Sensor Forward Modeling in the Multi-Instrument Inversion Testbed (MIIST)

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SIMULATION STUDY

Using the NASA-Unified Weather Research and Forecasting Model (NU-WRF), with Morrison 2M microphysics, we simulated a convective system from the Midlatitude Continental Convective Clouds Experiment (MC3E).

The cloud simulations were then used as input to the Atmospheric Radiative Transfer Simulator (ARTS), version 2.3. ARTS is a vector radiative transfer model for planetary atmospheres of one-to-three dimensions, and it includes a variety of scattering solvers. In this study, we used three-dimensional Monte Carlo integration to simulate airborne and spaceborne sensors.

Particle scattering properties were calculated using the T-Matrix method (cloud liquid and rain), Invariant Imbedding T-Matrix (horizontally-aligned cloud ice), and the Discrete Dipole Approximation (snow aggregates and graupel, from the ARTS developers at Chalmers and the University of Hamburg).

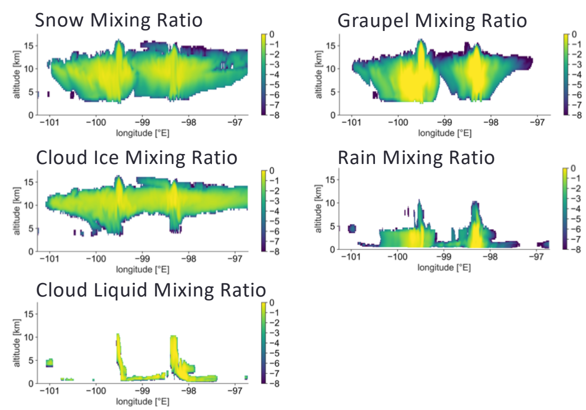
Case 1 Description

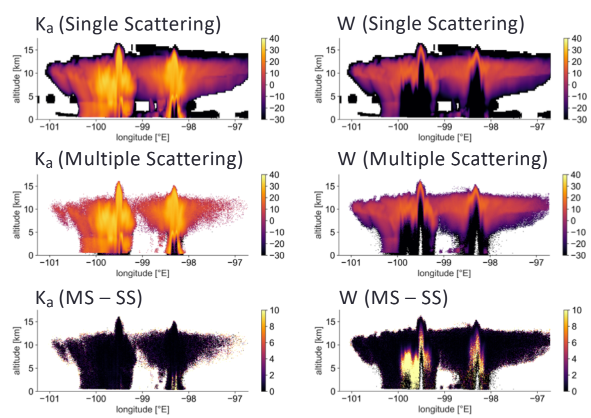
This simulation uses the 0600 UTC timestep from 20 May 2011. We simulated a flight line that traversed two convective towers. The hypothetical sensors were HIWRAP (Ka band only), CRS (i.e., W band), and CoSMIR (166 GHz only). In the simulations, we placed the sensor at 20 km altitude, and prescribed a 4º 3-dB beamwidth for the radiometer and a 1º 6-dB beamwidth for the radars, although this beamwidth is coarser than the actual CRS beamwidth (0.5º). In the radar simulations, multiple scattering affects W band within and around the convective cores due to high graupel content, while at Ka band there is a small, but intense, region of multiple scattering at the bottom of the column near 98ºW Longitude. Multi-angle T_b simulations show significant structure, while the polarization differences are high in the anvil regions due to the presence of horizontally-aligned ice particles. The polarization differences corresponding to the convective cores trend toward zero from high concentrations of randomly-oriented snow and graupel. These regions are also characterized by the lowest T_b intensity.

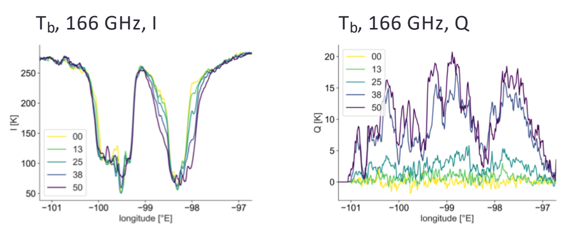
Case 2 Description

This simulation uses the 2300 UTC timestep from 20 May 2011. We simulated a hypothetical overpass of GMI. As with the multi-angle simulations from 0600 UTC, large polarization differences are present in the anvil regions, while the polarization trend toward zero for the deepest T_b depressions, corresponding to convective towers.

CASE 1: 20 MAY 2011, 0600 UTC







CASE 2: 20 MAY 2011, 2300 UTC