Spatial and temporal distribution of integrated water vapor and liquid water path in the Murg valley observed by a scanning microwave radiometer

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Measurement set-up

- The 14-channel Microwave Radiometer **HATPRO** (Humidity And Temperature PROfiler) was deployed at the supersite M in the Murg valley from April to December 2007.
- Integrated Water Vapor **IWV**, Liquid Water Path **LWP** and vertical profiles of humidity and temperature were derived from the microwave emission observed at 14 channels (22-58 GHz).

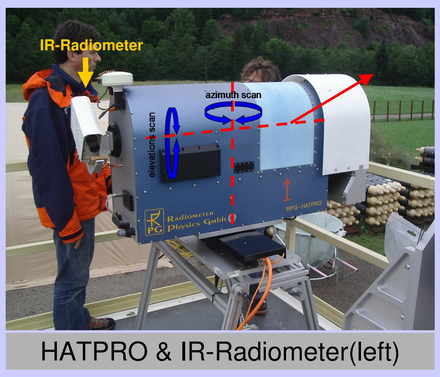
Supersite M in the Murg valley

- An **infrared (IR)-Radiometer** (8-12 μ m) was attached to HATPRO. Due to its high sensitivity to water and ice clouds it provides information on cloud base temperature. Slight corrections are necessary in case of significant water vapor emission below the cloud. In clear sky cases independent information about the spatial water vapor distribution is provided.
- Because approx. 90% of the IWV is located in the lowest 5 km of the atmosphere, the azimuth scans with 30° elevation show the variation of humidity within a horizontal distance of about 9 km from the radiometer.

Objectives and scan strategy

We developed a method to clearly identify the spatial and temporal distribution of clouds and integrated water vapor **IWV** within the Murg valley.

Furthermore, the spatial distribution of integrated water vapor and clouds was statistically analysed.

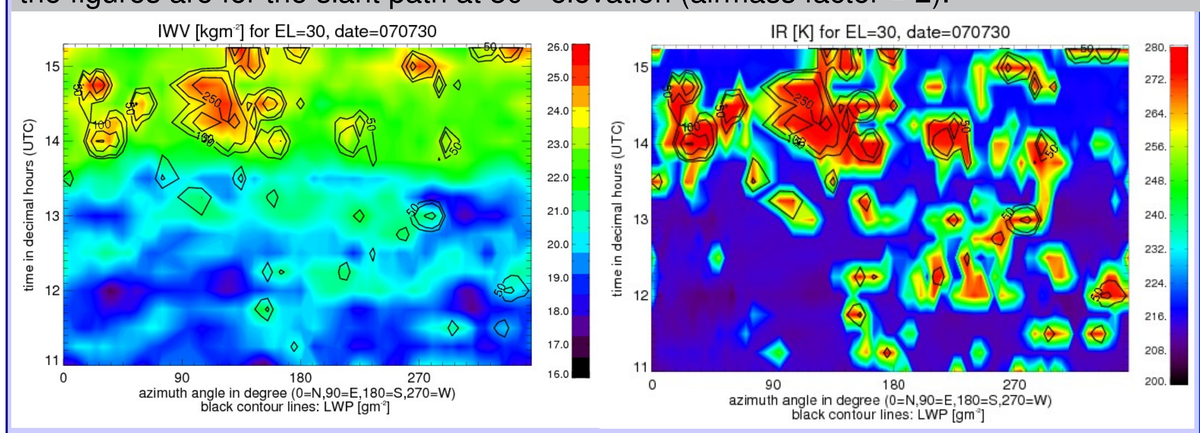


HATPRO & IR-Radiometer(left)

