

Overview of the COPS Aerosol and Cloud Microphysics (ACM) Subgroup Activities

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COPS Breakout Session
2008 ARM Science Team Meeting
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COPS Working Groups

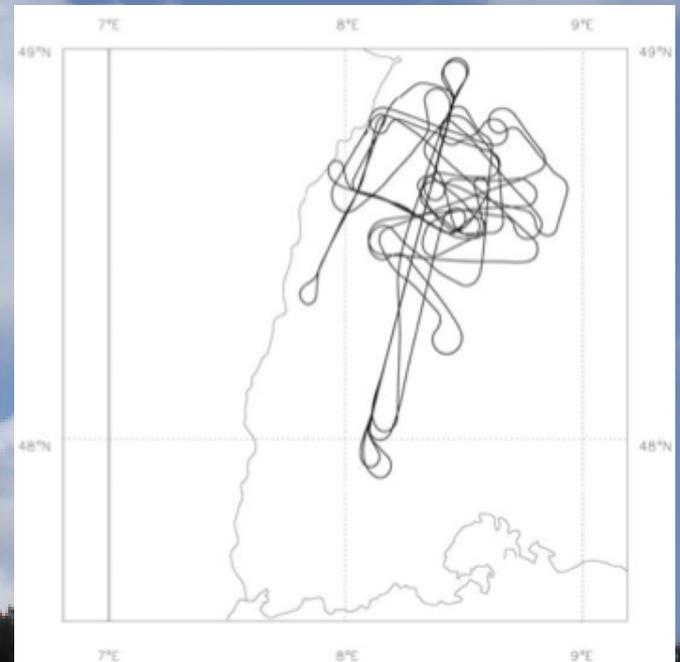
- Convective Initiation (CI)
 - Chairs: Cyrille Flamant, Ulrich Corsmeier, Tammy Weckwerth
- Precipitation Processes and Life Cycle (PPL)
 - Chairs: Martin Hagen, Reinhold Steinacker
- Data Assimilation and Predictability (DAP)
 - Evelyne Richard, Hans-Stefan Bauer
- Aerosol and Cloud Microphysics (ACM)
 - Chairs: Susanne Crewell, Dave Turner, Stephen Mobbs

ACM Scientific Questions

- What are the microphysical properties of orographically induced clouds and how do these depend on dynamics, thermodynamics, and aerosol microphysics?
- What is the role of aerosols and changing cloud microphysics on the initiation of convection?
- How does cloud turbulence promote condensation, coalescence and aggregation (thus precipitation)?
- Is there a correlation between (measurable) aerosol properties and ice formation?

BAe-146

- PIs: Alan Blyth and Stephen Mobbs, Univ. of Leeds
- Primarily tasked with in-situ observations of aerosol and cloud properties



BAe-146 Measurements

- Cloud particles: FFSSP, 2DC, 2DP, SID1/2, CIP100
- Aerosols: Aerosol mass spec., CVI, VACC, PCASP, CPC 2025A, 3010A (CVI), Nephelometer, PSAP
- Bulk-cloud: Liquid and total water content probe, JW LWC, in-cloud temp (wet for $T > 0$)
- Air motion: 5-port turbulence probe
- Thermodynamics: Rosemount temperature, GE Hygrometer
- Chemistry: CO, NO_x, Ozone
- Other: Heinmann downward facing radiometer

BAe-146 Flights

IOP	Date	BAe?	Summary
-	11 July	Yes	Ice initiation, but capped convection
8b	15 July	Yes	Isolated Cb over mts
SOP1	16 July	Yes	Too dry aloft
9a	18 July	Yes	Frontal zone; no precip during day; not quite
9b	19 July	Yes	MCS 6-12 Z; Strong cb in SE Germany; nothing in COPS
SOP4	24 July	Yes	Suppressed clouds; aerosols
11a	25 July	Yes	Dry. CBL evolution
11b	26 July	Yes	No cloud; very dry; aerosols
16	15 Aug	Yes	Weak frontal convection
SOP7	17 Aug	Yes	Good clouds studied
17b	22 Aug	Yes	Suppressed convection
18a	24 Aug	Yes	Good isolated convection; good ascent
SOP8	29 Aug	Yes	No convection; kite pattern

Lidars from Institute for Trospheric Profiling (IfT)

- IfT deployed two lidars at the AMF for Jun-Aug 2007
 - Multi-wavelength aerosol and water vapor lidar (BERTHA)
 - Doppler wind lidar
 - Mainly in vertical-pointing mode
- Operated primarily in the daytime, with some nighttime observations
- PIs: Albert Ansmann, Dietrich Althausen

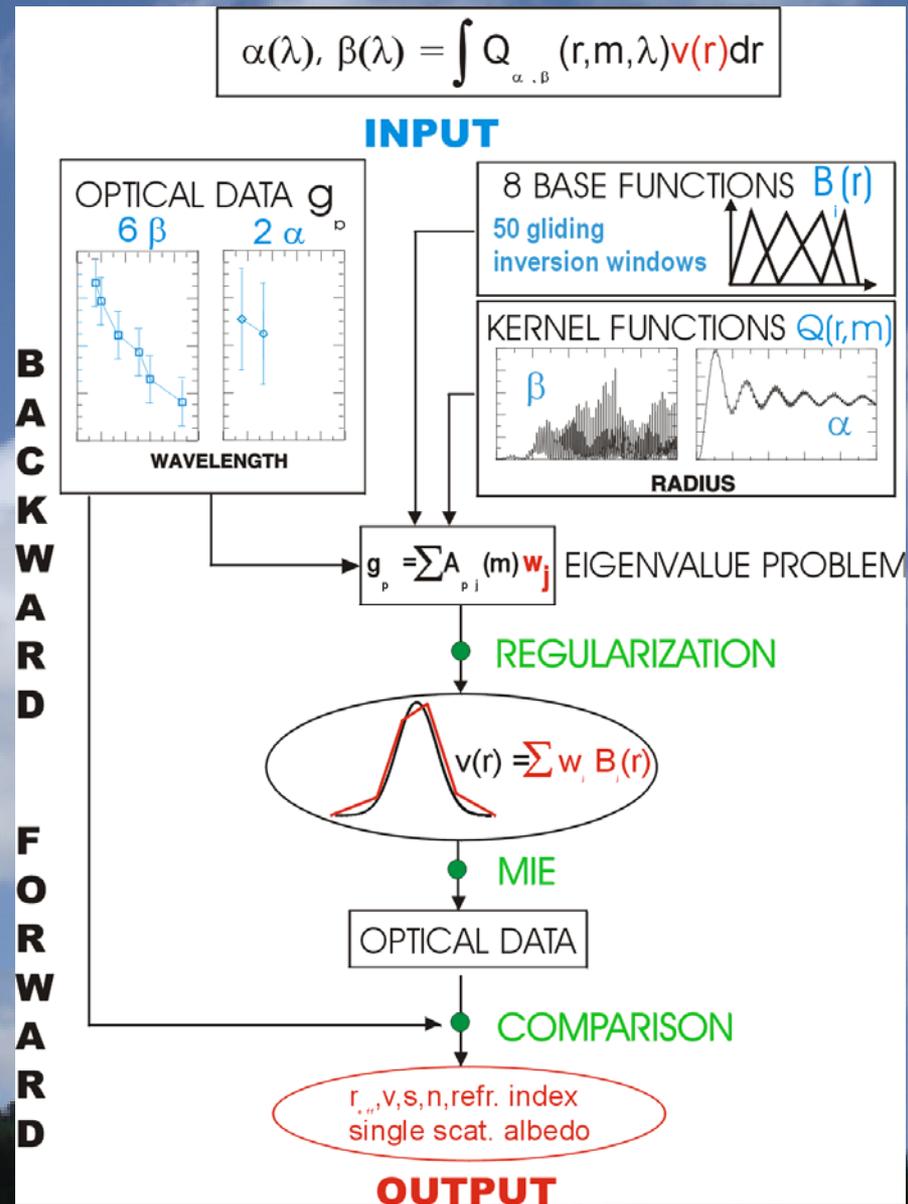
BERTHA Inversion Algorithm

Input:

- 6 backscatter coefficients
- 2 extinction coefficients

Output:

- volume size distribution
- effective radius
- total volume concentration
- total surface-area concentration
- mean complex refractive index
- single-scattering albedo



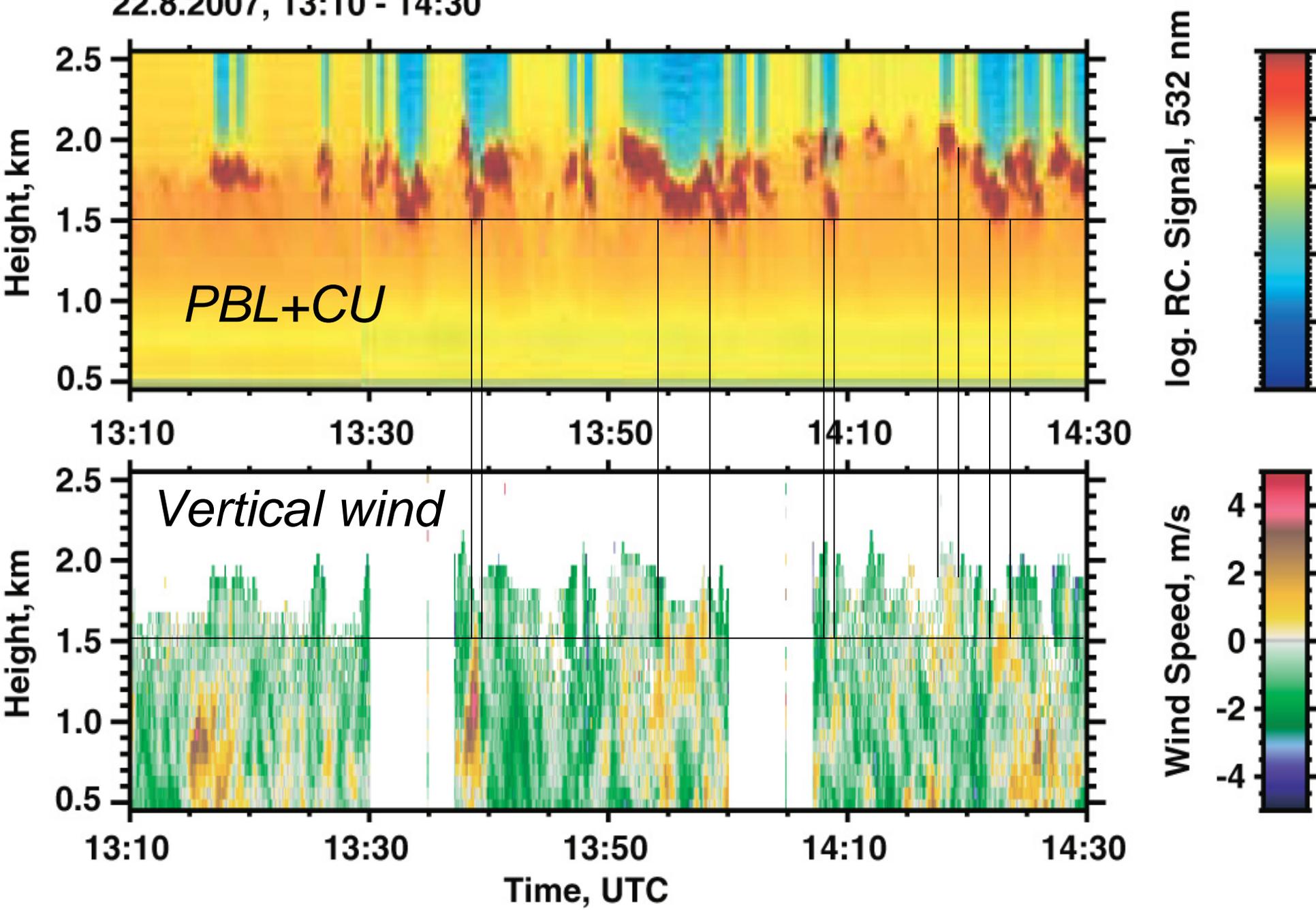
Aerosol Type: Finger Prints

Aerosol type	Lidar ratio (sr)	Depol. ratio (%)
Maritime	$S_{355} = S_{532}$ (low)	<5% (low)
Urban	$S_{355} \geq S_{532}$ (high)	<5% (low)
Forest fire smoke	$S_{355} < S_{532}$ (high)	<10-15% (med)
Desert Dust	$S_{355} \geq S_{532}$ (high)	25-35% (high)

