Radiometer Physics
A Rohde & Schwarz Company

RPG-HATPRO
Multi-Channel Microwave Radiometers for Meteorological Observing Systems

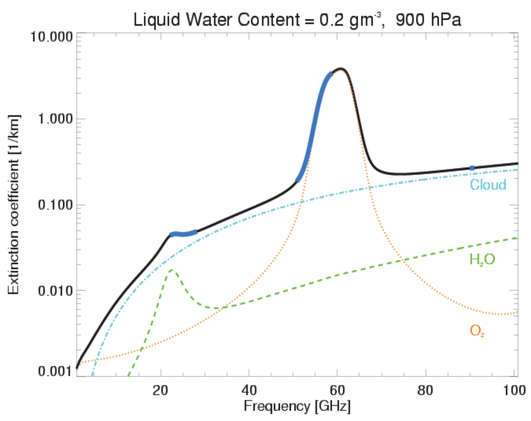
Scientific Background

- The atmosphere emits radiation according to its temperature (Planck's law)
- Radiation intensitity depending on spectral absorption and physical temperature
- Multi-channel radiometers observe several channels along wings of absorption lines in the microwave region
- Humidity: water vapour molecular lines at 22.235 GHz or 183.3 GHz
- Temperature: Oxygen lines at 55 / 118 GHz
- Water clouds: continuum absorption

Statistically independent parameters for lineshape:

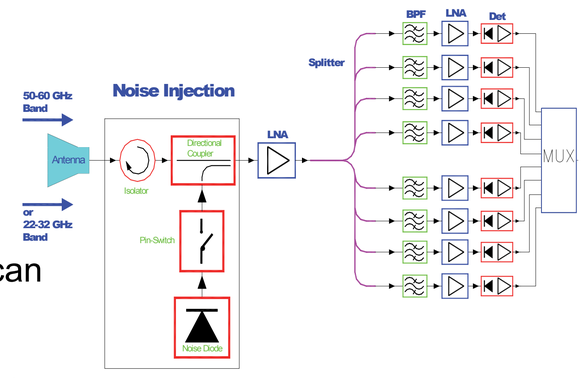
2 to 3 on H_2O
4 to 5 on O_2
emission lines

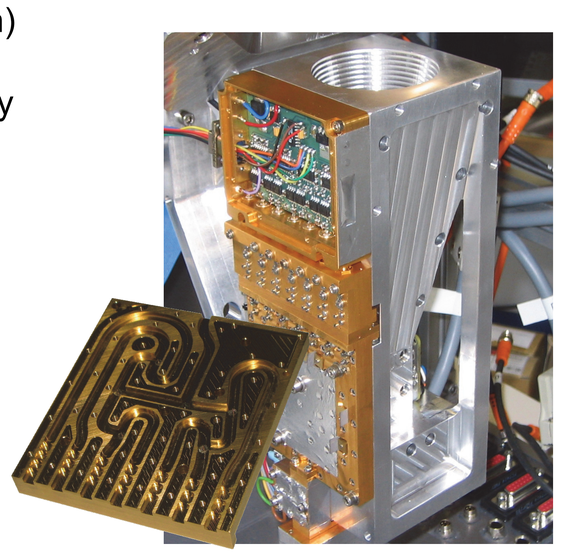
➔ oversampling for redundancy



The HATPRO Humidity and Temperature Profiler

- **Direct Detection Filterbank Radiometer**
- Amplification, filtering, and detection at 20 and 60 GHz
- No Down-Conversion to low IF → no RFI below 18 GHz
- Parallel data acquisition in all channels → fast sky scanning → fast calibrations → 100% duty cycle
- Individual band-passes for all channels (200 – 2000 MHz) → enables high-precision boundary layer temperature profile
- Large optics (primary mirror 300mm) → narrow beam for BL-scan
- IR-radiometers for cloud base height and thin-cloud LWP (single channel and dual-channel IR for cloud effective radius)
- Fully steerable microwave and IR observations (zenith, azimuth)
- Network-suitable: web-interface, data transfer quality checking RFI-detection and correction, opaque atmospheres, consistency
- Instrument health checks, house-keeping data
- Data formats: BUFR, NetCDF, Binary, ASCII, …
- Data levels L0, L1, L2: raw voltage, calibr. brightness temperature, retrieved meteorological products
- Blower/heater: No condensation or wetness on radome
- Fibre optical control connection: Lightning protection, speed
- All weather proof, all climate regions, all altitudes.

