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USING MSG SEVIRI SATELLITE OBSERVATIONS FOR CONVECTIVE-SCALE DATA ASSIMILATION

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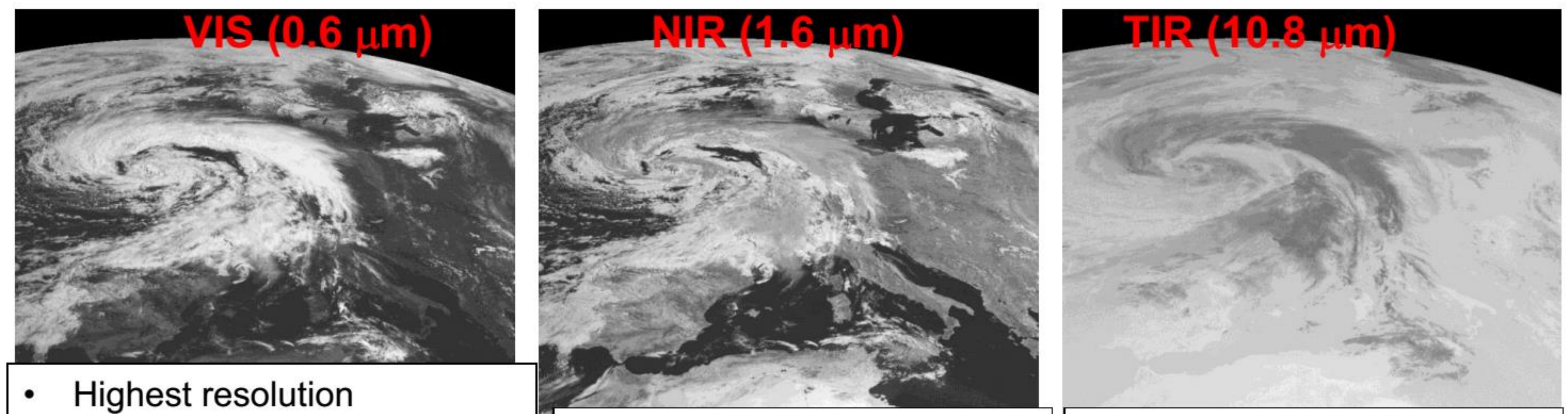
BACKGROUND

- Geostationary satellite observations have a high spatial and temporal resolution and provide information on atmospheric humidity, temperature and clouds
- In particular cloud-affected observations provide valuable information on convective activity, but their assimilation poses significant challenges (different sensitivities in clear/cloudy conditions, realism of model clouds and RT assumptions, non-linearity)
- The combination of different channels provides detailed cloud information
- So far only infrared (IR) observations are assimilated due to the lack of suitable fast forward operators forward operators for visible (VIS) and near-infrared channels (NIR)

