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

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QUEST Objectives

Improved parameterizations of processes determining the amount of precipitation at the ground are of paramount importance for an improved quality of precipitation forecasts.

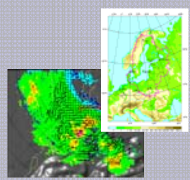
Because of the complexity of atmospheric processes it is of utmost importance to observe the atmospheric state as complete as possible. **Multi-dimensional remote sensing data** are best suited to observe the spatial-temporal distribution of **water in all its phases**. QUEST aims at establishing a framework for a physically based quantitative evaluation and improvement of weather forecasts employing as extensively as possible **existing and upcoming remote sensing** data. In particular QUEST will:

- Establish a data base of quality controlled ground-based and satellite remote sensing observations matched with Lokal-Modell simulations
- Develop a set of forward modelling tools to simulate as completely and as accurately as possible the multi-dimensional observations from model output
- Use data from field experiments to investigate the process chain from water vapour to precipitation at the ground
- Perform a long-term (one year) evaluation of Lokal-Modell forecasts using the **observation-to-model** and **model-to-observation** approaches

Data Pool

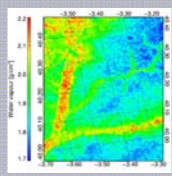
Active and passive observations – both from the ground and from satellites – will be used to investigate the processes which determine the amount of precipitation at the ground. With observations covering **vertical** (at reference stations), **horizontal** (from satellite) and **three-dimensional** (from radar) distributions of water vapour, clouds and precipitation, as well as hydrometeors and wind, a solid data base for in-depth understanding of the relevant atmospheric processes will be generated. In addition, this data base will include all relevant Lokal-Modell simulations matched to the observations in space and time.

Ground-based



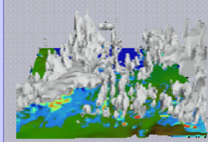
CLIWA-NET, VERTIKATOR, BBC2, CLOUDNET

Satellite



MODIS, MERIS, MSG, AMSR, SSMIS, AMSU, CLOUDSAT

Lokal-Modell



One year of +36h forecast model results matched to high resolution time series and satellite overpasses

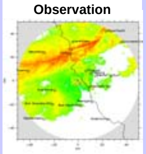
Evaluation Approach

Observation-to-model approach

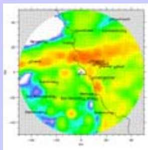
- Classical method for model evaluation
- Retrieval algorithms can combine multi-wavelength information to derive model variables
- Sensor synergy can be exploited to optimize retrieval
- Model variable can be evaluated using independent data sources
- Retrieval algorithms are sufficiently mature for use in an operational environment

Observations
- multi-frequency radiances
- polarimetric radar quantities

Retrieval
- water vapour
- cloud properties
- precipitation



Observation



Simulation

Forward Operator
Radar and satellite simulator
- scattering data base
- interface to LM microphysics
- surface emissivity
- viewing geometry

Weather Forecasts
three-dimensional description of the forecasted atmospheric state

Model-to-Observation approach

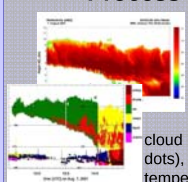
- Advanced method for evaluation of integrated model physics
- The *forward* model calculates pseudo-observations from model output fields; error characteristics for observables are better known than for retrieved quantities
- Forward operator (radiative transfer) can be more accurate than the inversion process; independence from training data
- Potential for error modelling
- important step towards future data assimilation methods

Model Evaluation

Data from field experiments and the one-year (2004) set of corresponding model and remote sensing data will be used to investigate

- the initiation of precipitation and occurrence of drizzle.
- the subgrid variability of water vapour, clouds, and precipitation.
- the development of convective precipitation systems.
- the process chain from water vapour to precipitation at the ground.

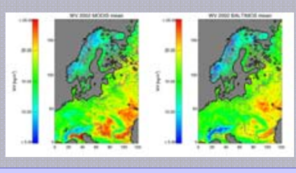
Process Studies



Time series of radar reflectivity profile with overlaid cloud classification based on Doppler velocity, linear depolarisation, cloud base height (black dots), liquid water path and temperature profiles. This is a typical situation where seeding effects of an ice cloud lead to precipitation initiation

Long-term Evaluation

Comparison of the mean water vapour contents (January-October 2002) estimated by satellite measurements of MODIS and the regional climate model REMO.



Project Organisation

WP	Tasks	2004			2005				future SPP periods
1	Coordination / meetings (x)		x		x			x	
	Recommend validation environment								
2	Forecast and observation data base								
	Setup & selection of case studies (MIM)								
	Ground-based remote sensing data (MIM, DLR)								
	Sat.: retrieval&error assessment (FUB, MIUB)								
	Sat.: quality control (FUB)								
	LM: Case study/analysis tools (DLR, MIUB, MIM)								
	LM: - 2004 forecast run (DLR, MIM, MIUB)								
3	Microwave Simulator								
	Orientation and planning phase (MIUB)								
	Land surface emissivity model (MIUB)								
	Scattering data base (MIUB, DLR)								
	Viewing geometry for different sensors (MIUB)								
	Interface microphys./rad. transfer (MIUB, MIM)								
	Sensitivity studies (MIUB)								
4	Polarimetric radar simulator								
	Orientation and planning phase (DLR)								
	Scattering data base (DLR, MIUB)								
	Integration Bringi/RSM & diff. phase (DLR, MIM)								
	Sensitivity studies (DLR)								
5	Process Studies								
	Precipitation initiation (MIM)								
	Sub-grid variability (MIM, FUB)								
	Water vapour-cloud-precipitation (FUB, MIM)								
	Convective precipitation events (DLR, MIUB)								
	Parameterisation tuning (DLR)								
6	Long-term evaluation								
	Observation-to-model (MIM, FUB)								
	Model-to-observation (MIM,MIUB)								

Optimisation and continuation for GOP 2007

Infrared Simulator

Assimilation using inverse models

Begutachtung Schwerpunktprogramm 'Quantitative Niederschlagsvorhersage', Walberberg, 11-12. Dezember 2003