QUEST

Quantitative evaluation of regional precipitation forecasts using multi-dimensional remote sensing observations

Partnership

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- Michael Baldauf, Deutscher Wetterdienst (*DWD*)
- Nicole van Lipzig, Katholieke Universiteit Leuven (*KUL*), Belgium

Contributes to PQP Goals

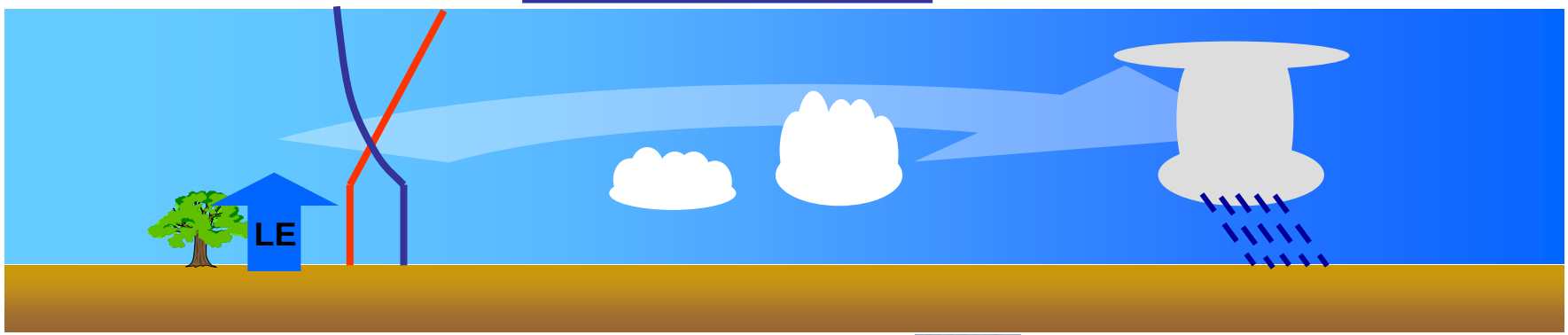
- Identification of physical and chemical processes responsible for the deficiencies in quantitative precipitation forecast
- Determination and use of the potentials of existing and new data and process descriptions to improve quantitative precipitation forecast

Combining different remote sensing techniques

satellite

MSG ~ 5km; 15min
- Cloud Mask
- Cloud top pressure

MODIS ~ 1km; 1day
- Cloud Mask
- Optical thickness



IPT / Micro-wave

1D vertical; Lindenberg (and Cabauw)
- temperature profile
- humidity profile
- LWC

GPS

147 stations; Germany; 30min
- IWV

Ceilometer

17 stations; Germany; 1min; ranges up to 4km
- Cloud base height
- Cloud cover (<4km)

Radar

DX radar composite; 1km; 5min
- Rain rate

Polarimetric radar (DLR)

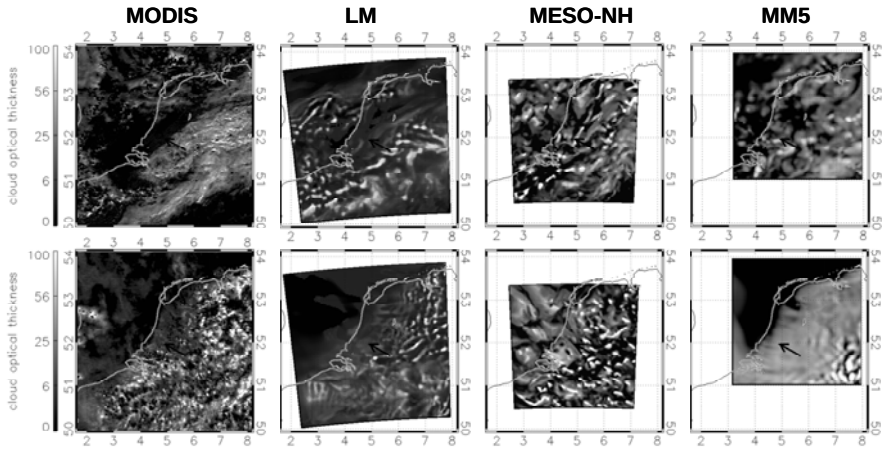
QUEST: Strategy

Observations

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

Retrieval

- water vapour
- cloud properties
- precipitation



Schröder et al. [2006]

Forward Operator

- SynPolRad (polari. radar)
- SynSat (MSG, MODIS)
- SynSatMic (AMSU, SSM/I)

Weather Forecasts

- three-dimensional description of the forecasted atmospheric state
- focus on Lokal-Modell Kürzestfrist (**LMK**)

QUEST: Approach

Case Studies (ongoing)

Tool development

- SynPolRad
- SynSat (-Mic)
- MSG µ-phys. retrievals
- verification measures
- ..

