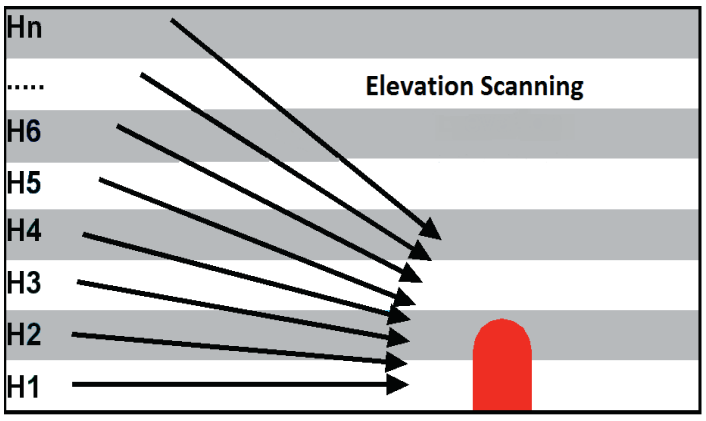
Introduction

RPG-HATPRO microwave profilers use a 7-channel V-band receiver to retrieve atmospheric temperature profiles. In the boundary layer mode, the radiometer scans the atmosphere in elevation to acquire more information about the lowest ~2 kilometers of the atmosphere. The receiver's filter-bank design allows for a parallel data acquisition and narrow beam widths. The advantages of this design are most prominent, when the radiometer is operated in the boundary layer mode.

Boundary Layer Scanning

Within the atmospheric boundary layer, the vertical resolution of temperature profiles retrieved from microwave radiometers can be significantly improved by elevation scanning using the high opacity channels in the V-band. These channels receive most of their signal from a limited range within the boundary layer. The higher the channel opacity, the less height layers contribute to the measurement.



The principle of boundary layer temperature profiling is to reduce the number of contributing height levels by observing various elevation angles. The quality of boundary layer temperature profiles depends very much on the radiometer design. In order to resolve the additional height information, microwave profilers require narrow beam widths and a high measurement accuracy. RPG-HATPRO radiometers comply with both criteria.

Instrument Design

RPG-HATPRO's V-band channels are located on the low-frequency wing of the oxygen absorption complex around 60 GHz. Vertical temperature profiles of the entire troposphere are retrieved from zenith measurements at all 7 V-band channels between 51 GHz and 58 GHz. The vertical resolution of the retrieved profiles is ~200 m below 2000 m. In the boundary layer mode, the vertical resolution below 2000 m is gradually improved up to ~50 m close to the surface. This is made possible by:

RPG Radiometer physics GmbH
Werner-von-Siemens-Str. 4
53340 Meckenheim, Germany

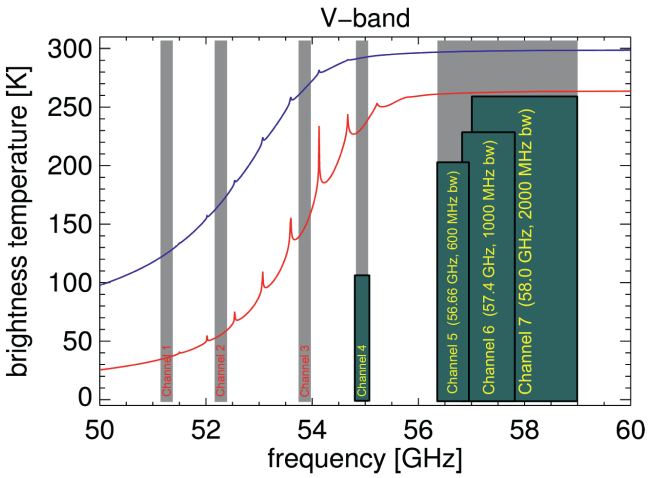
09/2022
+49 (0) 2225 99981 – 0
www.radiometer-physics.de
remotesensing-sales@radiometer-physics.de

- RPG-HATPRO's parallel receiver design allowing individual channel band widths.

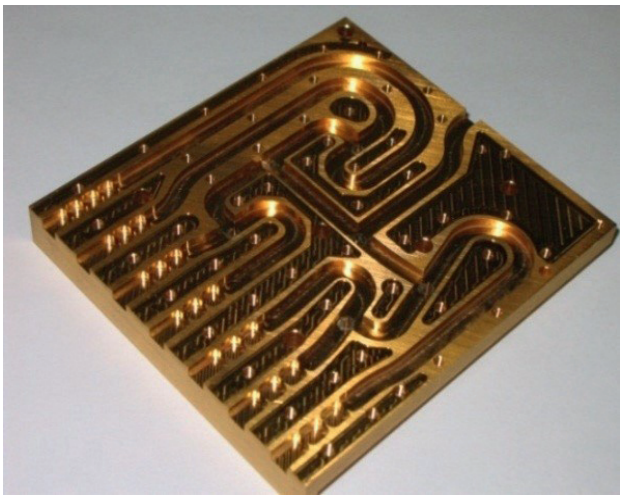
- RPG-HATPRO's large parabola antenna covering a projected diameter of 250 mm and resulting in a narrow antenna beam width of 1.8° for V-band channels.

For the low opacity channels a narrow bandwidth is preferred, as the channels are located between single spectral peaks of the oxygen absorption complex. These peaks become more prominent with increasing deployment heights.

However, for high opacity channels measured brightness temperatures observed in high-opacity channels only slightly vary with the elevation angle. The variation of brightness temperatures in a boundary layer scan is typically in the order of 1 K to 4 K. For these channels a high sensitivity is required to resolve additional height information. This can be achieved by extended integration times and broad band-pass filters above 56 GHz. It is only the filter-bank design used with RPG receivers, which enables an individual adjustment of band-pass filters and fast elevation scanning with high accuracy.



Band-pass filters widths and brightness temperature spectra for standard pressure and 830 hPa (5320 m above sea level).



Parallel multi-channel data acquisition: 7-way splitter including band-pass filters for RPG-HATPRO's V-band channels.

Summary

- Noise reduction by increasing band width in opaque channels (×10) and integration time (×10)
- Noise level better than 0.03 K RMS @ 10 s integration time
- Parallel data acquisition (fast scanning, individual filters)
- 3-minute update when using 10 elevation angles / 10 s each
- High resolution beam due to large aperture optics
- Scans down to 4.2° elevation with 1.8° beam
- Retrievals with optimized angle / frequency selection
- Vertical resolution up to 50 m at the surface, 0.25 K RMS