355 nm versus 532 nm

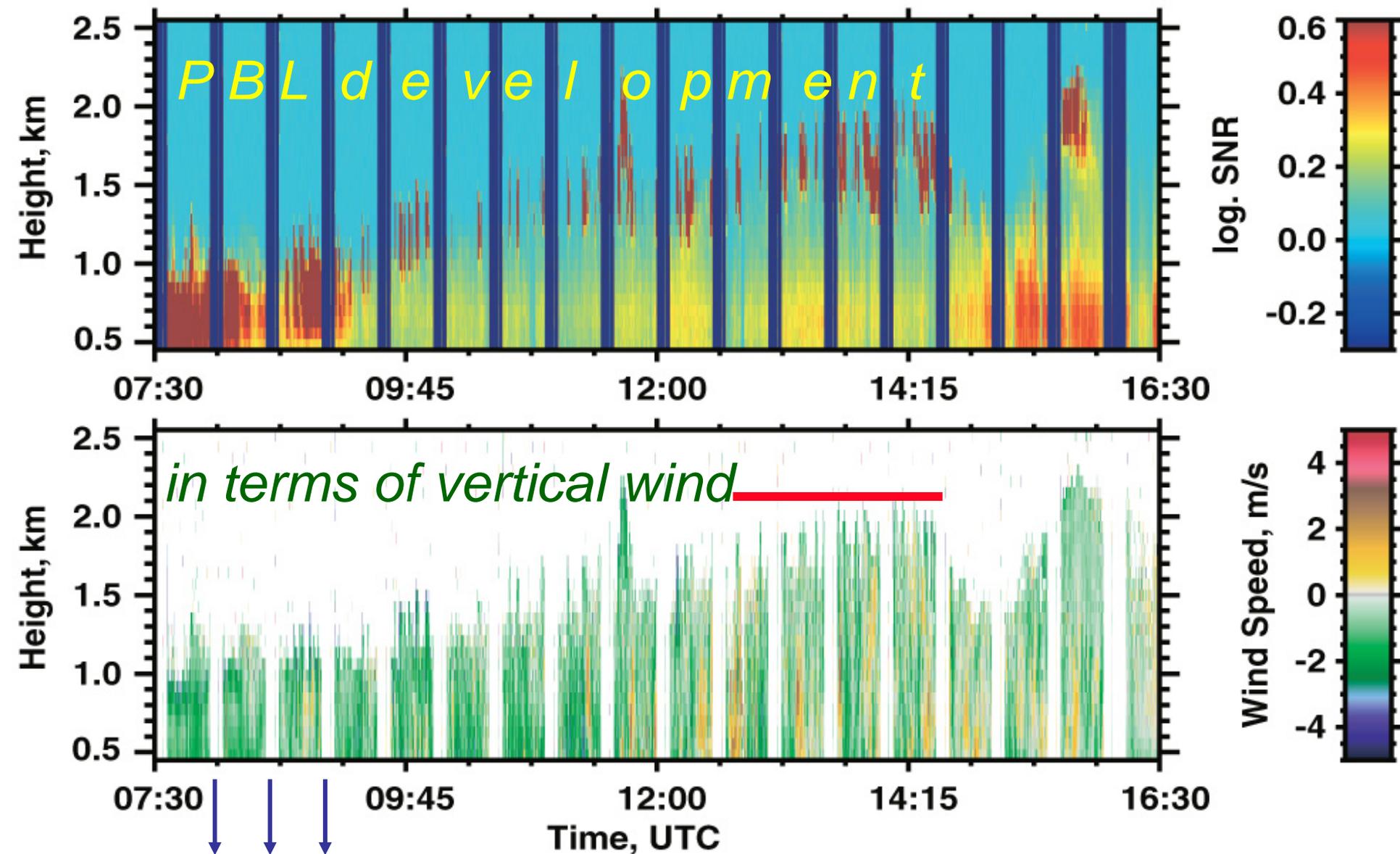
Range Corrected Signal, 532 nm and Vertical Wind Speed

