

German Priority Research Program

PQP Quantitative Precipitation Forecasts



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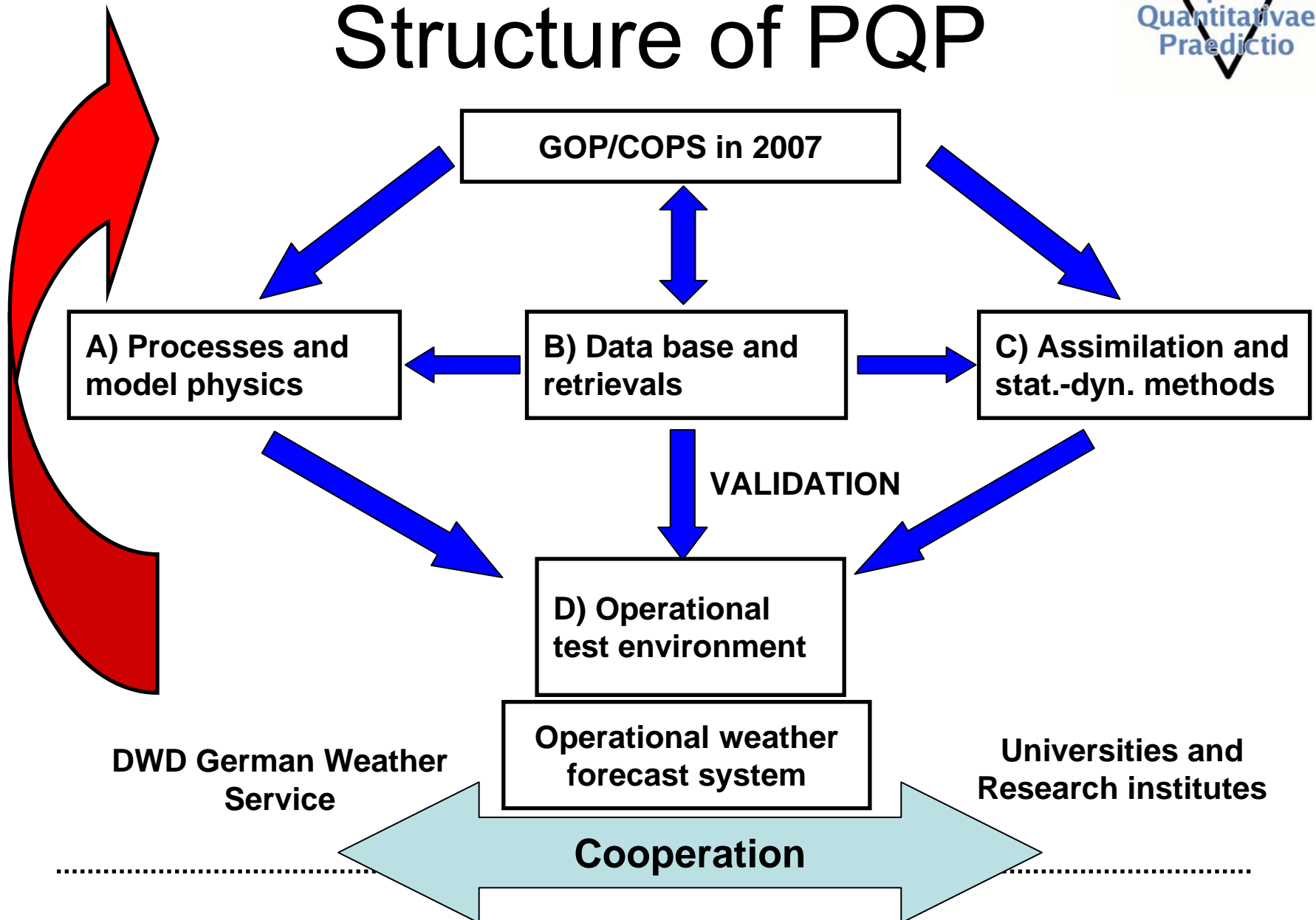
Goals

- I. **Identify** processes responsible for the **deficiencies** in QPF
- II. Fully exploit the potential of **existing/new data and process descriptions** to improve QPF
- III. Determine **potentials and limits of weather forecast models** with respect to QPF by statistical-dynamical analyses

Itinerary of PQP

- first draft in 2001
- Elbe flood in 2002
- approval by DFG (German NSF) in May 2003
 - 8 Mio € spread over 2004-2010
 - split into 3 two-year-phases
- Phase 1 finished mid 2006
- Phase 2 has started, including
 - Intensive Observation Period year 2007
 - Field experiment COPS in summer 2007