Model Sensitivity Runs

Hypothesis formulation

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

comparison tools
test of hypotheses

→

Model Improvement (new)

- cloud microphysics
- land surface
- turbulence

←

case study selection for process studies

Long Term Evaluation

Lokal-Modell Kürzestfrist

- test suites
- GOP duration 2007
- benefits of high resolution modelling

Identification of systematic model deficits

Conditional verification

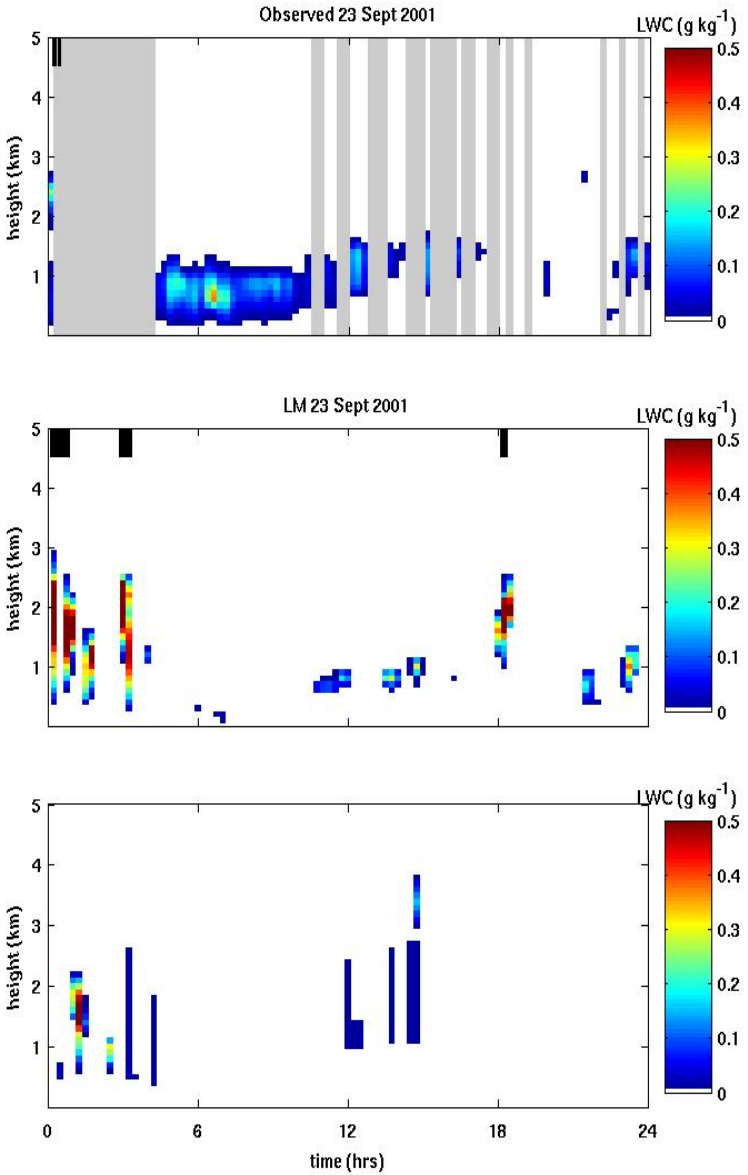
- regionalization
- diurnal cycle
- weather situation dep.

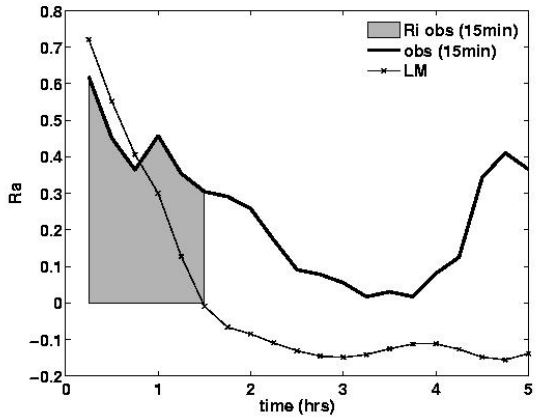
Cross correlation of different variables

"How important is physical consistency?"

