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Atmospheric temperature profiles from ground to stratopause with a new microwave radiometer (51-57 GHz)

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A new Temperature Radiometer (TEMPERA) has been built at IAP, University of Bern, Switzerland. This instrument is the first ground-based radiometer which can measure tropospheric and stratospheric temperature profiles at the same time. TEMPERA operates in the frequency range from 51 to 57 GHz in the oxygen-emission region of the microwave spectrum and is measuring continuously since 2012 in our lab on the roof. The spectral analysis is done with a filterbank with 12 channels for the troposphere and with a digital FFT spectrometer which measures two oxygen-emission lines around 53 GHz with 32000 channels for the stratophere. In the measured spectra the influence of the Zeeman effect can be seen.

A measurement is built up of a tipping curve from 30 to 70 degree zenith angle. For every zenith angle we change the frequency of the local oscillator to three different frequencies with a synthesizer in combination with an active multiplier. With this method we can measure 12 frequencies with only 4 detectors. The frontend is thermally stabilized with Peltier elements. An off-axis parabolic mirror feeds the incoming microwave radiation to the horn antenna providing an angular resolution of 4 degree (FWHM). Absolute calibration is done with a hot load and a noise diode. The noise diode is calibrated regularly with a liquid nitrogen load and a hot load.

The temperature retrieval is done with the optimal estimation method by using the QPack2/ARTS2 software. For the a priori profile of the atmospheric temperature we use monthly mean of radiosonde data for the troposphere and climatology of satellite data (MLS) for the upper atmosphere. The forward model is calculated with the Rosenkranz 98 model.

As atmopheric temperature is a key parameter for the investigation of dynamical and chemical processes in the atmosphere, this new instrument provides important information about the local atmospheric temperature over a high altitude range (ground to 50 km). The temporal resolution is about 15 minutes for the troposphere and about 2 hours in the stratosphere.

We will present the design, the measurement method and results compared with radiosonde and satellite data from this new concept.