Structure of PQP





PQP-Cooperations

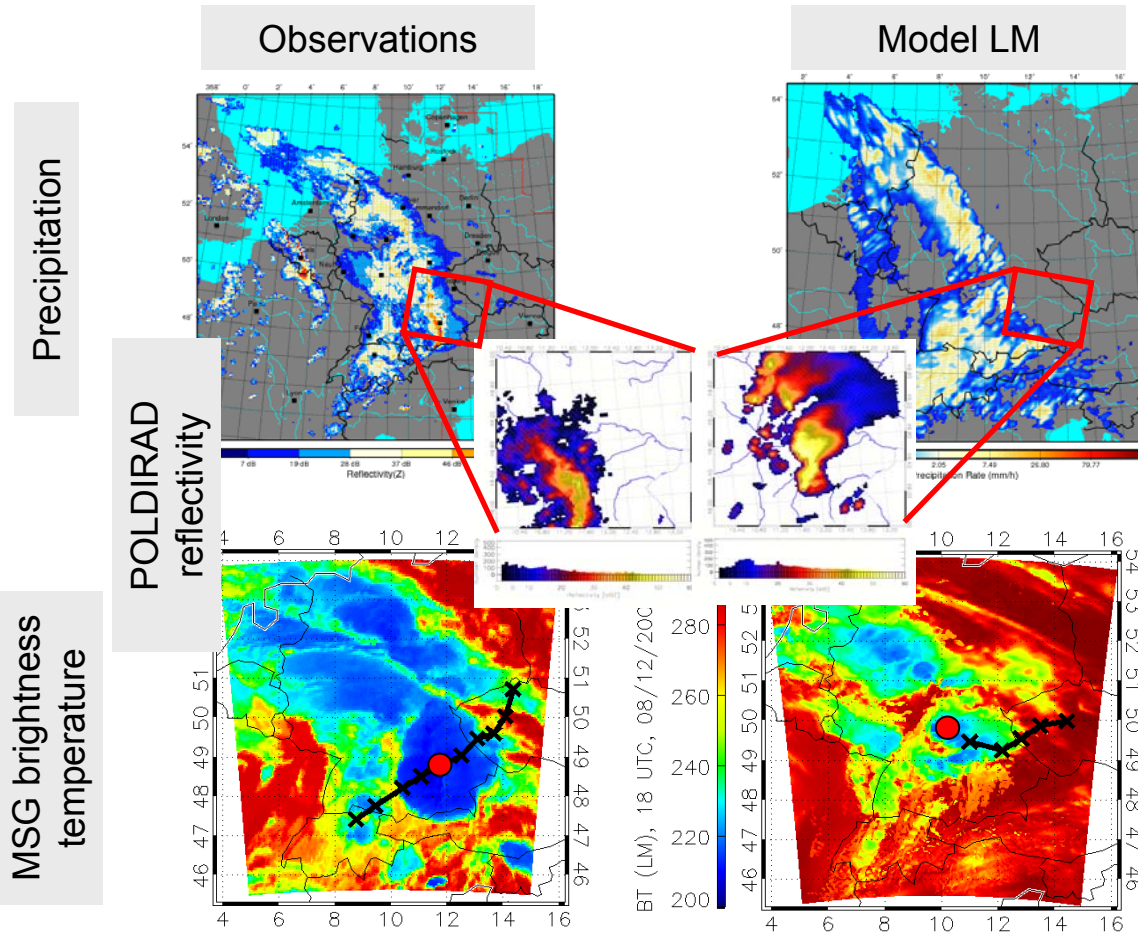
- National
 - German Weather Service (DWD):
 - individual collaborations within the working groups
 - Use of the operational forecasting system
 - databank and data assimilation system
 - suite of models GME/LM/LMK
 - model output statistics and validation tools
- International
 - Groups from Austria, Switzerland and Belgium funded
 - Memo-of-Understanding with CSIP and IHOP
 - Use of non-DWD models (MM5, WRF,...)
 - COPS (presented by Christoph Kottmeier)
 - coordination with with MAP-D-Phase
 - contribution to THORPEX



PQP Phase 2

- Research topics of the 21 projects
 - 2 x data assimilation
 - 3 x microphysics
 - 3 x ensemble forecasting
 - 5 x verification/nowcasting
 - 2 x experiment (COPS IOP)
 - 1 x remote sensing
 - 2 x convection
 - 1 x numerics
 - 1 x theory
 - 1 x orography
- More information:
 - www.meteo.uni-bonn.de/projects/SPPMeteo
 - including a **Newsletter**