PQP Phase 1: Case study 23 Sep. 2001

Vertical structure



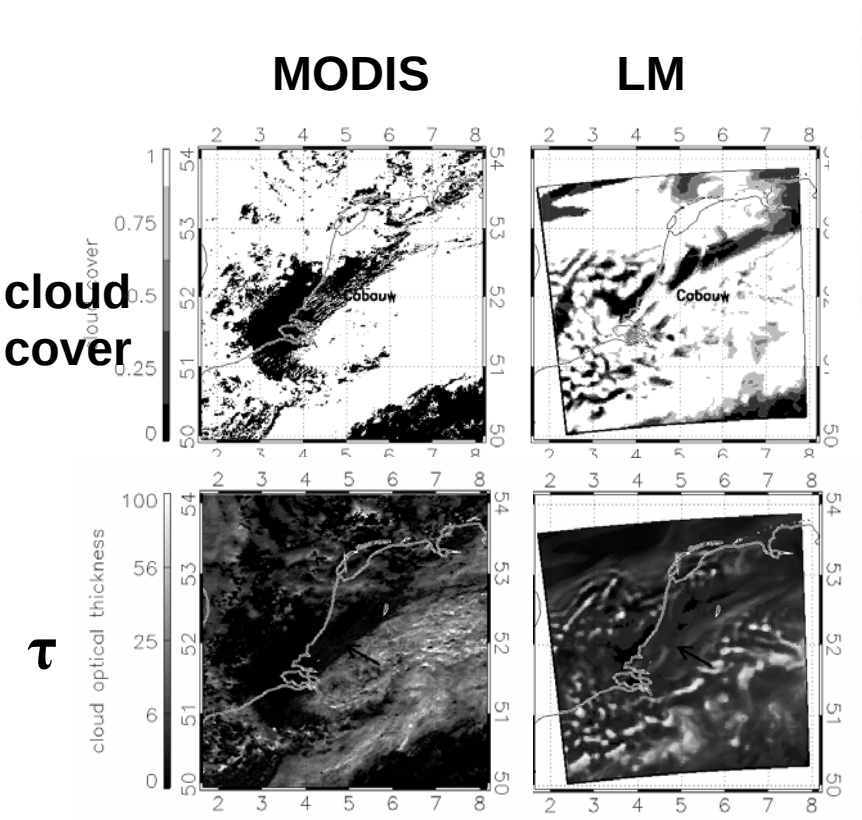


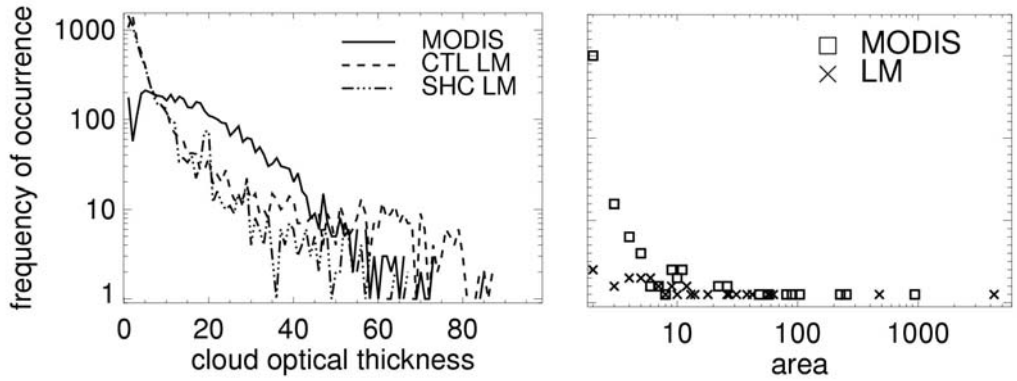
- Shallow convection scheme gives no significant benefit.
- LM underestimates the life-time of clouds.
- LM has deficiencies to represent small-scale cloud structures.