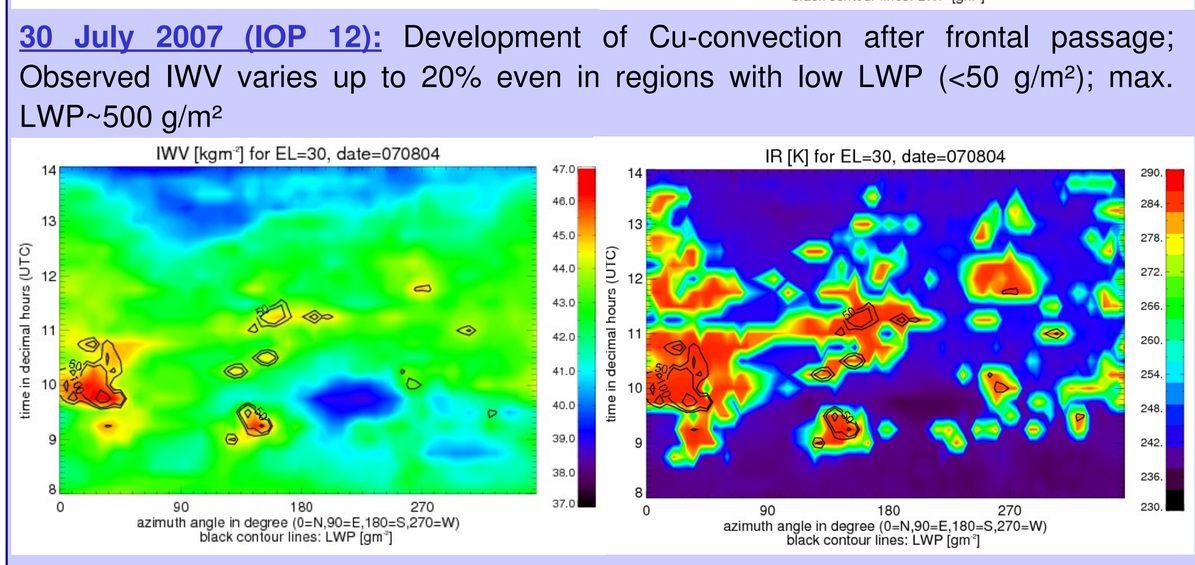
- In order to investigate spatial inhomogeneities HATPRO performed regular **elevation and azimuth scans**.
- From **July 6 until August 28** azimuth scans of IWV, LWP and IR-temperature with 5° resolution in azimuth at fixed 30° elevation were carried out approx. every 15 minutes.
- Every azimuth scan (duration ~4.5 min.) was followed by an elevation scan (~ 2 min.); in the remaining time zenith observations were performed with a temporal resolution of one second.
- Comparisons with aircraft measurements showed similar spatial and temporal variabilities in the water vapor field. (Kneifel et. al. 2008)

Spatial and temporal evolution

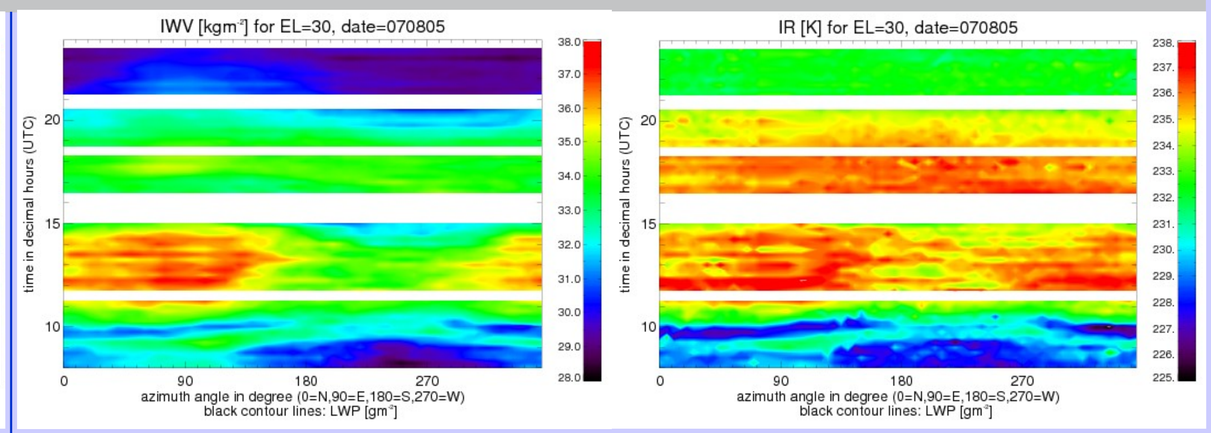
The spatial and temporal evolution of IWV, sky-temperature (IR) and LWP are visualized with Time-Azimuth-(Hovmöller) Diagrams. Please note that the values for IWV/LWP in the figures are for the slant path at 30° elevation (airmass factor = 2).



