Atmos. Meas. Tech. Discuss.,
doi:10.5194/amt-2019-293-RC1, 2019

Atmospheric Measurement Techniques Discussions

Interactive comment on "Using passive and active microwave observations to constrain ice particle models" *by* Robin Ekelund et al.

Anonymous Referee #1

Received and published: 10 September 2019

This is a very thorough attempt to validate and constrain the large number of particle models available in the recently published Eriksson et al. (2018) single scattering DDA database. This database, known as the ARTS scattering database, contains 34 particle models over 34 frequencies (1 - 886.4 GHz). This study addresses the complex question which models are the best representations of ice hydrometeors? In order to do so, a combined active and passive radiative transfer model framework is employed under a combination of particle models and particle size distributions. CloudSat observations are converted to simulated brightness temperatures at GMI (only 186.31 and 190.31 GHz) and ICI (328.65, 334.65, and 668.2 GHz) channels. Simulated TBs are compared with the real GMI observations, but the study concludes it is difficult under GMI frequencies to choose a particular particle model over another one, although ICI

simulations show the potential these observations will have in the near future to tackle the central question of this study. The publication is fit for publication with only a few points to be discussed or considered.

General comments

* One of my main comments is why the GMI 89 and 166 GHz channels were not simulated. Trying to address the representativeness of ice particle models, excessive scattering at the lower microwave frequencies should be avoided and these channels could help. These channels would also give a very complete frequency-wise analysis of the most up to date database coupled with ARTS, which is extensively used. Is this outside the scope of this paper?

* Similarly, with the 243 GHz channel in ICI.

Specific Comments (individual scientific questions/issues)

Abstract: (L13) Could you please elaborate on what is meant by "a compensation effect between bulk extinction at passive frequencies and radar reflectivity." L168: For completeness perhaps it is worth including a comment about the suitability / experience when using the other scattering solvers in ARTS in the sub-millimetre range. Are there other publications where ARTS is used in that range? L193: What is the definition of aspect ratio? L194: What sort of mixture was used? Ice in air, or air in ice? L208: "Above 500 μm, most of the particles, except the DARDAR spheroid and the 8-column aggregate, have aggregated to a single cluster of lines." Differences are still important. L246: "Overall, while smaller particles are more numerous, intermediately sized particles dominate in terms of scattering impact." From the text only the MH97 PSD has more numerous smaller particles, the other PSDs have higher emphasis on larger particles. So this sentence is a confusing. L267: Also in the importance of consistency when making assumptions throughout the chain of simulations. L285: Please discuss what is meant by "59 CloudSat orbits could be found and selected as references for the synthetic scenes". How coincident in time and space are you requiring CloudSat

to overpass the GMI footprint. L289: By LWC do you mean cloud droplets? Please specify. I am assuming this because a few lines later you say you retrieve Rain Water content too. L291: Please also refer the reader to section 3.2. L380: simulated TBs are indeed highly dependant upon assumed particle model (in the IWC retrieval). L393: lower TB-depressions (i.e., warmer simulated TBs). These are expected for the MH97 PSD since it's inclined to favour smaller particles? L400: Don't you mean the 186 GHz channel is closed to the centre of the water vapour line? L402: 328 vs 334. Why especially different for the 9.2 degree? L429: agreement to GMI (channels explored) is good. L433: you mention that there are a few exceptions. It would be nice to include them in the text. L438: Figure 11: why do you switch from MH97 to D14? L458: I don't understand the comment about azimuthally oriented particles. If there were azimuthally oriented particles, shouldn't the TB depressions be actually larger hence even colder temperatures? You would increase retrieved IWC but you would be simulating colder too? This is the first concluding remark which needs revision, no horizontally aligned DDA shapes have ever been simulated. L490: It would have been nice to evaluate this weak scatterer at the lower GMI frequencies. L520: I didn't catch the discussion made about the DARDAR spheroid. L544: fairly insensitive at 190 GHz. Figure 11 (specially using F07T shows differently) Figure 10. It is interesting that the soft sphere with MH97 and dBZ-based mode, isn't worst than the sector snowflake. L464: simulations performed in this study (specially at 668.2 GHz)

Technical corrections / Minor issues

L165: Suggesting changing the phrase "It is intended to be as general as possible. For instance, radiation is described using the full Stokes vector notation and in terms of usage it behaves as a scripting language" to "It is intended to describe radiation using the full Stokes vector notation in the most general manner possible, allowing a large amount of user input flexibility. In itself ARTS behaves as a scripting language on its own." L184: I should read "A particle mixture consists of pristine crystals" without the "a". L346: Please mention that the colored lines represent IWP from radar inversions

(for the F07 PSD) L390: Instead of "9.2" use of "9.2 latitude" (same in line 402) L392: The effect is similar in the top right panel, where the PSD has been switched to (used is the) MH97 (but still using the IWC-based mode). In both cases the uncertainty is reduced by a factor of roughly 3 (when the dBZ-based mode is used), L437: you use Figure instead of Fig. like in the rest of the paper. L472: reveal little on the performance of (the) tested particle models L495: Please review "they puts fairly [. . .]" formulation/grammar L500: typing error. "too" should be "to".

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