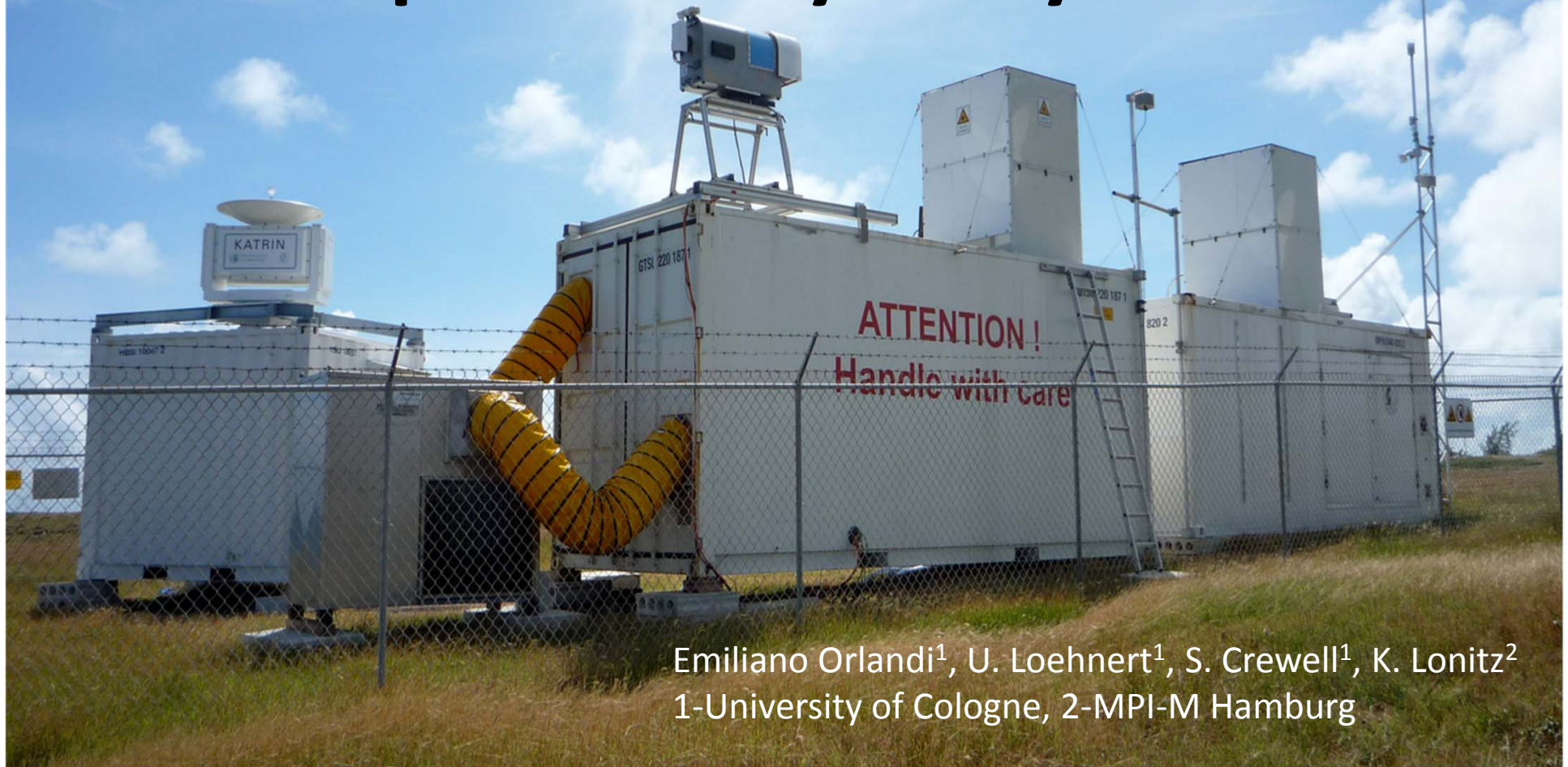


Introduction to IGMK radiometer status of the instrument and preliminary analysis



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OUTLINE



- **Radiometer description**
 - Measured quantities, methodology and accuracy
 - What we need to improve radiometer data analysis

- **Available database**
 - Measurement strategy and known problems

- **Scientific interest**
 - Synergy with RADAR measurements
 - 2D structure of the clouds