MSG SEVIRI OBSERVATIONS

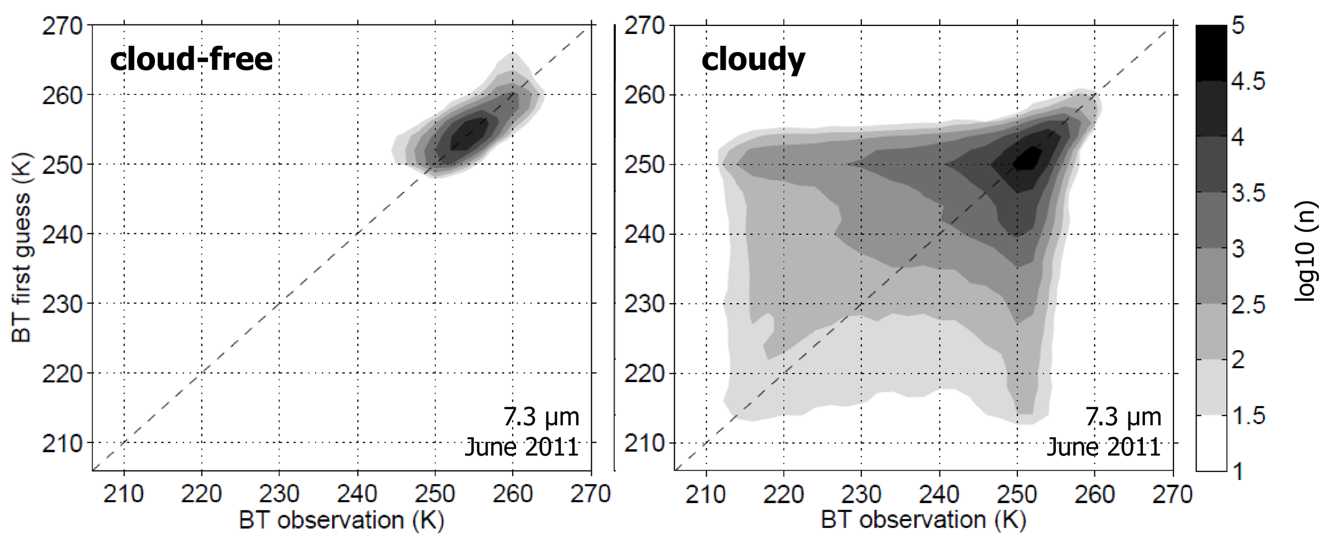


- Highest resolution
- Can see through thin cirrus
- Difference low cloud/surface

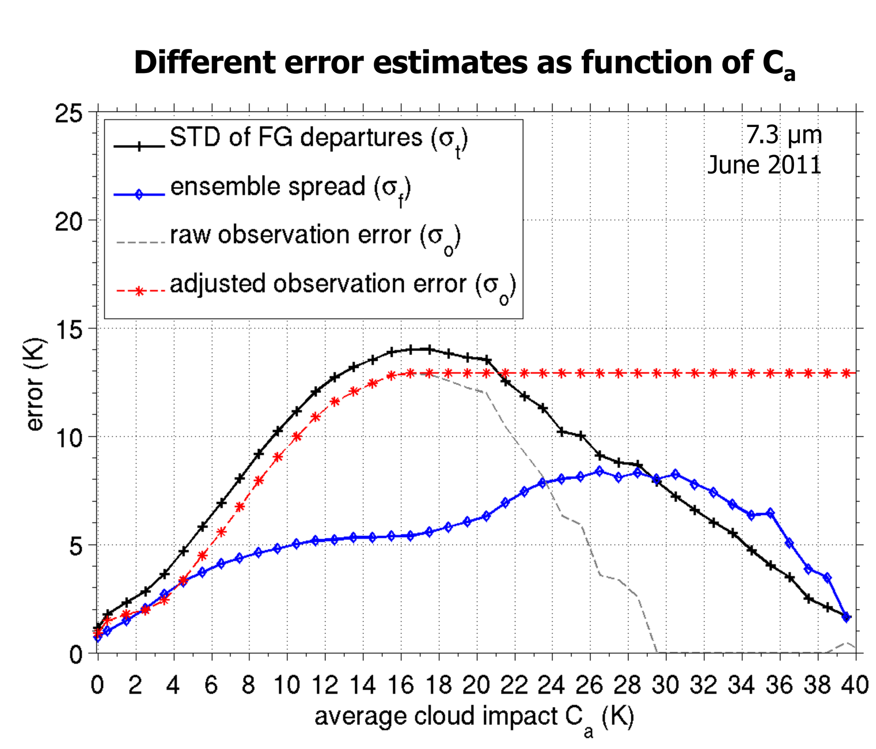
- Identification of cloud phase (water/ide)