22.8.2007, 13:10 - 14:30



Signal Strength and Wind Speed

22.8.2007, 7:30 - 16:30, Res.: 75 m, 5 s

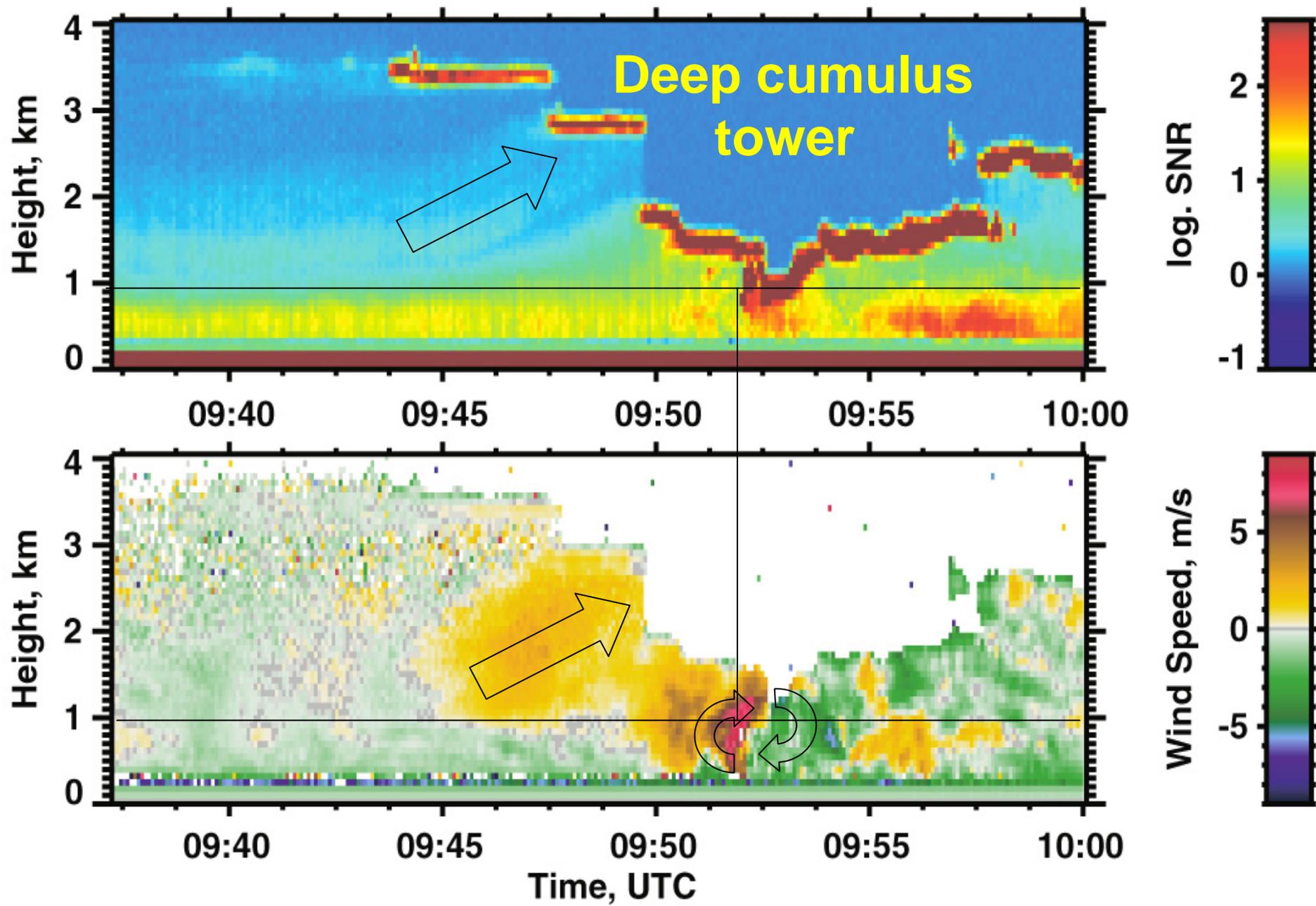


profile of horiz. wind speed and direction

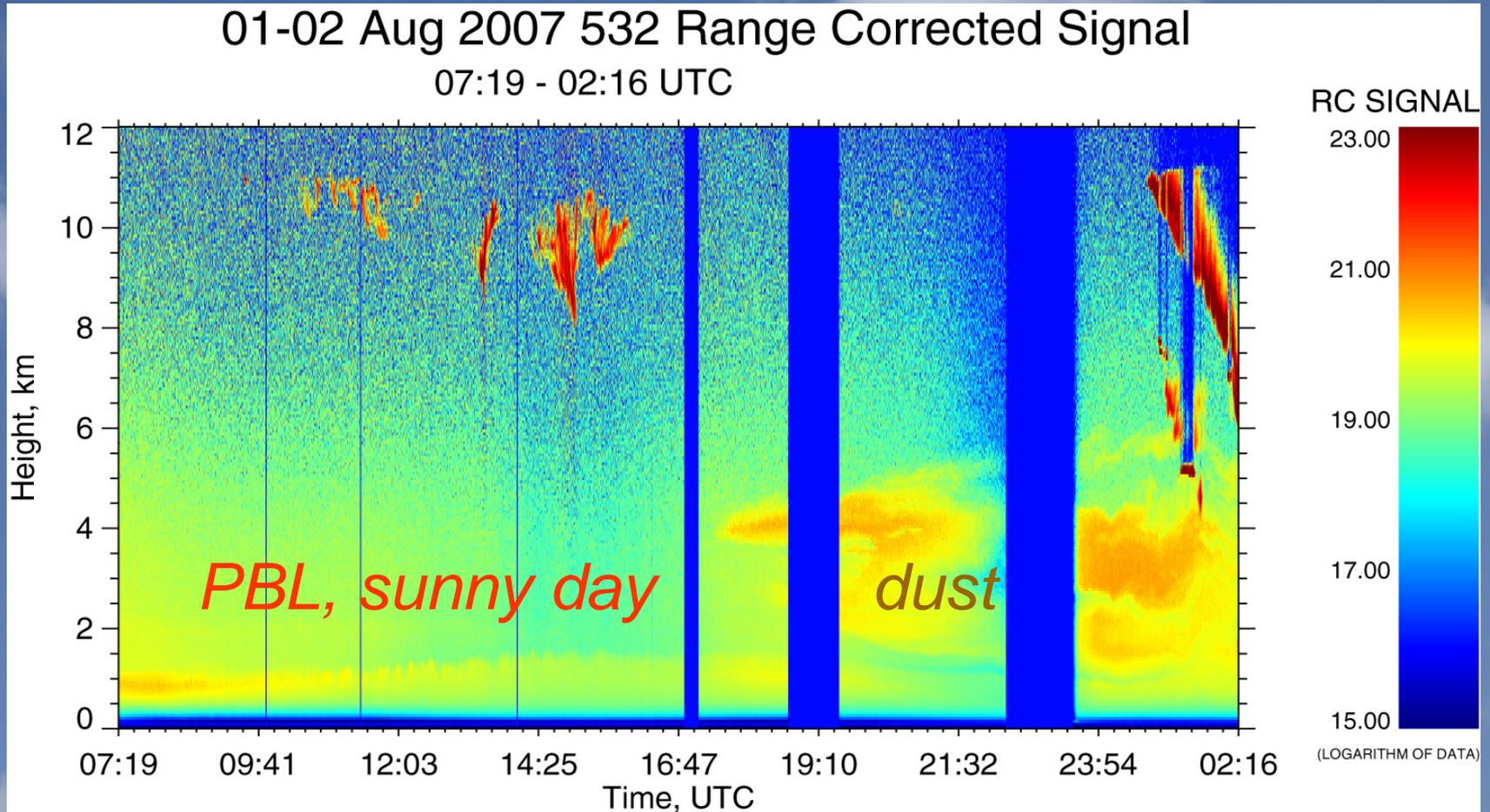
Signal Strength and Wind Speed

20.7.2007, 9:37 - 10:00, Res.: 75 m, 5 s

Spectacular event



BERTHA, Heselbach, 532nm backscatter signal



Integrated Profiling Technique (IPT)

Integration = physically consistent combination
of all employed measurement information

Need knowledge on:

- inversion methods
- instrument characteristics (theory, error)
- forward model, i.e. radiative transfer
- Background information