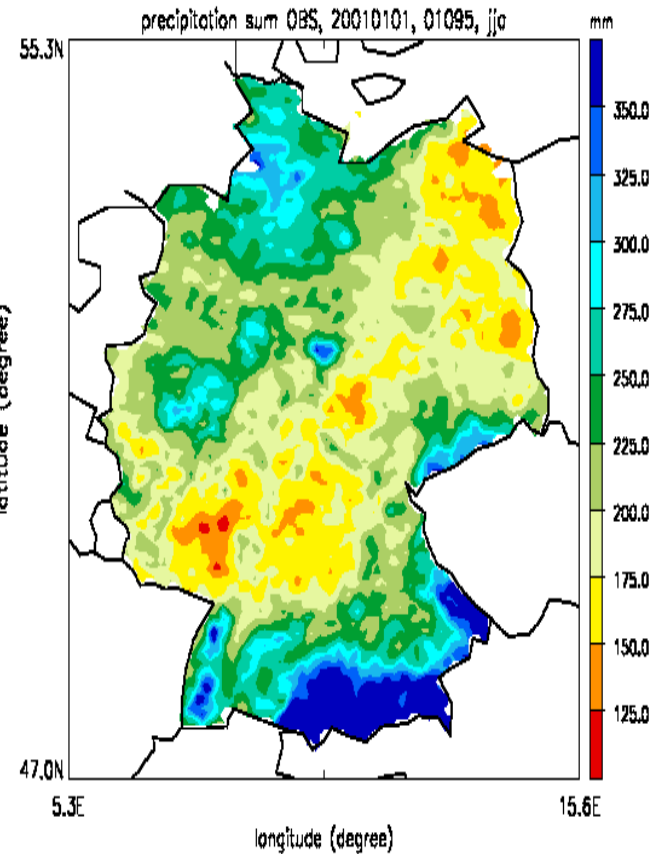
Employing the Model-to-Observations Approach for Model Verification



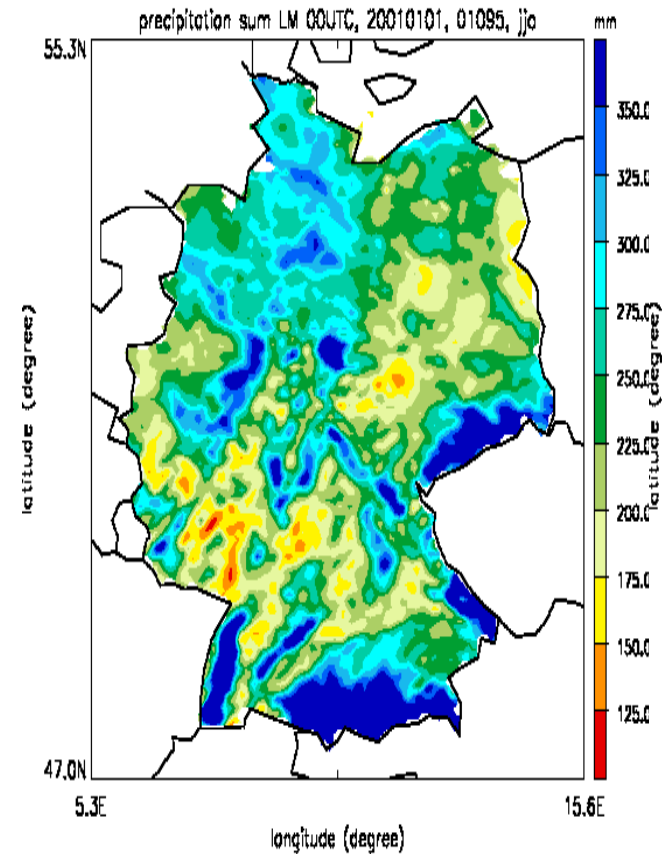
Comparison of model in terms of observed quantities by using forward operators

- Modeled reflectivities in the POLDIRAD domain are derived from a LM simulation with reduced Foehn (12 August 2004, 18UTC).
- QPF problems (a phase shift in this case) are visible in other variables of the hydrological cycle, e.g. clouds.

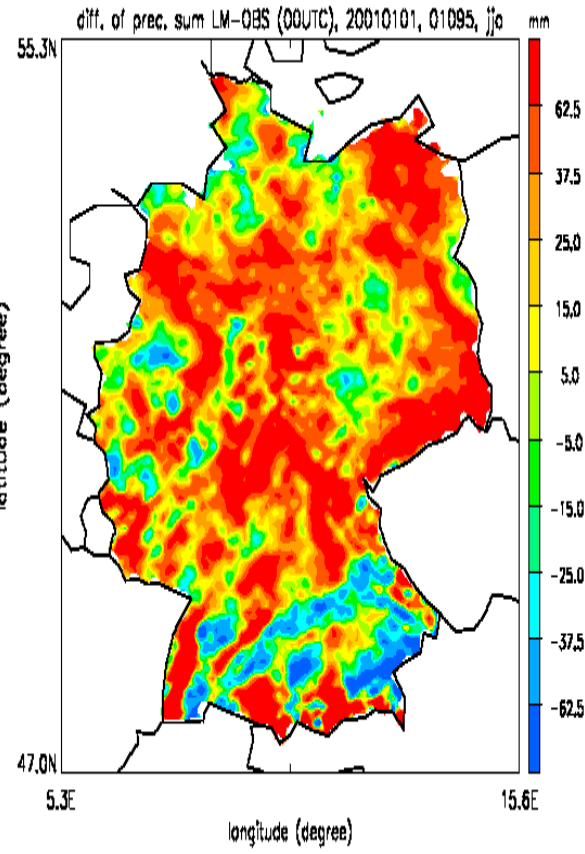
Systematic over-prediction of Summer precipitation related to non-alpine orography