Van Lipzig et al.: “Model predicted low-level cloud parameters. Part I: Comparison with observations from the BALTEX Bridge Campaigns”, *Atmospheric Research*, accepted

PQP Phase 1: Case study 23 Sep. 2001

Horizontal structure:





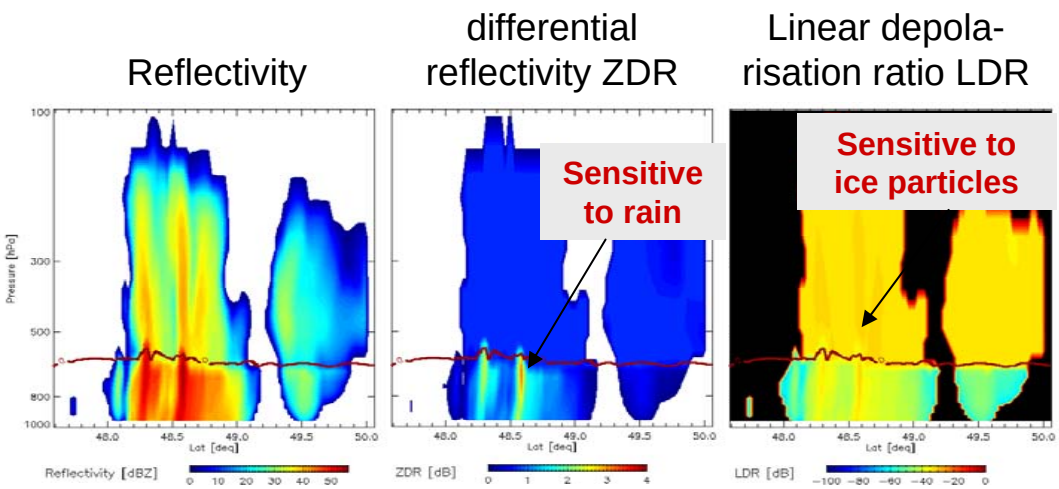
- Modeled and observed cloud structure are different.
- LM underestimates clouds with moderate LWC / optical depth.
- Shallow convection scheme gives no significant benefit.

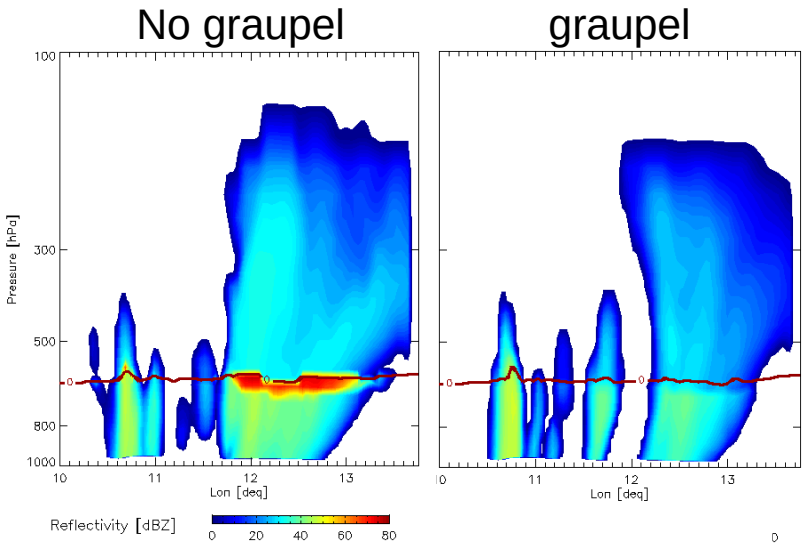
Schröder et al.: “Model predicted low-level cloud parameters. Part II: Comparison with satellite remote sensing observations during the BALTEX Bridge Campaigns”, *Atmospheric Research*, acc.

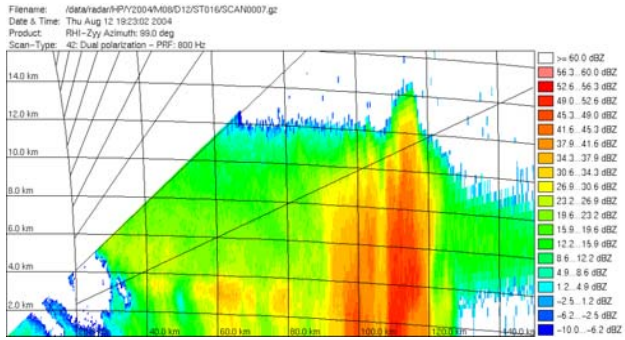
PQP Phase 1: Case study 12 Aug. 2004

Polarimetric radar quantities

- Forward operator SynPolRad links LM predictions and observations.
- Polarimetric data provides information about hydrometeor types.
- Inclusion of graupel in LMK improves representation of convective cells.