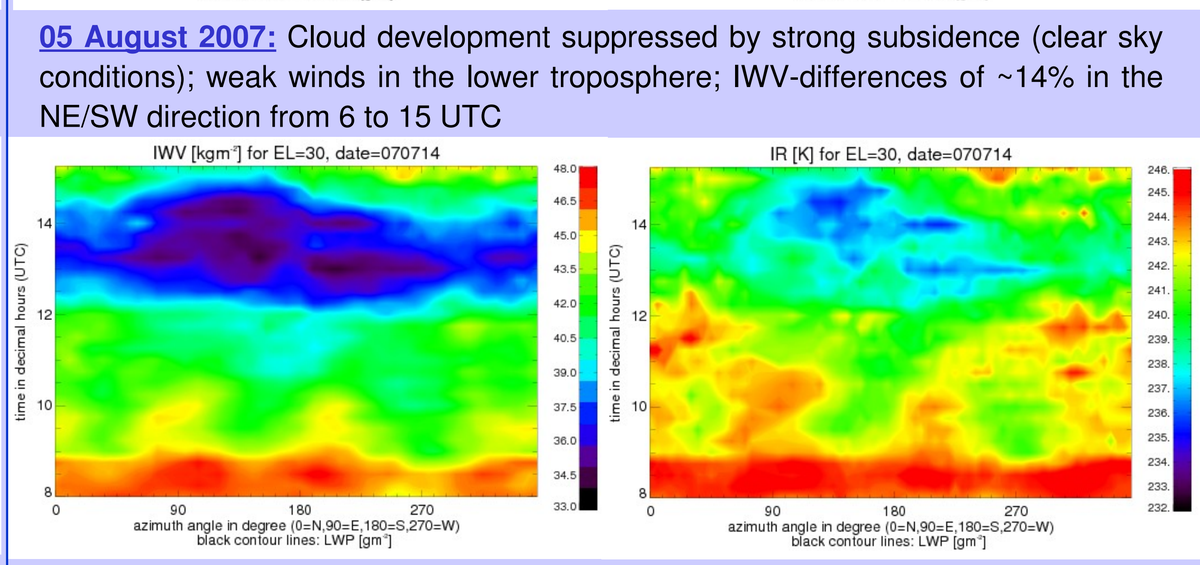
30 July 2007 (IOP 12): Development of Cu-convection after frontal passage; Observed IWV varies up to 20% even in regions with low LWP (<50 g/m²); max. LWP~500 g/m²



04 August 2007: High pressure conditions with warm air advection; very weak winds in the lower troposphere; Cu-convection mainly concentrated in NE, SE and W.

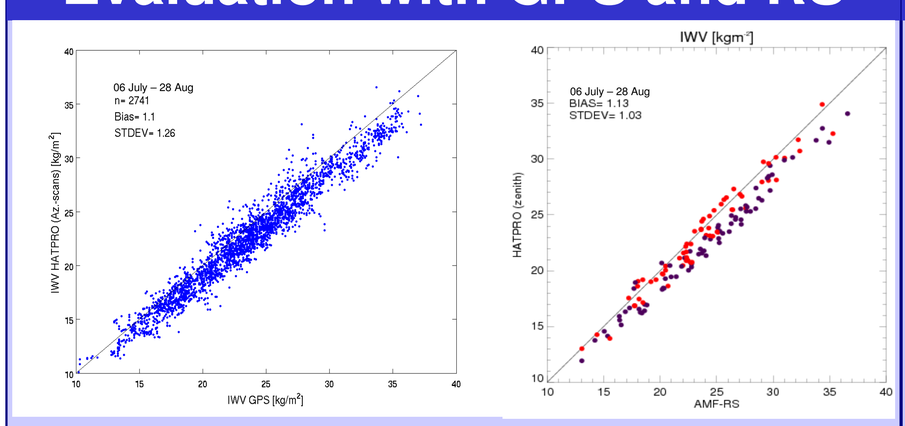


05 August 2007: Cloud development suppressed by strong subsidence (clear sky conditions); weak winds in the lower troposphere; IWV-differences of ~14% in the NE/SW direction from 6 to 15 UTC



14 July 2007 (IOP 8a): Clear sky conditions (strong subsidence); Spatial and temporal structures appear in the measurements of IWV and IR-temperature.

