Improved snow, graupel and ice cloud modelling in RTTOV-SCATT v13.0

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The Radiative transfer for TOVS microwave scattering code (RTTOV-SCATT) saw diverse improvements at v13.0. This presentation focuses on aspects relating to frozen hydrometeors. A first development was to make the hydrometeor specification more flexible, so that any number of hydrometeors can be represented, and the bulk optical properties can be specified with an increased choice of particle size distributions, along with new non-spherical particles from the Atmospheric Radiative Transfer Simulator (ARTS) scattering database. In the previous default configuration, frozen hydrometeors were represented by the just two categories, snow and ice, but now a graupel type has been added. All three hydrometeor types are now represented by particles from the ARTS database. The microphysical choices (along with the cloud overlap over land) were guided using parameter estimation. This aimed to minimise the discrepancies between observations from Special Sensor Microwave Imager / Sounder (SSMIS) and simulations from RTTOV-SCATT, based on atmospheric profiles from the European Centre for Medium-range Weather Forecasting (ECMWF) weather prediction system. Although deficiencies remain, particularly in tropical deep convection, improvements are seen over extratropical land surfaces, and the new default configuration is likely to be better at representing sub-millimetre channels on upcoming missions like the Ice Cloud Imager (ICI). A further development is an initial representation of polarised scattering from oriented hydrometeors. This is achieved by scaling the bulk extinction from frozen hydrometeors as a function of channel polarisation (vertical or horizontal). The scaling factor is empirically determined by minimising discrepancies between RTTOV-SCATT simulations and GPM Microwave Imager (GMI) observations. This does a surprisingly good job of representing observed polarisation differences. These developments are a step forwards in representing frozen hydrometeors in a more physically realistic way, with improved microphysical assumptions, more realistic particle shapes, and a representation of preferential particle orientation.