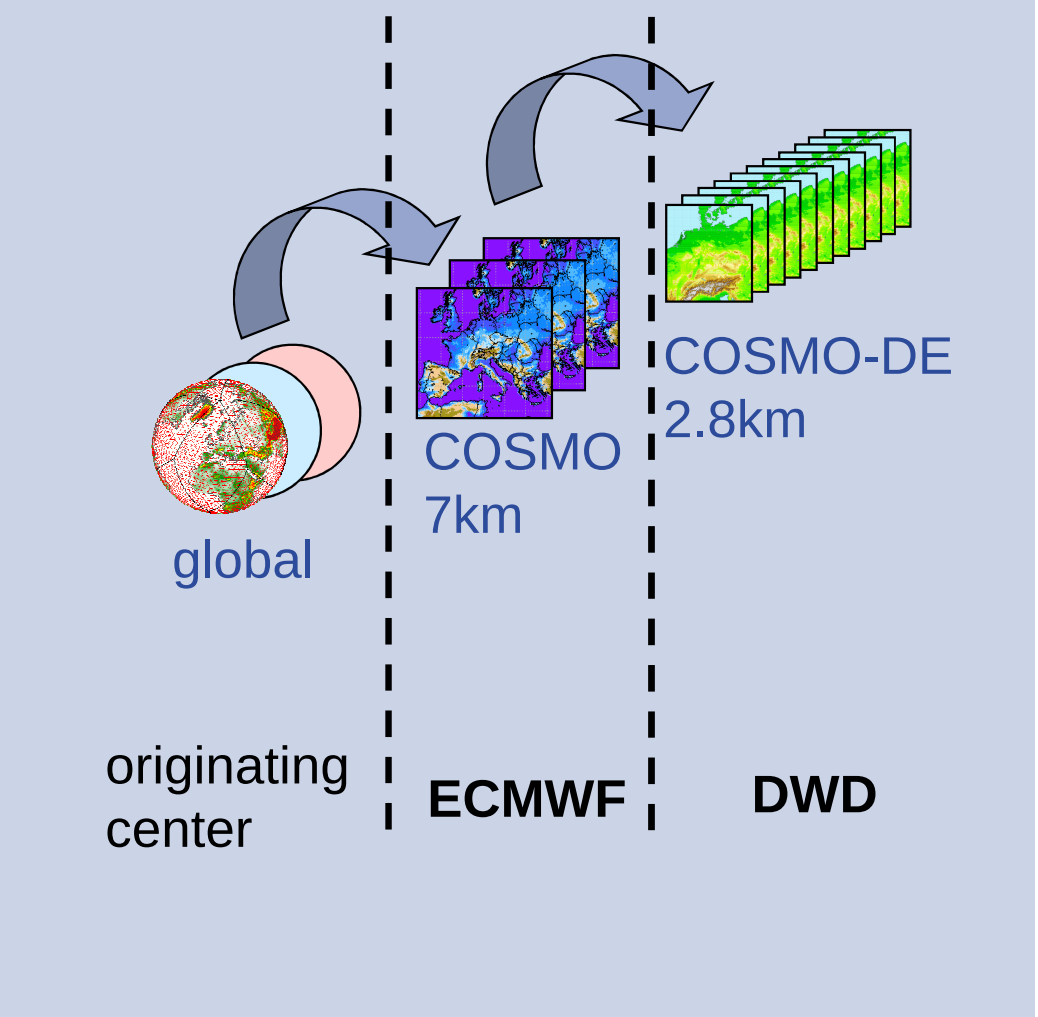
plus the variations of
- initial conditions
- model physics





Generation of Ensemble Members

- Which computers are used?
  - at ECMWF: „7 km Ensemble“
  - at DWD: COSMO-DE-EPS



Generation of Ensemble Members

- Which computers are used?
  - at ECMWF: „7 km Ensemble“
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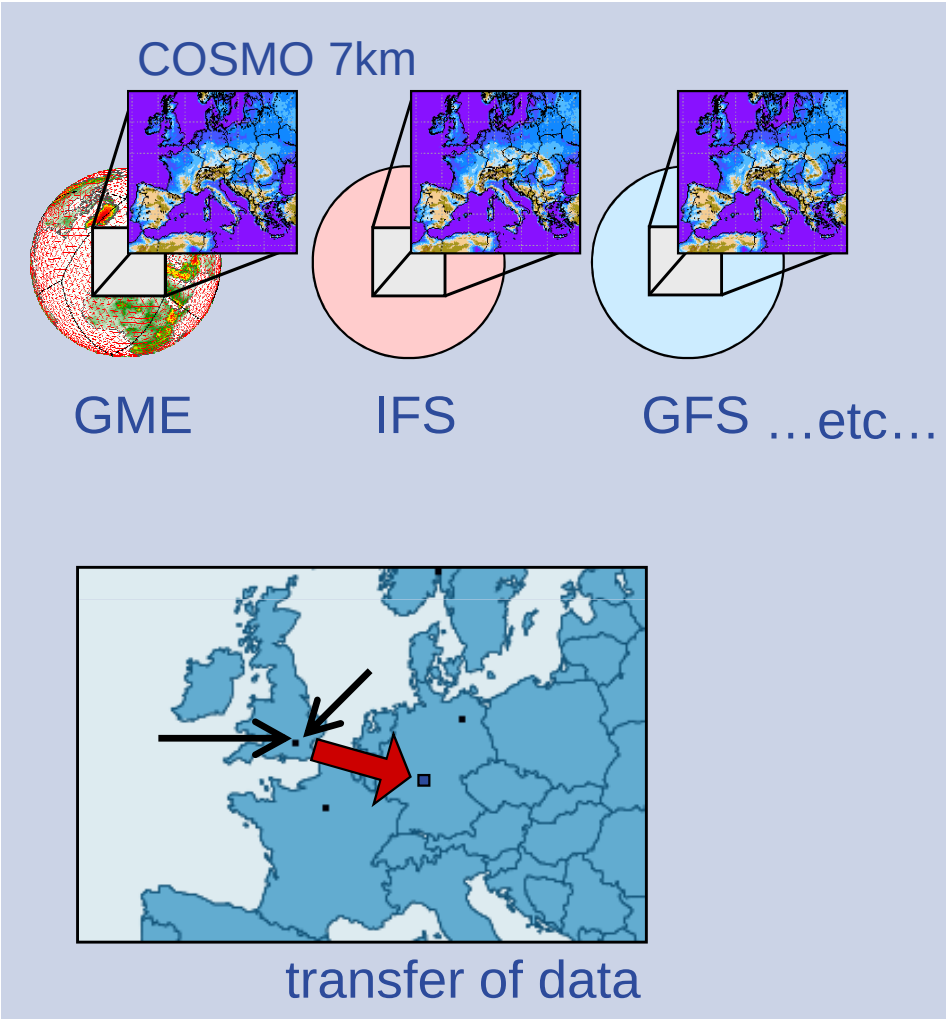


Generation of Ensemble Members

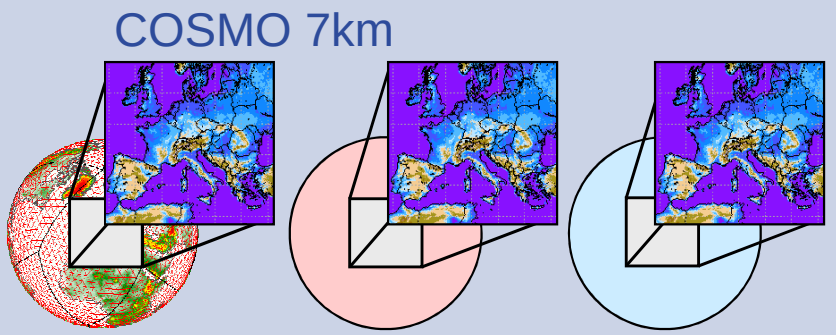
- Which computers are used?
  - **at ECMWF: „7 km Ensemble“**
  - at DWD: COSMO-DE-EPS

