# UC microwave radiometry and sensor synergy during the COPS AMF deployment

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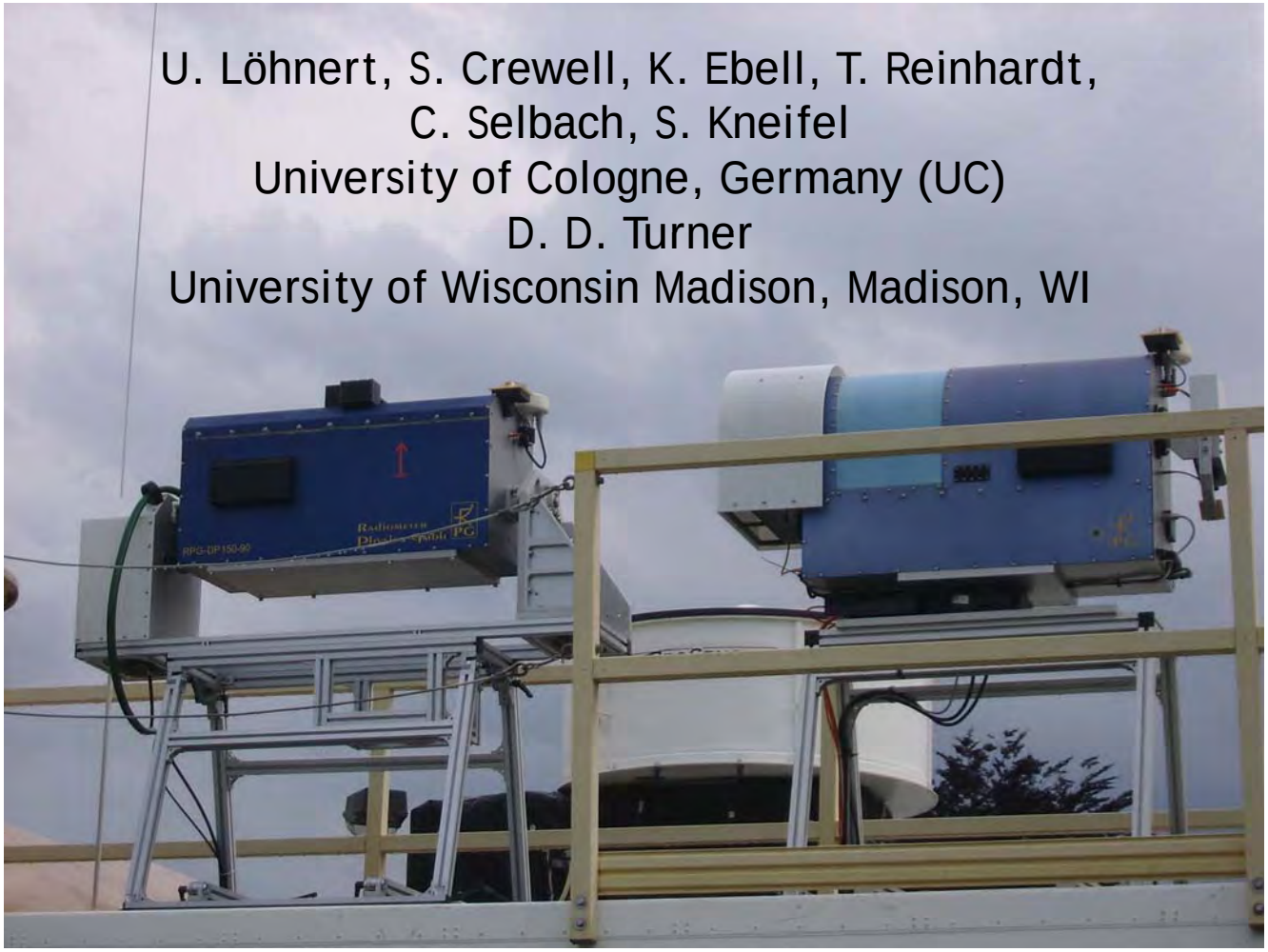
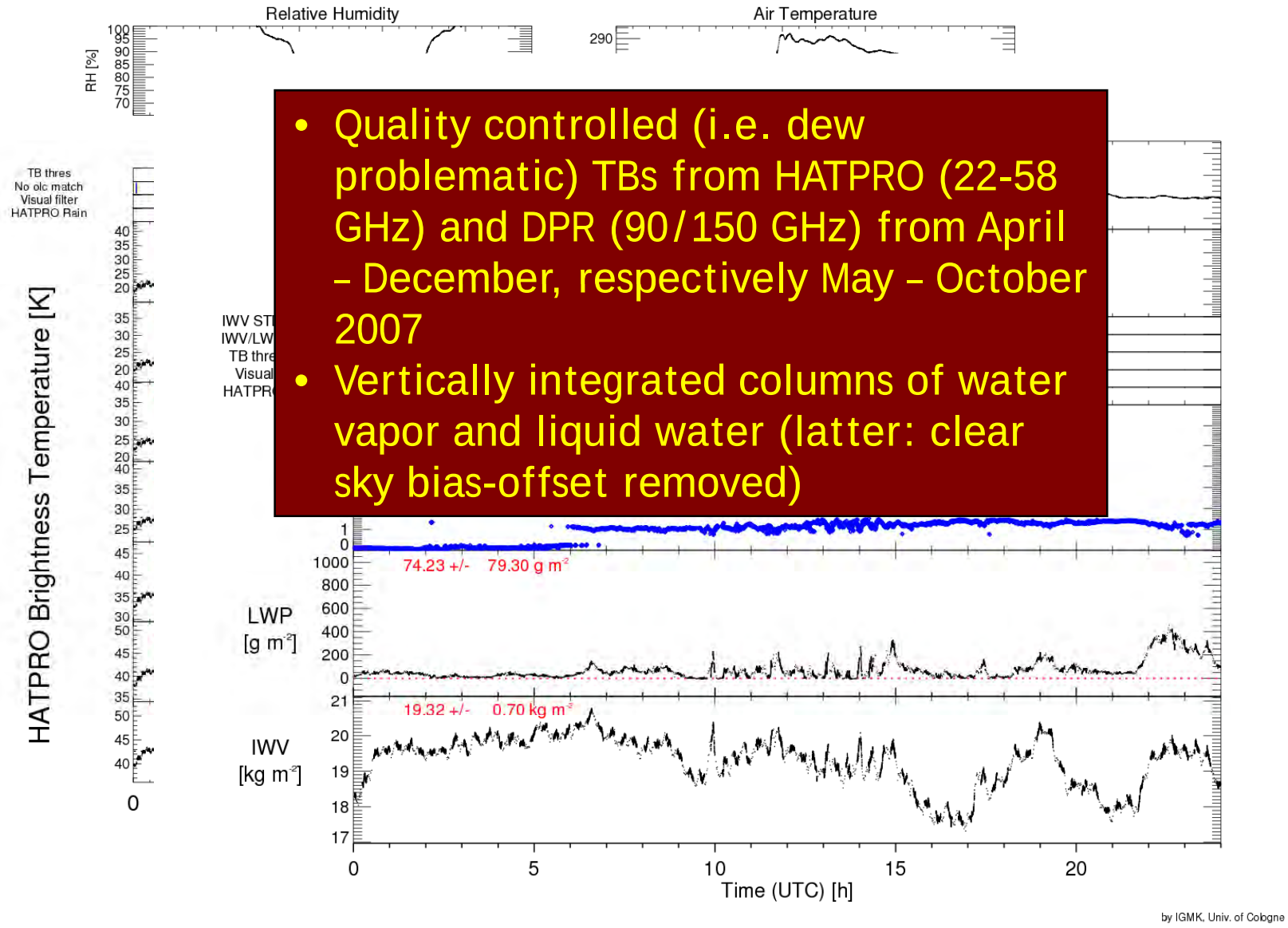


