Long-term evaluation of water cycle variables in short-term weather forecasts

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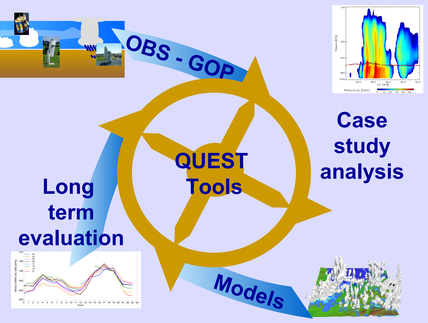
Objectives

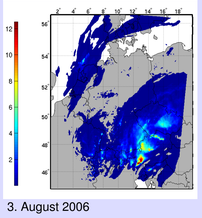
Precipitation is the final atmospheric process of the **hydrological cycle**. Consequently quantitative precipitation forecasts (QPF) can only be successful, if a model represents all processes of this cycle accurately. The project "Quantitative evaluation of regional precipitation forecasts using multi-dimensional **remote sensing observations**" (QUEST) aims at a complete analysis of the modeled hydrological cycle in order to **identify the reasons of QPF deficiencies** and to give **distinct advices for model improvement**.



Case Studies

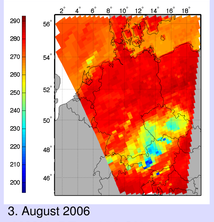
In order to demonstrate the QUEST tools two case studies (stratiform **3 August 2006** and convective 28 August 2006) were performed [Pfeifer et al., 2009]. In order to optimally exploit satellite observations forward operators were applied to simulate synthetic brightness temperatures (BT)) from the model output.

COSMO-DE: frozen hydrometeors



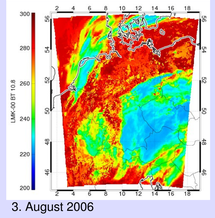
3. August 2006

COSMO-DE: BT at 150 GHz



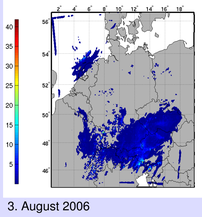
3. August 2006

COSMO-DE: BT at 10.8 µ m



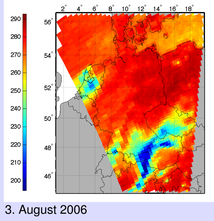
3. August 2006

COSMO-DE: surface rain rate



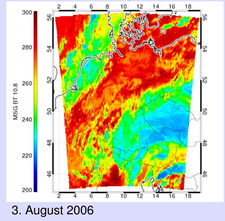
3. August 2006

AMSU: BT at 150 GHz



3. August 2006

MSG: BT at 10.8 µ m



3. August 2006

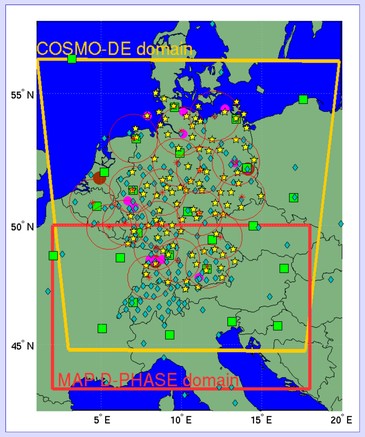
- MSG Infrared observations indicate widespread system with high clouds over Germany whose cloud top height is underestimated
- AMSU Microwave observations indicate underestimation of amount of highly scattering frozen precipitation

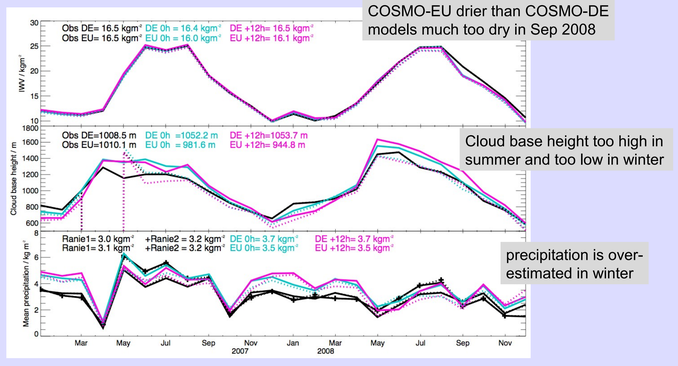
Long-term Validation using GOP

During the **General Observation Period** (**GOP**, Crewell et al. 2008) started in the beginning of 2007 a comprehensive data set of observations and corresponding model forecasts by the operational forecasts of DWD's COSMO-DE (Δx≈2.8 km) and COSMO-EU (Δx≈7 km) models has gathered:

Satellites:
- SEVIRI on MSG
- AMSU on NOAA/Metop
- Cloudsat

- Radiosonde
- Cloudnet
- Micro Rain Radar
- GPS
- Ceilometer
- Weather Radar

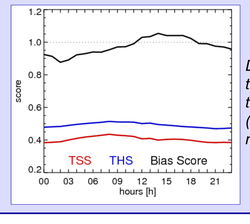




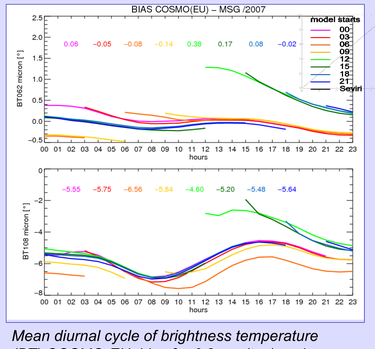
Time series of intergrated water vapor (IWV, top) observed by GPS network, cloud base height observed by ceilometer network (middle) and precipitation observed by Ranie1 (gauge only) and Ranie2 (gauge/radar) together with closest (blue) and +12 h (magenta) forecast for COSMO-DE (solid) and COSMO-EU (dotted).