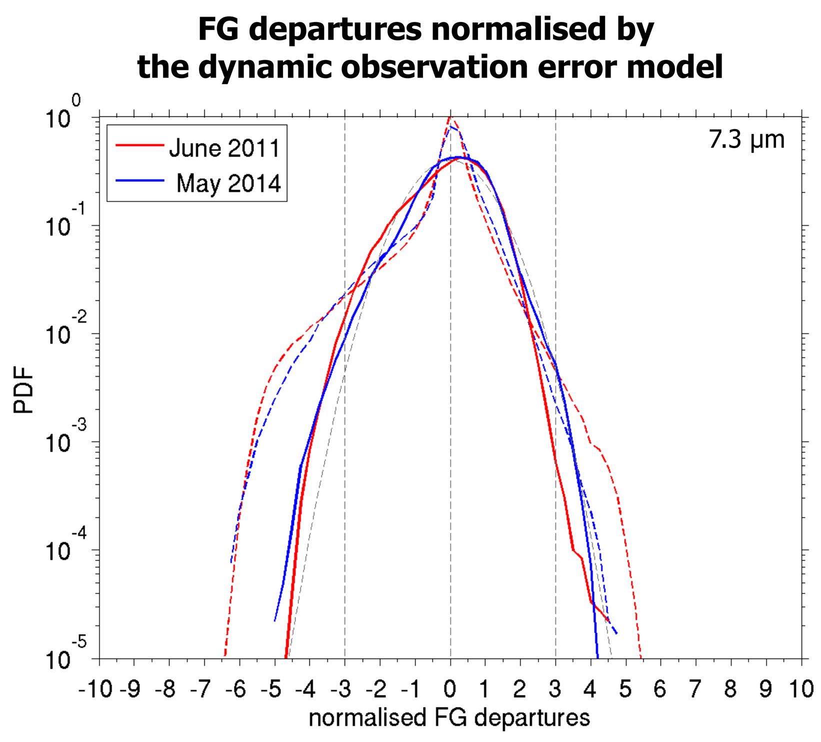
- Information on cloud height

ALL-SKY ERROR MODEL



- Cloud-free: BT observations and first guess match quite well
- Cloudy: large differences between BT observations and first guess (mislocation)
- Different sensitivities and different errors for clear/cloudy conditions