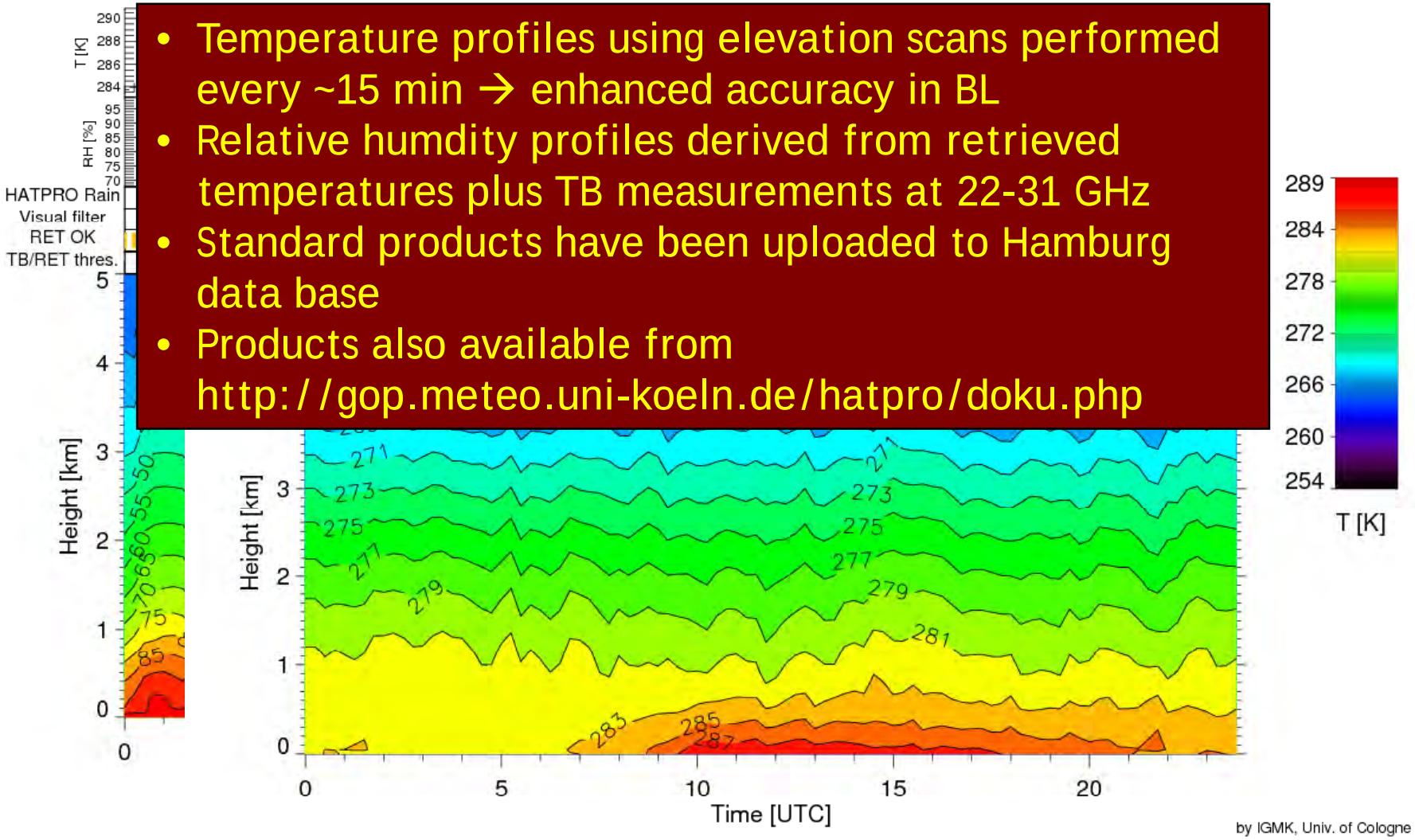

# Standard UC Microwave Products




- Quality controlled (i.e. dew problematic) TBs from HATPRO (22-58 GHz) and DPR (90/150 GHz) from April – December, respectively May – October 2007
- Vertically integrated columns of water vapor and liquid water (latter: clear sky bias-offset removed)

# Standard UC Microwave Products

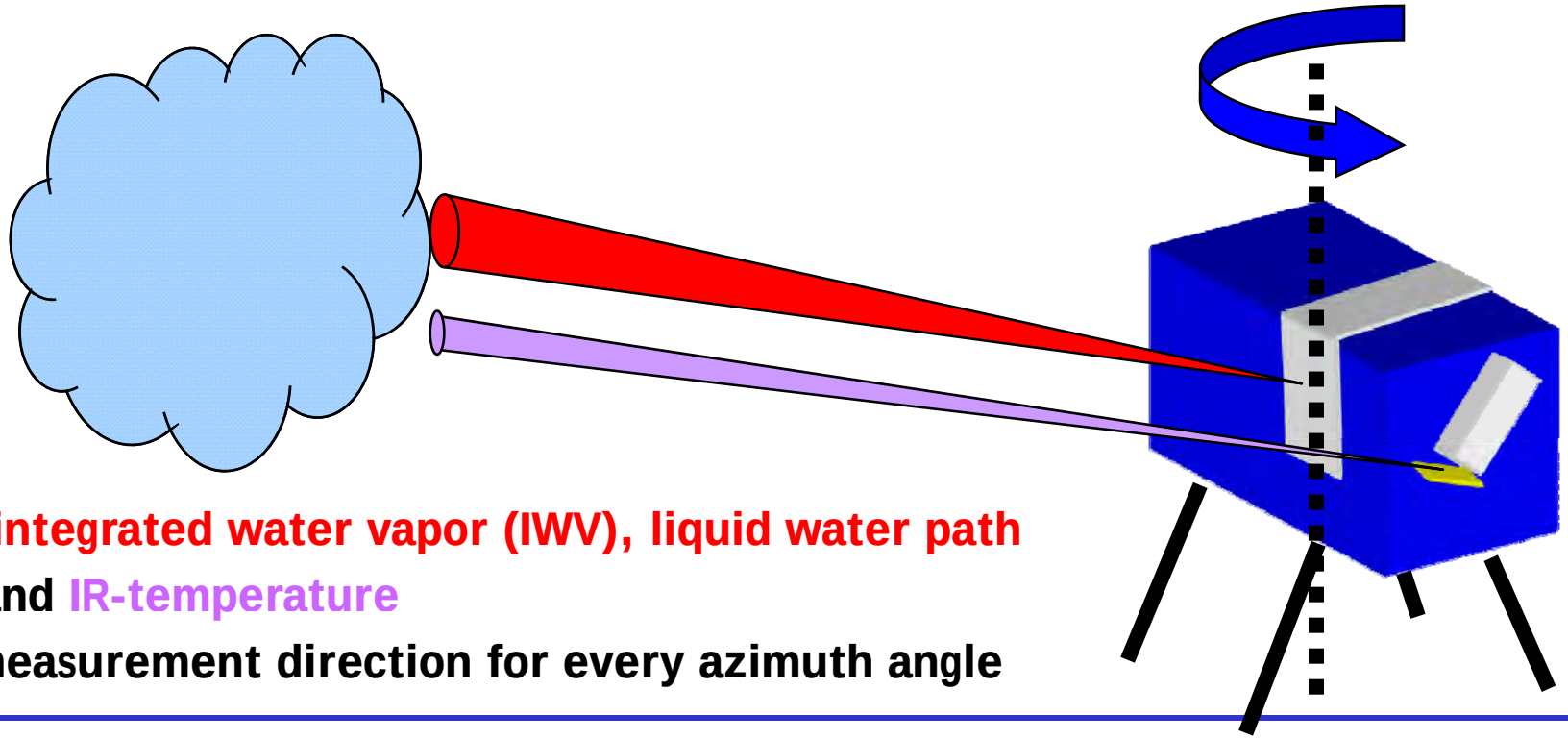
- Temperature profiles using elevation scans performed every ~15 min → enhanced accuracy in BL
- Relative humdity profiles derived from retrieved temperatures plus TB measurements at 22-31 GHz
- Standard products have been uploaded to Hamburg data base
- Products also available from http://gop.meteo.uni-koeln.de/hatpro/doku.php



