Comment on amt-2022-247

Anonymous Referee # 5

Referee comment RC5 on "Retrieval of Terahertz Ice Cloud Properties from airborne measurements based on the irregularly shaped Voronoi ice scattering models" by Ming Li et al.

General comments

This study compares the capability of the Voronoi and sphere models in the retrieval of IWP and re using aircraft-based terahertz measurements. The study shows that the Voronoi model can provide promising results as compared to Evan's Bayesian retrievals using data from the CoSSI instrument. The inversion algorithm among the Voronoi and Sphere models suggests that the Voronoi model is better than the Sphere model. The paper seems clear and well-written. From the single-scattering properties of ice particles to the ice cloud retrievals, the structure is complete, and the analysis is quantitative. In my opinion, this paper could be a good supplement to the development of ice cloud terahertz remote sensing. The topic presented in this study is suitable for Atmospheric Measurement Techniques. I recommend Minor Revisions for publication.

Response: Thank you very much for your significant comments.

Specific comments

1. Are those comparisons between the single-scattering properties of the Voronoi and Sphere models under the same complex refractive index of ice particles? Please add the real and imaginary parts of the refractive index at 325 and 874 GHz in Figures 2 and 4.

Response: According to the comments, we have added the refractive index in the caption of Figures 2 and 4 as shown below.

"Figure 2: The extinction efficiency, single-scattering albedo and asymmetry factor as functions of the SZP for the Voronoi, Column and Sphere ICS models with a refractive index of $1.78 + 0.005i$ in the (a, c, e) 325 GHz and $1.78 + 0.015i$ in the (b, d,

f) 874 GHz frequencies."

"Figure 4: The scattering phase functions for ice particles with four sizes (R_e = 30, 71, 107 and 153 μm) for the (a, d) Voronoi, (b, e) Sphere and (c, f) Column ICS models with a refractive index of 1.78 + 0.005*i* in the 325 GHz and 1.78 + 0.015*i* in the 874 GHz, respectively."

2. In the paper, the $BTD_{1\text{-}3}$ may be confused with the $BTD_{1\text{-}2}$-$BTD_{2\text{-}3}$. Please confirm the Acronyms throughout the manuscript.

Response: According to the comments, we have replaced the $BTD_{1\text{-}2}$-$BTD_{2\text{-}3}$ with $BTD_{1\text{-}3}$ and have unified them in the revised manuscript. The relevant descriptions are shown below.

Lines 221-223: "The difference between the 640 GHz BTD and the 874 GHz BTD is simplified to $BTD_{2\text{-}3}$. And the difference between the 380 GHz BTD and the 640 GHz BTD is simplified to $BTD_{1\text{-}2}$. We named the difference between the $BTD_{1\text{-}2}$ and $BTD_{2\text{-}3}$ as $BTD_{1\text{-}3}$."

3. In Figure 6, the brightness temperature differences at 640GHz are shown, albeit not used in the following retrieval. Please give explanations or redraw Figure 6.

Response: According to the comments, we have replaced BTD_2 with $BTD_{2\text{-}3}$ in Figures 6 and 7, as shown below.

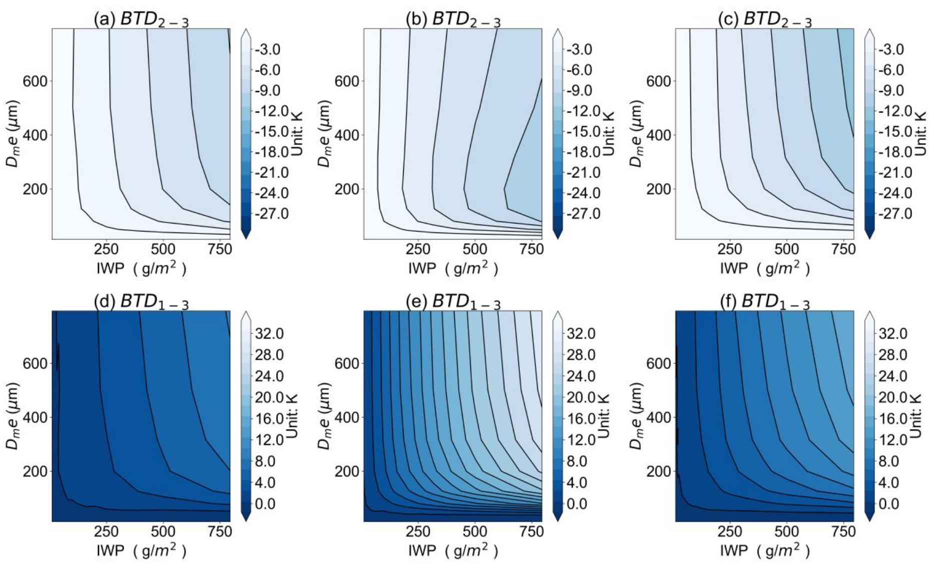

Figure 6: The $BTD_{2\text{-}3}$ and $BTD_{1\text{-}3}$ for the (a, d) Voronoi, (b, e) Sphere and (c, f) Column ICS models as functions of the IWP and D_{me}, respectively.

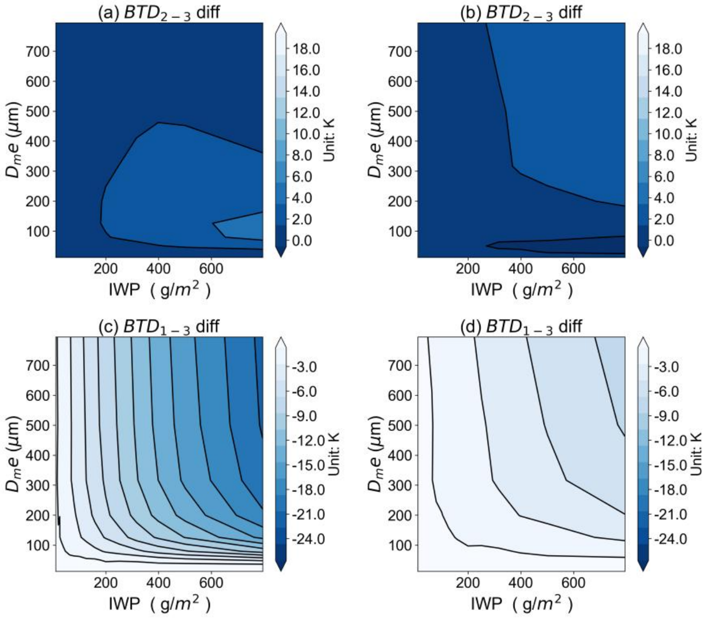

Figure 7: The difference of BTD_{2-3} and BTD_{1-3} for the (a, c) Voronoi minus Sphere ICS models and (b, d) Voronoi minus Column ICS models as functions of the IWP and D_{me}, respectively.

4. I recommend the authors give more possible explanations about why large difference exists for large ice particles in the result section.

Response: We have added reasons on lines 261-264 as shown below.

Lines 273-277: "On the one hand, the higher extinction efficiency and single-scattering albedo of the Voronoi ICS model for large particles are possibly due to the multifaceted shapes of the Voronoi ICS model, which can result in significant side and backward scattering and increase the scattered energy. On the other hand, for large particles, the higher asymmetry factor of the Voronoi ICS model is possibly because the scattered energy is dominated by diffraction. The diffracted energy is concentrated in the forward direction, leading to a large asymmetry factor."