**Observations
2001-2003**



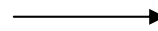
**LM – forecasts
2001-2003**



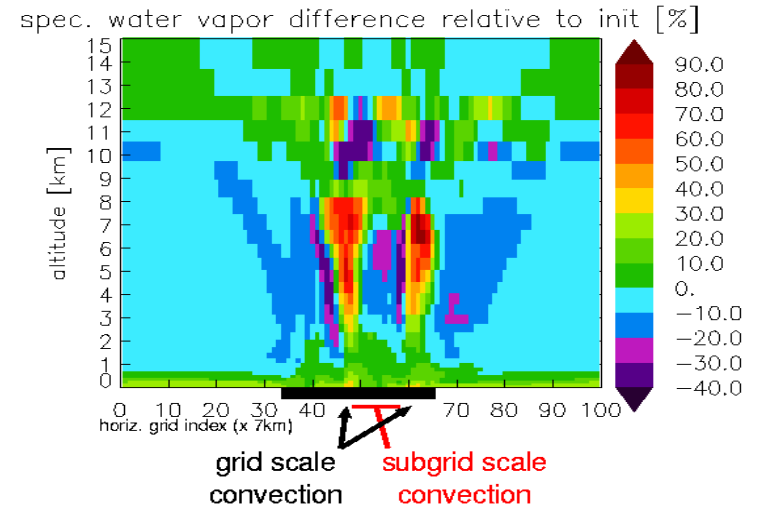
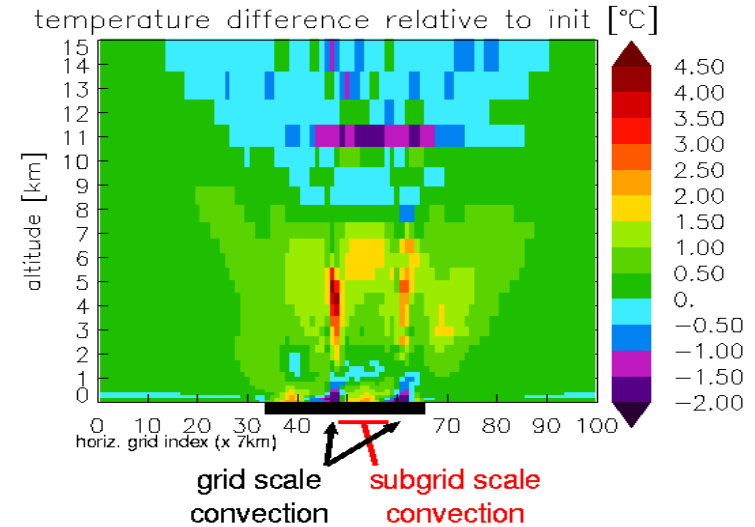
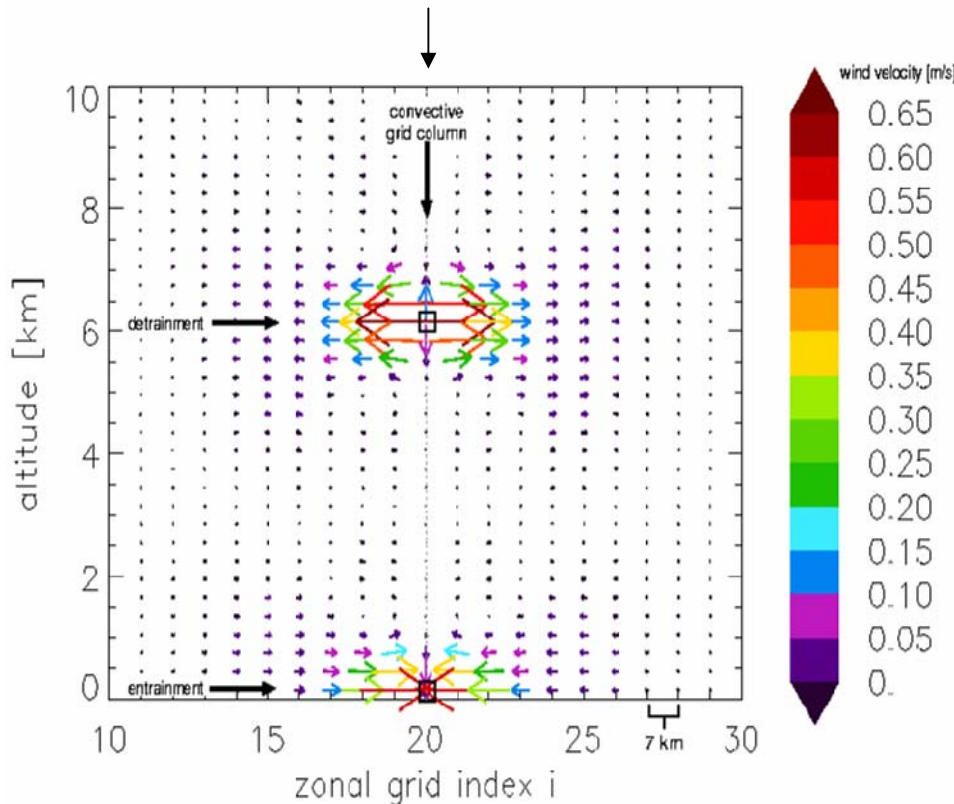
**Model – Observations
2001-2003**