# Regular HATPRO Azimuth-Scans

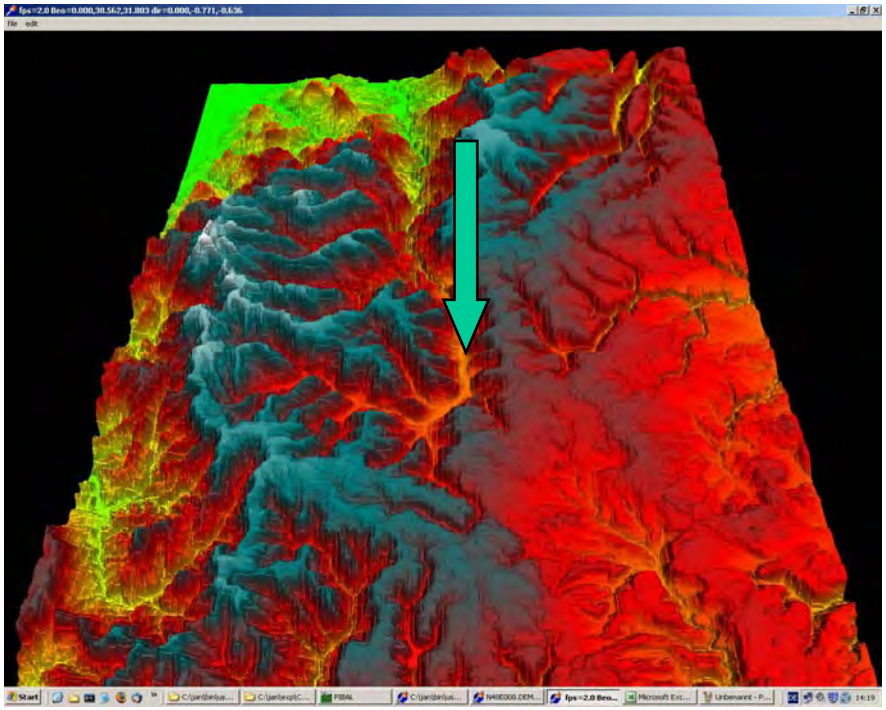
**Azimuth-scan-mode (every 15 min):**

- fixed elevation angle (30°)
- 355°- turn around vertical axis in 5°- steps
- Aperture: HATPRO: ~2°, Broadband IR (9.6-11.9 microns): ~1°
- scan duration ~6 min



**derive integrated water vapor (IWV), liquid water path (LWP) and IR-temperature**
**along measurement direction for every azimuth angle**