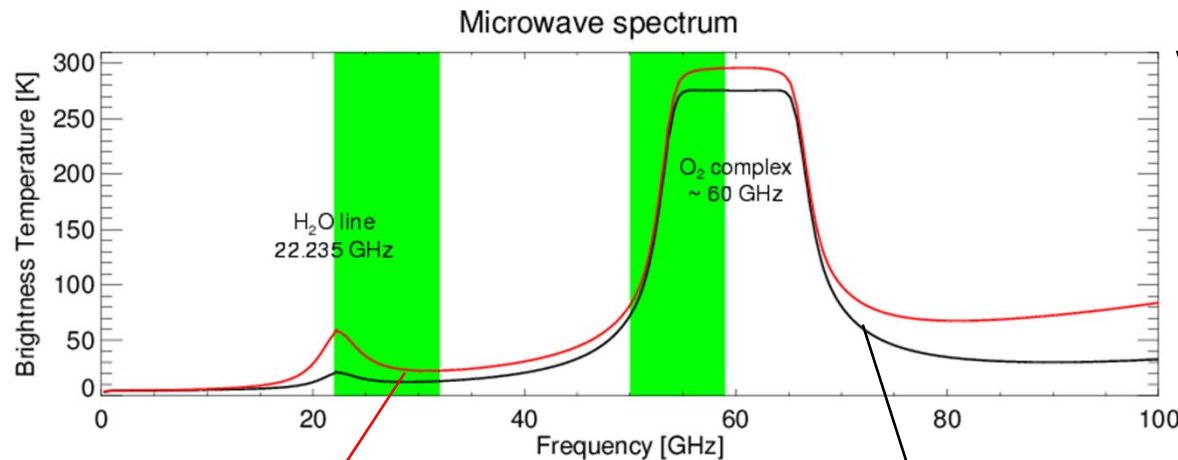
HATPRO instrument description



Humidity And Temperature
PROfiler (HATPRO)

- 7 channels between 22.235 – 31.4 GHz (water vapor & liquid water)
- 7 channels between 50 – 58 GHz → O₂ band (temperature retrieval)
- clouds are semi-transparent in the microwave region → humidity, temperature and cloud liquid water content can be derived together

Temperature and humidity profiling



warm & humid mid-lat. clear sky case

cold & dry mid-lat. clear sky case

well posed forward problem:

