RPG- HATPRO: Temperature- and Humidity- Profiler for Operational Networks

Radiometer Physics GmbH

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Instrument Layout

Objectives

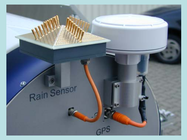
Targets:

- accurate tropospheric / boundary layer temperature profiles
- tropospheric humidity profiles
- LWP (Liquid Water Path), IWV (Integrated Water Vapour)

Designed for operational networks:

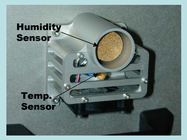
- wide operating temperature range (-30°C to +45°C)
- low maintenance level for instrument support (every 2 month)
- data interface connection to internet or other network
- automatic built-in retrieval for atmospheric parameters
- automatic rain, hail, snow and dew protection system

Weather station and time reference:



Rain sensor: Providing rain flag for measurement documentation, control of shutter system

GPS-clock: Providing time reference standard for satellite synchronization

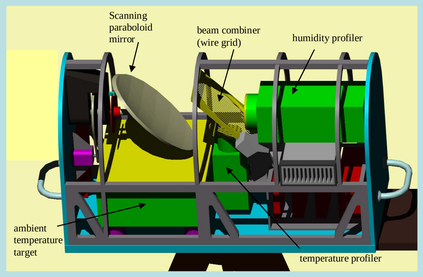


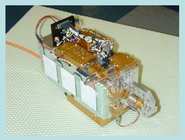
Humidity sensor: Providing input data for retrievals, controls dew blower heating

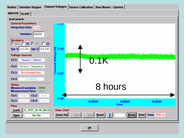
Temperature sensor: Providing input data for retrievals

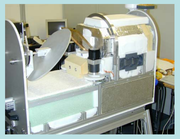
Pressure sensor: Providing input data for retrievals, LN-target calibration

rain / dew protection system (for continuous outdoor use)









Full retrieval support:

Supported retrieval algorithms:

- linear/nonlinear regression
- neural network
- empirical orthogonal functions (EOFs)

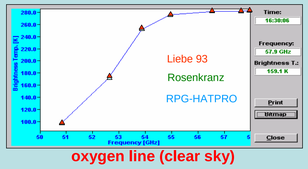
Algorithm data base:

- customer provided radiosonde data
- alternative use of RPG's data base

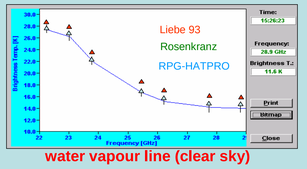
Results

Verification with radiosonde data

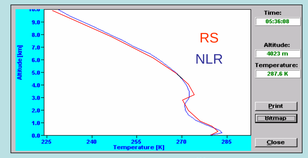
BBC2 Measurement Campaign in Cabouw/NL (2.5.2003 – 23.5.2003)



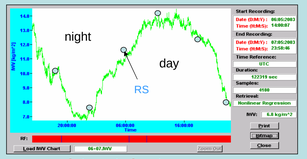
oxygen line (clear sky)



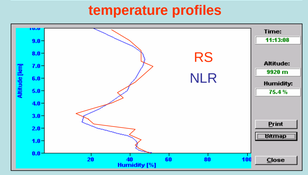
water vapour line (clear sky)



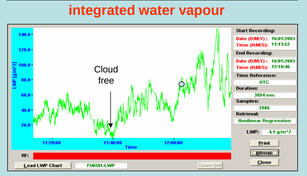
temperature profiles



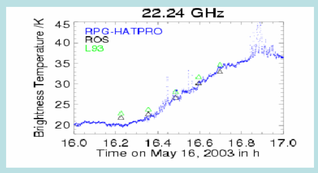
integrated water vapour



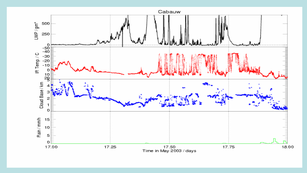
humidity profiles



liquid water path

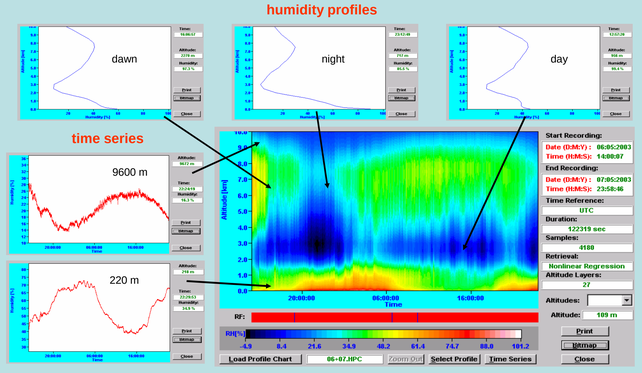


time series of 22.24 GHz channel



LWP time series with IRR

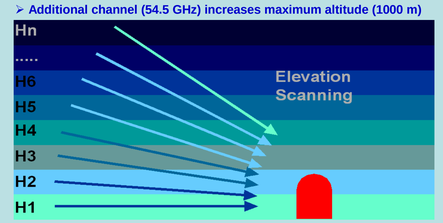
humidity profiles



Accurate Boundary Layer Profiling (New Design)

Principle: Elevation scanning utilizing frequencies with high opacity (@ 58 GHz)

- Altitude resolution: 50 m
- Additional channel (54.5 GHz) increases maximum altitude (1000 m)



Problem: Profile information contained in approx. 1.5 K brightness temperature variation (@ 58 GHz)

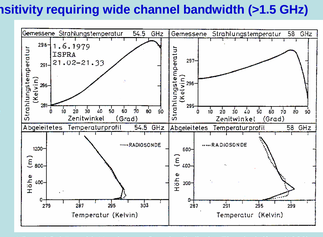
Radiometric requirements for accurate retrieval:

- Long integration time (approx. 3 minutes/profile)
- High channel sensitivity requiring wide channel bandwidth (>1.5 GHz)

$$\Delta T = \frac{T_{sys}}{\sqrt{\tau \cdot B}}$$

Usage of EOFs leads to much more stable and accurate profiles.

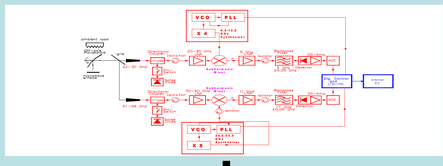
Narrow beam-width (2.5 DEG FWHM) improves retrieval accuracy (low side-lobe level)



* Bernd Schönwald, Hamburger Geophysikalische Einzelschriften (1980)

Solution

Synthesizer tuned heterodyne receiver does not provide sufficient sensitivity!



Dual profiler direct detection filterbank receiver: