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The potential of surface based remote sensing to fill the observational gap in the lower troposphere

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Profile observations of temperature, humidity and wind in the lower troposphere are still sparse and represent an essential observational gap. Through various actions and programmes, COST and EUMETNET made considerable efforts to bring emerging surface based remote sensing techniques to operational maturity and fit for purpose of operational meteorology. The focus is mainly on radar windprofilers (RWP), microwave Radiometers (MWRs) and different kinds of lidars for profiling of wind, temperature, humidity and aerosols including volcanic ash. We will discuss the potential of these techniques to fill the observational gap in the lower troposphere.
The European RWP network which has been set up in the framework of several COST actions consists today of 30 systems. It is part of the EUMETNET observation programme since 2005. The network is assimilated in various global and regional numerical weather prediction (NWP) models and several recent studies based on the forecast to sensitivity (FSO) technique have shown that RWPs have a positive impact on NWP, comparable to radiosondes.
Automatic (elastic) lidars and state of the art ceilometers (ALC) have the capability to do vertical profiling of aerosols including volcanic ash. Nearly 200 ALCs with profiling capabilities in Europe have been integrated in EUMETNET's E-PROFILE ALC network. This network is now an important component of the observing system for volcanic ash, Saharan dust and other airborne natural hazards and will provide the basis for new applications in the area of aviation but also air quality and fog forcasting. In a tight collaboration with the COST action TOPROF, algorithms have been developed to calibrate ALCs using the atmosphere itself as calibration target achieving a calibration uncertainty of 25%. Comparisons with the ECMWF C-IFS model using an ALC forward operator revealed biases up to 50% indicating room for improvement concerning the representation of aerosols in the model and the potential of the ALC network to constrain the analysis using data assimilation techniques.
Raman, differential absorption and high spectral resolution lidar are emerging techniques for the profiling of water vapor and temperature. The Raman Lidar for Operational Meteorology, RALMO, operated by MeteoSwiss at Payerne, Switzerland, is a demonstrator for the Raman lidar technology and one of the very few instruments worldwide that has reached operational status (24/7 unattended). Recent data assimilation experiments using continuous water vapor and temperature measurements from the lidar revealed a clear positive impact.