- **Status: in testing phase**

  together with

  COSMO-SREPS by ARPA-SIMC

new suite



transfer of data

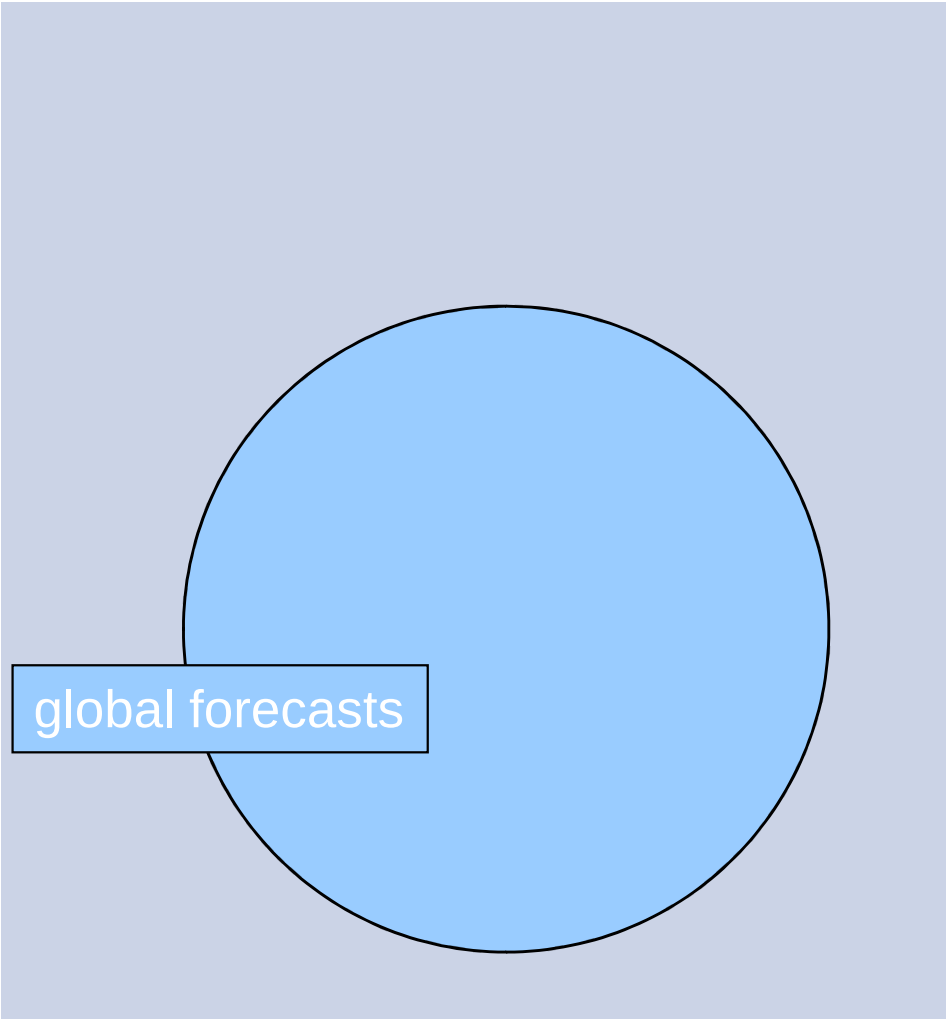
Generation of Ensemble Members

➔ variation of initial conditions

Generation of Ensemble Members

➔ variation of initial conditions

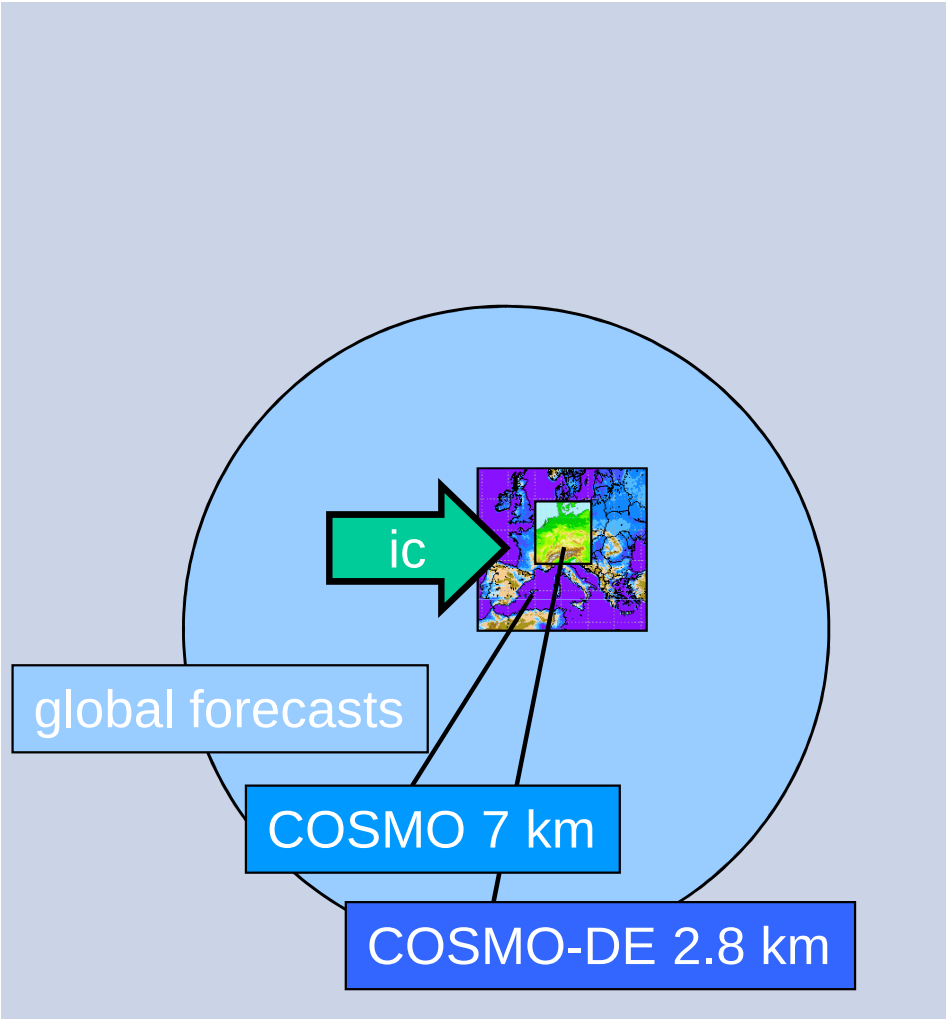
new



Generation of Ensemble Members

➔ variation of initial conditions

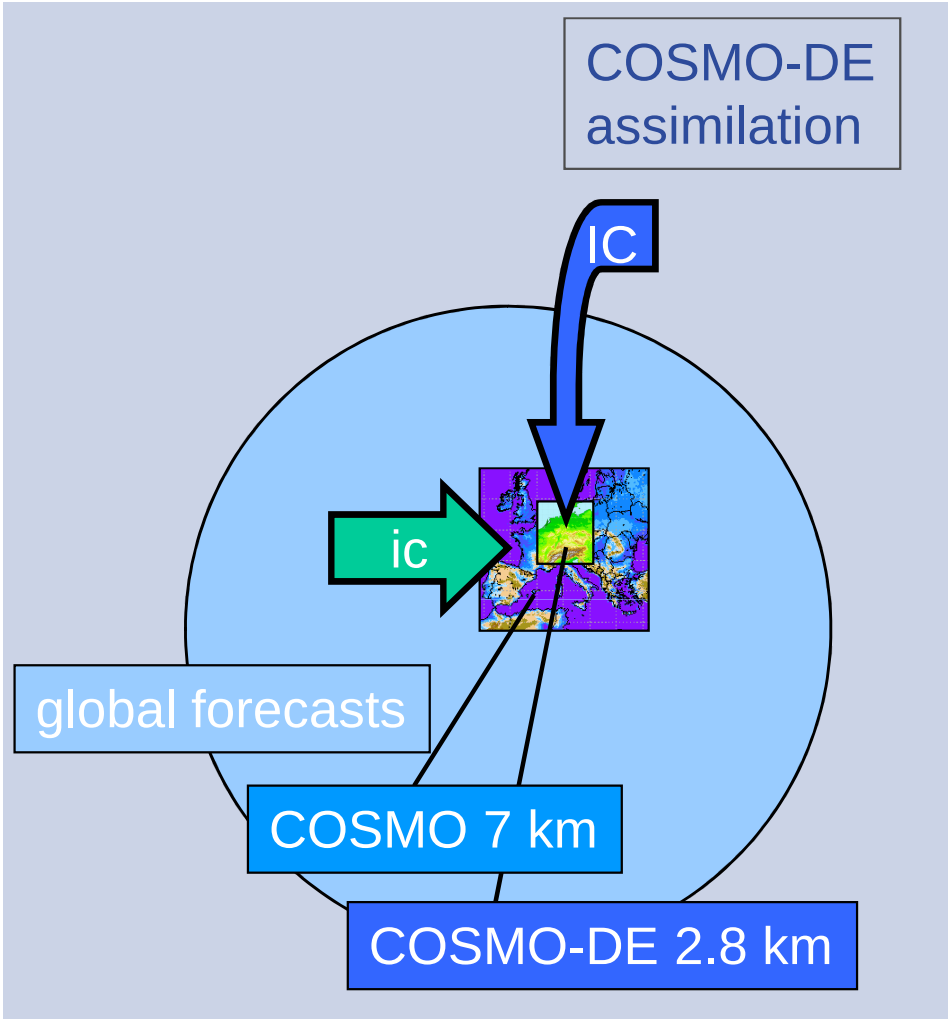
new



Generation of Ensemble Members

➔ variation of initial conditions

new



Generation of Ensemble Members

➔ variation of initial conditions

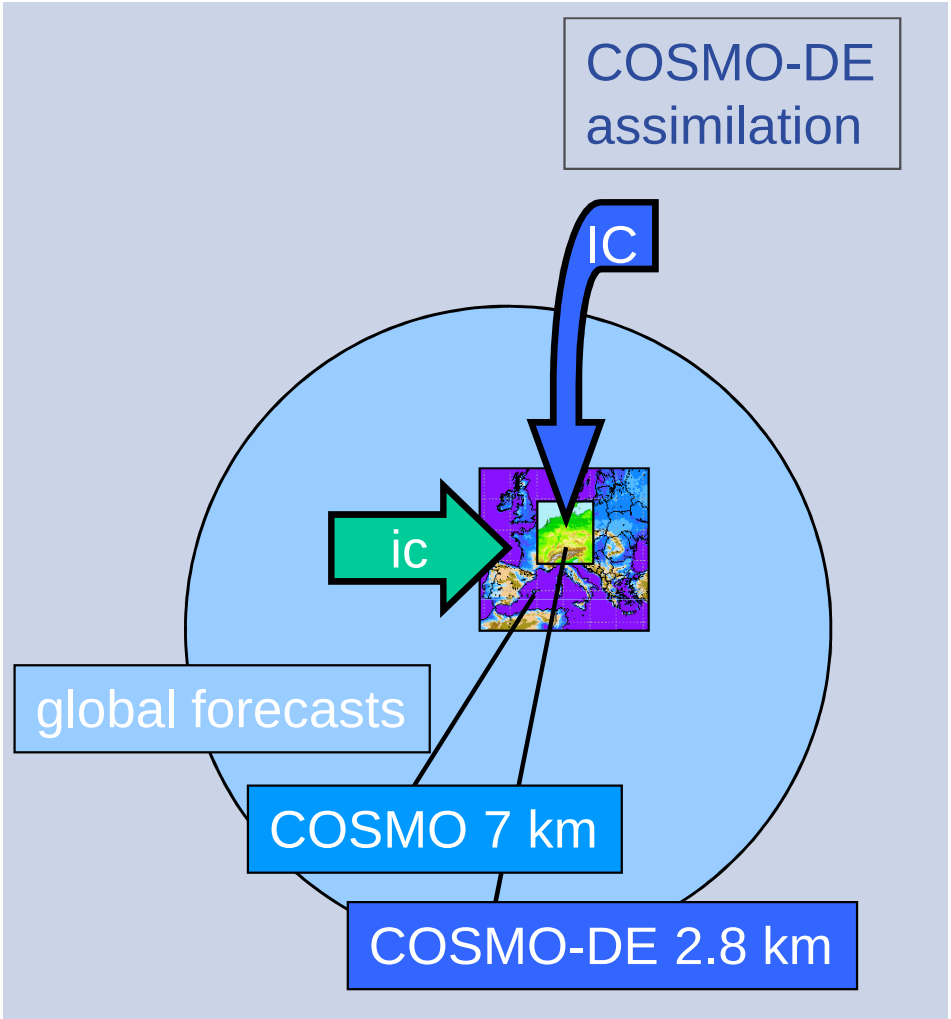
new

modify initial conditions of COSMO-DE

by using differences between

the COSMO 7km initial conditions

$$IC' = F\,(IC,\ ic - ic_{ref})$$



Generation of Ensemble Members

➔ variation of „model physics“

different configurations
of COSMO-DE 2.8 km:

1. entr_sc
2. rlam_heat
3. rlam_heat
4. q_crit
5. tur_len

Generation of Ensemble Members

➔ variation of „model physics“

Selection of Configurations

subjective, based on experts, verification

Selection Criteria:

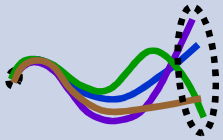
1. large effect on forecasts
2. no „inferior“ configuration

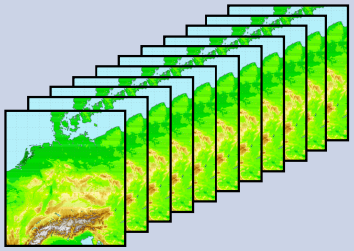
different configurations
of COSMO-DE 2.8 km:

1. entr_sc
2. rlam_heat
3. rlam_heat
4. q_crit
5. tur_len

COSMO-DE-EPS production steps

„variations“ within forecast system





ensemble members

2

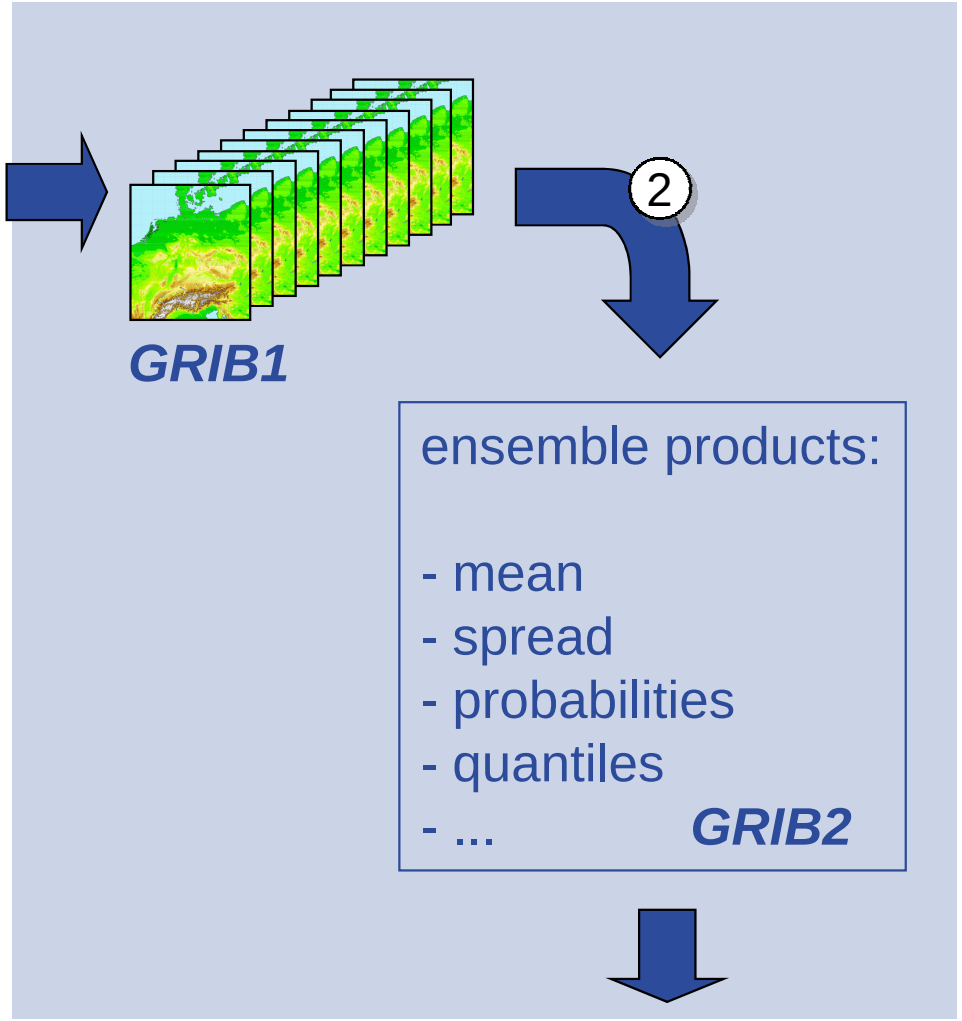
Ensemble products:

- mean
- spread
- probabilities
- quantiles
- ...

next slides:
step 2, generating „products“

Generation of „Ensemble Products“

- variables (list will be extended):
  - 1h-precipitation
  - wind gusts
  - 2m-temperature
- ensemble „products“:
  - probabilities
  - quantiles
  - ensemble mean
  - min, max
  - spread



Generation of „Ensemble Products“

- further improvement:
  - adding a spatial neighbourhood
  - adding simulations started a few hours earlier (planned)

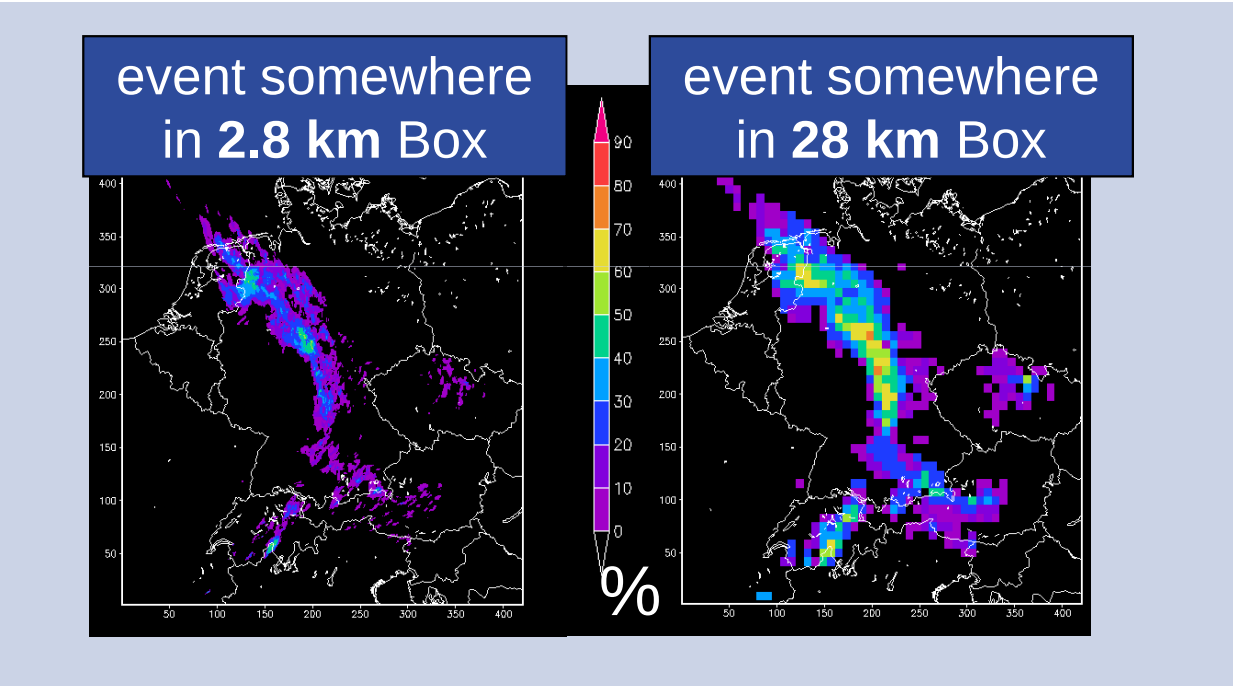
Generation of „Ensemble Products“

- ➔ further improvement:
  - ➔ adding a spatial neighbourhood
  - ➔ adding simulations started a few hours earlier (planned)

- ➔ additional product:

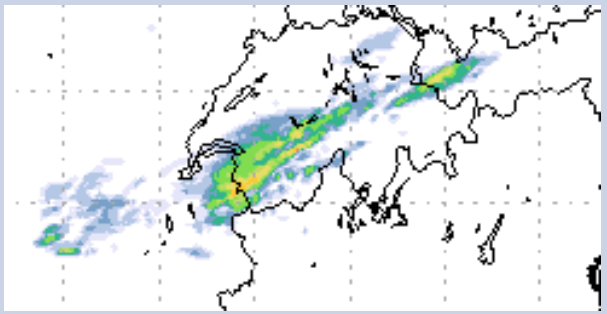
  probabilities

  with upscaling

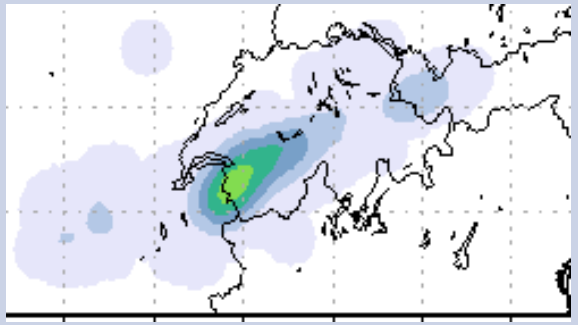


Product Generation: Example

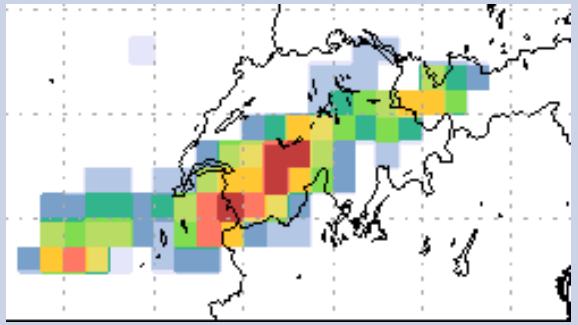
Probability of Event „Precipitation > 10 mm/24h“