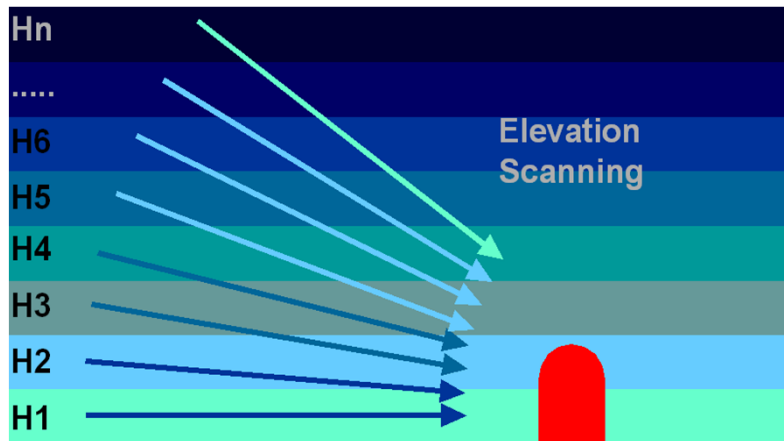
$$TB = RTO(T, q, clouds)$$



However, the *inversion* of this equation is ill-posed

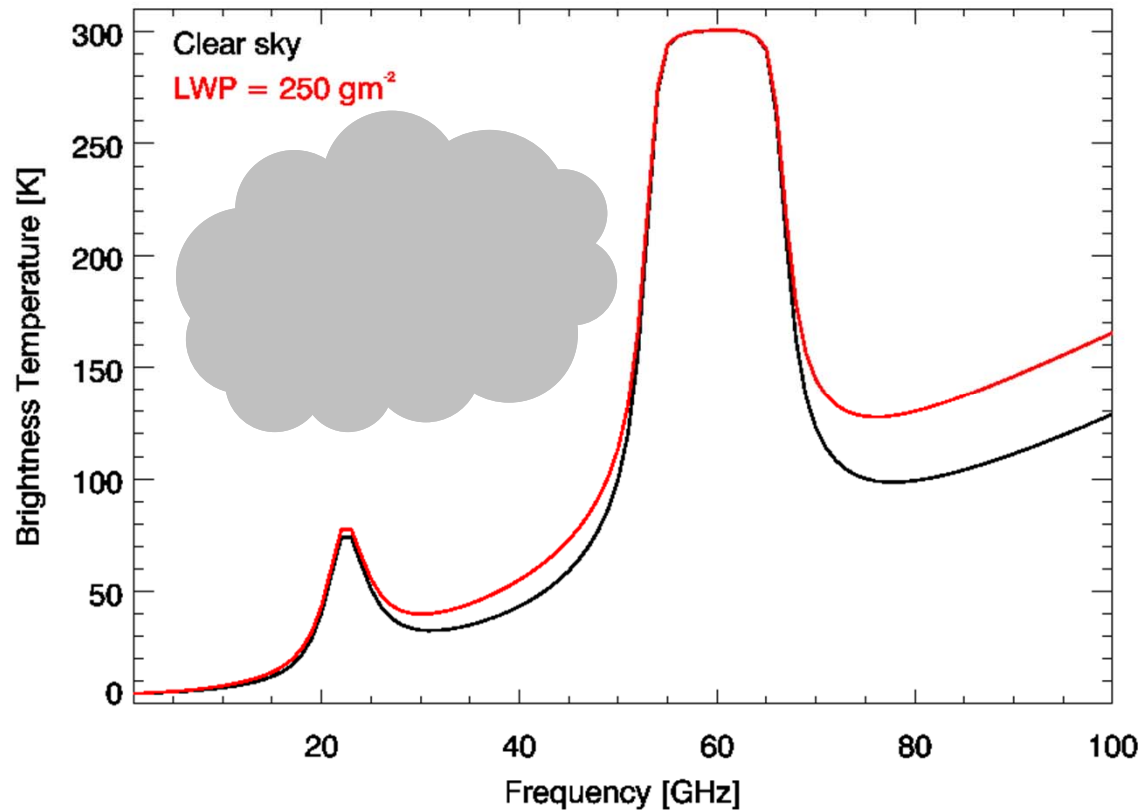


a large number of solutions may exist for one and the same radiance measurement



Multi-frequency, multi-angle boundary layer retrieval

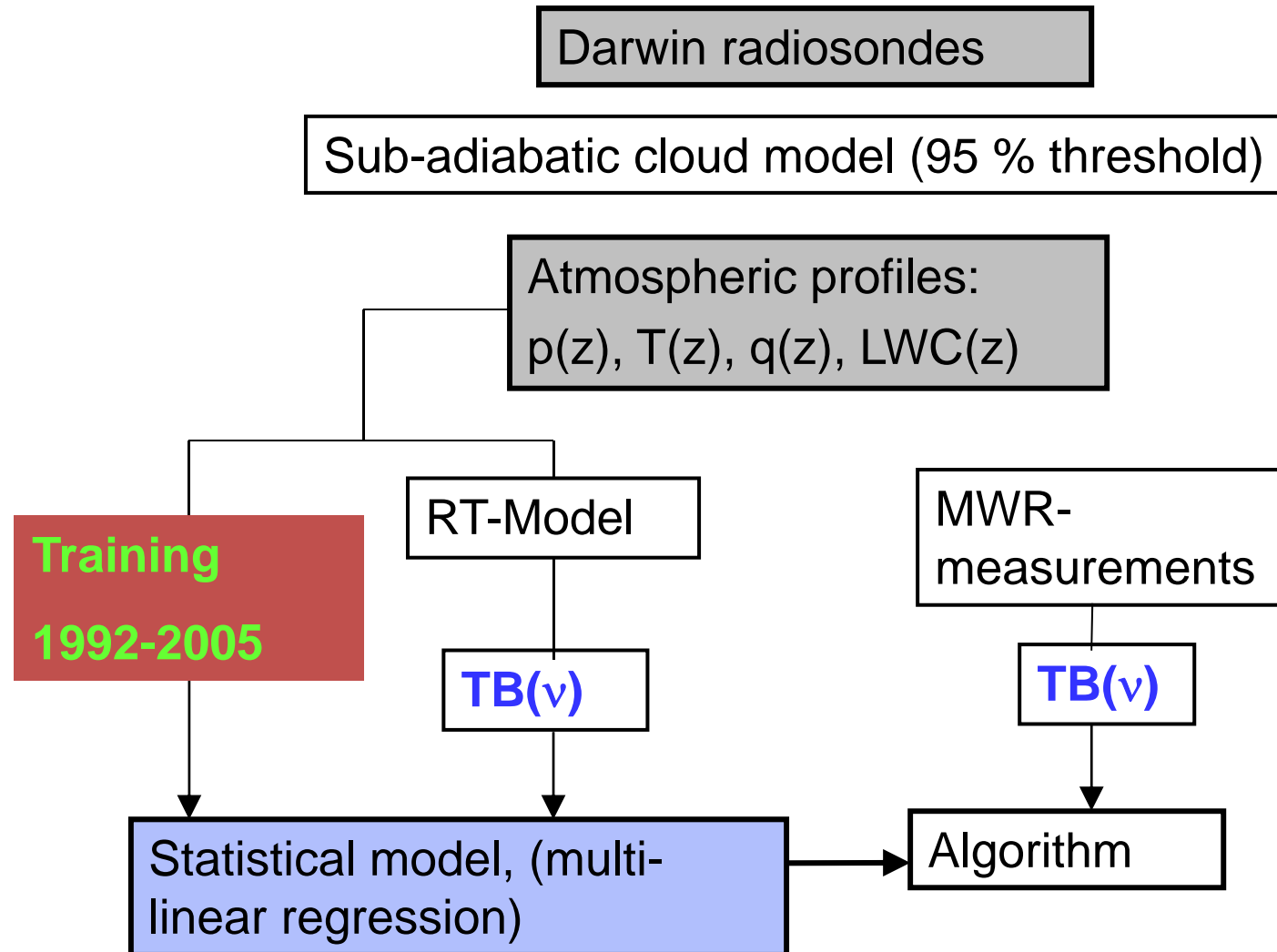
Dealing with cloud



- Sufficient SNR to detect clouds and retrieve LWP starting at 30 gm⁻²
- Scattering is negligible for non-precipitating cases below ~100 GHz
- Ice cloud emission negligible
- HATPRO to deliver temperature and humidity information throughout the atmosphere in cloudy conditions (no significant accuracy decline expected)

