Priority Program SPP 1167 of the DFG

Quantitative Precipitation Forecast

QUEST – Second Phase

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Objectives

The "Quantitative Evaluation of regional precipitation forecasts using multi-dimensional remote sensing observations" (QUEST) project contributes to the PQP goals:

I. Identification of physical and chemical processes responsible for the deficiencies in quantitative precipitation forecast

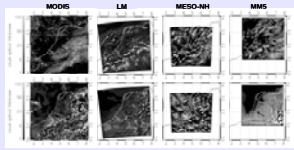
- *evaluating mesoscale model forecasts of water cycle variables*
- *combination of detailed case study investigations and long-term model evaluations*
- *systematic model deficits by averaging out stochastic errors (initial and/or boundary conditions)*
- *changing model physics in order to attribute the errors to the treatment of specific processes*

II. Determination and use of the potentials of existing and new data and process descriptions to improve quantitative precipitation forecast

- *remote sensing data currently not used in routine model verification*
- *radar/satellite observations with resolution comparable to Lokal-Modell Kürzestfrist (LMK, ~ 2.8 km)*
- *polarimetric radar, millimetre wave radiometry to investigate different hydrometeor species*
- *life cycle of clouds and precipitating cells from model and reality with MSG*

Strategy

Observations
- multi-frequency radiances
- polarimetric radar quantities
- ground based and space borne observations



Retrieval
- water vapour
- cloud properties
- precipitation

Forward Operator
- SynPolRad (polarimetric radar)
- SynSat (MSG, MODIS)
- SynSatMic (AMSU, SSM/I)

Weather Forecasts
three-dimensional description of the forecasted atmospheric state

(Optical thickness: Matching model and observations involves retrieval and model operator)

Case Studies (ongoing)

Model Sensitivity Runs
- different LMK settings
- different initial conditions
- different models (MM5, Meso-NH, RACMO)

Tool development
- transfer of Meso-NH microwave satellite simulator to LMK (SynSat-Mic)
- polarimetric radar operator
  - adaption to different microphysical schemes
  - reduction of computing time
- adaptation of SynSat to LMK
- refinement of MSG microphysical retrievals
- scale dependent verification measures

Hypothesis formulation
"What are the crucial variables/processes to observe and to improve?"

comparison tools test of hypotheses →

← **case study selection for process studies**

Long Term Evaluation (starting)

Lokal-Modell Kürzestfrist (LMK)
- test suites for different seasons
- over GOP duration 2007
- benefits of high resolution modeling

Identification of systematic model deficits
- water vapor, cloud properties, precipitation
- radar reflectivities, satellite radiances
- variability and pattern

Conditional verification
- regionalization
- diurnal cycle
- general weather situation dependent

Cross correlation of different variables
"How important is physical consistency; e.g. how well do we need to model clouds for a good precipitation forecast?"

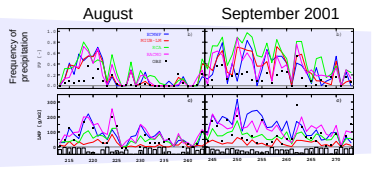
Model Improvement (new)

Cloud microphysics
- two-moment/spectral microphysical schemes
- frozen hydrometeor parameterizations (e.g. density formulation, size distribution)
- autoconversion rates
- drizzle formation/evaporation

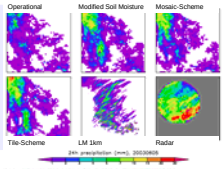
Land surface
- sensitivity test by removing known systematic model errors (e.g. soil moisture BIAS or shifts in the phase of surface fluxes)
- improved surface parameters, e.g. LDAS type soil moisture analysis
- MOSAIC-approach for subgrid-scale variability

Turbulence
- shallow convection scheme
- 3D turbulence

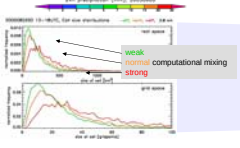
- models tend to overestimate frequency of precipitation



- convective precipitation is sensitive to land surface description

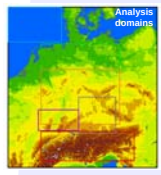


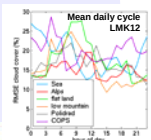
- horizontal mixing affects cell size distribution



Examples:

- Regionalization



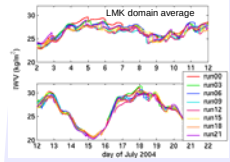


Certain model problems are bound to special regions, e.g. pronounced cloud cover errors in the morning occur only over land with moderate topography.

Comparison of MSG retrieval and LMK prediction, July 2004

Cloud cover (%) LMK00 / LMK12	BIAS (%)	STD (%)	Correlation
LMK total	8 / 5	9 / 9	0.80 / 0.80
Sea	9 / 8	17 / 17	0.72 / 0.70
Alps	6 / 2	14 / 15	0.78 / 0.81
Flat land	9 / 7	17 / 17	0.68 / 0.70
Low mountain	7 / 5	15 / 16	0.68 / 0.67
Poldirad domain	5 / 2	17 / 17	0.72 / 0.75
COPS domain	4 / 0	22 / 20	0.49 / 0.61

- Lumped Ensemble



- Identification of effects due to initial conditions.
- Evaluating the spread of model simulations.

PQP Collaborations

- **Beheng and Blahak, Karlsruhe**
  Test of the newly developed cloud microphysics parametrization
- **Bott and Gassmann, Bonn**
  Evaluation of the newly developed convection scheme, case study selection
- **Cubasch, Nevir and Reimer, Berlin (STAMPF)**
  Verification measures, precipitation analysis, satellite data, connection to clouds and vertical velocity
- **Schlünzen, Hamburg**
  Support in verification activities, process studies
- **Simmer et al., Bonn (DAQUA)**
  Identification of test cases, satellite data, verification of assimilation runs
- **Wernli, Hagen and Frei,** Mainz (VERIPREG)
  Verification measures, aggregated radar products, cross correlation of variables

Requested Funding

Group	Personal	Consum.	Travel	Publications	Equipment
MIM	2 years BAT IIa Felix Ament	1000 Eu	3200 Eu	1500 Eu	2000 kEu
FUB	2 years BAT IIa Marc Schröder	1000 Eu	3200 Eu	1500 Eu	4000 kEu
DLR	1 year BAT IIa/2 1 year BAT IIa Monika Pfeifer	1000 Eu	3200 Eu	1500 Eu	
KUL			2000 Eu		
DWD			1000 Eu		
Total	**66 PM**	**3000 Eu**	**12600 Eu**		**6000 Eu**