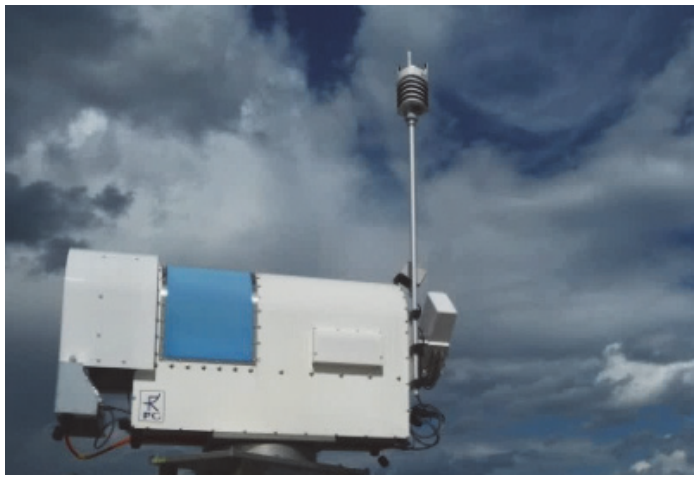
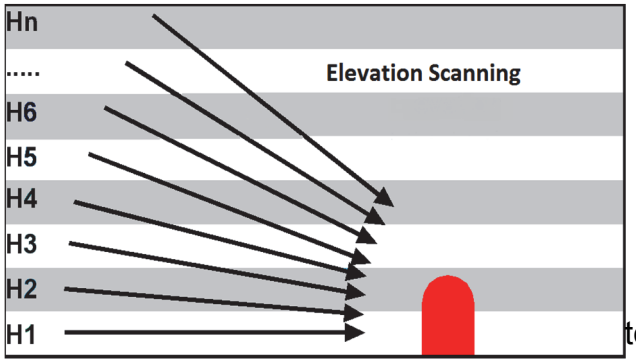
Introduction

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 lower atmospheric. The receiver's filter bank design allows 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 resolve the additional height information, microwave profilers require narrow beam widths and 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 at about 60 GHz. The vertical temperature profiles of the entire atmosphere 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 5000 m and 400 m above. In the boundary layer mode the vertical resolution below 1200 m is reduced to 50 m. This is made possible by:

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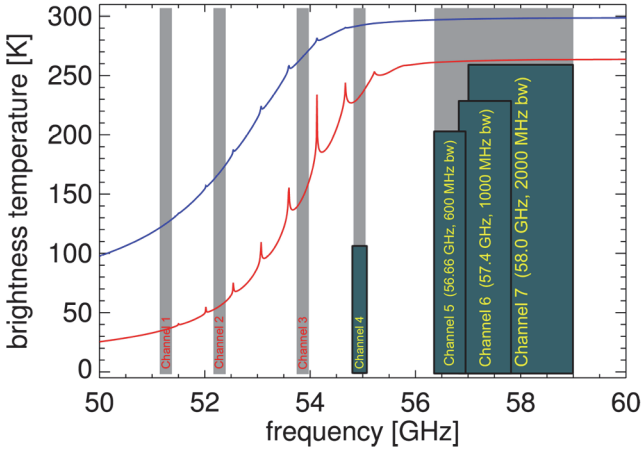
- RPG-HATPRO's parallel receiver design allowing individual channel band widths

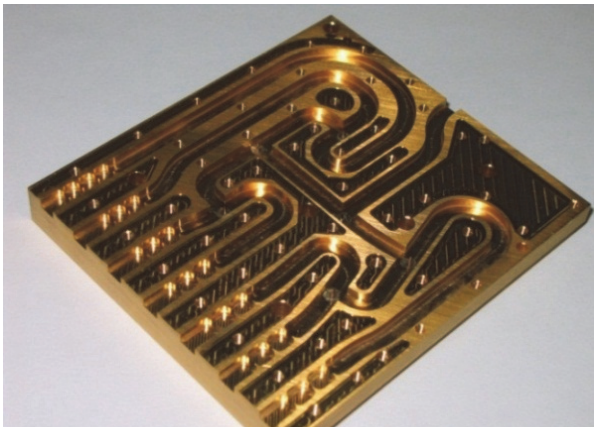
- RPG-HATPRO's large parabola antenna covering a projected diameter of 250 mm and resulting in a narrow antenna beam width of 1.8° for V-band channels.



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

For the low opacity channels a narrow band-width 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 only slightly vary with the elevation angle. For these channel a high accuracy is needed to resolve the additional height information. The variation of brightness temperature in a boundary layer scan is typically in the order of 1 K to 4 K. Therefore, high accuracy measurements are needed. This is achieved by extended integrations times and broad band-pass filter above 56 GHz. At this point, the filter bank design allows for individual adjustment of band-pass filters and fast elevation scanning at high accuracy.



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 (×20)
- Noise level better than 0.03 K RMS @ 20 s integration time
- Parallel data acquisition (speed, individual filters)
- 3-minute update when using 8 elevation angles / 20 s each
- High resolution beam using large-aperture optics
- Scans down to 4.8° elevation with 1.8° beam
- Retrievals with optimized angle / frequency selection
- Vertical resolution around 50 m at surface, 0.25 K RMS

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