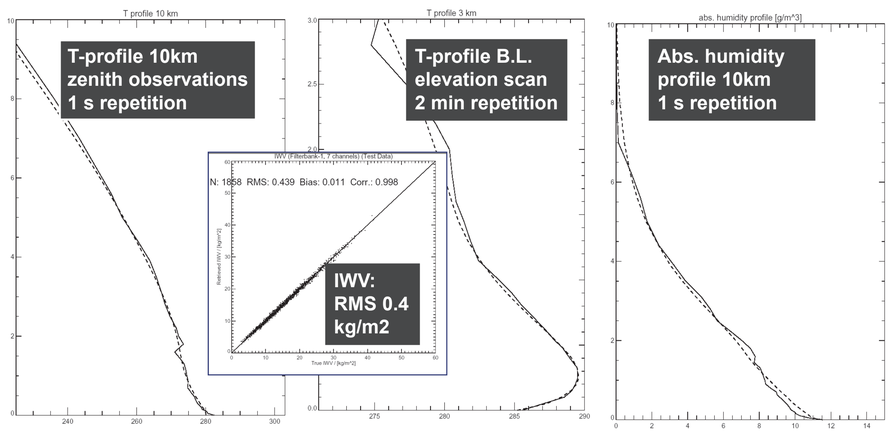


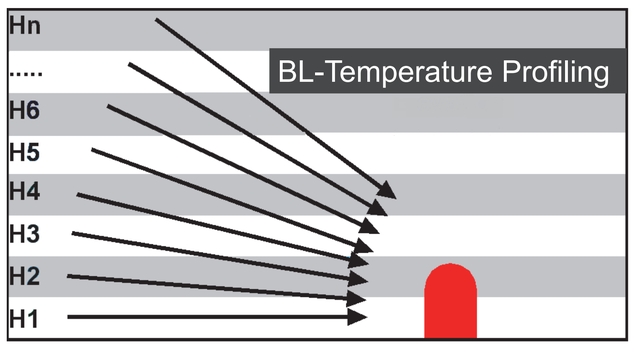


Data Products & Measurements

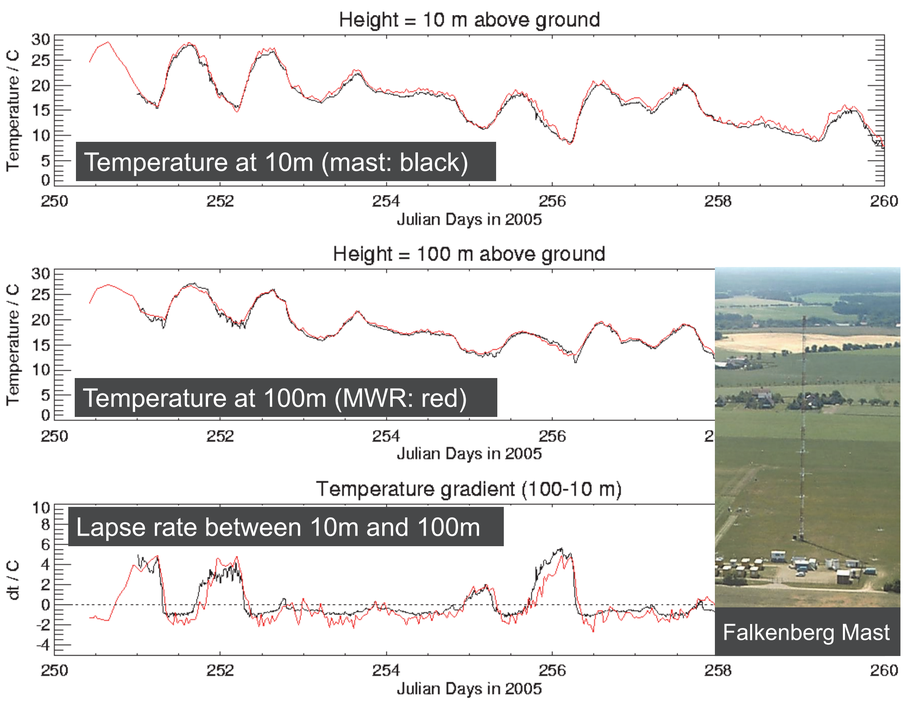
- **Vertical profiles** of
  - temperature
  - humidity
  - cloud water (approximation)
- 1s time resolution, 10km height
- LWP / IWV, attenuation and path delay at 1s resolution (for cloud observations)

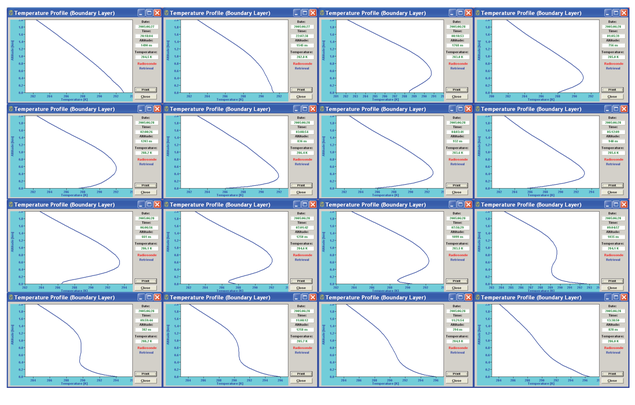
- **Boundary layer temperature profile:** 50 m vertical resolution, 0.25 K RMS 2 minutes time resolution
- Better than radio-sounding in lower 200 m
- BL-Observation relies on **technological advantage:**
  - Individual broad-band channel at 58 to reduce noise
  - Large optics (narrow beam!) for 5 degree elevation
  - parallel detection of 14 channels (duty cycle!)