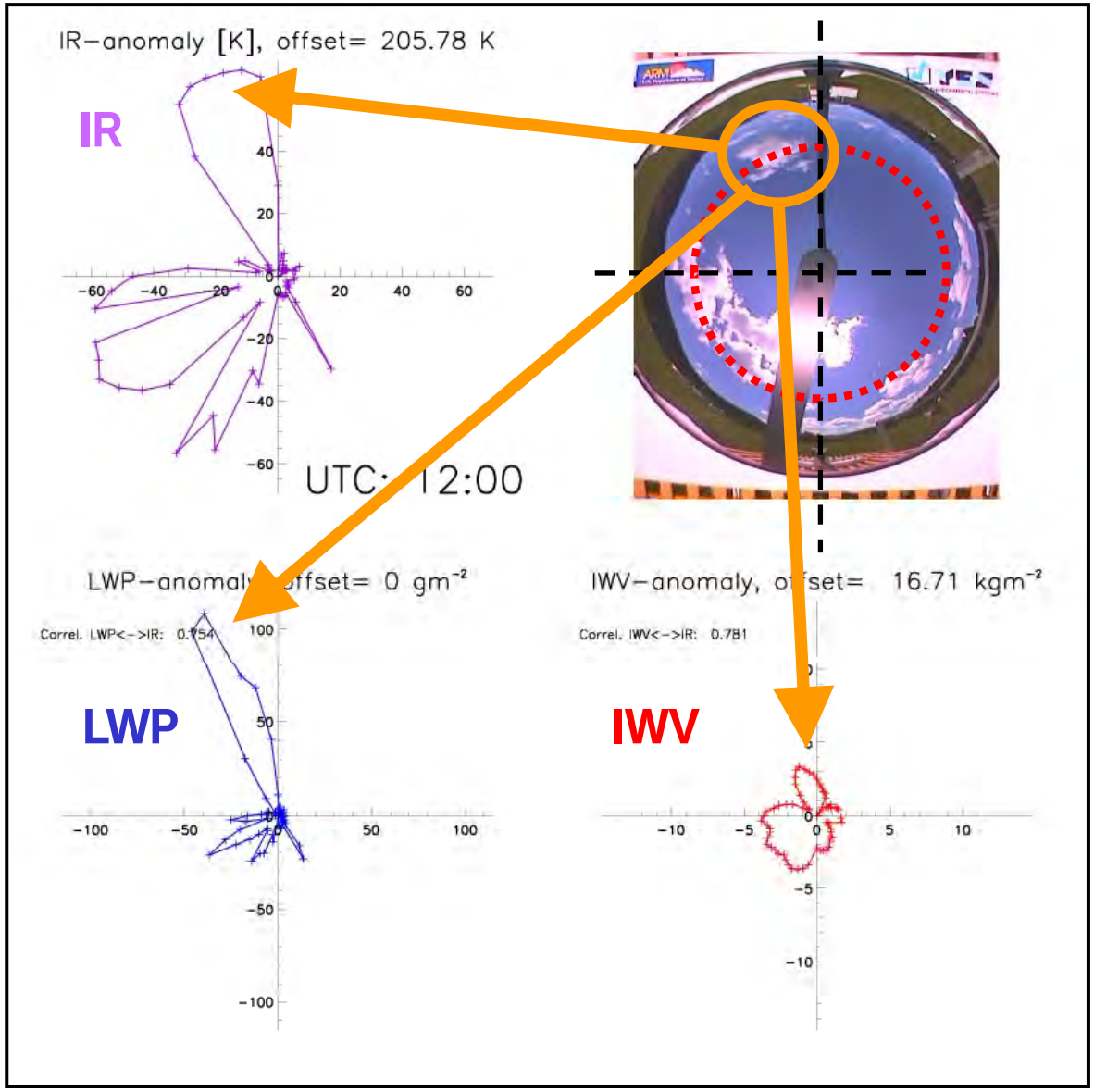
# Measurement Set-Up



**Heselbach in the Murgvalley (Schwarzwald)**


**staring 06. July 2007: continuously scanning measurements**

# Measurment Examples

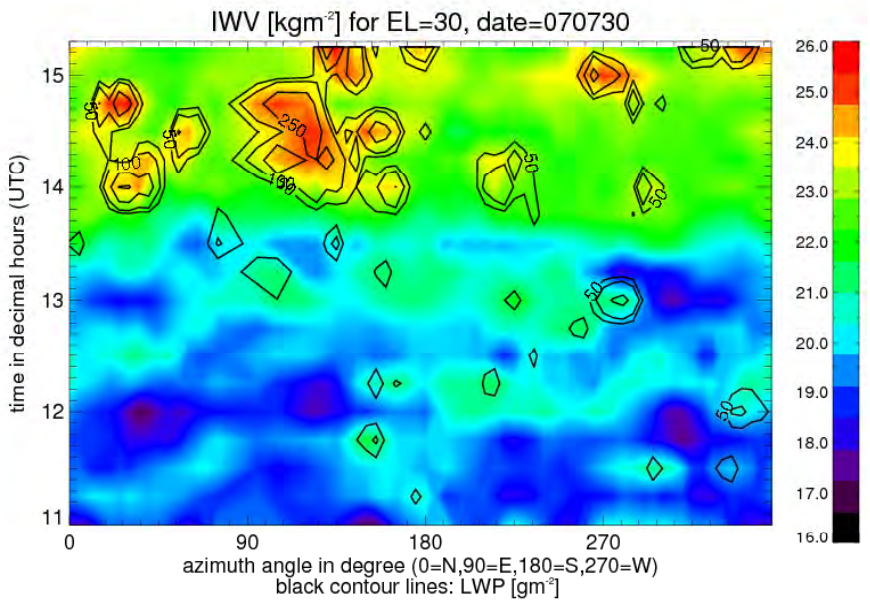


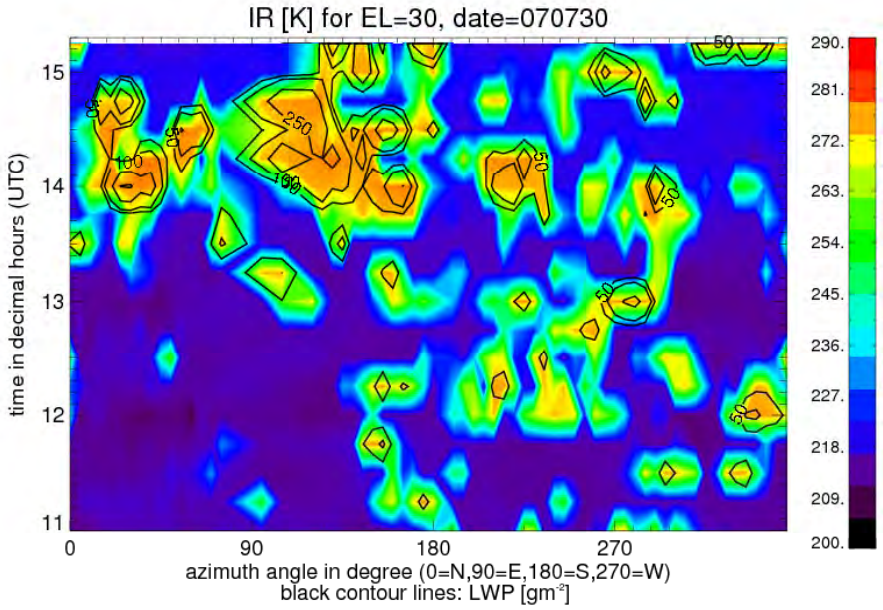


- **IR, LWP and IWV on polar coordinates**
- **shown are azimuthal analomalies**

# Development of Water Vapor and Liquid Cloud Fields

- Continuous hemispheric scans of microwave profiler, broadband IR-radiometer over ~3h
- Can provide spatio-temporal BL-evolution, "cloud life cycle" issues
- Day and night observations of cloudiness
- Are these observations of additional value for meso-scale model evaluation or assimilation?
- What about parametrizations of convection?



# Some Scientific Questions

- Where are the humidity variations localized in height (BL or mid-troposhere?)
- Which role does the orography, time of day and the synoptic situation play?
- How are the humidity variations coupled to the latent heat flux at the surface?
- How are the humidity variations related the lidar Doppler winds? → Can we observe convergence in the areas of enhanced humidity and cloud?

- Is there a correlation between the magnitude of the humidity variablilty and the convective cloud amount?
- Are the observed features reproduceable by small-scale (LES) models?

# Multi-Instrument Retrievals
# Motivation:

single instrument deficits:
- resolution
- simultaneous sensitivity to other parameters
- ambiguous solution

Idea: Find instruments that capture the desired parameter in a complementary way

→ different spectral regions
→ active/passive methods
→ scanning configurations

# Integrated Profiling Technique (IPT)
## a 1DVar approach towards multi-instrument retrieval

**Measurements = INPUT**

passive RS – measurem. + error

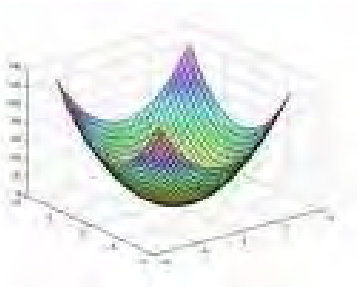
active RS – measurem. + error

in-situ measurem. + error

a priori information + error

**Integration**

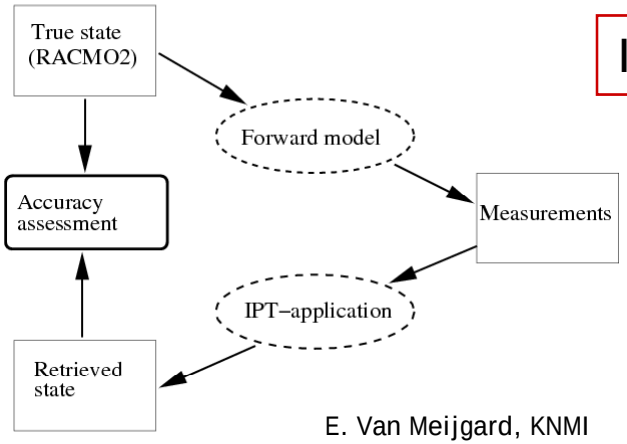
**e.g. 1DVAR**



**OUTPUT**

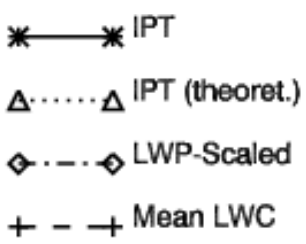
**atmospheric composition**: temperature, humidity, hydrometeors **+ errors**

