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1D variational retrievals of boundary layer temperature profiles from ground-based microwave radiometers in an Alpine valley

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A better understanding and modeling of boundary layer (BL) processes is essential to improve forecasts of high impact weather events like fog, convection, heavy precipitation or pollution. However, classical upper-air observations (radiosondes) are unable to precisely describe the temporal evolution of boundary layer thermodynamic profiles over long periods. On the contrary, ground-based microwave radiometers (MWR) enable the continuous retrievals of temperature and humidity profiles at a high frequency (around one minute) with information mostly residing in the boundary layer (BL) below 2 km altitude. In this study, BL temperature profiles were retrieved in an Alpine Valley through a one dimensional variational algorithm (1D-Var) combining MWR brightness temperatures and short-term forecasts from the convective scale model AROME. A 14 channel microwave profiler HATPRO (Humidity And Temperature PROfiler) was deployed during 3 months in a 2-km wide Alpine Valley in order to understand how the atmospheric dynamics during wintertime anticyclonic conditions drives the accumulation and dispersion of pollutants in the atmosphere. 1D-Var retrievals were compared to 84 radiosondes launched every 3 hours during two IOPs characterized by very stable BL conditions during which the AROME model overestimated the temperature below 1 km altitude reaching up to 12 K errors during the strongest stable episode. Thanks to the high information content of MWR in the BL specifically in the altitude range where the AROME model presents the largest errors, an accuracy of 0.5 to 1K was observed in clear-sky conditions. A large improvement of background errors is thus observed through the 1D-Var assimilation of MWR observations, which also demonstrate the potential for an operational assimilation of these data. The MWR was found to catch very well deep near-surface temperature inversions while high level inversions are still challenging. Sensitivity of 1D-Var retrievals to elevation angles or the background profile used to initialize the algorithm will be discussed. The development of the fast radiative transfer model RTTOV is also a key component for future data assimilation or operational 1D-Var retrievals on instrumented sites and field campaigns. 1D-Var retrievals will be performed with RTTOV and compared to the line-by-line model ARTS known for its accuracy.