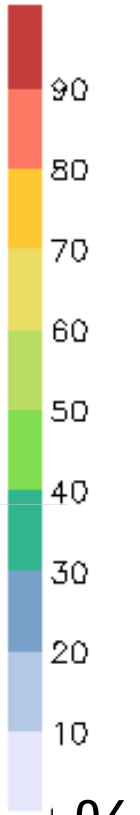
traditional



Derived from:
Ensemble Members
+ Spatial Neighbourhood

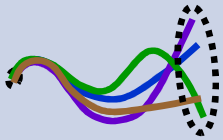


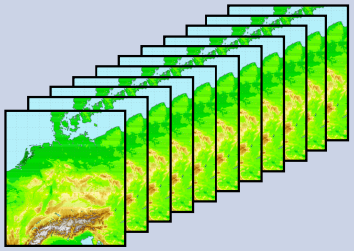
Defined for:
area of
10x10 grid boxes



COSMO-DE-EPS production steps

„variations“ within forecast system





ensemble members

Ensemble products:

- mean
- spread
- probabilities
- quantiles
- ...

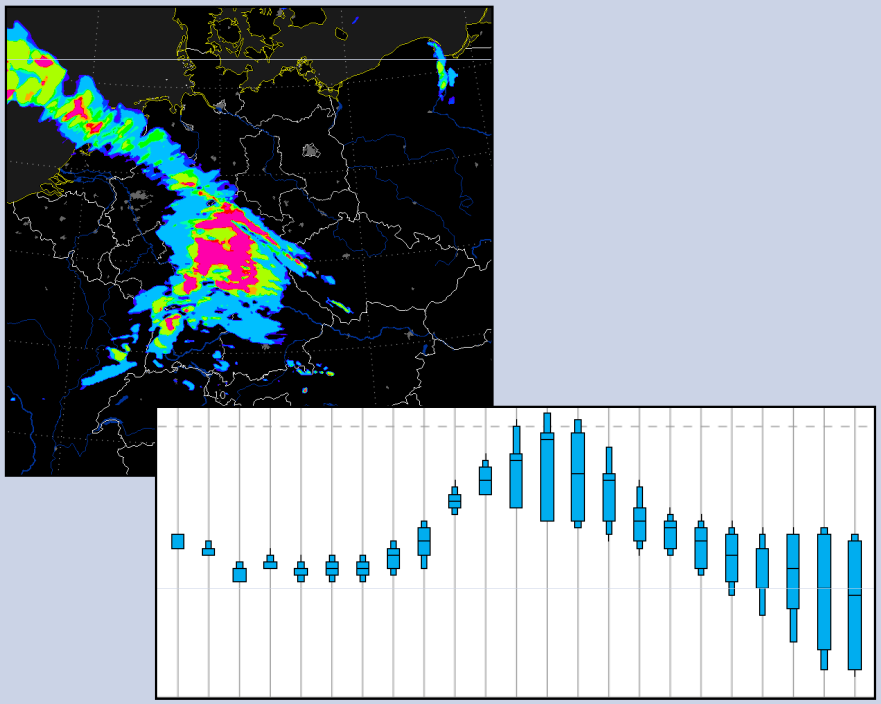
3

next slides:
step 3, visualization in NinJo

Visualization in NinJo

- New Development: „Ensemble Layer“
- for NinJo Version 1.3.6
- released in August 2010

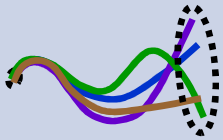
new

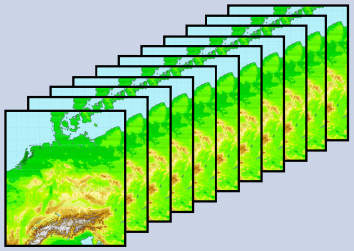


Examples

COSMO-DE-EPS production steps

„variations“ within forecast system





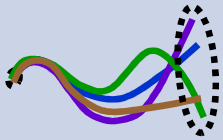
ensemble members

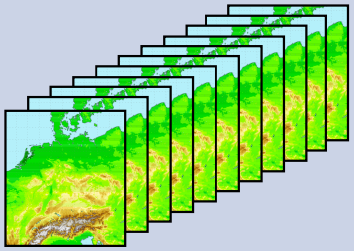
Ensemble products:

- mean
- spread
- probabilities
- quantiles
- ...

COSMO-DE-EPS production steps

„variations“ within forecast system





ensemble members

Ensemble products:

- mean
- spread
- probabilities
- quantiles
- ...

+ verification

+ postprocessing

Verification Results

➔ Very first aim:

Does the ensemble meet some basic requirements?

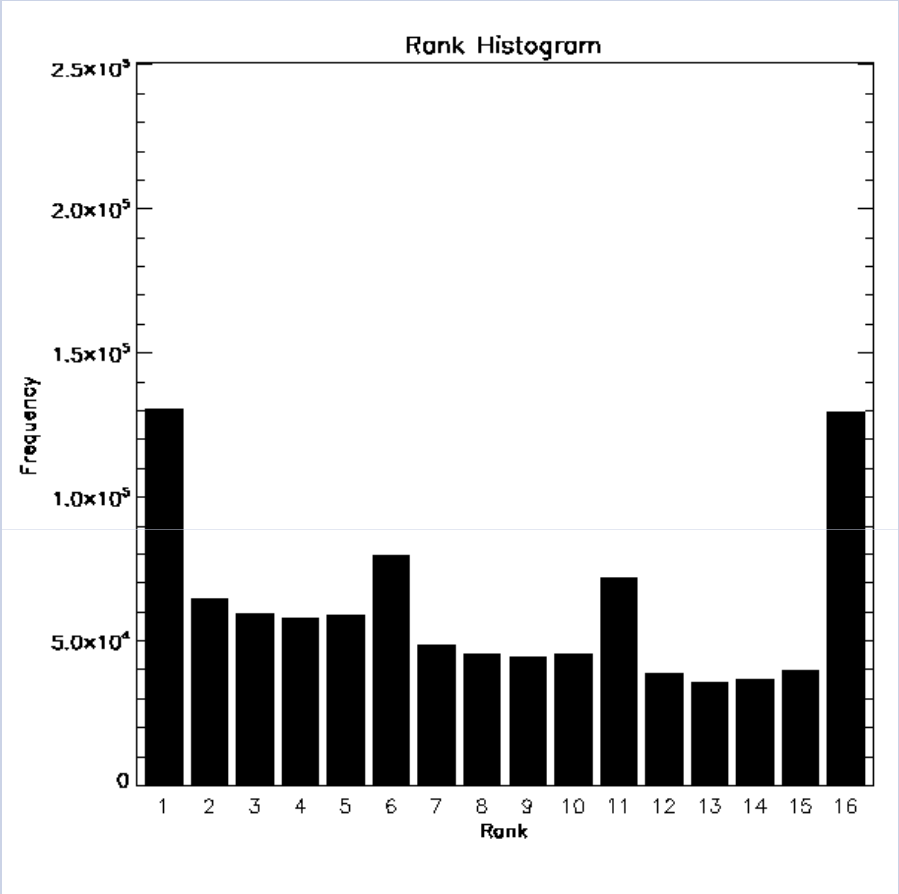
➔ Results:

- ensemble spread is present
- members are of similar quality
- quality of ensemble is superior to quality of individual forecasts

GEBHARDT, C., S.E. THEIS, M. PAULAT, Z. BEN BOUALLÈGUE, 2010:

Uncertainties in COSMO-DE precipitation forecasts introduced by model perturbations and variation of lateral boundaries. Submitted to Atmospheric Research.