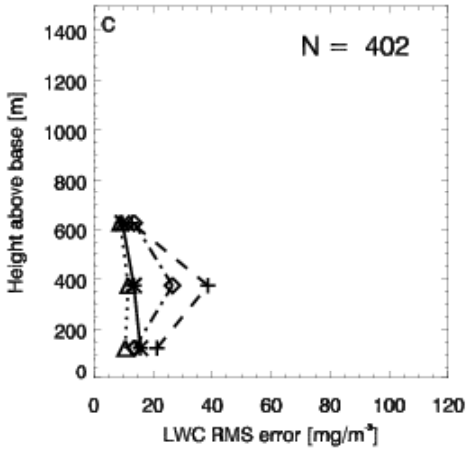
# RACMO Simulation: LWC accuracies

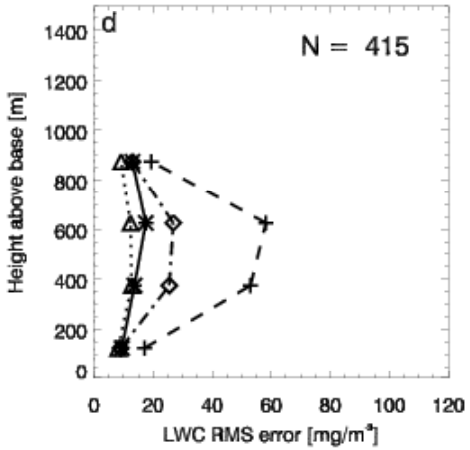


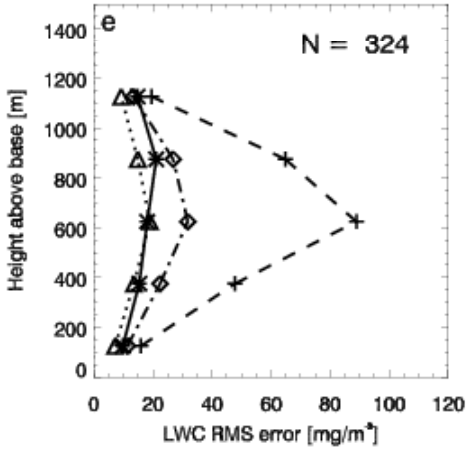

E. Van Meijgard, KNMI

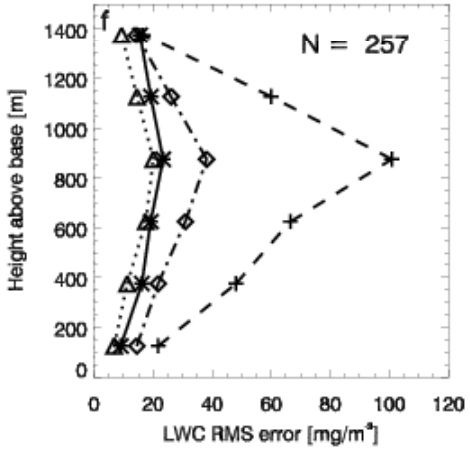
Instrument synergy: radar/microwave



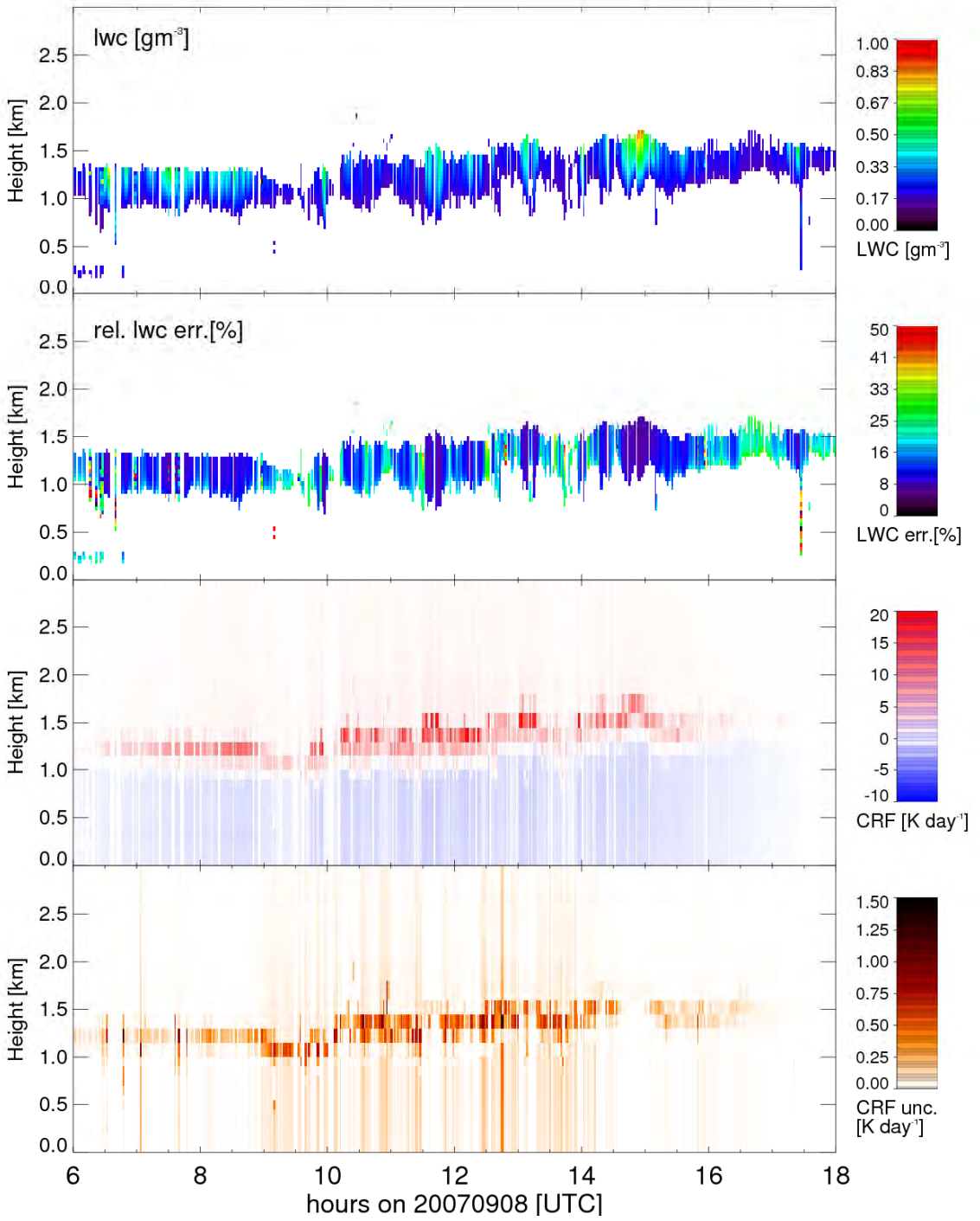




- overall LWC-accuracy: ~30%
- improvement w.r.t. LWP-scaled retrieval: ~17%

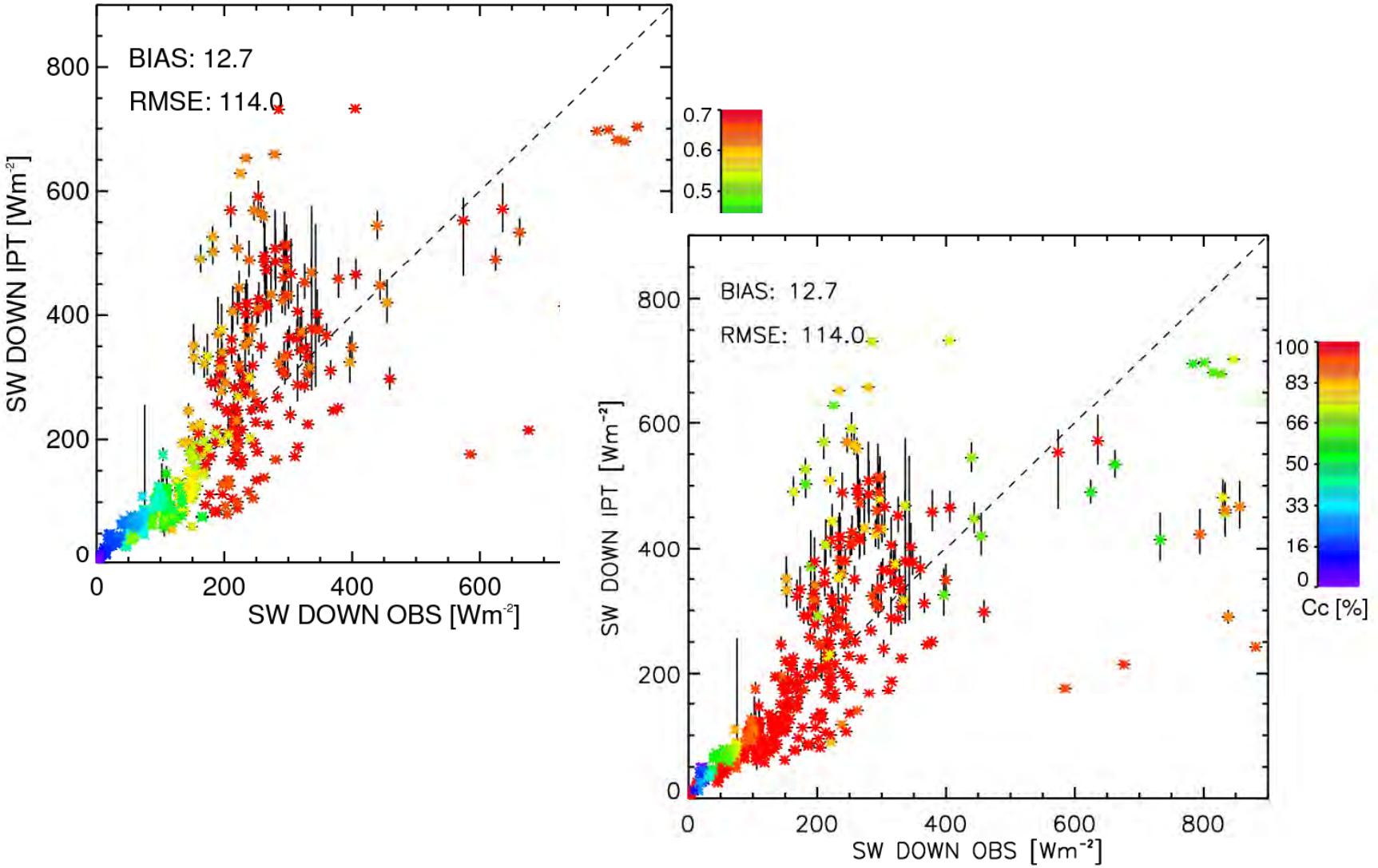



# IPT application during COPS

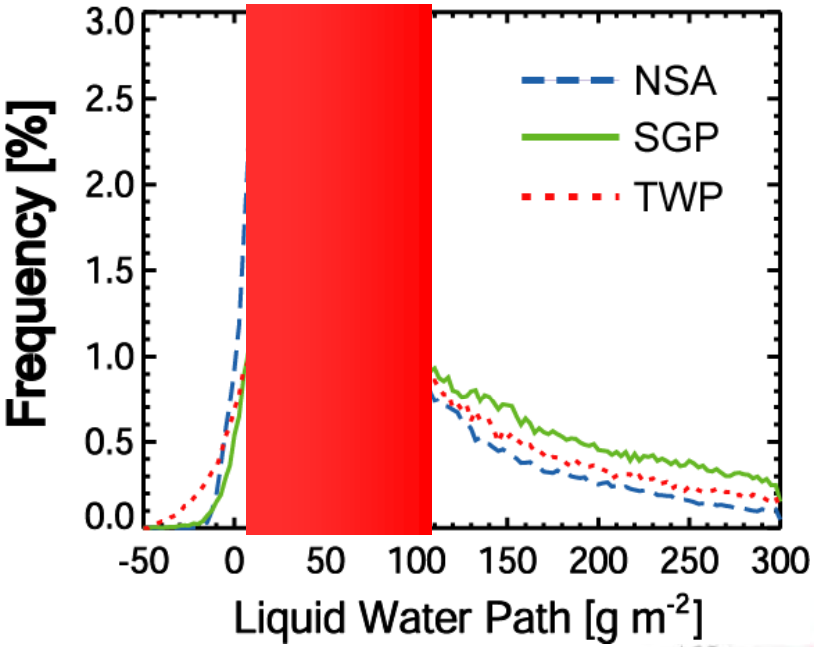
- Need more precise determination of vertical cloud distribution to be able to correctly model and evaluate heating rates