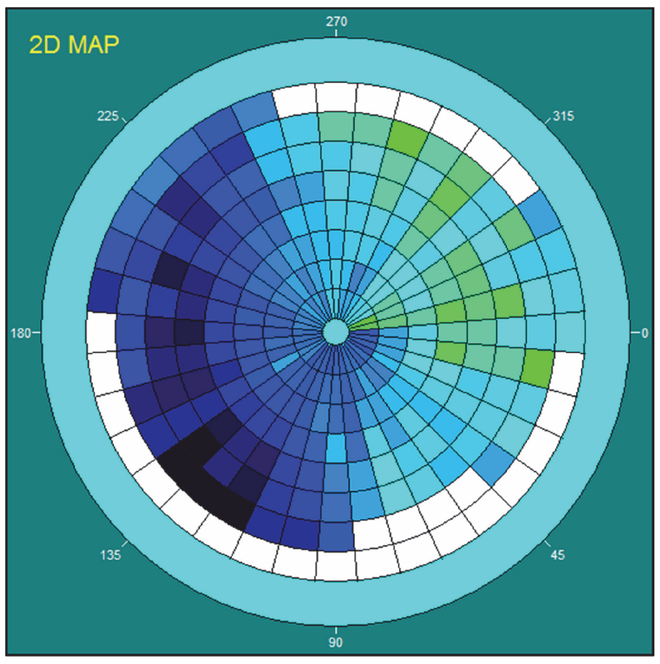
- Elevation scan down to 5°
- limited range (700m), high opacity
- 6 angles, multi-frequency
- change in TB with elevation: 4 K maximum at 58 GHz
- Resolving BL-inversions

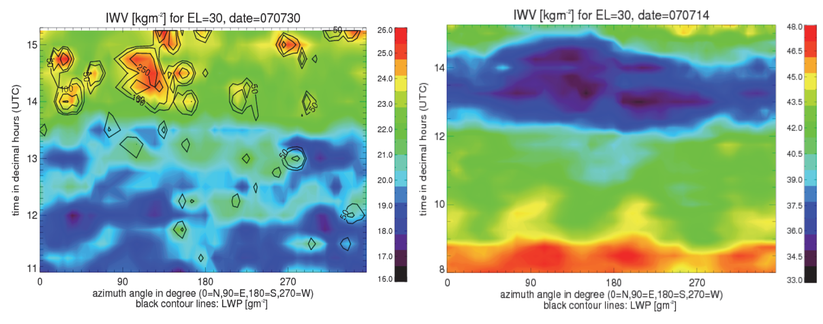




Full Sky Scanning

- Scanning the sky in less than 5 minutes (10 × 10 degree resolution, 300 samples)
- Inhomogeneous IWV/LWP fields
- Advection, surface effects, cloud fractions
- For scans faster than sky-change:
  - 0.4 seconds integration time for 14 ch.
  - rapid & robust scanning mechanisms



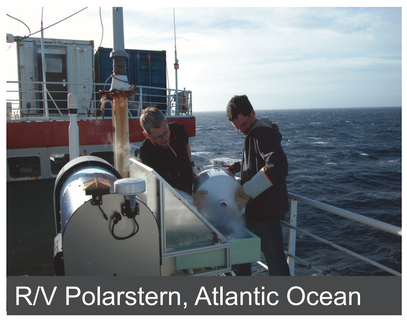


Deployment Examples

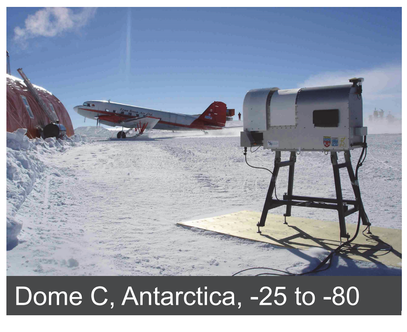

Zugspitze, Germany, 2962 asl


Lampedusa, Italy (hot, wet, salty)


Bangalore, India


R/V Polarstern, Atlantic Ocean


Atacama Desert, Chile, 5500m asl


Dome C, Antarctica, -25 to -80

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