EMS Annual Meeting 2023 Abstract

Tobias Böck, Bernhard Pospichal, Ulrich Löhnert
University of Cologne

Session UP1.5 on Atmospheric Measurements

Measurement uncertainties of scanning microwave radiometers and their influence on temperature profiling

Ground-based microwave radiometers (MWRs) operating in the K-band and V-band frequency ranges (22 – 32 GHz and 51 – 58 GHz) are increasingly used for acquiring temperature profiles (T) and coarse humidity profiles (H) of the troposphere. These instruments measure microwave radiances, expressed as brightness temperatures (TB), in zenith and other angles over a region with a radius of approximately 10 km. Those measured TBs are used to derive profiles. Ground-based MWRs are also highly reliable instruments for measuring integrated water vapor (IWV) and liquid water path (LWP), with uncertainties below 0.5 kg/m2 and 20 g/m2, respectively. Zenith observations provide these variables with high temporal resolution (up to 1 second), while elevation scans offer the capability to obtain more precise temperature profiles close to the surface and evaluate horizontal water vapor and cloud inhomogeneities.

Two years ago, the E-PROFILE program has initiated a business case proposal that was accepted by EUMETNET to offer continuous MWR data to the European meteorological services for boundary layer monitoring and assimilation in numerical weather prediction (NWP) models. Additionally, the European Research Infrastructure for the observation of Aerosol, Clouds, and Trace gases ACTRIS and the European COST action PROBE (PROfiling the atmospheric Boundary layer at European scale) are presently committed to establishing continent-wide quality and observation standards for MWR networks for research and NWP applications.

For all that it is important to provide an estimate of all the uncertainties of scanning MWR measurements. When installing a MWR, it has to be kept in mind that measurement uncertainties due to the instrument setup and originating from external sources can have an impact on observations and the quality of the obtained atmospheric profiles. Therefore, identifying and coping with these kinds of errors is one important part of the quality control, especially while searching for a suitable measurement location with minimum disturbances. We will present the impact of the following measurement uncertainties – namely (1) physical obstacles in line of sight of the instrument, (2) pointing errors or a tilt of the instrument, (3) horizontal inhomogeneities of the atmosphere, and (4) radio frequency interference (RFI) – and give recommendations on how to set-up a MWR accordingly.