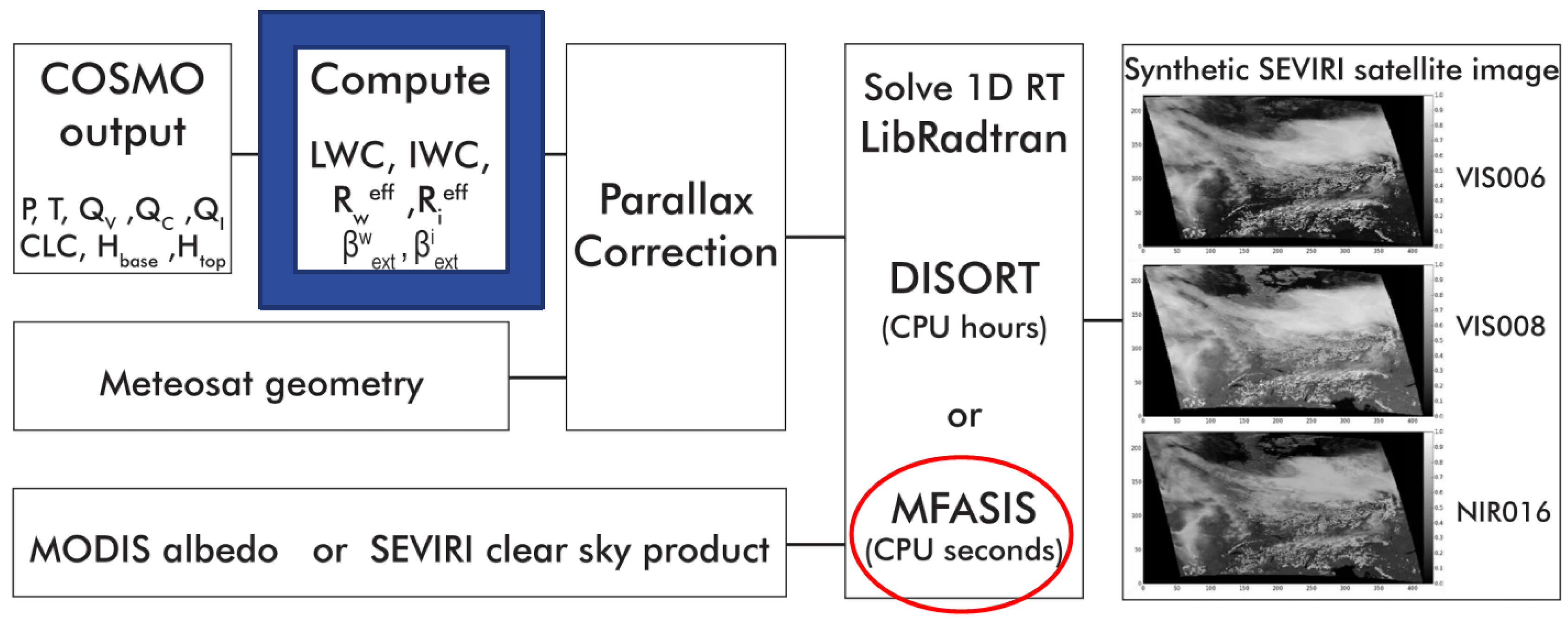


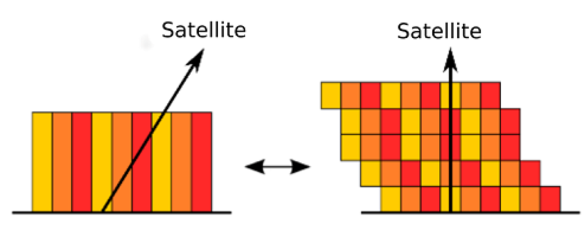


- First guess errors are much smaller than observation error for larger C_a, likely due to a too small spread of cloud variables and definition of C_a ("boundedness")
- Using the dynamic observation error model as function of the average cloud impact leads to more Gaussian FG departures for the 6.2 µm and 7.3 µm channels

Harnisch, F., M. Weissmann, and A. Perianez, 2016, Error model for the assimilation of cloud-affected infrared satellite observations in an ensemble data assimilation system, Q. J. R. Meteorol. Soc., accepted.

NEW FORWARD OPERATORS FOR VIS/NIR





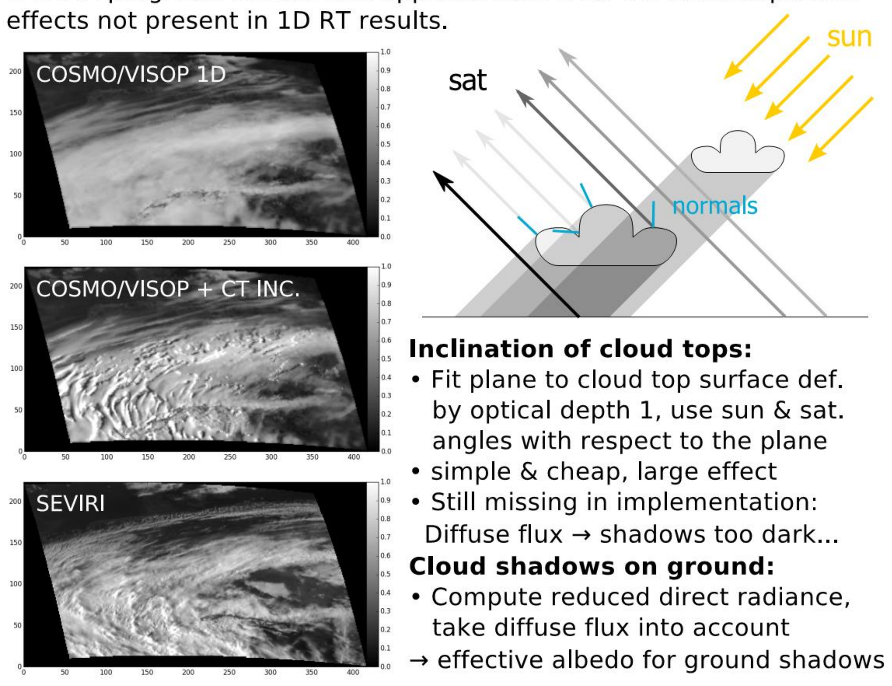
Parallax Correction

DISORT: DIScret Ordinate Radiative Transfer
MFASIS: Method for FAst Satellite Image Simulations

Scheck, L. and Frerebeau, P. and Buras, R. and Mayer, B., 2016, A fast radiative transfer method for the simulation of visible satellite imagery, Journal of Quantitative Spectroscopy and Radiative Transfer, accepted.