Talagrand Diagram



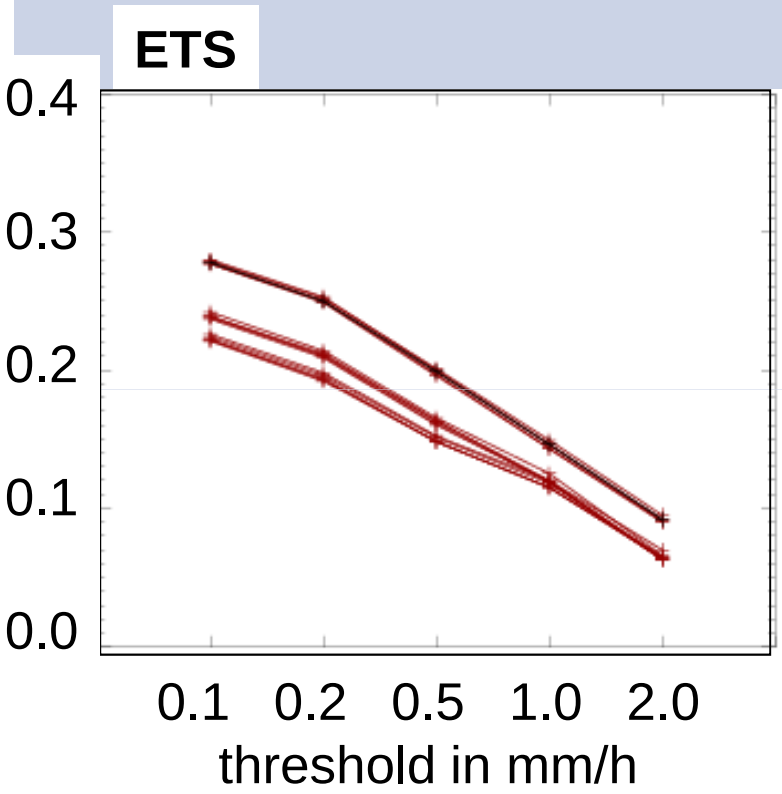
Oct 7 – Nov 24 2009
15 days selected
(15 ensemble members)

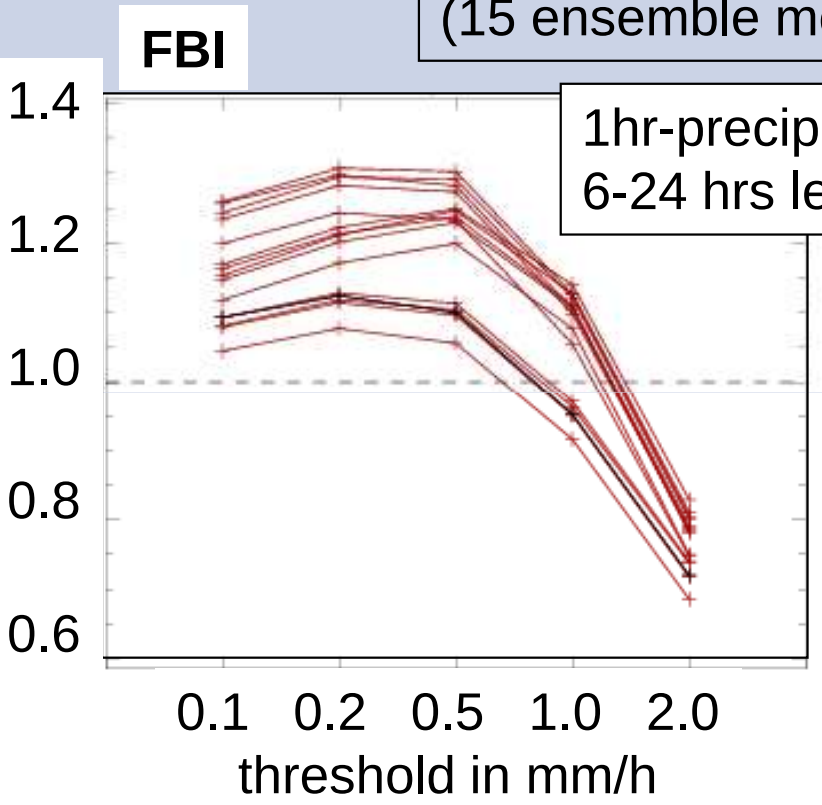
1hr-precipitation
24 hrs lead time

Individual Member Verification

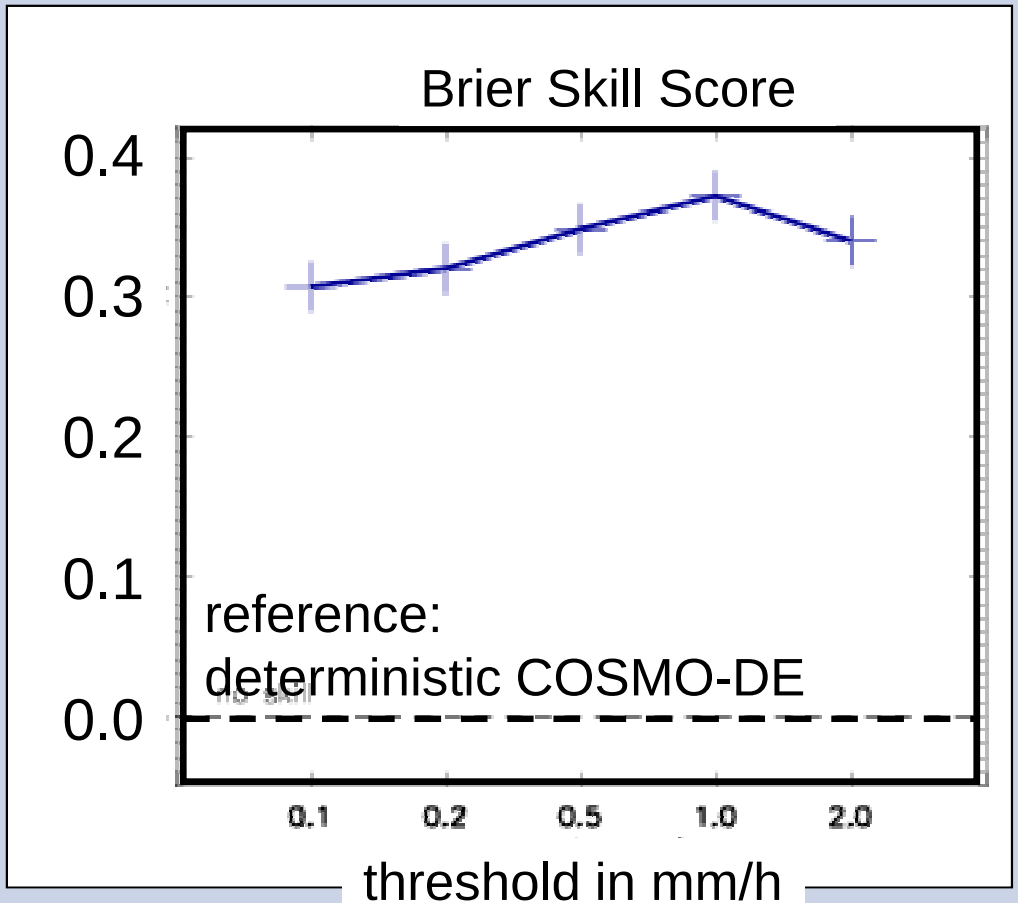
Oct 7 – Nov 24 2009
15 days selected
(15 ensemble members)