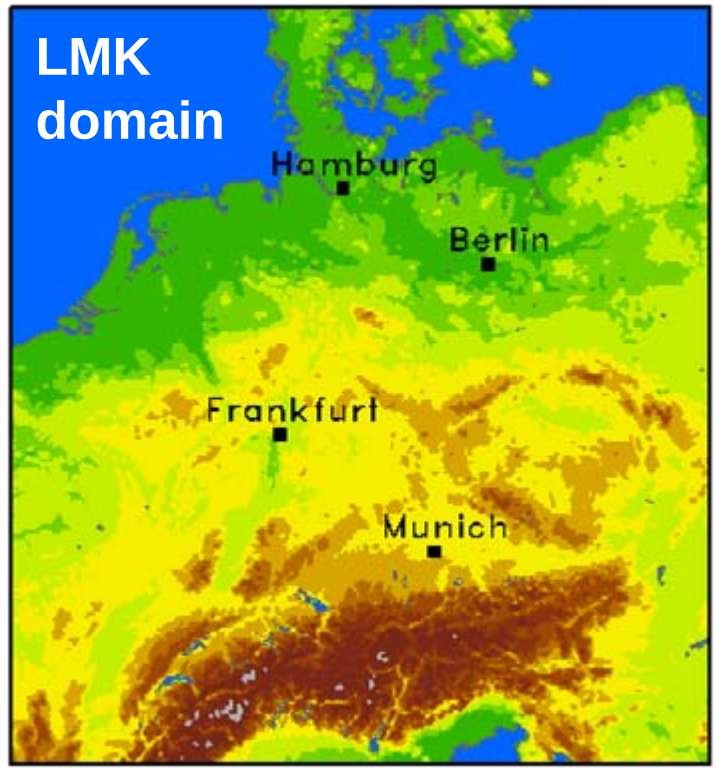
- add more observations for better constraints
- test more microphysical schemes

Pfeifer, M., Craig, G., Hagen, M. and Keil, C.: "A polarimetric forward operator", *Proceeding of ERAD 2004*, 494-498

Lokal-Modell Kürzestfrist (LMK)

