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RTTOV-gb - Adapting the fast radiative transfer model RTTOV for the assimilation of ground-based microwave radiometer observations

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The Planetary Boundary Layer (PBL) is the single most important under-sampled part of the atmosphere. According to the WMO Statement Of Guidance For Global Numerical Weather Prediction (NWP), temperature and humidity profiles (in cloudy areas) are among the four critical atmospheric variables not adequately measured in the PBL. Ground-based microwave radiometers (MWR) provide temperature and humidity profiles in both clear- and cloudy-sky conditions with high temporal resolution and low-to-moderate vertical resolution, with information mostly residing in the PBL. Ground-based MWR offer to bridge this observational gap by providing continuous temperature and humidity information in the PBL. The MWR data assimilation into NWP models may be particularly important in nowcasting and severe weather initiation. The assimilation of thermodynamic profiles retrieved from MWR data has been recently experimented, but a way to possibly increase the impact is to directly assimilate measured radiances instead of retrieved profiles. The assimilation of observed radiances in a variational scheme requires the following tools: (i) a fast radiative transfer (RT) model to compute the simulated radiances at MWR channels from the NWP model fields (ii) the partial derivatives (Jacobians) of the fast radiative transfer model with respect to control variables to optimize the distances of the atmospheric state from both the first guess and the observations. Such a RT model is available from the EUMETSAT NWPSAF (Numerical Weather Prediction Satellite Application Facility) and well accepted in the NWP community: RTTOV. This model was developed for nadir-viewing passive visible, infrared, and microwave satellite radiometers, spectrometers and interferometers. It has been modified to handle ground-based microwave radiometer observations. This version of RTTOV, called RTTOV-gb, provides the tools needed to exploit ground-based upward looking MWR brightness temperatures into NWP variational data assimilation schemes. The performances of RTTOV-gb have been tested against accurate and less time-efficient line-by-line RT models using both dependent and independent profile datasets. The Jacobians computed with RTTOV-gb have been compared with those obtained with a reference radiative transfer model as well as the brute force method. The tests have already shown that RTTOV-gb is up to 8-time faster than reference RT models, producing differences that are well within the expected MWR instrumental error.