DPR 90/150

HATPRO



Cloud radar



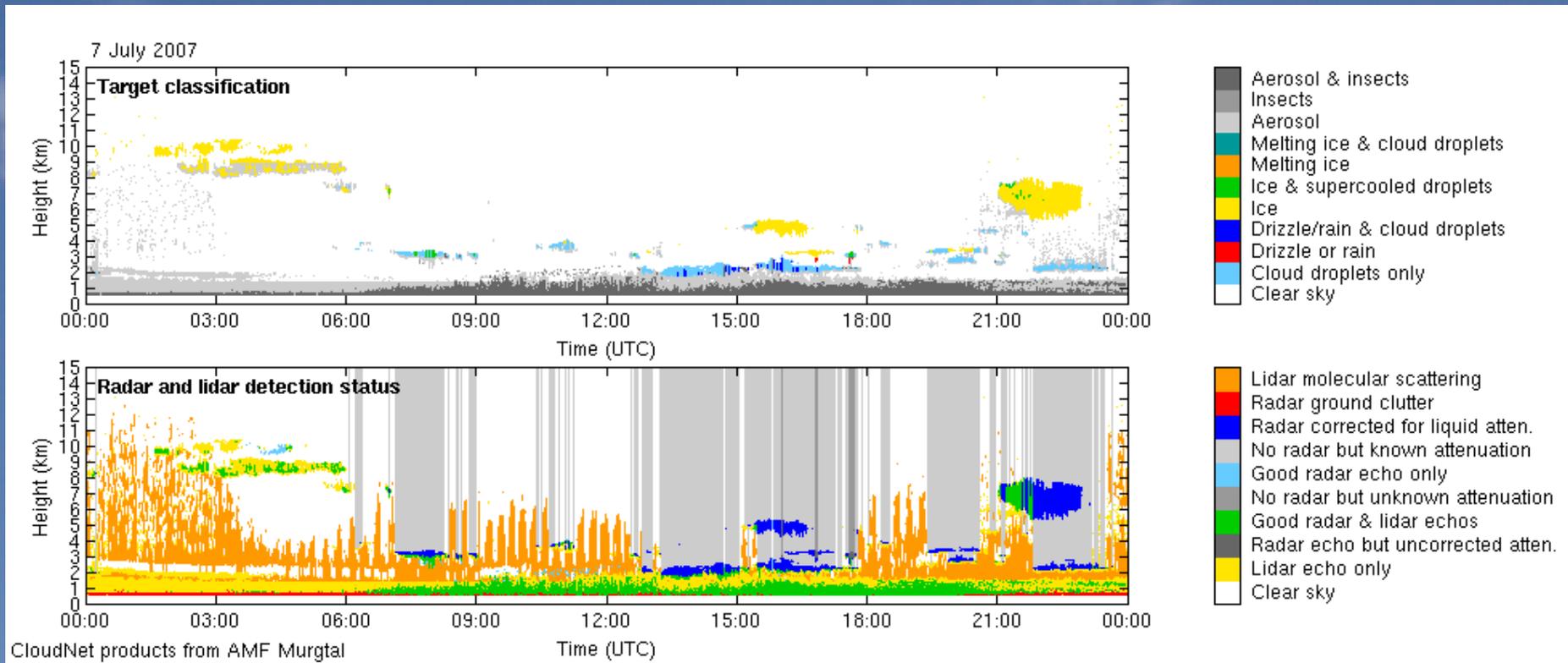
Radiosondes



AERI

IPT Example: 7 July 2007

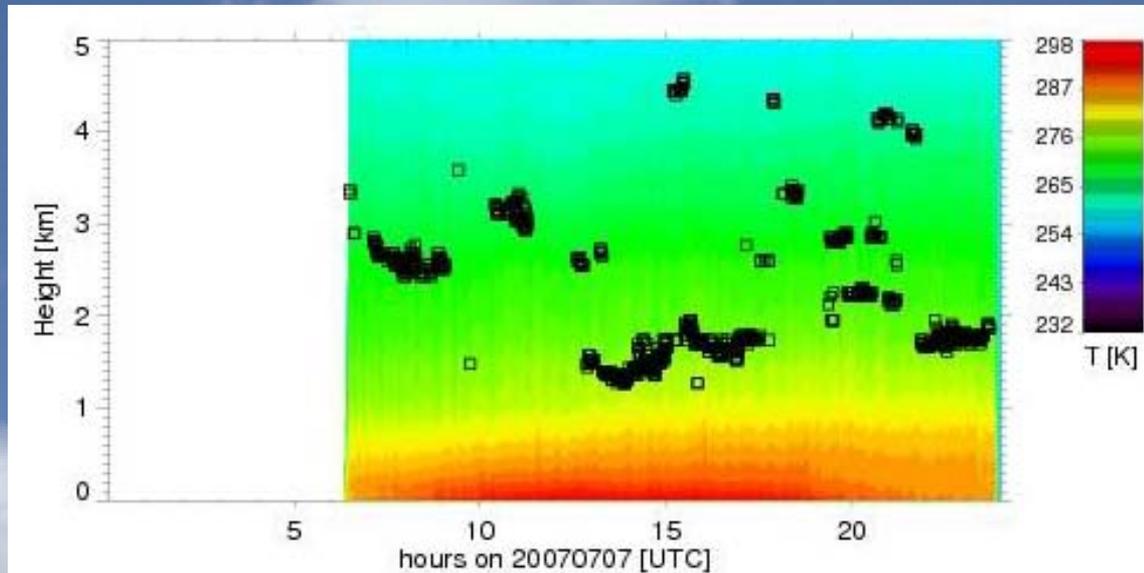
- CloudNet Target Classification (via Ewan O'Connor)



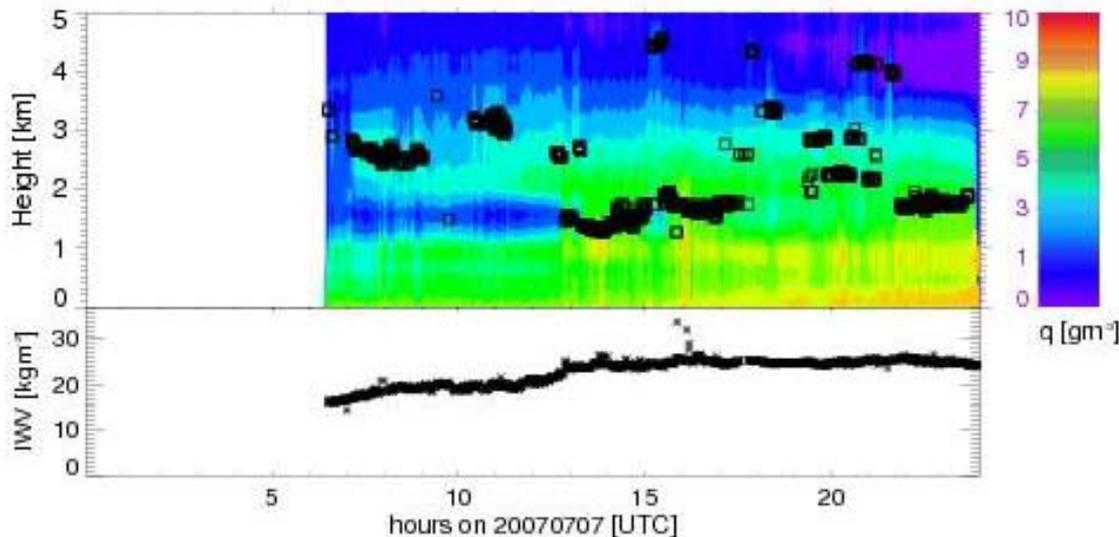
IPT Example: 7 July 2007

- Retrieves profiles of T & q
- Profiles in clear and cloudy scenes

temperature (K)



absolute humidity (g/m^3)