Development of a hybrid cumulus convection scheme

sea breeze simulation



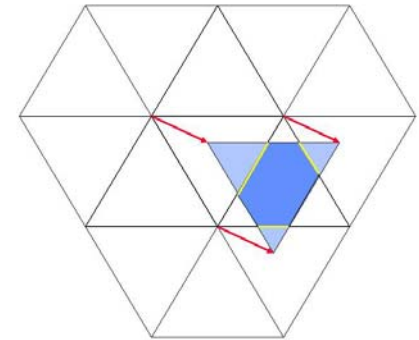
idealized transport of mass



Semi-Lagrangian integrated-mass transport algorithm based on the integro-differential continuity equation for the icosahedral grid

Scheme reduces numerical errors by improved

- semi-Lagrangian schemes
- conservation properties
- preservation of shape
- increased accuracy
- reduction of non-physical oscillations



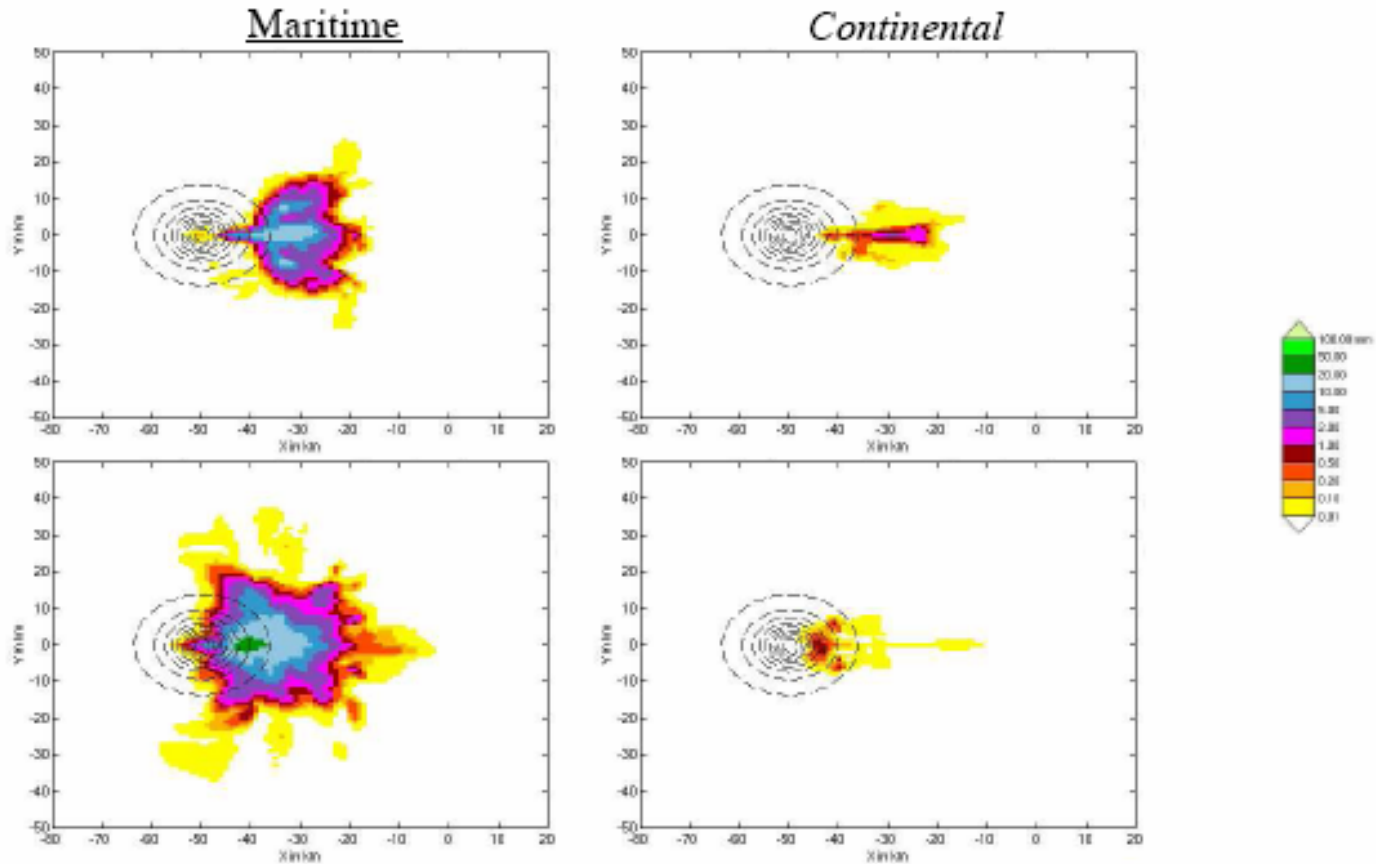
Preparatory work on the next generation ***unified climate and weather forecast system*** of DWD (ICON) in cooperation with Max-Planck-Institute for Meteorology, Hamburg (MPI-M)