Pre-operational phase may 2006 – spring 2007

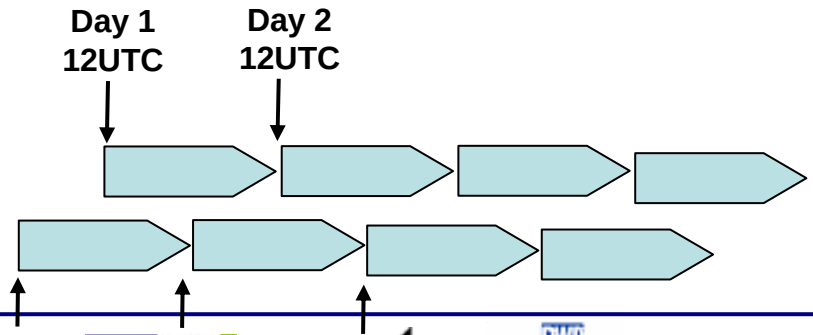
Operational expected spring 2007



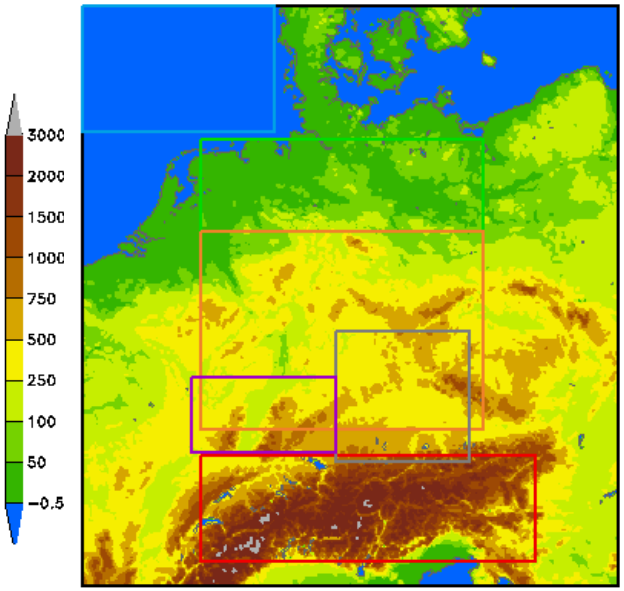
Testsuite 2.2b: July 2004

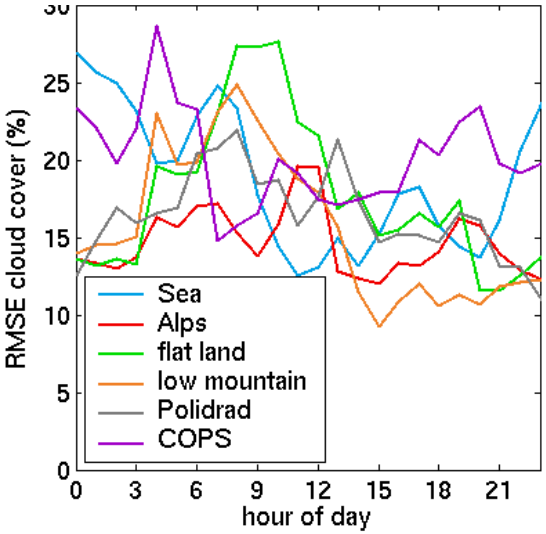
- Prognostic treatment of cloud water, cloud ice, rain and snow
- 2.8km horizontal resolution, 50 vertical levels