00:00-6:50 UTC
dew on radome

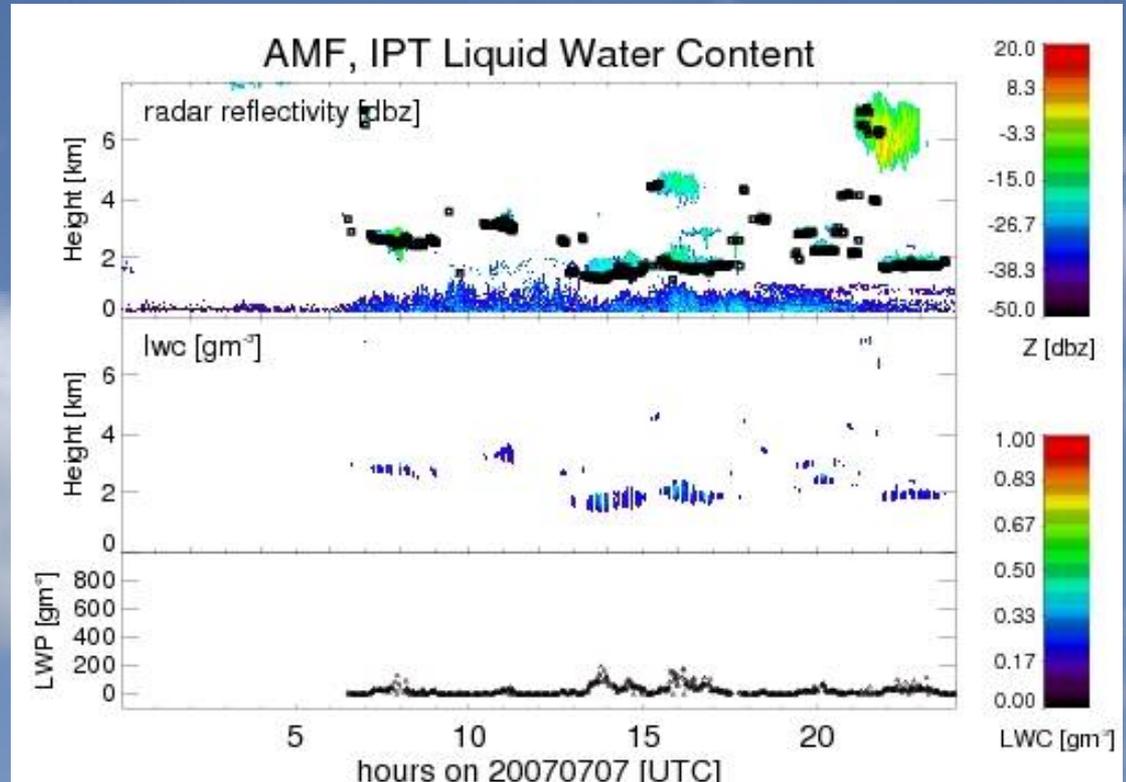
IPT Example: 7 July 2007

- retrieved profiles: liquid water content

radar reflectivity (dBZ)

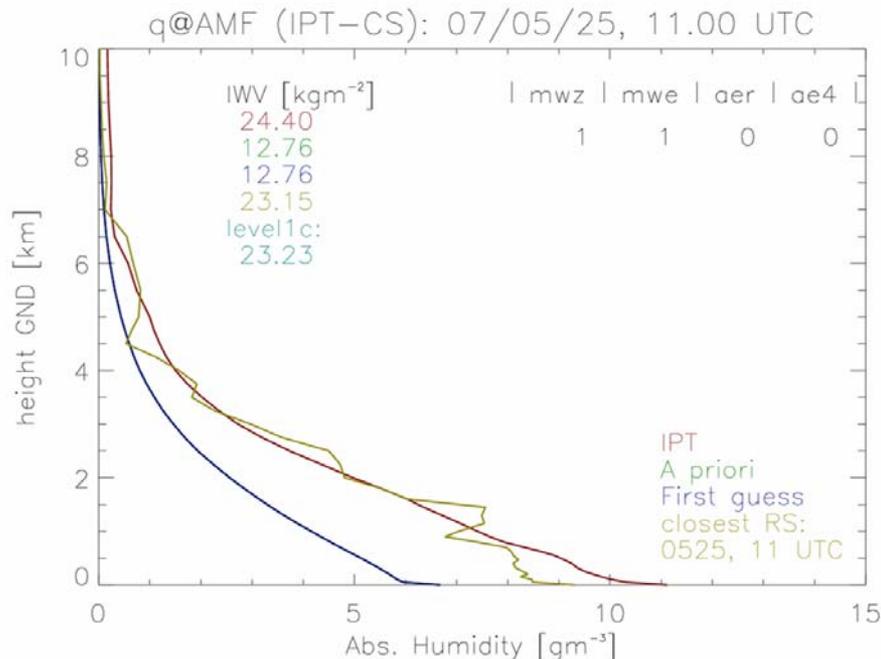
liquid water content (g/m^3)

liquid water path (g/m^2)

