Microwave radiometry and sensor synergy at the AMF during COPS

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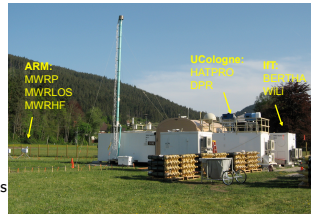
Setup and Motivation

During the ARM Mobile Facilities deployment in the Black forest, Germany, additional microwave radiometers and lidars were operated in the Murg Valley in order to

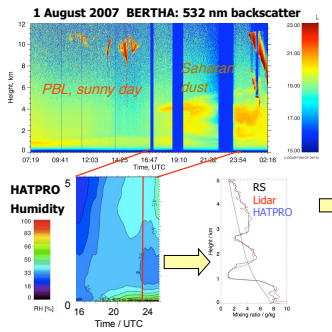
- intercompare microwave radiometers
- evaluate water vapour (WV) profiles and radiative transfer models
- gather aerosol characteristiscs
- analyse spatial inhomogeneity of WV & clouds
- investigate cloud-aerosol interactions
- improve sensor synergy methods



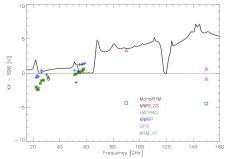
Lidar Systems
- Backscatter Extinction lidar-Ratio Temperature Humditiy profiling Apparatus (BERTHA)
- WiLi (2.2 μm Doppler Wind Lidar)

Microwave Radiometer
- MWRLOS (standard ARM 2-ch radiometer)
- MWRP (ARM 12-ch profiler)
- MWR-HF (ARM's new 90/150 GHz)
- HATPRO (UCologne scanning 14 ch profiler)
- DPR (Dual polarization 90/150 GHz)

Clear sky case: Challenges



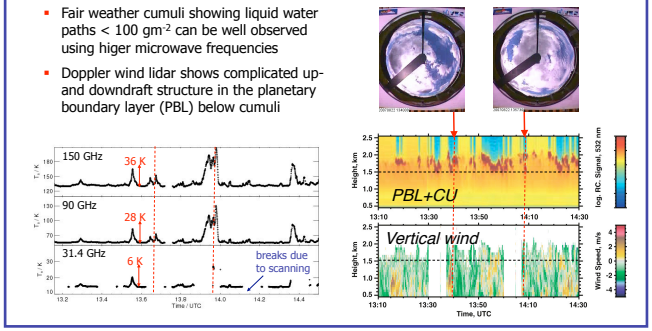
- Water vapour absorption at higher microwave frequencies is uncertain
- Vertical resolution of profiles from passive microwave observations is limited



Radiative transfer calculation for the radiosonde launch from 23:30 on 1 August 2007. Brightness temperature differences compared to the Rosenkranz gas absorption model are shown for the MonoRTM model (solid line) and the different microwave radiometers (symbols).

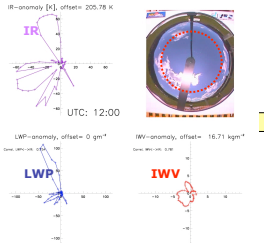
Boundary layer clouds: New approaches

- Fair weather cumuli showing liquid water paths < 100 gm^{-2} can be well observed using higer microwave frequencies
- Doppler wind lidar shows complicated up- and downdraft structure in the planetary boundary layer (PBL) below cumuli



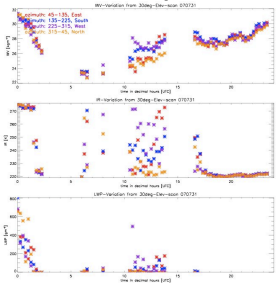
Scanning microwave radiometry

30 deg azimuth scans



30 deg azimuth scans were performed with HATPRO every 15 min to map liquid water path (LWP) and integrated water vapour (IWV) as well as infrared (8-11 μm) temperature (IR).

Diurnal development



Typical diurnal course of IWV (top), IR-temperature (middle) and LWP (bottom) for different sectors (North, East, South, West). Differences occur mainly during daytime when convective cumulus clouds are present.

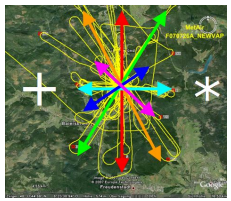
July/August statistics

	N	E	S	W
N		1.25	1.35	1.19
E	195		1.03	1.60
S	216	197		1.30
W	256	303	261	

Standard deviation of difference between sectors (North, East, South, West) in **IWV** (kg m^{-2}) and **LWP** (g m^{-2}). Largest variations occur between East and West, i.e. the sides of the south-north oriented valley.

