

## ***Interactive comment on “Non-Gaussian Bayesian retrieval of tropical upper tropospheric cloud ice and water vapour from Odin-SMR measurements” by B. Rydberg et al.***

**Anonymous Referee #2**

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This is an important and innovative manuscript because it is the first microwave limb sounding article that considers the inhomogeneous ice cloud problem and simultaneously retrieves water vapour and ice mass. The procedure of generating 3D fields of ice cloud parameters from CloudSat reflectivity slices is clever and generally appropriate. The inversion method introduces a priori information in a transparent manner. Comparing the joint distribution of the a priori and actual Odin-SMR microwave brightness temperatures is insightful. The authors thoroughly consider the error sources of the retrieval, and compare their new retrieval results with their previous algorithm results and with water vapour and ice cloud retrievals from other microwave limb sounders. The presentation is well organized, the writing is generally clear, and the figures are

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appropriate. The only major disappointment is the use of a fixed parameterized ice particle size distribution and ice spheres for the scattering calculation, which is a step backwards from Rydberg et al. (2007).

Specific comments:

1. Given that the procedure for generating ice particle size distributions from radar reflectivity in Rydberg et al. (2007) included variations in the mean particle size and width of the distribution, there ought to be a stronger justification for not using that procedure in the current algorithm. Was there a computational limitation? The current method underestimates the IWC retrieval error, as the authors acknowledge, but their simple means of adding in estimated errors from the previous 1D retrievals is not particularly satisfying.
2. The problem with using mass equivalent ice spheres for the scattering calculation is not only one of polarization. At submillimetre-wave frequencies the scattering properties (e.g. extinction and asymmetry parameter) of mass equivalent ice sphere deviates substantially from more realistic, low density ice crystal habits. This issue should be explored and discussed more thoroughly.
3. There should be a little more explanation of how the retrieval accuracy is determined (e.g. in Figs 7 and 9).
4. In Section 6.2 there should be more emphasis on comparing the 3D a priori IWC retrievals with purely 1D retrievals, since that is the novel element of this new retrieval algorithm.
5. I question whether the CloudSat-c IWC averaging method is appropriate because it uses the averaging kernel of the SMR retrieval algorithm, and is thus not independent of the current retrieval algorithm. Isn't the goal to compare the IWC averaged over the same physical volume, and not considerations of correlations between layers due to the retrieval algorithm? Some discussion of this issue would be appropriate.

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