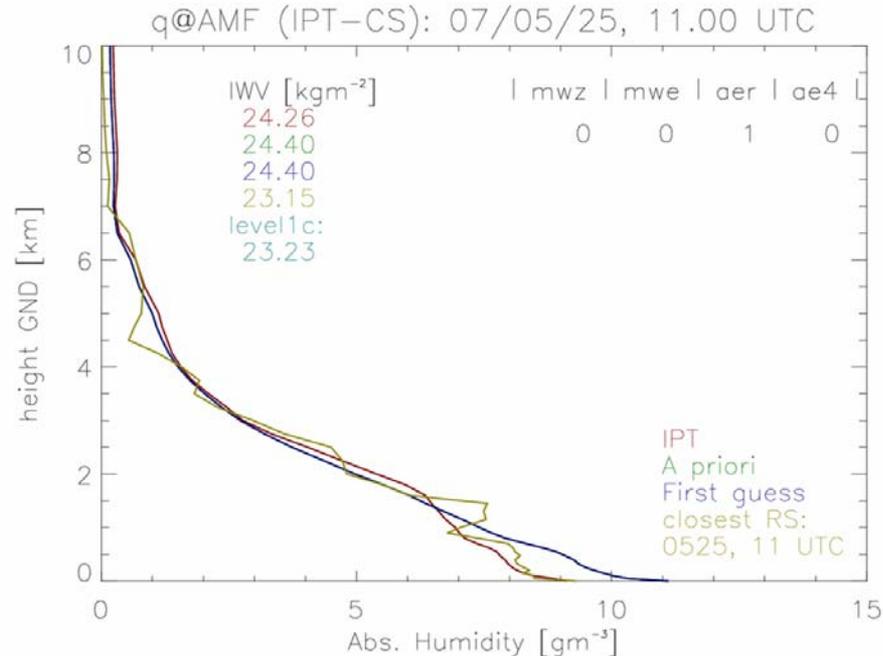


Impact of AERI Radiance in IPT Retrieval

Original Retrieved Humidity Profile

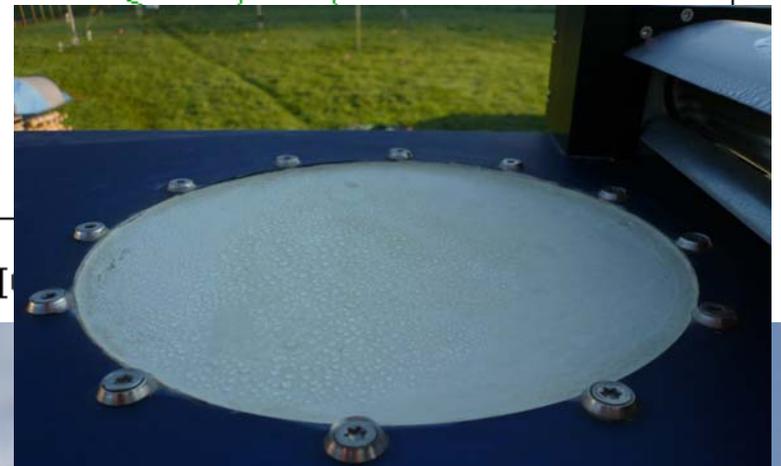
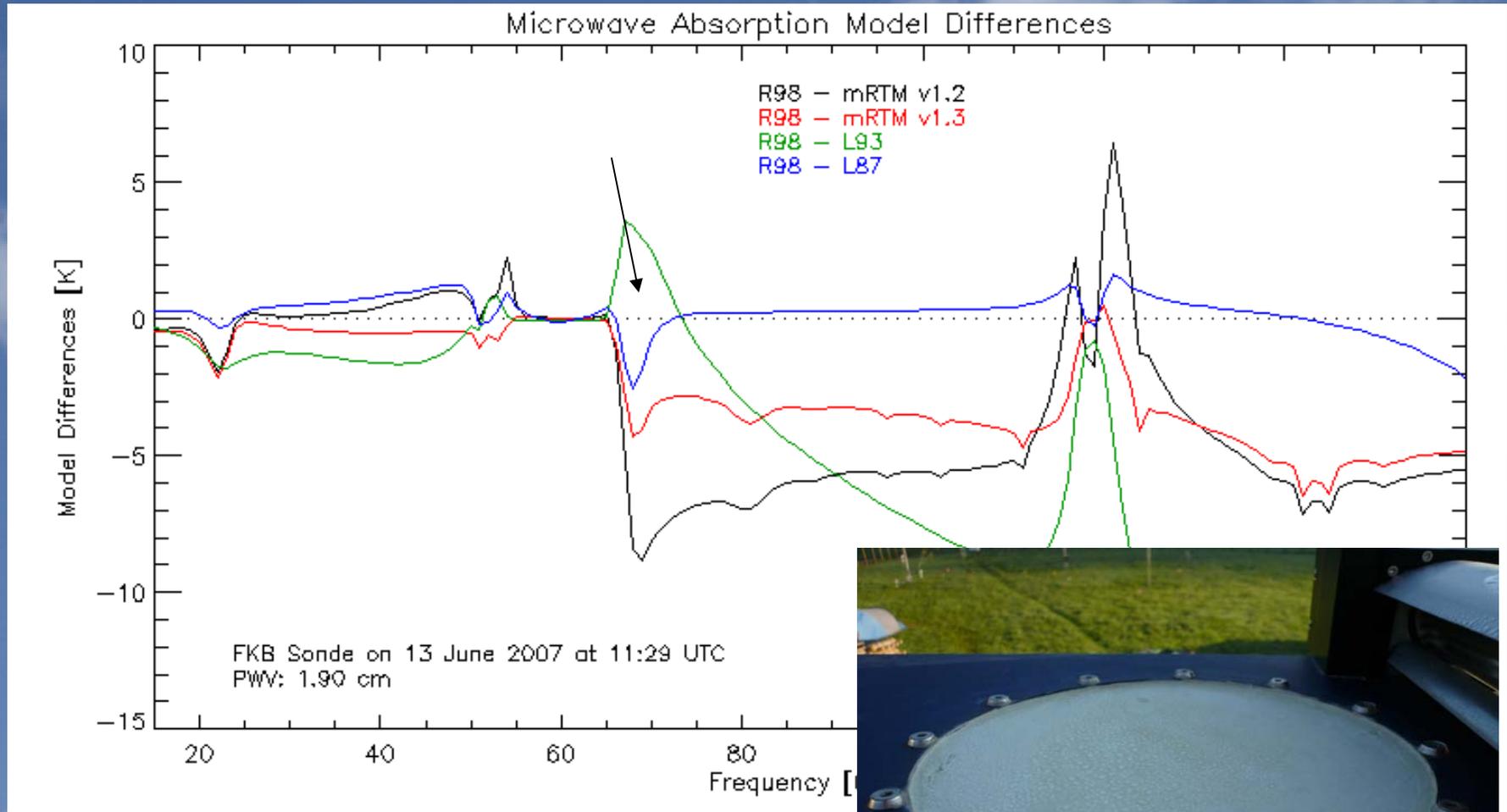


Improved Retrieved Humidity Profile



- Improved resolution/accuracy in T/q profiles
- Improved sensitivity to CLOWD clouds
- Sensitivity to ice cloud properties