Even if cloud boundaries are given, HATPRO measurements **contain practically NO information on distribution of cloud liquid water!**

HATPRO retrieval

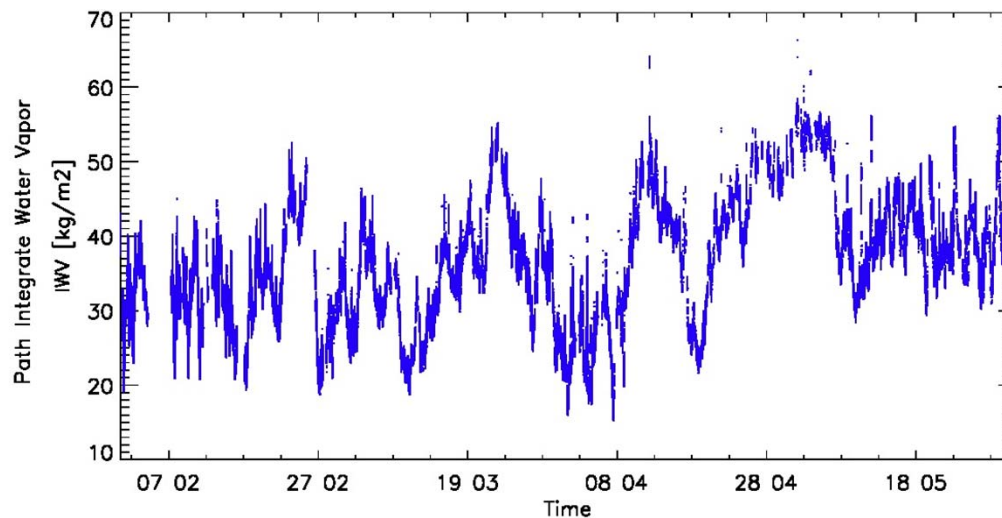


What we can provide



Time series of:

1. **integrated liquid water** (LWP) multiple elevation and azimuth angles
Accuracy @ zenith 20-30 g/m²
2. **path integrated water vapor** (IWV) multiple elevation and azimuth angles
Accuracy .5 - 1.0 kg/m²



Path integrated water vapor
Only zenith view
Period: 01 Feb - 30 May 2011

Possible: Boundary layer profiles of **temperature** (RMSE .5-1.5 K below 4 km)
specific **humidity** (.8-1.5 g/m³ below 4 km)



