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Towards an operational assimilation of ground-based microwave radiometers into convective scale model: a 1D-Var study

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Ground-based microwave radiometers (MWR) are robust instruments enabling the continuous and automated retrievals of temperature and humidity profiles at a high frequency (around one minute) under nearly all conditions. They are potential candidates to supplement radiosonde networks and satellite data to improve numerical weather prediction (NWP) at local scale especially in case of severe events (fog, convection, turbulence). In this presentation, we study how MWR observations can improve operational convective scale models by directly assimilating brightness temperatures. In the first part of this study, a one dimensional variational method combining MWR observations and 3-hour forecasts from the French convective scale model AROME has been used to retrieve temperature profiles in all-sky conditions. A 14-channel microwave profiler HATPRO (Humidity And Temperature PROfiler) was operated during 6 months at the meteorological station of Bordeaux to benefit from radiosonde profiles launched twice a day (11 and 23 UTC). MWR brightness temperatures were monitored during 6 months against simulations from the Atmospheric Radiative Transfer Simulator (ARTS) and AROME forecasts. Bias, standard deviation and frequency distribution of observation minus background (O-B) departures have been evaluated to select channels respecting variational analysis constraints. 1D-Var temperature retrievals were performed in clear-sky and cloudy conditions. The 1D-Var retrievals were found to significantly improve the AROME forecasts up to 2 km with a maximum gain of approximately 50% in root-mean-square-errors (RMSE) below 500 m. They were also found to outperform neural network retrievals that are usually used. The present implementation achieved a RMSE with respect to radiosondes within 1 K in clear-sky and 1.3 K in cloudy-sky conditions.
To progress towards an operational assimilation of MWR, the fast radiative transfer model RTTOV, which meets operational requirements, has been adapted to ground-based MWR. The NWP SAF 1D-Var algorithm has been interfaced with this new version and evaluated in the context of observing system simulation experiments. The results show that the background is always improved by the analysis from the surface up to 3 km for temperature and 6 km in humidity. The liquid water path can be successfully retrieved with a RMSE of 20 g.m-2.
In future, the 1D-Var algorithm with ground-based RTTOV will be tested on real MWR observations acquired during the Alpine Valley Experiment Passy-2015 for an extensive evaluation.