EGU23-11941, updated on 30 Sep 2023
https://doi.org/10.5194/egusphere-egu23-11941
EGU General Assembly 2023

Temperature retrievals from a ground-based, fully polarymetric, 50 GHz radiometer

Witali Krochin[1,2], Gunter Stober[1,2], Axel Murk[1,2], Roland Albers[1], and Tobias Plüss[1]
[1]Institute of Applied Physics, University of Bern, Bern, Switzerland
[2]Oeschger Centre for Climate Change Research, University of Bern, Bern, Switzerland

Continuous temperature measurements in the stratosphere (12-50 km) and the mesosphere (50-80 km) are crucial for the deeper
understanding of the physical processes in the middle atmosphere and our understanding of the vertical coupling between the
different atmospheric layers. Several studies have shown the importance of atmospheric waves such as planetary waves, tides,
and gravity waves, their propagation and breaking at these altitudes, and its effect on the global circulation.

Investigating these effects requires long-term measurements with high temporal resolution and altitude coverage. Satellite data
covers the required altitude range but provides limited temporal resolution due to its fixed orbital geometry. Active measurement
techniques such as LIDAR are usually limited to nighttime and only a few instruments have daytime capability and therefore
are unsuitable for continuous observations. Ground-based microwave radiometry provides a robust observational method that
is independent of the daytime, almost independent of the weather conditions, and that permits to perform continuous soundings
from 20-60 km altitude.

TEMPERA (TEMPErature RAdiometer) is a ground-based radiometer developed at the University of Bern in 2013. It measures
microwave radiation spectra from atmospheric oxygen in a range between 52 GHz and 53 GHz. Atmospheric temperature profiles can be retrieved from these spectra. In the last 9 years, the accuracy and performance of this instrument were continuously
improved. The latest version of TEMPERA has a temporal resolution of one measurement per 30 min and temperature profiles
can be retrieved up to an altitude of about 50 km.

The reason for the altitude limitation is the Zeeman effect, which occurs due to the interaction of the atmospheric oxygen with

the Earths magnetic field. The polarisation of atmospheric radiation affected by the Zeeman effect depends on the orientation of the propagation direction to the magnetic field. Therefore the altitude range for temperature retrievals could be further improved by decomposing the measured radiation in its polarisation components. In addition, the inclusion of the Zeeman effect in the retrieval algorithm provides the ability to retrieve the Earths magnetic field from measurements of atmospheric microwave emissions.

The microwave group from the Institute of Applied Physics of the University of Bern, is currently developing a temperature radiometer (TEMPERA-C), which is based on the former instrument (TEMPERA), but allows a fully polarymetric analysis of the atmospheric emission spectra. In my talk I will present the technical details of TEMPERA-C as for example the challenges in the calibration process. Furthermore I will present calibrated measurements of circular polarized atmospheric emission spectra as well as temperature retrievals and discuss the effect of the Earth's magnetic field on these measurements.