Radiative Closure at Millimeter Wavelengths

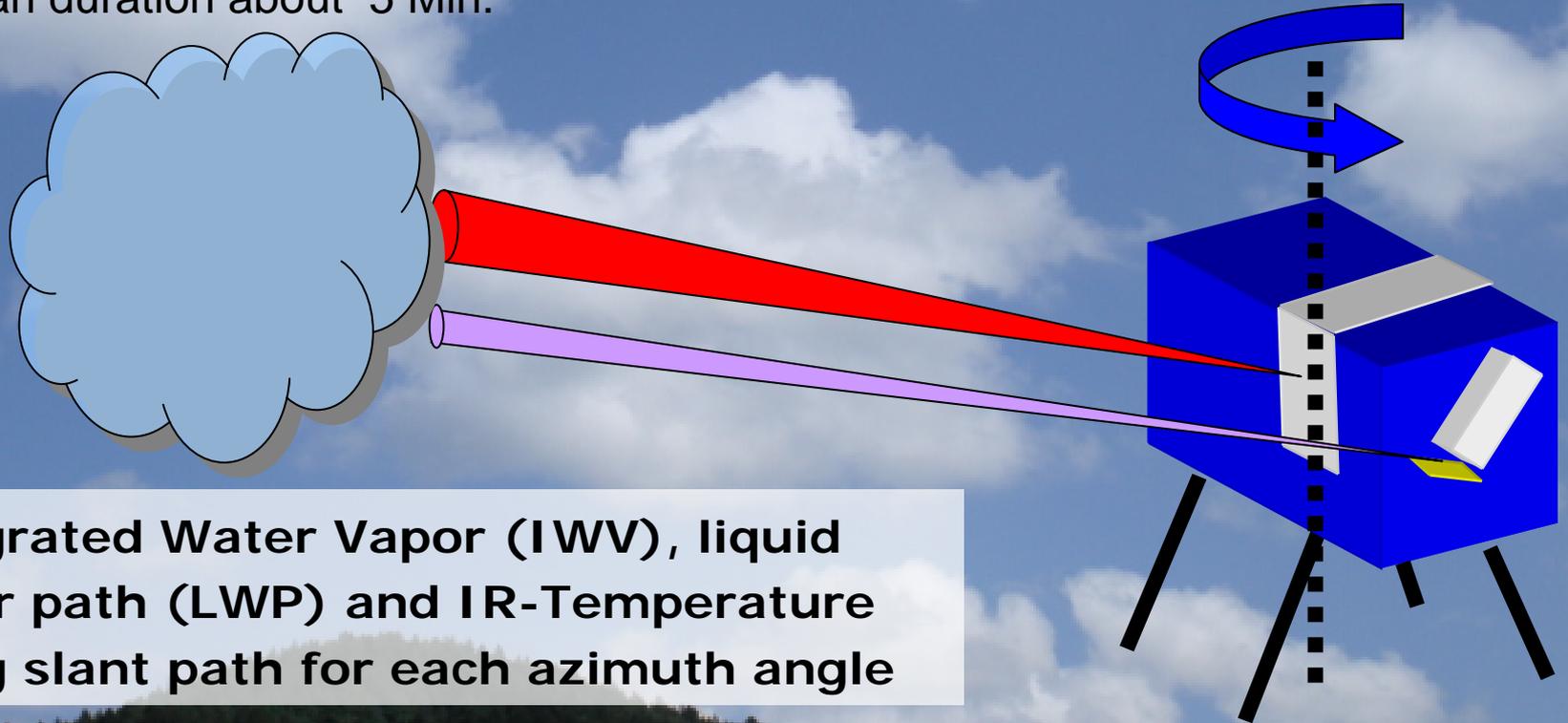


Water on Radome

Scanning Microwave Observations

COPS: Azimuth scans every 15 min with U. Cologne HATPRO

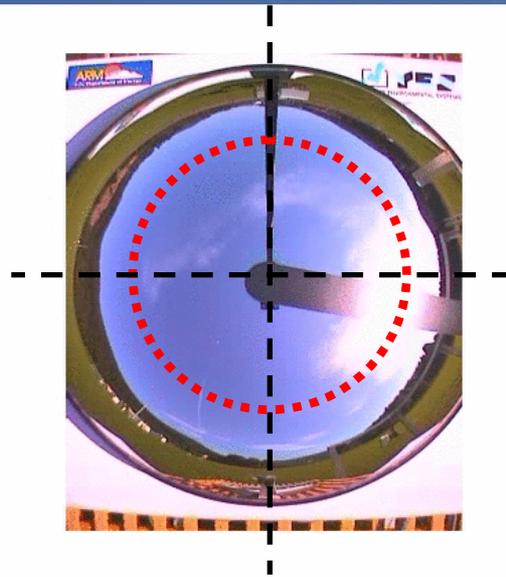
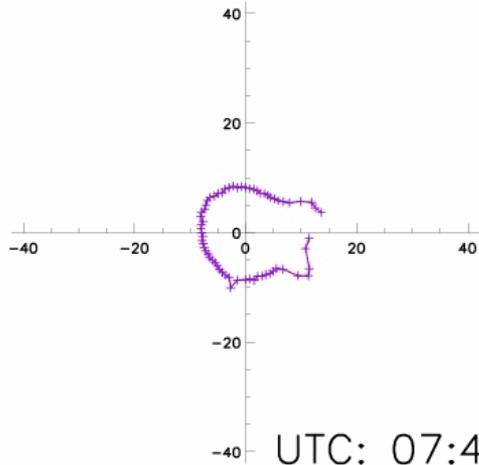
- fixed elevation angle (30°)
- 355° - rotation with 5° resolution
- beamwidth: HATPRO: $\sim 4\text{-}2^\circ$, IR: $\sim 1^\circ$
- scan duration about 5 Min.



Integrated Water Vapor (IWV), liquid water path (LWP) and IR-Temperature along slant path for each azimuth angle

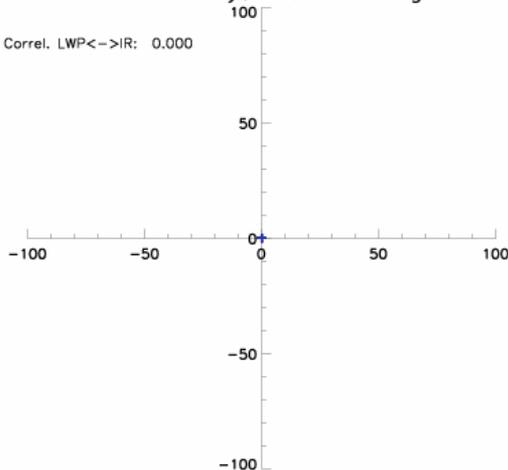
Azimuth Scans Example: 14 July 2007

IR-anomaly [K], offset= 235.31 K



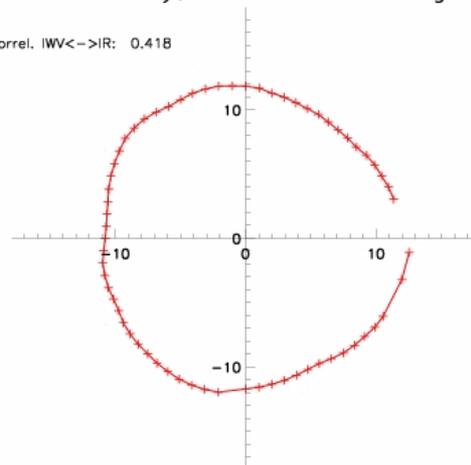
LWP-anomaly, offset= 0 gm^{-2}

Correl. LWP<->IR: 0.000



IWV-anomaly, offset= 33.60 kgm^{-2}

Correl. IWV<->IR: 0.418



30 deg azimuth scans

- **Morning**
strong asymmetry of the humidity field
- **Noon**
strong humidity reduction of about 5 kgm^{-2} (in zenith)
- **13:00-14:30 UTC**
Convection in the North West
- **after 15:00**
humidity increase



**ARM Mobile
Facility**

Photo: Jan Schween

COPS Data Access

- COPS archive manager: Claudia Wunram (Max Planck Institute for Meteorology)
- To access plots of data: <http://cops.wdc-climate.de>
- To access COPS data, send email to cops@zmaw.de
- Data are 'restricted' until March 2010, then data will be openly distributed

Any Questions?



Contributions from: Susanne Crewell, Ulrich Löhnert, Stefan Kneifel, Kerstin Ebell (U. Cologne), Albert Ansmann and Dietrich Althausen (IfT), Alan Blyth (U. Leeds), Ewan O'Connor (U. Reading)