Sensitivity of precipitation amount on cloud microphysics

Accumulated precipitation amount in mm after 3 hours

High 0°C-level

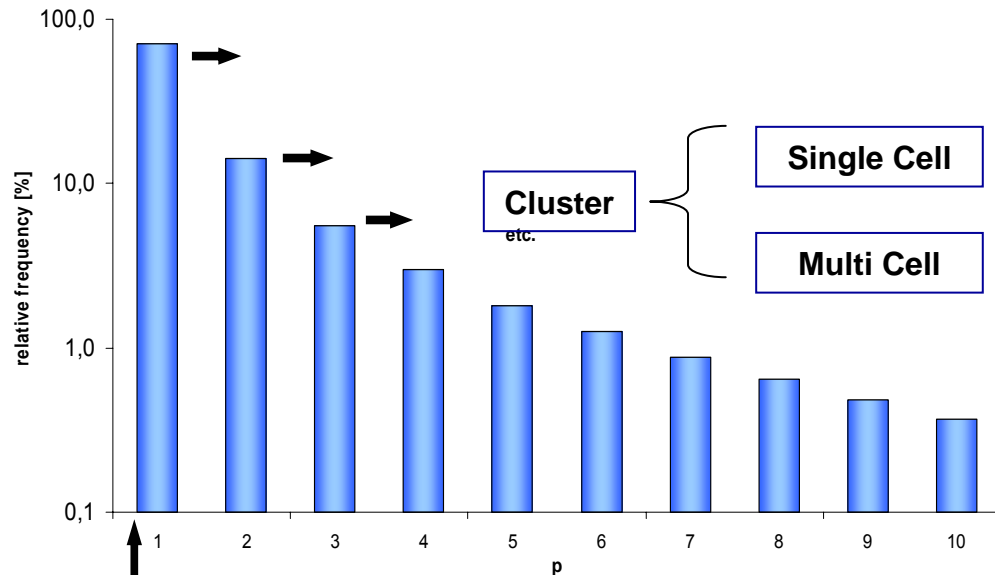
Low 0°C-level



Hybrid Probabilistic Forecast Scheme for Post-Frontal Shower Precipitation

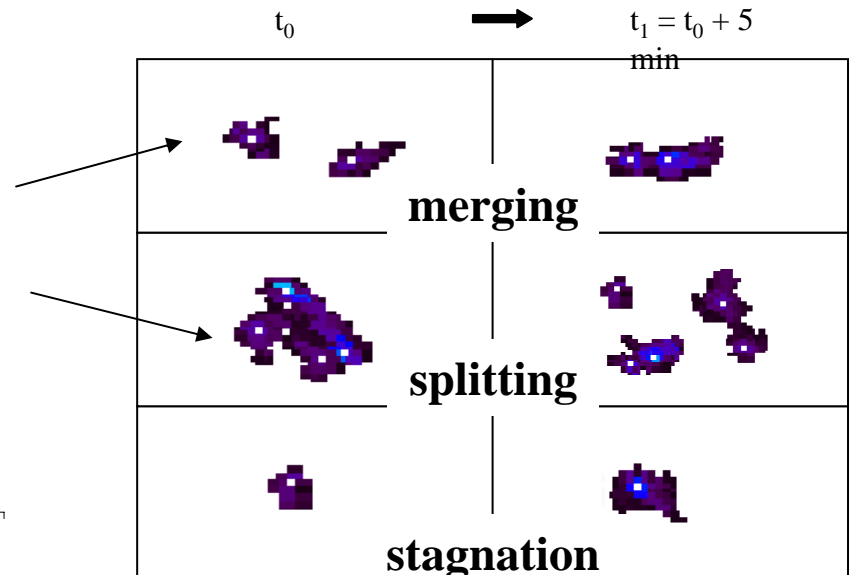
Investigation of cluster behaviour from Radar

- 60% of tracks consist of single cells over their whole life span
- larger clusters dominate with respect to the area and show merging and splitting
- Single cells growing only by internal growth does not fit the observations