- Which uncertainties do we obtain from the LWC retrieval and how are these propagated to the calcualtion of cloud radiative forcing?
- How large are these uncertainties in comparison of the errors assocaited with a plan-parallel atmosphere?
- Use this data to quantify differences in different RTMs (e.g. COSMO-GRAALS vs. RRTM)

# IPT application during COPS

2007-09-08

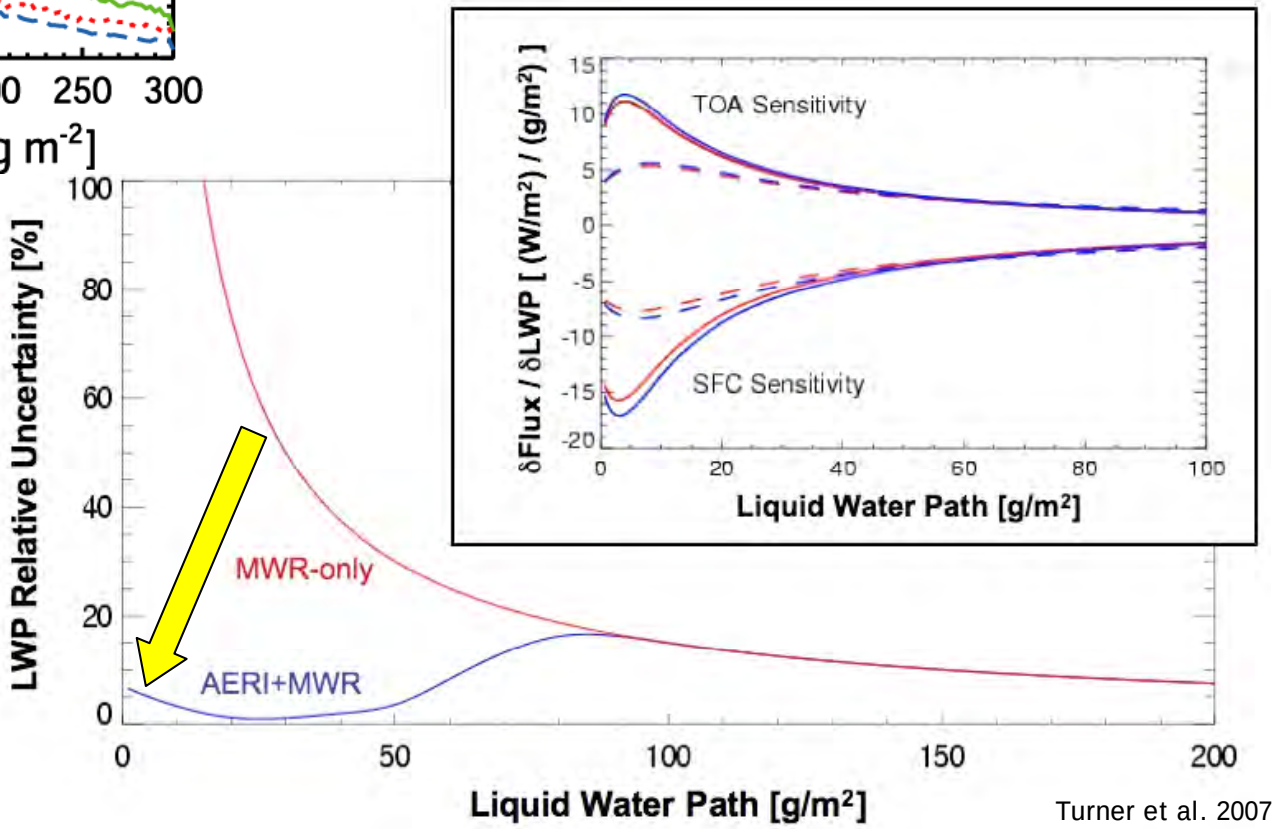


# Dealing with low-LWP clouds …




- low LWP-clouds are very frequent and significantly influence solar radiative forcing
- however, these clouds are difficult to measure and model

passive **infrared** and **microwave** measurements reveal high potential for capturing these clouds accurately

