Passive and Active Microwave Transfer (PAMTRA): a tool to simulate observations from space, air, and ground

Mario Mech[1], Maximilian Maahn[2], Stefan Kneifel[1], Davide Ori[1], Vera Schemann[1], and Susanne Crewell[1]

[1]Institute for Geophysics and Meteorology, University of Cologne, Germany
[2]Leipzig Institute for Meteorology, University Leipzig, Germany
e-mail: mario.mech@uni-koeln.de

Forward models are a key tool to compare observations and models by converting the output of atmospheric numerical models to synthetic observations. By the capability to create such synthetic observations, these forward models are very beneficial for studies related to future satellite missions like MWI and ICI flown on MetOp-SG. Such tools can help to understand the expected observations. They are also an integral part of inversion algorithms that aim to retrieve geophysical variables of interest from observations.
Here, the comprehensive microwave forward model PAMTRA (Passive and Active Microwave TRAnsfer) is introduced, which can simulate passive and active measurements across the microwave spectral region up to 800 GHz. The passive forward model in PAMTRA provides up- and down-welling polarized brightness temperatures and radiances for arbitrary observation angles, while the active forward simulator is capable of simulating the full radar Doppler spectra and its moments. Both can be applied to arbitrary plane-parallel atmospheric scenes, including those with complex hydrometeor assumptions. PAMTRA implements various gas absorption models and methods for the approximation of the scattering properties (Mie, T-matrix, DDA, self-similar Rayleigh-Gans) and uses the same for the passive and active forward simulations. To give an estimate of the surface emmissivity of ocean and land needed for passive microwave applications, several tools are included. The PAMTRA framework includes interfaces to various atmospheric models and considers their respective assumptions in the microphysical schemes with different complexity like one- or two-moment schemes or full bin microphysics. The core module is written in FORTRAN90, whereas the framework and user interface are python based. Therefore, the model is easy to use and extendable.
In this presentation we will introduce the complete PAMTRA framework. By various examples, we will furthermore demonstrate PAMTRAs capabilities to simulate active and passive observations for space, air, and ground based instruments by making use of cloud resolving model output and measurements from various campaigns.