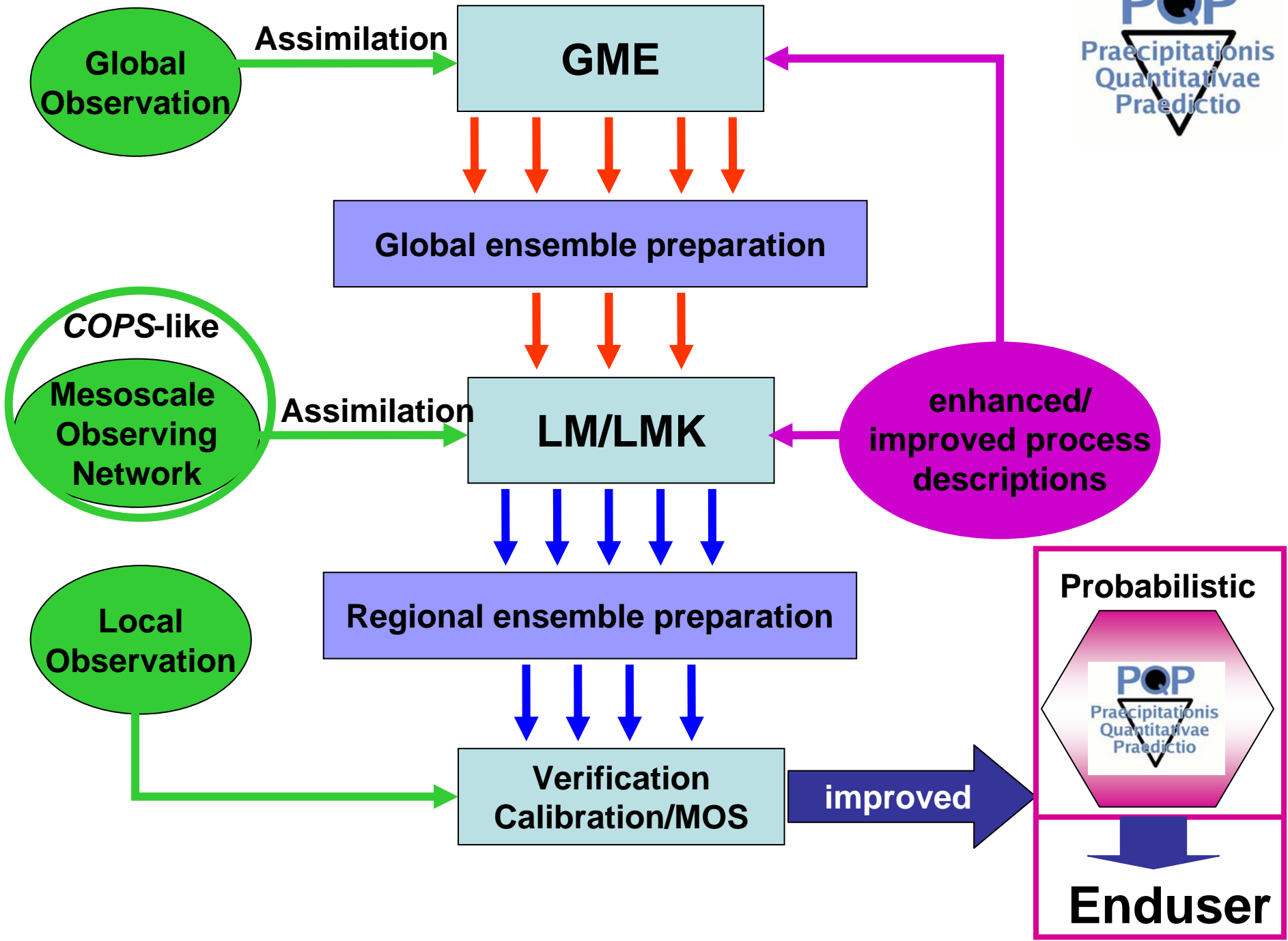
Simplified growth model:

- Initiation of clusters by single cells (input)
- Growth by merging or internal growth
- Decrease of clusters by splitting or internal decrease
- In between, a stage of stagnation (i.e. no change in maxima number).



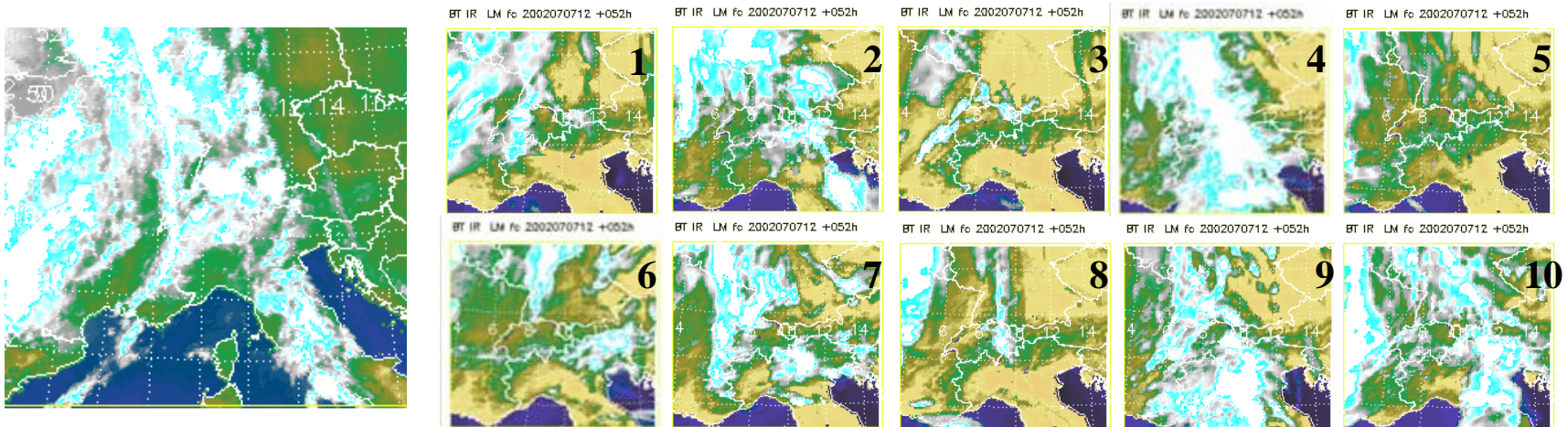
Work for a vision

- Development of a concept for a nested ensemble forecasts system GME – LM – LMK
 - Quantify ***inherent component of uncertainty*** for deterministic models from initial and boundary conditions
- As part of a European multimodel ensemble system
 - Quantify the ***missing knowledge component of uncertainty***