What we need

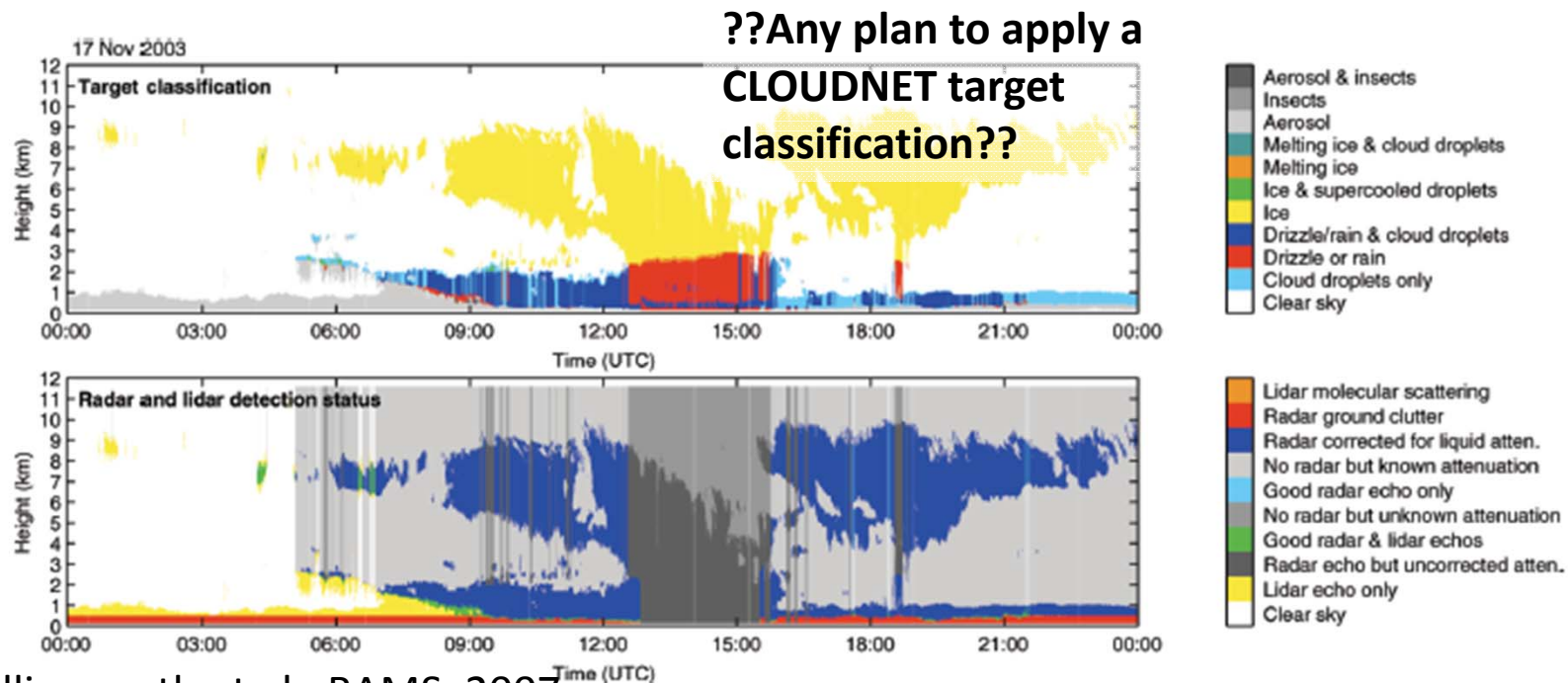
Rain gauge data

-> better quality check on radiometer data
disfunctions of HATPRO rain sensor due
to sea salt deposit

Presence of cloud and cloud base
height from **ceilometer**

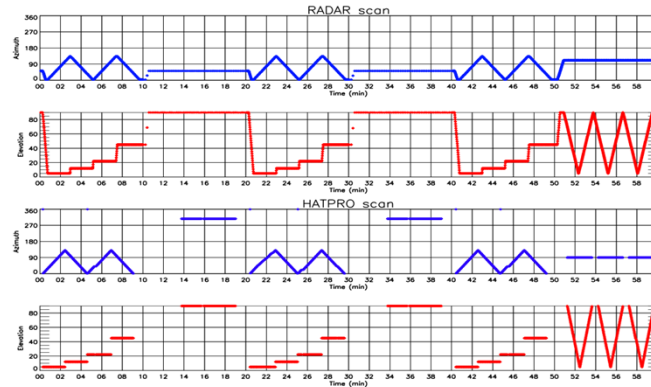
-> clear/cloud cases

- Compare radiometer humidity data with independent measurements





Available dataset



elevation + azimuth scans

25/02

RADAR and HATPRO
coincident scans

14/04

Problems with
the mirror

14/08

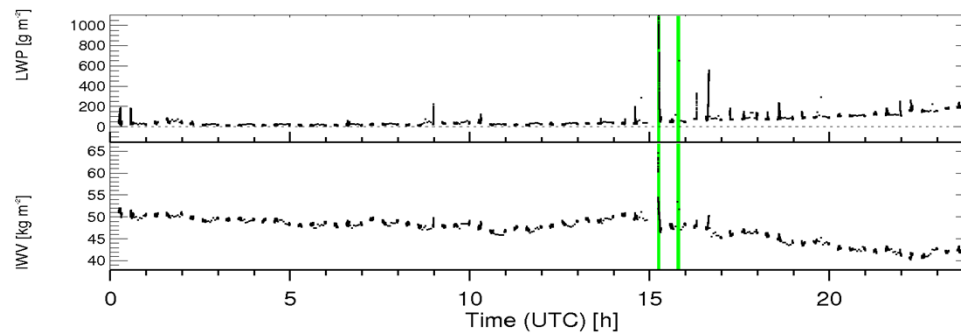
06/09

06/01

24/03

HATPRO bias
started

04/10 Today
HATPRO driver
stopped

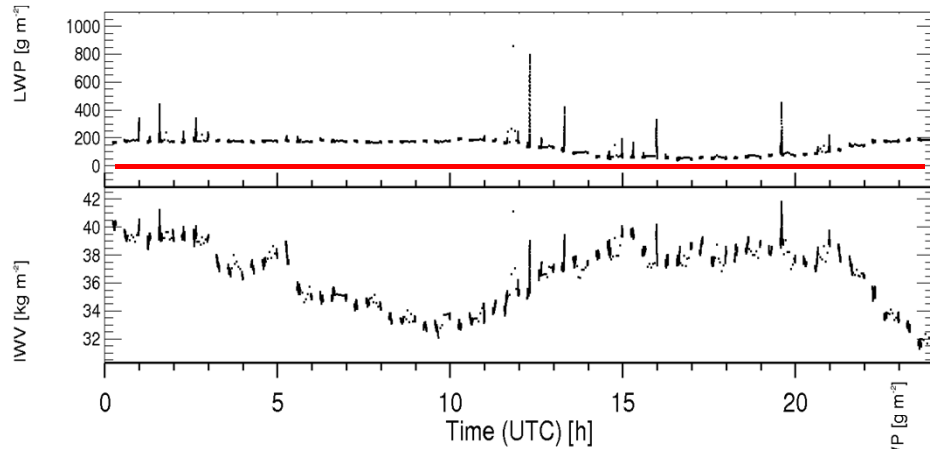


bbd, 110324

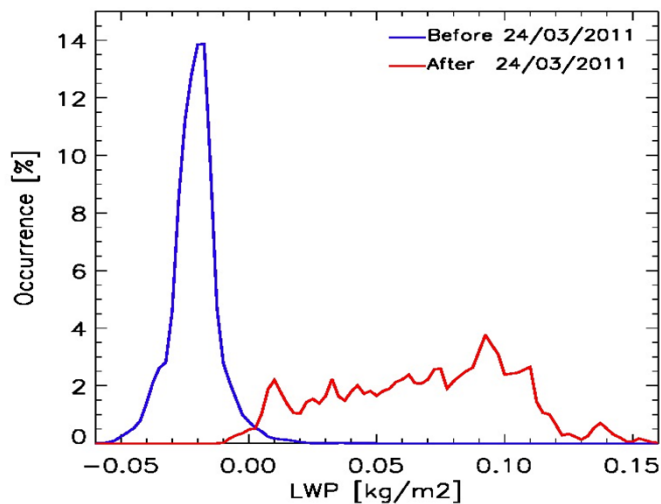
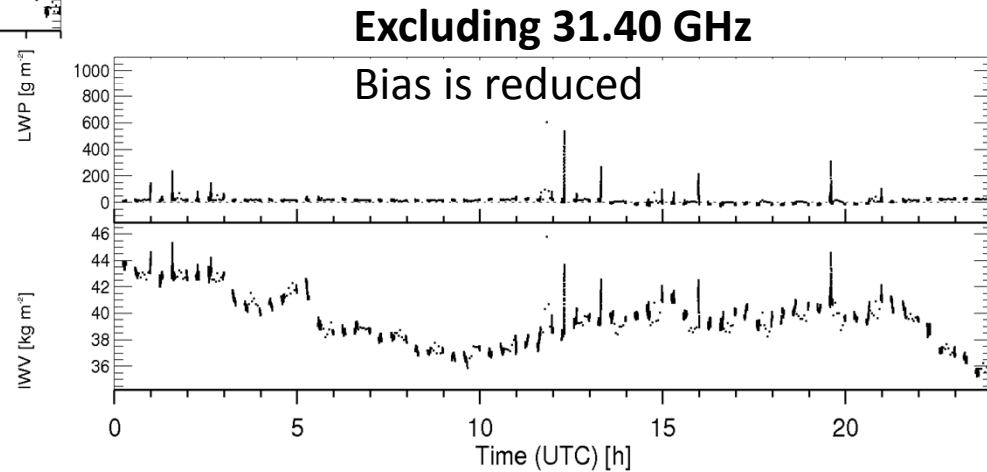
Rain events - blocked green



