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Characterizing the influence of obstacles on scanning microwave profilers

Ground-based microwave radiometers (MWRs) which operate within the K-band and V-band (22 – 32 GHz and 51 – 58 GHz) are used to obtain temperature profiles (T) and rather coarse humidity profiles (H) of the troposphere. MWRs measure microwave radiances, expressed as brightness temperatures (TB), in zenith and other angles over an area of ~10 km radius. The brightness temperatures can be used to retrieve the T-profiles and H-profiles. Ground-based MWRs are also among the best instruments to measure path integrated values like IWV (Integrated Water Vapor) and LWP (Liquid Water Path), with excellent uncertainties below 0.5 kg/m^2 and 20 g/m^2, respectively. Besides zenith observations which provide these variables with a high temporal resolution (up to 1 second), elevation scans are used to retrieve more precise temperature profiles close to the ground, as well as to assess horizontal water vapor and cloud inhomogeneities.

Driven by the E-PROFILE program, a business case proposal was accepted by EUMETNET last year to continuously provide MWR data to the European meteorological services for boundary layer monitoring and assimilation to numerical weather prediction (NWP) models. Also, 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) currently focus on establishing continent-wide quality and observation standards for MWR networks for research as well as for NWP applications.

When installing a MWR, it has to be kept in mind that external error sources like physical obstacles and radio frequency interference (RFI) can have an impact on observations and the quality of the obtained atmospheric profiles when they are within the range of the MWR. 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 low disturbances. If physical obstacles like trees, towers, masts and walls are too close to the MWR they can have significant repercussions in elevation scans which are necessary for deriving accurate T-profiles. That is why it is crucial to pinpoint the exact location of these obstacles and to determine a minimum distance at which they do not interfere with the MWR anymore. We will present a sensitivity study which uses a line-by-line (LBL) radiative transfer (RT) model and in which obstacles at any distance from the profiler can be simulated. Output comparisons with and without these simulated obstacles provide a theoretical atmospheric penetration depth per frequency channel and elevation.