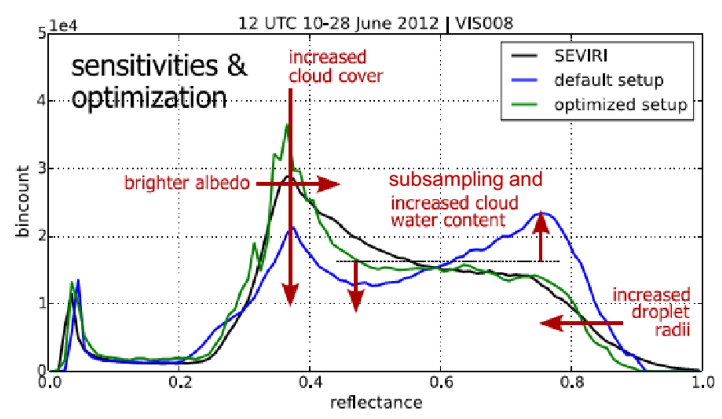
FROM 1D TO 3D: SHADOWS AND CLOUD TOP INCLINATION

Work in progress: Include fast approximations for the most important effects not present in 1D RT results.



Inclination of cloud tops:
- Fit plane to cloud top surface def. by optical depth 1, use sun & sat. angles with respect to the plane
- simple & cheap, large effect
- Still missing in implementation: Diffuse flux → shadows too dark...

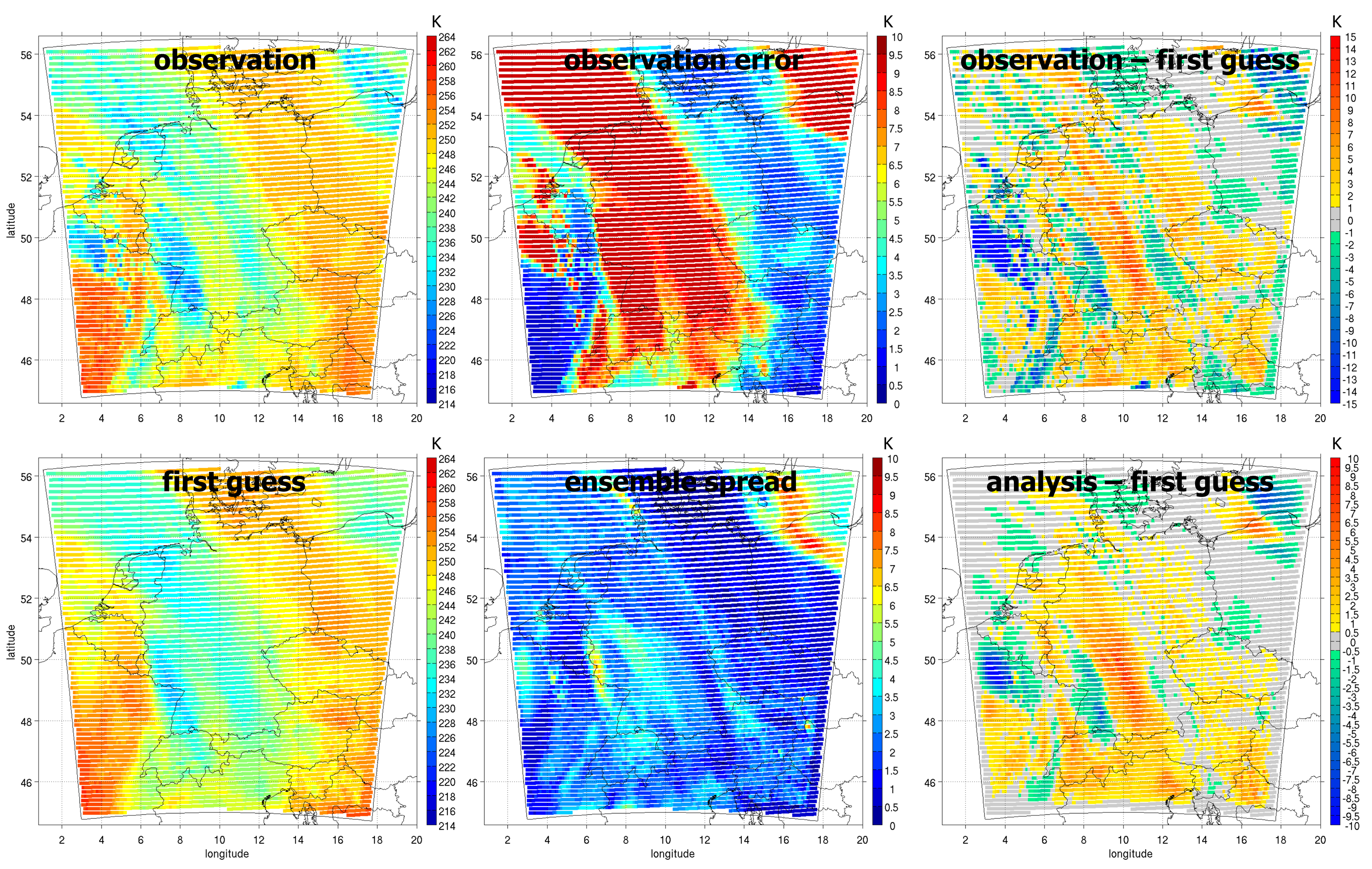
Cloud shadows on ground:
- Compute reduced direct radiance, take diffuse flux into account
- → effective albedo for ground shadows