Lagged average forecast ensemble



Conditional Verification: LTE



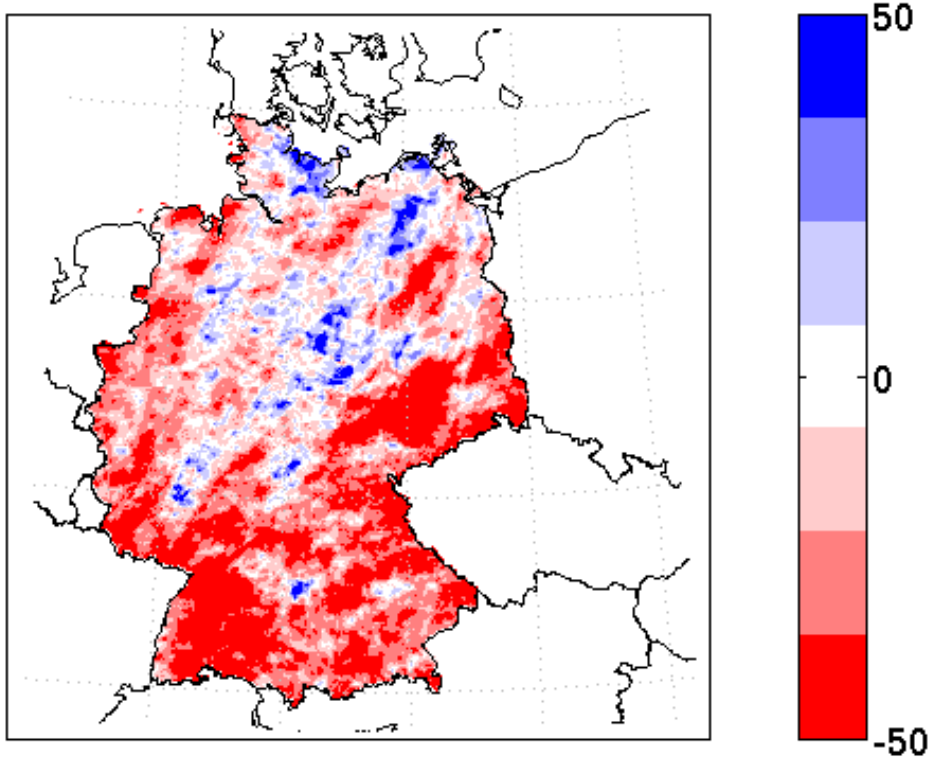


MSG Comparison: July 2004

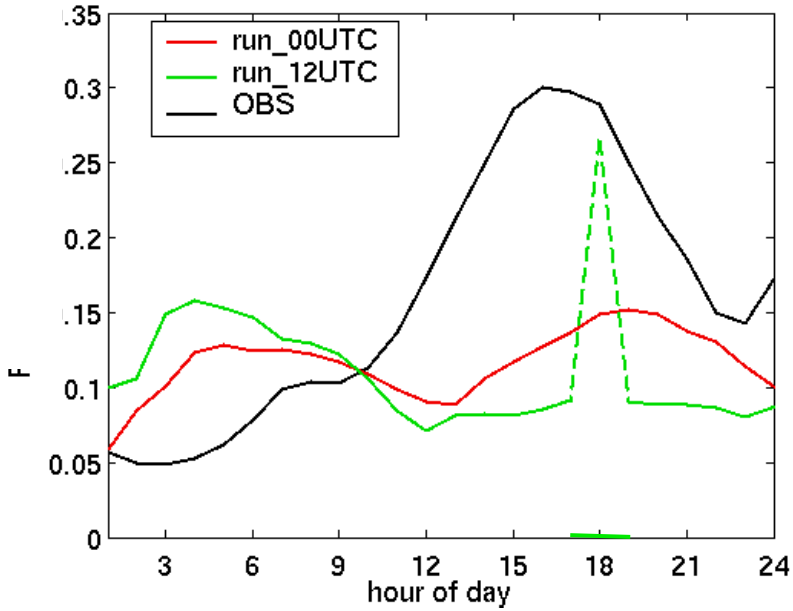
Cloud cover (%) LMK00 / LMK12	BIAS (%)	STD (%)	Correlation
LMK total	8 / 5	9 / 9	0.80 / 0.80
Sea	**9 / 8**	17 / 17	0.72 / 0.70
Alps	6 / 2	14 / 15	0.78 / 0.81
Flat land	**9 / 7**	17 / 17	0.68 / 0.70
Low mountain	7 / 5	15 / 16	0.68 / 0.67
Poldirad domain	5 / 2	17 / 17	0.72 / 0.75
COPS domain	4 / 0	**22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

- complete test suites analysis
- separate weather regimes
- cross correlate variables
- prepare GOP exploitation

Accumulated precipitation

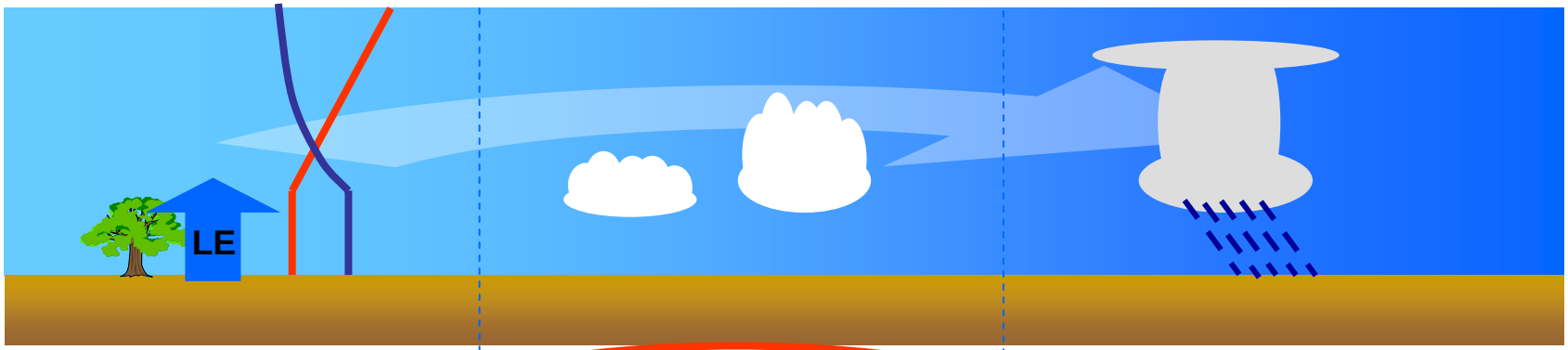


Relative bias in accumulated precipitation over the month compared to radar



Daily cycle of accumulated precipitation over the month compared to radar

Summary of long term evaluation of LMK



- Boundary layer too thin and too wet
- IWV predicted very well
- IWV bias of -0.85 kg/m2 for run started at 12UTC

- Clouds too thick
- Total cloud cover agrees well with MSG

- Precipitation underestimated by 20%
- Observed timing maximum not reproduced

Case studies to look into more detail in the problems

PQP Collaborations

COPS & GOP Preparation

Improvement of Model Physics

- **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

Data assimilation

- **Simmer et al., Bonn (DAQUA)**
  Identification of test cases, satellite data, verification of assimilation runs

Verification

- **Cubasch, Nevir and Reimer, Berlin (STAMPF)**
  Verification measures, precipitation analysis, satellite data, connection to clouds and vertical velocity
- **Wernli, Hagen and Frei, Mainz (VERIPREG)**
  Verification measures, aggregated radar products, cross correlation of variables