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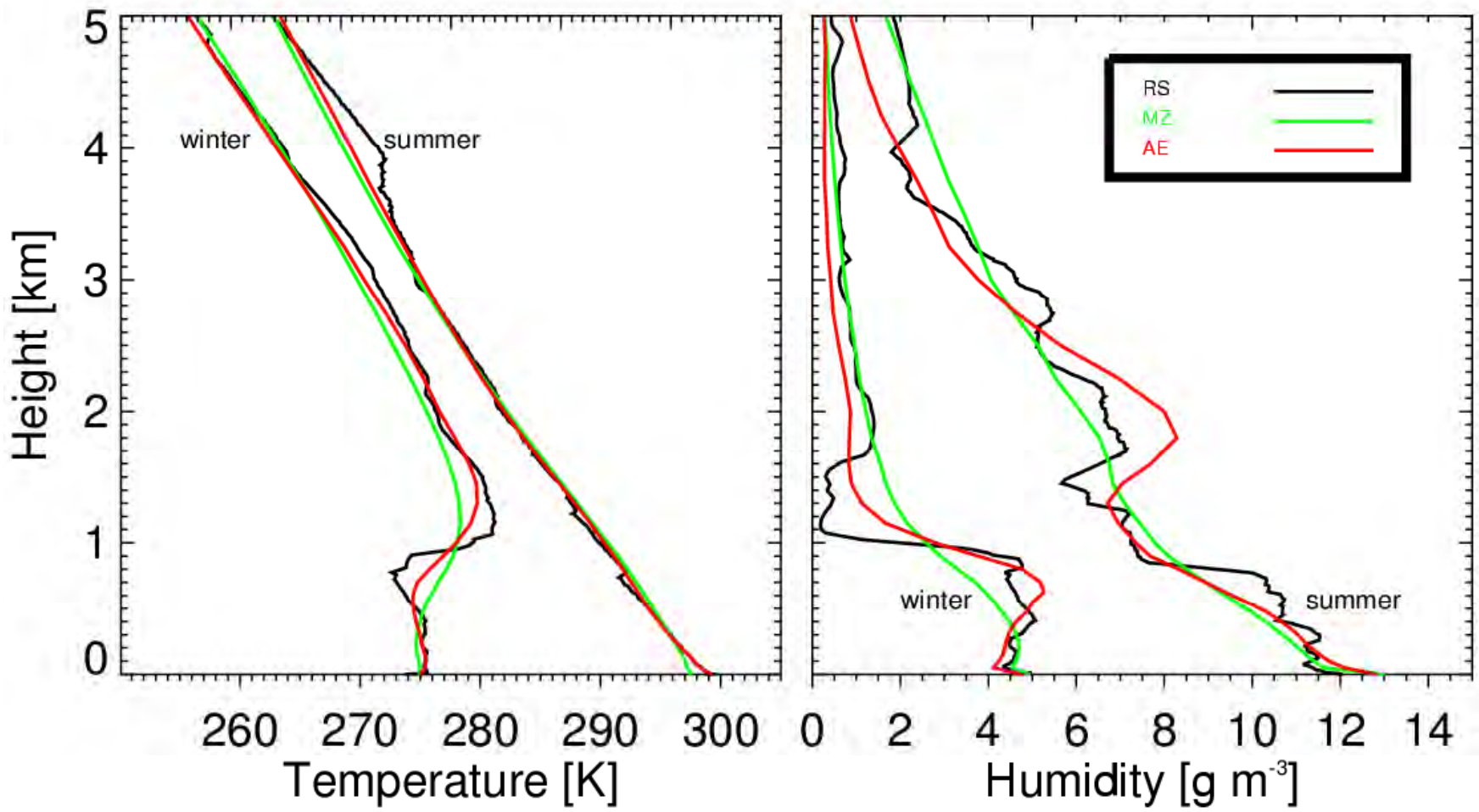
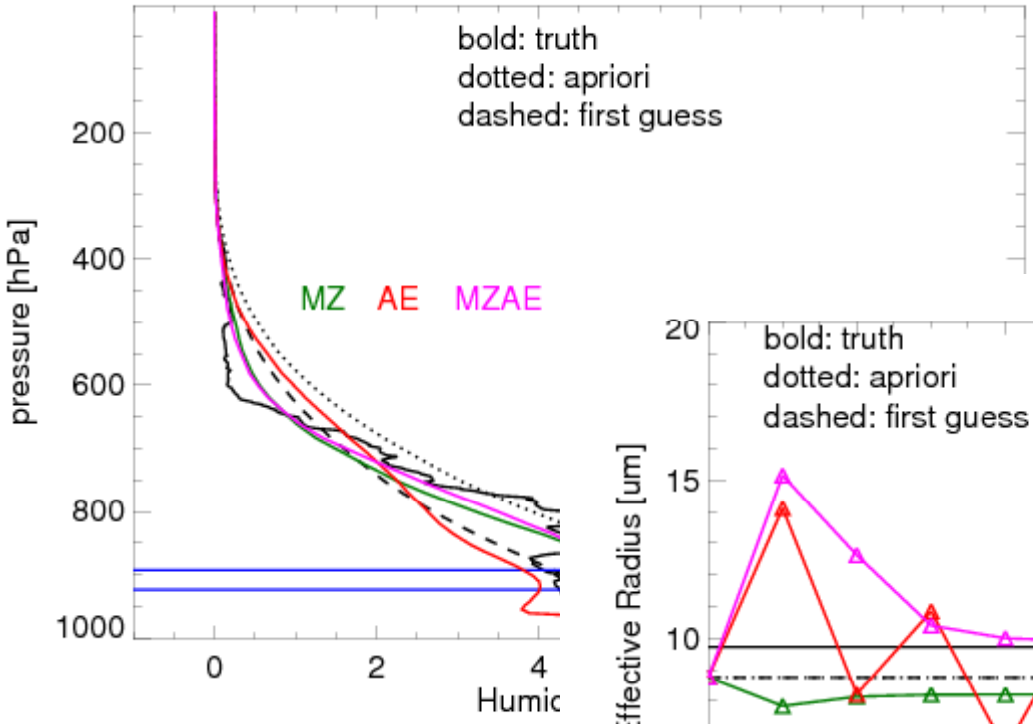
# Microwave and Infrared, clear sky

