First middle-atmospheric wind profile measurements with a novel ground-based microwave radiometer

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Introduction

Wind measurements in the middle-atmosphere are important for a better understanding of the coupling between the upper and the lower atmosphere. Besides the potential for validation and improvement of models they could provide deeper insight into dynamical processes such as tides or sudden stratospheric warmings. However, wind measurement between 35 and 70 km is one of the more difficult problems in atmospheric remote sensing. The commonly used techniques are sensitive only below or above this altitude range. For this reason a significant data gap in upper stratosphere lower mesosphere region exists.

Instrument and measurement principle

The Wind RAdiometer WIRA is a new ground-based passive microwave receiver specifically designed for wind measurements in the upper stratosphere lower mesosphere region (30-80 km) operational since September 2010. It observes the emission line of atmospheric ozone at 142 GHz. The horizontal wind speed can be deduced from the frequency shift between the spectra measured in opposite viewing directions using the Doppler effect formula (\(v = c \Delta f / f_0\)). Thanks to pressure broadening of the O\(_3\) emission line altitude resolved wind information can be obtained.

Measurement results

Our measurements of middle-atmospheric zonal winds over Bern and Sodankylä (11 and 10 months of data, respectively) have been compared to operational analysis data from the ECMWF model. Very good agreement in the long-term statistics as well as in short time structures with a duration of a few days has been found.

Conclusion and outlook

Microwave radiometry is a promising tool for middle-atmospheric wind measurements. A technical upgrade with new high-frequency components has recently been completed improving WIRA’s signal to noise ratio by a factor of 2.4. WIRA is currently operated at the Observatoire de Haute-Provence (France) in the framework of a campaign of the middle-atmospheric dynamics project ARlSE.

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