1hr-precipitation
6-24 hrs lead time





Probabilistic Verification of Ensemble



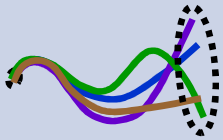
Oct 7 – Nov 24 2009
15 days selected
(15 ensemble members)

1hr-precipitation
6-24 hrs lead time

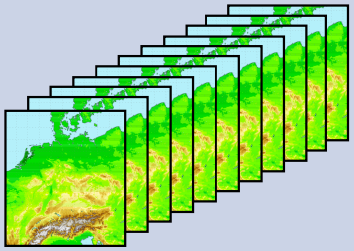
Postprocessing / Calibration

Postprocessing / Calibration

„variations“ within forecast system



X



ensemble members

X

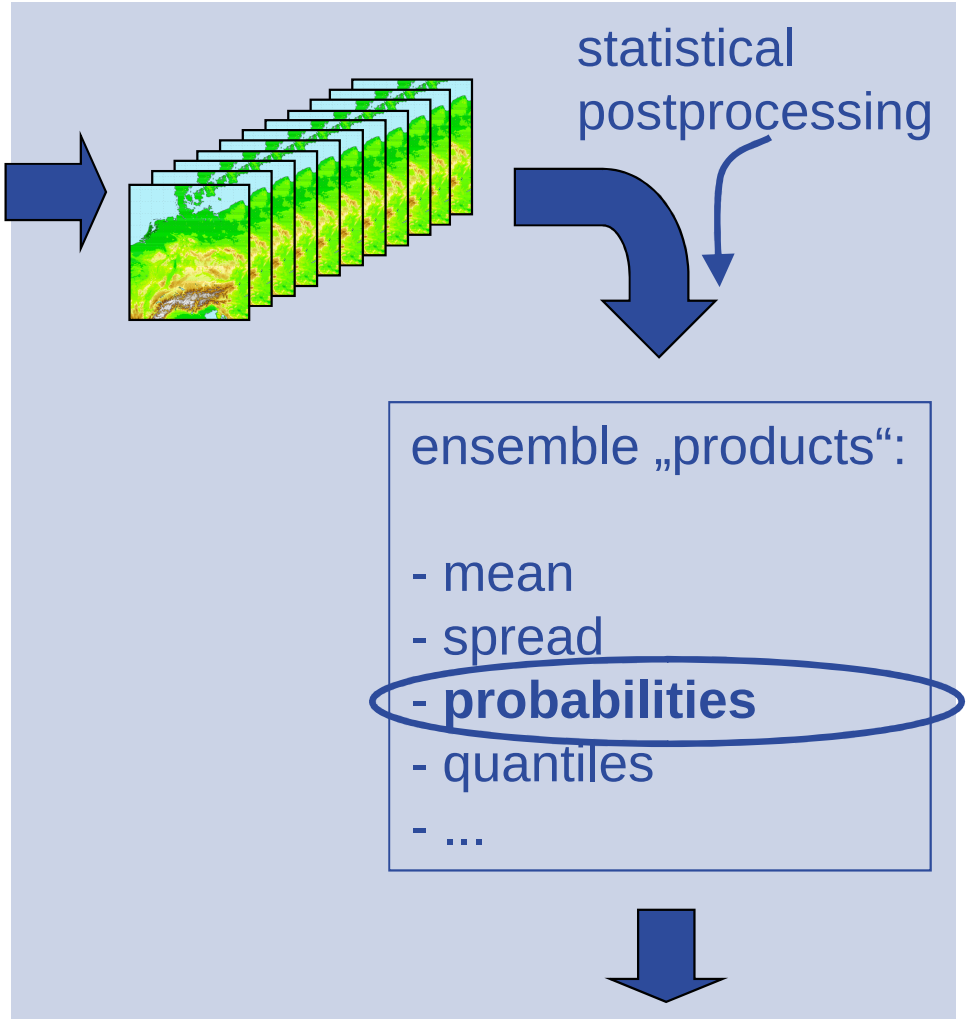
Ensemble products:

- mean
- spread
- probabilities
- quantiles
- ...

Method for Postprocessing / Calibration

➔ First Approach:

logistic regression



Method for Postprocessing / Calibration

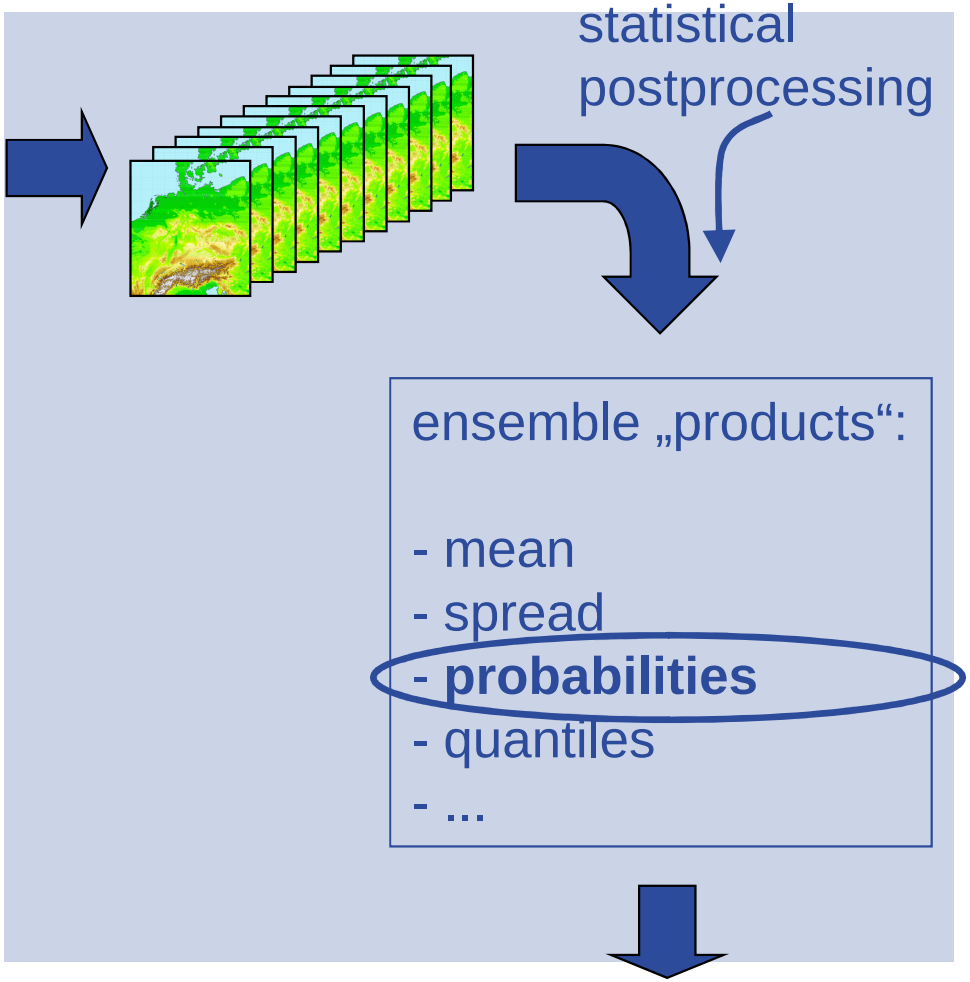
➔ First Approach:

logistic regression

deriving probabilities

by statistical connection between

Predictor ←→ Observation Yes / No



Method for Postprocessing / Calibration

➔ First Approach:

logistic regression

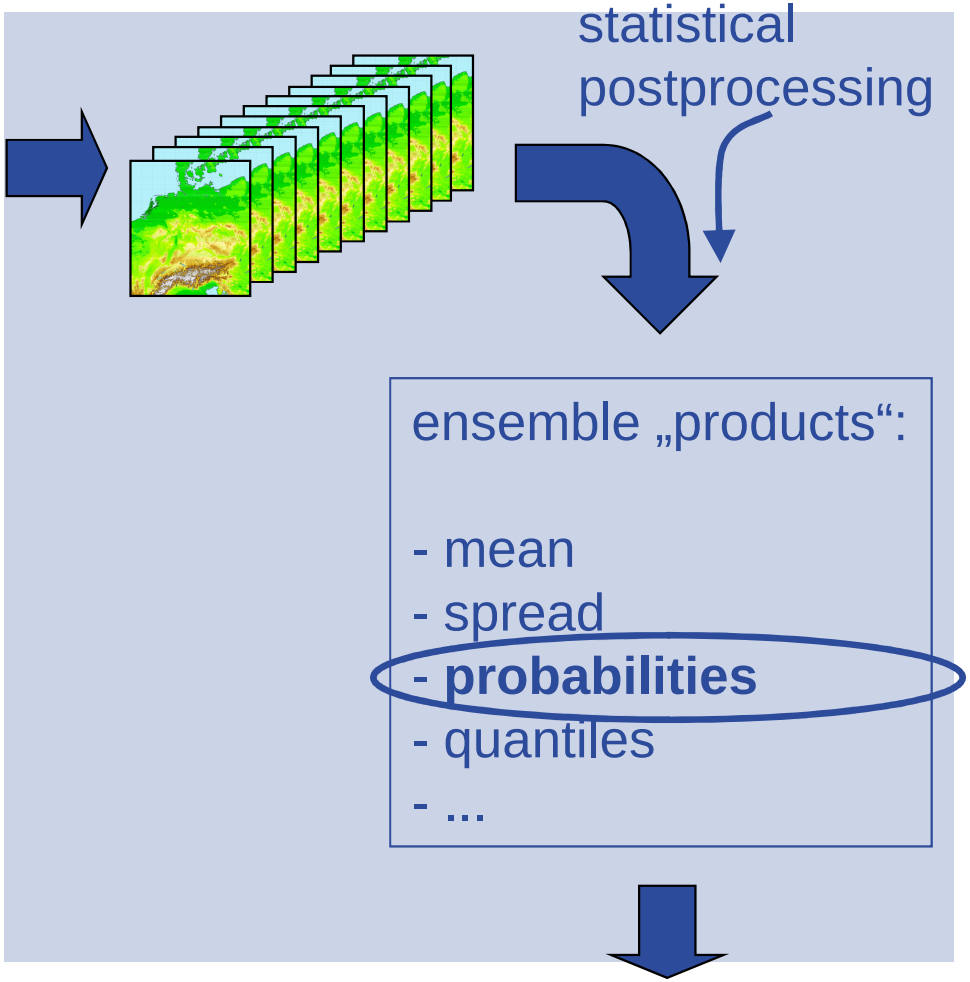
deriving probabilities

by statistical connection between

Predictor ←→ Observation Yes / No

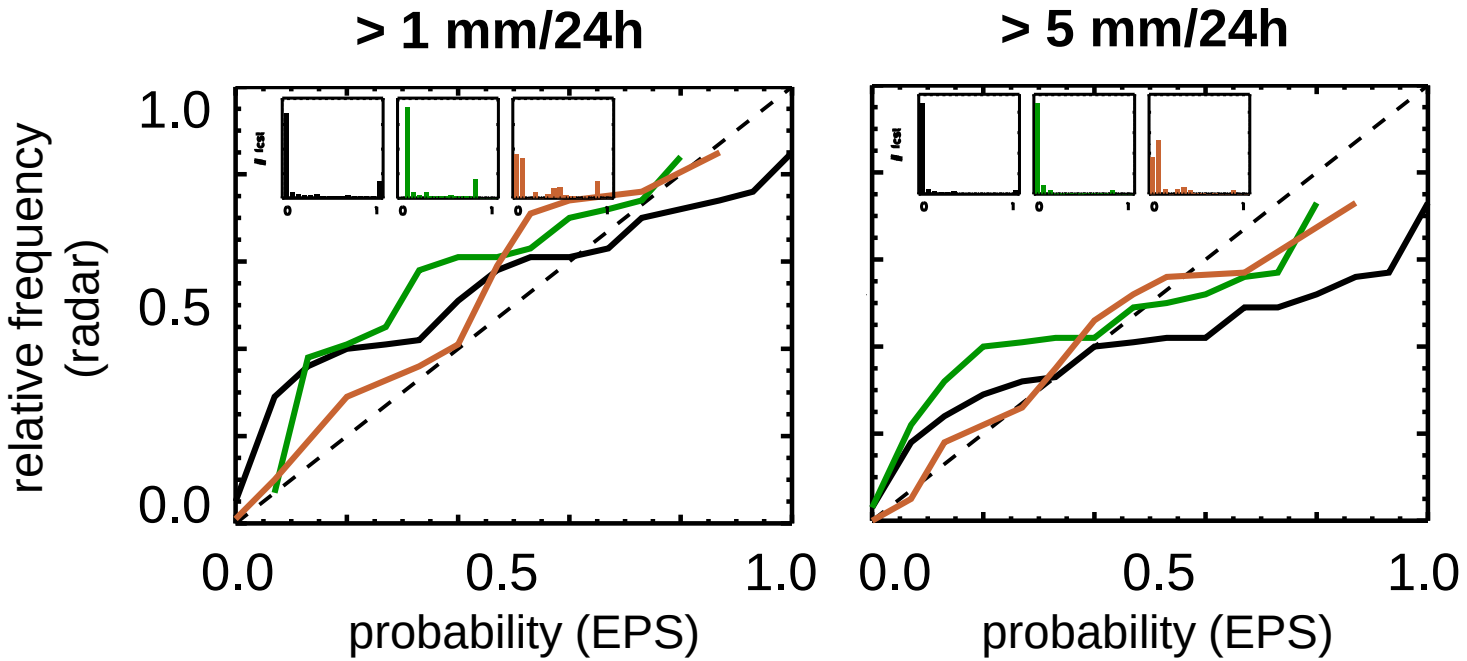
Plan: preoperational in 2011

for precipitation



Result for Postprocessing / Calibration

new



without calibration

with calibration

with calibration, including pre-processing

Research for Postprocessing / Calibration

➔ In addition:

Research at Universities, funded by DWD

- University of Bonn:

  Petra Friederichs, Sabrina Bentzien

  Methods: ***Quantile Regression, Extreme Value Statistics***

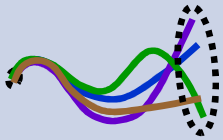
- University Heidelberg:

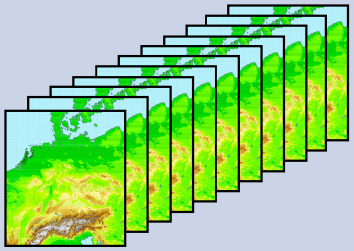
  Tilmann Gneiting, Michael Scheuerer

  Methods: ***Bayesian Model Averaging, Geostatistics***

COSMO-DE-EPS production steps

„variations“ within forecast system





ensemble members

Ensemble products:

- mean
- spread
- probabilities
- quantiles
- ...

+ verification

+ postprocessing

Plans COSMO-DE-EPS

- **2010: start of preoperational phase**

  (20 members)

- 2010-2012: further extensions
  - statistical postprocessing
  - 40 members

- **2012: start of operational phase**

convection-permitting ensemble → operational