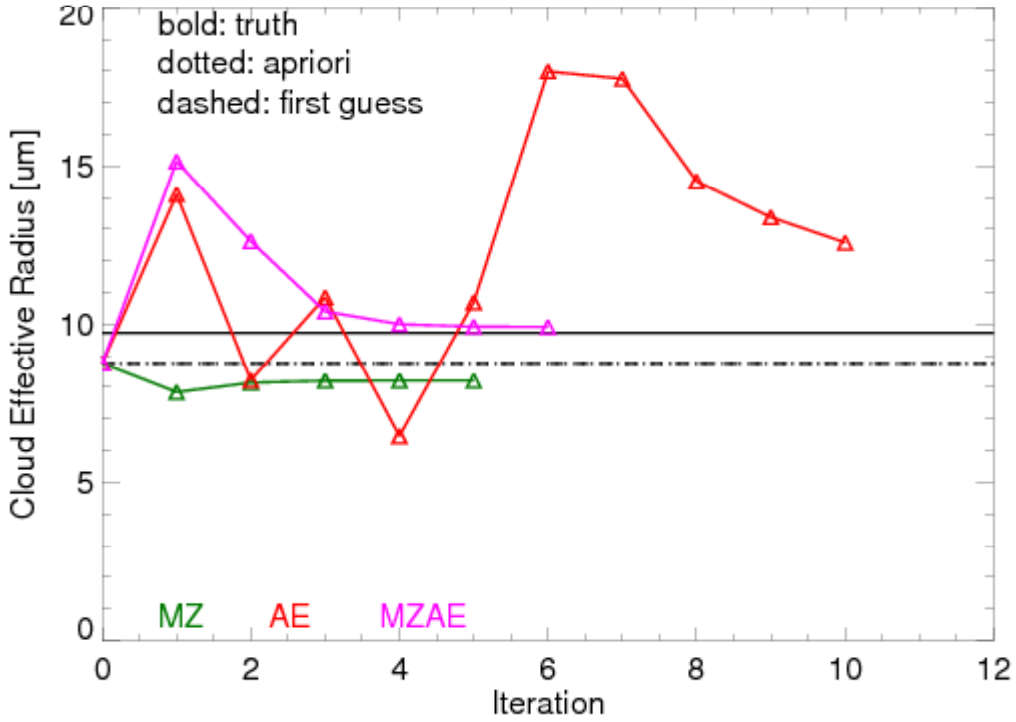



**winter**: cold and dry
**summer**: hot and humid

# Microwave and Infrared, cloudy sky

Synergy: MWR+AERI information

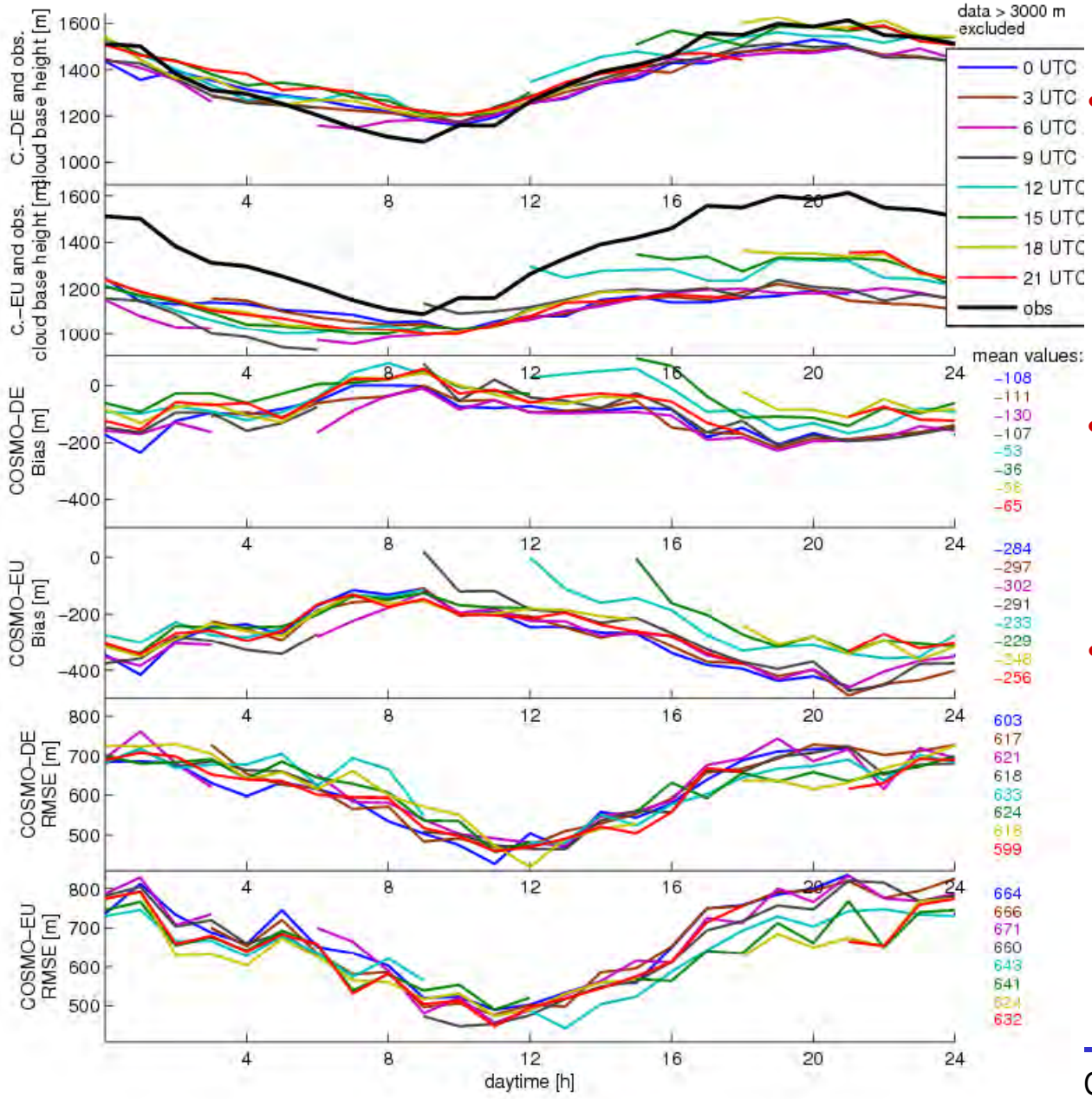



MZ: Microwave zenith observing
AE: AERI only (zenith)
MZAE: combined AERI + Microwave

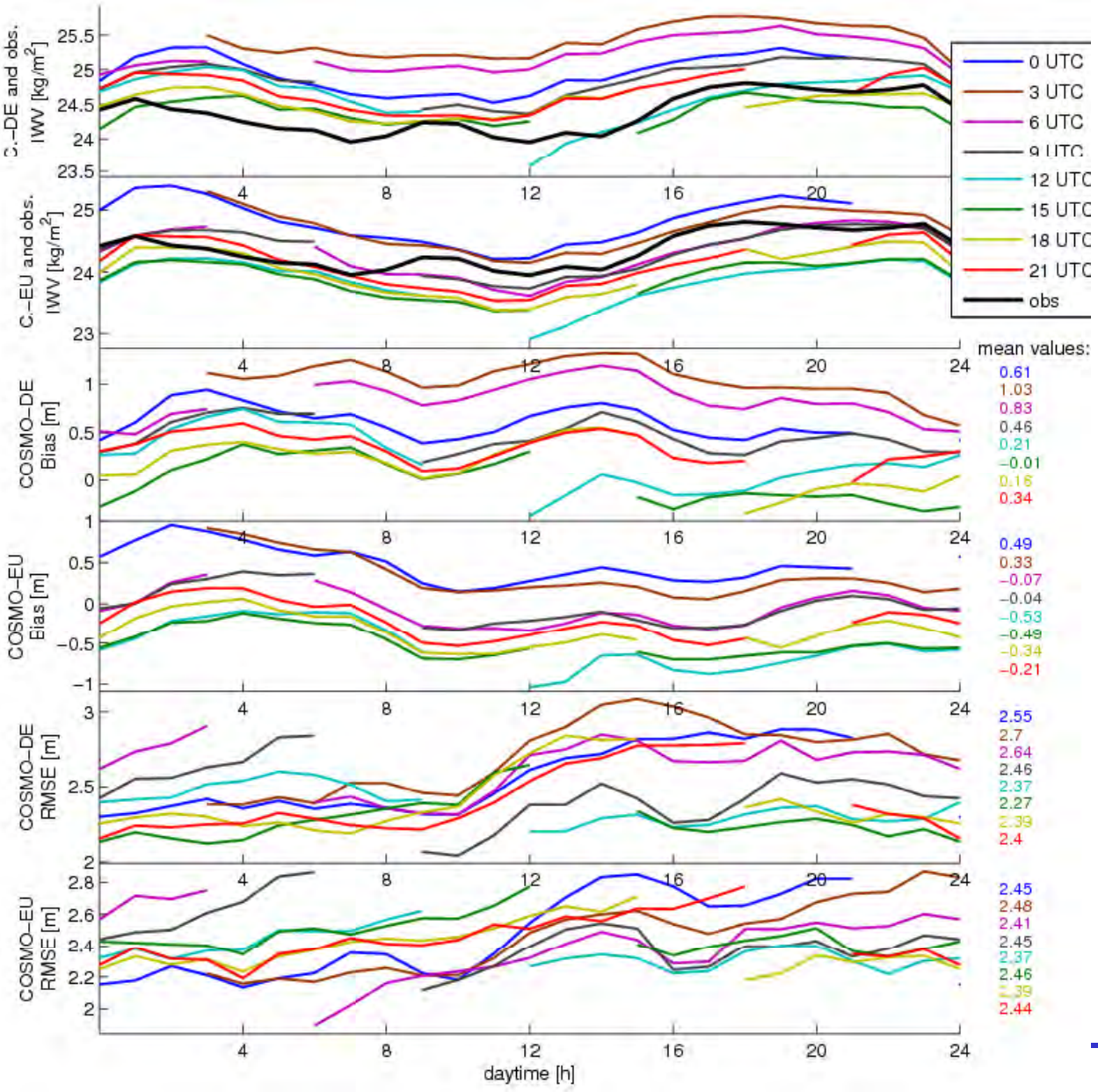
once "operational": apply algorithm to suited COPS periods

# Model Evaluation, COPS region: Cloud Base Height




- 12 UTC model runs start drier and with higher cloud base. Possible reason for that: assimilated radiosondes with dry bias at daytime.
- COSMO-DE resolves the mean diurnal cycle of cloud base heights very well in COPS region.
- Big problems of COSMO-EU cloud base forecasts in COPS region (cloud base heights significantly too low in model forecasts).

# Model Evaluation, COPS region: Int. Water Vapor




- For both regions: 12 UTC model runs start drier and with higher cloud base. Possible reason for that: assimilated radiosondes with dry bias at daytime.
- Compared to GPS observations model runs are moister in COPS region and drier in North West Germany (not shown).

# IPT application during COPS

2007-09-08