HATPRO bias



Using all the frequency in the K band
Bias in Liquid Water Path (max 200 g/m²)
Bias has diurnal cycle

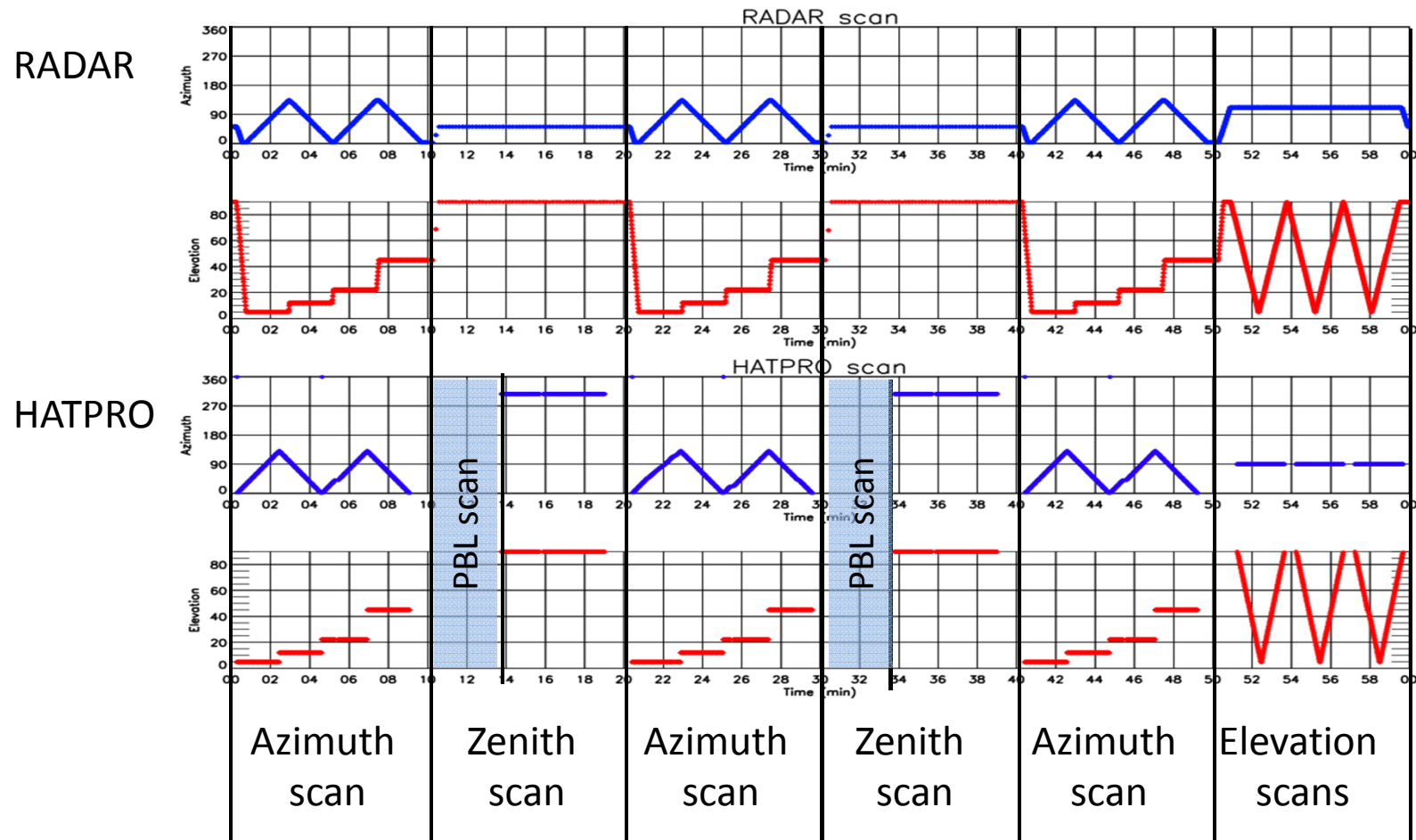


Clear sky liquid water path distribution
Before: systematic error $\sim -23\text{g/m}^2$
sharp pdf \rightarrow high accuracy
After: broad pdf \rightarrow larger uncertainty