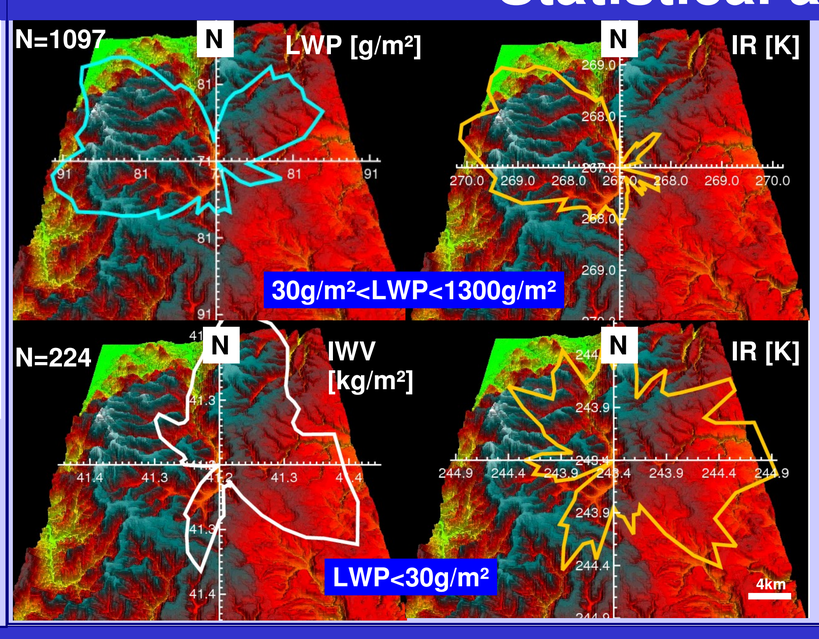
Evaluation with GPS and RS



Left: Spatially averaged IWV from azimuth scans compared with GPS-Station at supersite M (operated by GFZ-Potsdam).

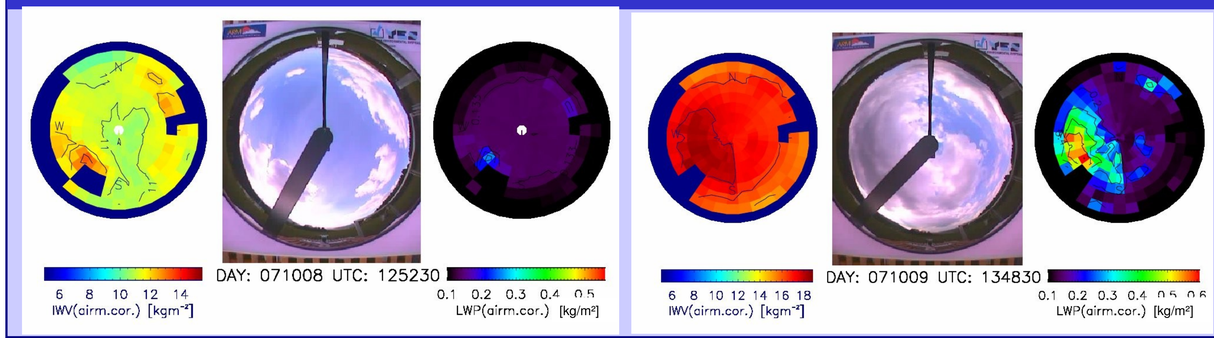
Right: 5min-averaged IWV zenith measurements compared with AMF-RS (red: daytime, blue: nighttime)

Statistical analysis



- Polar diagrams (origin at the location of supersite M) of the temporally averaged azimuth scans from the whole 2-month period.
- The underlayed orography shows the northern black forest with the Murg valley.
- The scans were separated into cloudy (upper) and cloudfree (lower) events.
- LWP shows (similar to IR-temperature) a spatial signal (max.diff~30 g/m²) in the W and NE which seems to be influenced by the surrounding orography.
- In both selections the spatial IWV-variation is very weak (<0.5 kg/m²).

Outlook and Acknowledgements



From **October 4 to the end of December 2007** HATPRO performed **full hemispheric scans of IWV and LWP** with 10° resolution in azimuth and 10.8° in elevation (scan duration ~10 min.). These data will be used to extend our analysis to the full hemisphere.

We thank the DFG for funding the project and the ARM/AMF for the possibility to install the instruments at the supersite.

Related publication:

Kneifel, S., S. Crewell, U. Löhnert and J. Schween, "Investigating water vapor variability by ground-based microwave radiometry: evaluation using airborne observation." IEEE Geosc. and Remote Sens. Letters, 2008, in press.