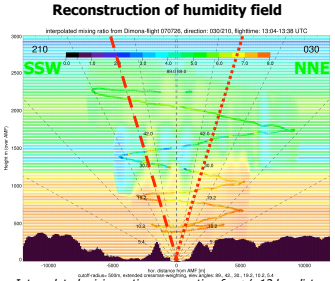
Evaluation using aircraft

On 26 July and 1 August 2007 the Metair Dimona aircraft performed in situ observations in order to map the humidity field in the vicinity of the AMF. The airplane was ascending or descending in six azimuth directions (colors) giving vertical sections of the fields.

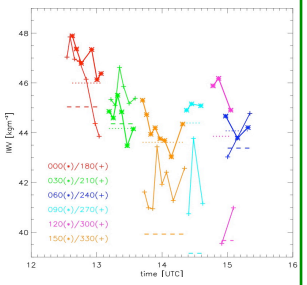


Flight tracks on 26 July 2007 performed between 12 and 15 UTC.

Reconstruction of humidity field

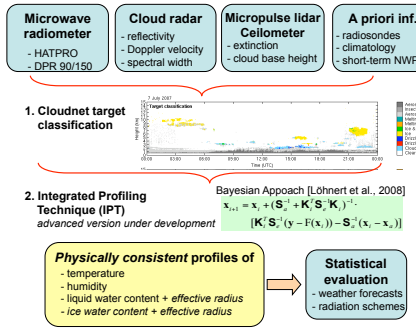


Interpolated mixing ratio cross-section for +/- 12 km distance from AMF. Dotted lines show elevation angles of HATPRO.

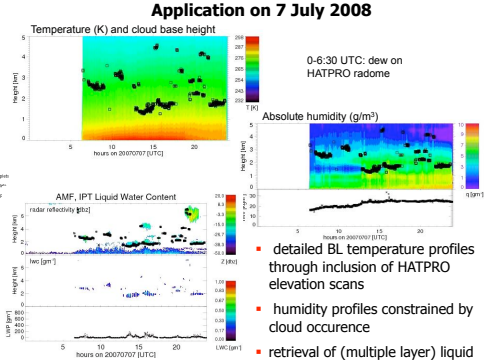


- IWV measured with HATPRO shows similar dependence on azimuth direction as IWV calculated from interpolated humidity fields (horizontal lines).
- Differences in IWV could originate from uncertainties in the interpolated field.

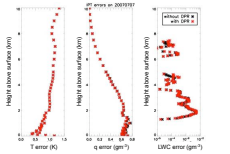
Integrated Profiling Technique



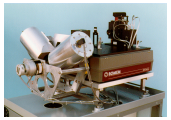
Application on 7 July 2008



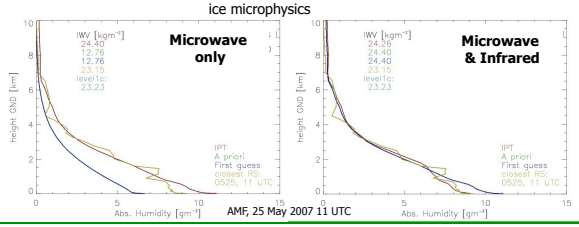
- detailed BL temperature profiles through inclusion of HATPRO elevation scans
- humidity profiles constrained by cloud occurence
- retrieval of (multiple layer) liquid clouds, also in drizzling cases



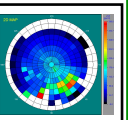
Combining Microwave and Infrared Radiometry



Integration of the Atmospheric Emitted Radiance Interferometer (AERI) to:
- develop a powerful, complementary retrieval tool (AERI+MW +cloud radar)
- improve accuracy & vertical resolution for temperature and humidity profile retrieval in clear-sky cases (and below cloud)
- allow accurate retrieval of cloud properties over a wider range of LWP (from very low to precipitating), inclusion of ice microphysics



Outlook



- Statistical analysis of 4 months of continuous volume scans with HATPRO
- Evaluation of microwave gas absorption model through comparison of radiometer obs. with lidar observations from ground&aircraft
- Application of IPT to the full AMF deployment period and subsequent model intercomparisons

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