MSG Diurnal Cycle

- Assimilation of radiosondes with dry bias (noon time) causes jump in bias for runs started at 12, 15 and 18 UTC; e.g. 6.2 and 10.8 µm TB are too high because of lower water vapor and lesser high clouds.
- Diurnal cycle of 10.8 µm BT is a superposition of diurnal surface warming and diurnal cloudiness. COSMO-EU shows a phase shift of ~1h.
- Cloud mask is overestimated in the afternoon and underestimated during night. THS and TSS perform slightly better during early morning hours.



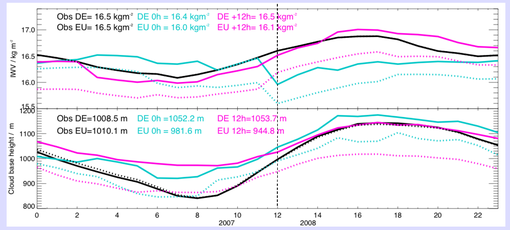
Diurnal cycle of bias, threat (THS) and true skill score (TSS) for cloud mask in 2007.



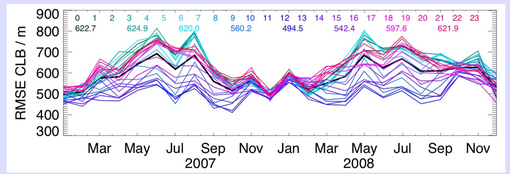
Mean diurnal cycle of brightness temperature (BT) COSMO-EU bias for 6.2 µm (top) and 10.8 µm (bottom).

Stefan Stapelberg, FU Berlin

IWV & Cloud Base Diurnal cycle

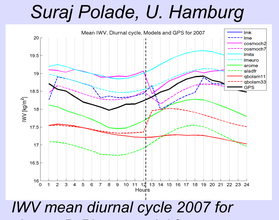


Mean diurnal cycle 2007&2008 of IWV (top) and cloud base height CLB (bottom) for closest (blue) and +12 h forecast (magenta).



Time series of COSMO-De 12h forecast CLB RMSE as a function of day time (color coded).

Suraj Polade, U. Hamburg



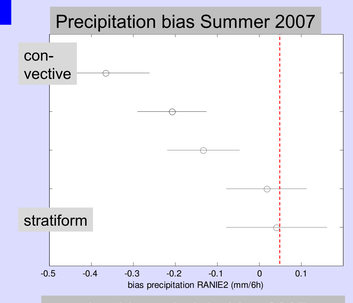
IWV mean diurnal cycle 2007 for closest D-Phase model forecast.

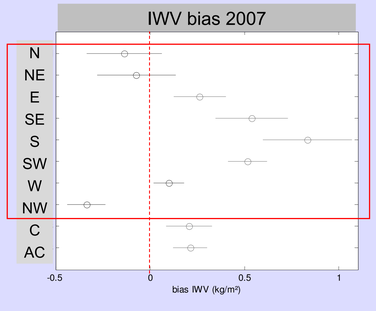
- Data assimilation has strong influence on diurnal cycle of closest forecasts.
- After 12h forecast COSMO-DE has developed a reasonable diurnal IWV cycle (1.0 vs 0.8 kgm^{-2} observed).
- Diurnal cycle in cloud base is predicted too weakly while seasonal cycle is predicted too strongly.
- Cloud base is predicted worst during night in summer revealing problems in the parametrization of stable boundary layer.

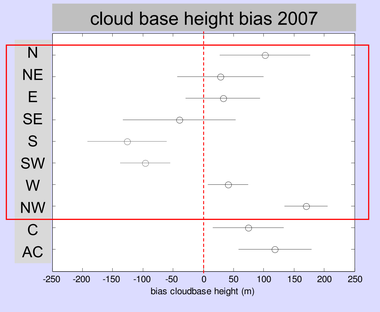
Dependence on Weather Type

Tom Akkermans, KU Leuven

- Classification into weather types (8 wind directional and 2 vorticity classes: cyclonic **C** + anticyclonic **AC**) after Jenkinson and Collison (1977) based on COSMO-EU output on 3 hourly base for whole Germany at 850hPa.
- During southerly flows to too humid conditions especially in South Germany connected with too low cloud bases were forecasted.
- Precipitation is underestimated during convective situations (stability diagnosed from radiosondes).







Publications:

Crewell, S., M. Mech, T. Reinhardt, C. Selbach, H.-D. Betz, E. Brocard, G. Dick, E. O'Connor, J. Fischer, T. Hanisch, T. Hauf, A. Hünerbein, L. Delobbe, A. Mathes, G. Peters, H. Wernli, M. Wiegner and V. Wulfmeyer, 2008: The General Observation Period 2007 within the Priority Programm on Quantitative Precipitation Forecasting: Concept and first results. *Meteorol. Z.* 17(6), 849-866.

Pfeifer, M., W. Yen, M. Hagen, G. Craig, T. Reinhardt, M. Mech, S. Crewell, A. Hünerbein, J. Fischer, M. Schröder, and M. Baldauf, 2008: Validating precipitation forecasts using sensor synergy: The case study approach, . *Meteorol. Z.* submitted.