Development of a Regional Ensemble System

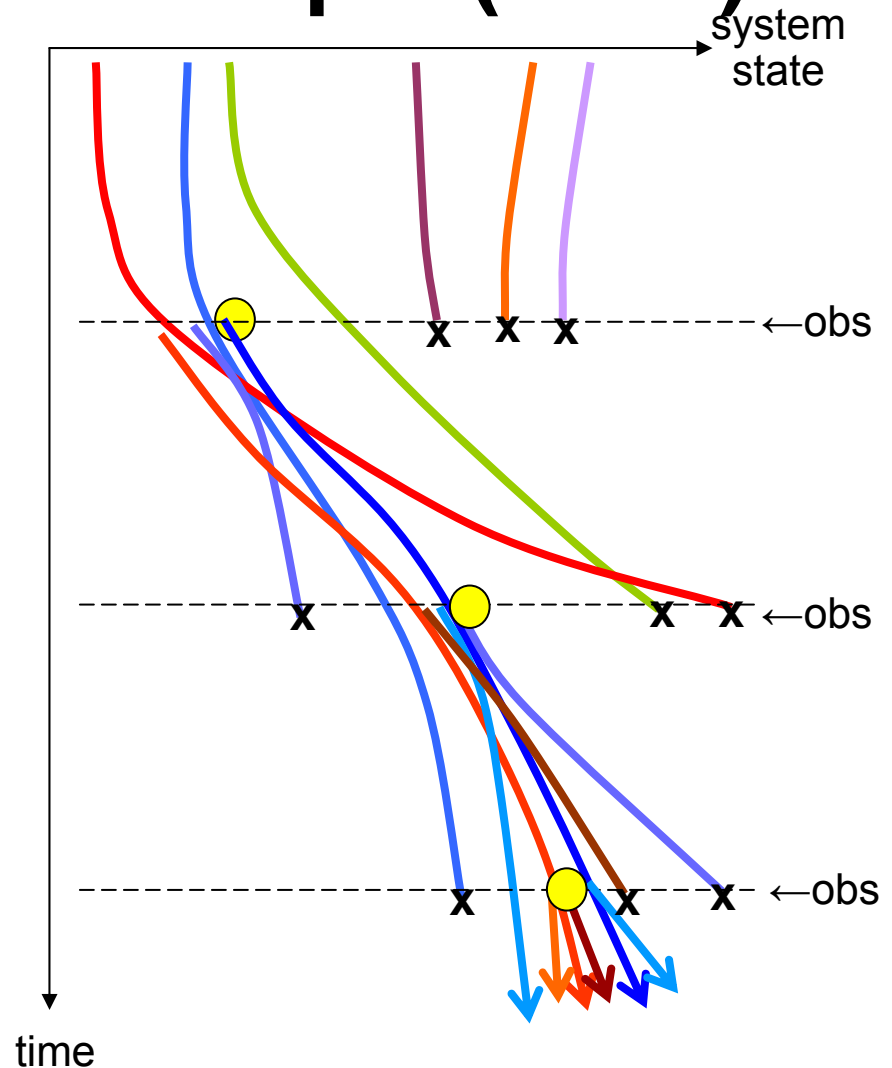
- 1. COSMO-LEPS:** based on ECMWF EPS (initial and boundary cond.) and Lokal-Modell (LM), quasi-operational since Nov 2002 (here:LM with 7km horiz. resol.)
- 2. LMSynSat:** generation of synthetic satellite imagery in LM (to use satellite data to weight different clusters)
- 3. Objective Pattern Recognition Algorithm** using Pyramidal Image Matching to determine quality of match



Meteosat 7 observed and forecast IR synthetic satellite imagery of the representative members (ranging from 1 to 10) of each cluster on 9 July 2002 16:00 UTC (LM +28h forecast range)

Sequential Importance Re-sampling Technique (SIRT)

- **continuous ensemble** of forecasts (LMK-ensemble started every 3 h)
- compares **sequentially** the forecasts with observations → **Bayesian weights, importance**
- removes members with very low weights and replaces the removed members by adding additional better performing members according to their weight → **resampling**
- **ensemble collapse** to be prevented by data assimilation (physical initialisation by genetic search algorithms)



POQ



**Praecipitationis
Quantitativae
Praedictio**

***Thanks for
your
Attention***