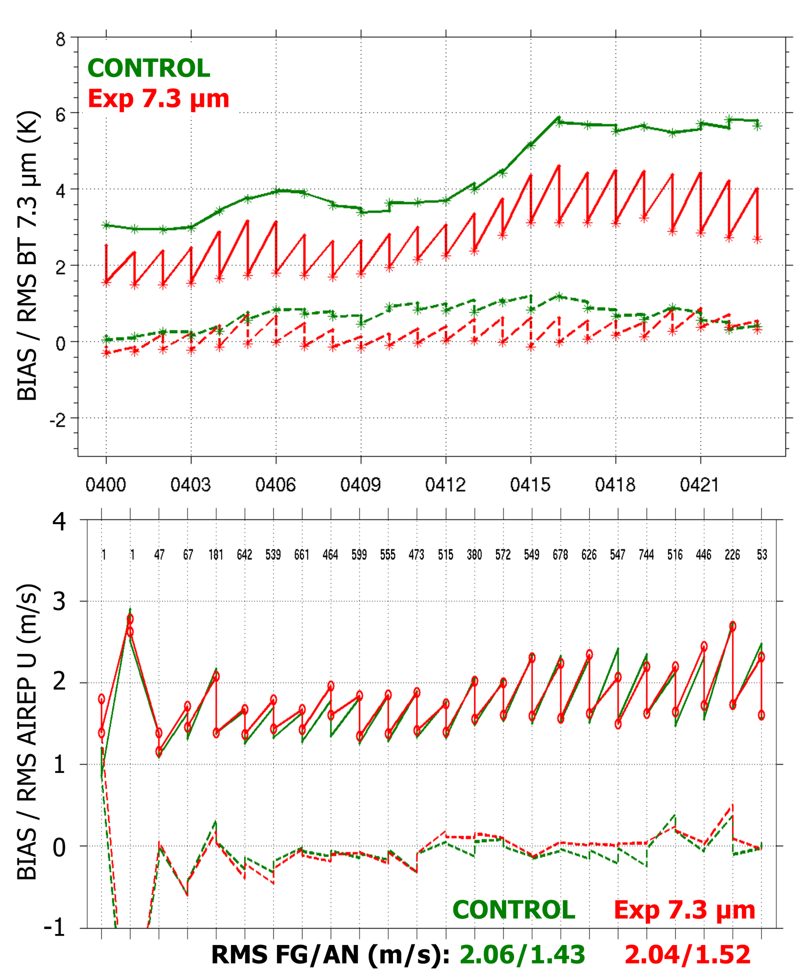


- A realistic distribution is essential for data assimilation
- Large sensitivity to subgrid assumptions
- Refined assumptions lead to much more realistic histogram (→feedback to model radiation scheme)

FIRST EXPERIMENTS ASSIMILATING IR SATELLITE OBSERVATIONS

Assimilation of all-sky MSG SEVIRI brightness temperatures (BT) at 6.2 µm / 7.3 µm over Germany with the 40-member KENDA system using the new observation error model





Single-cycle experiments:
- Error model inflates the observation error strongly
- Ensemble spread in cloudy regions is much smaller than observation error

Continuous cycling experiments:
- Model state is pulled towards the observations
- Moderate systematic differences for cloudy data
- BT observations do not degrade the fit to conventional observations

Next steps / future work:
- Vertical localization, super-obbing instead of thinning
- Sensitivity experiments to investigate systematic differences in cloudy regions
- Assimilation experiments with multiple channels
- Verification with VIS/NIR channels, radar, GNSS