What we are interested in



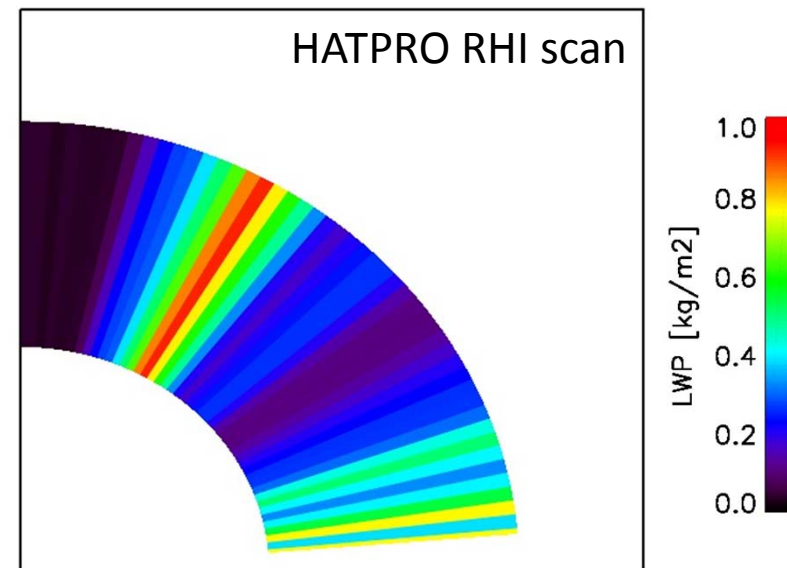
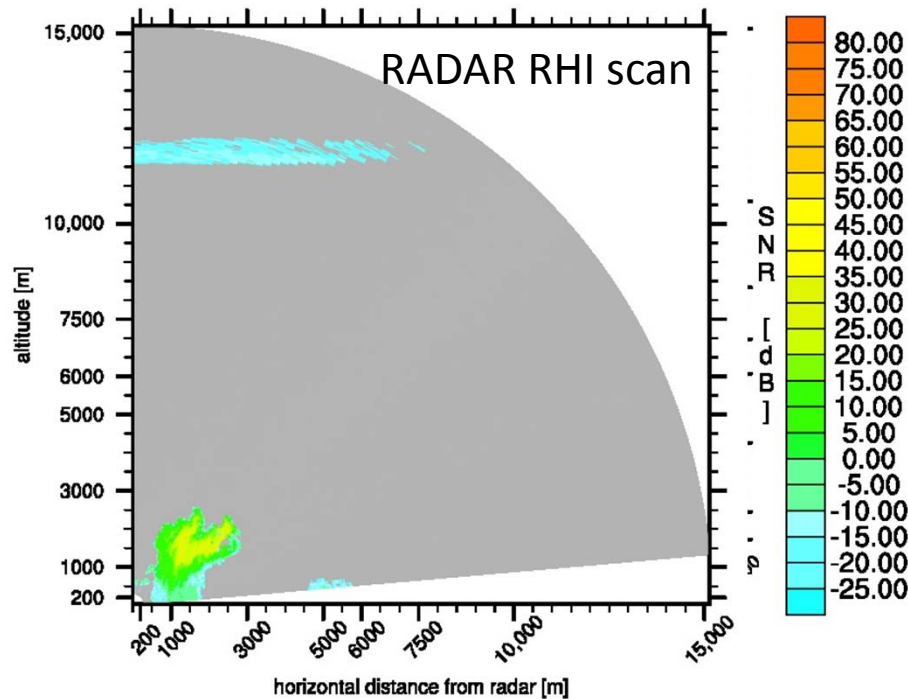
Coincident RHI (elevation) scans with the cloud RADAR



What we are interested in



- Exploit the synergy between active and passive microwave measurements to get profiles of liquid water content
- Develop and test inversion algorithms for cloudy cases
 - Same measurements are performed in Juelich
 - Same concept as HAMP (HALO 26 channels radiometer + cloud RADAR)
- **RHI scan**
 - 2D time evolution of the structure of the cloud on a fine (~ minutes) time scale



Summary



- Time series of path integrated water vapor and liquid water January-Today
Possibly Temp and Q boundary layer profiles
- Data quality can improve with rain gauge and ceilometer data
Comparison of path integrated humidity measurements with LIDAR data
- Our focus will be on RHI scan in parallel with RADAR

THANKS!

