

Comment on acp-2021-208

Anonymous Referee #3

Referee comment on "Investigation of ice cloud modeling capabilities for the irregularly shaped Voronoi ice scattering models in climate simulations" by Ming Li et al., Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2021-208-RC3>, 2021

General comments

This study focuses on the comparison of Voronoi model with four other ice cloud models. For the validation purpose, authors used CERES data. Authors conclude that Voronoi model based results are closer to CERES data than results obtained from other cloud schemes. The overall goal of the study looks interesting; however, the paper is poorly organized with several mistakes in English writing, literature reference, equation citation, and so on. The discussion part is also poor.

Specific comments

- Figure 1 shows single scattering properties of only Voronoi model, though Figure 3 shows band averaged values for all cloud models. Why not to show the single scattering properties for all models in Figure 1? It can make easy to understand Figures 3 and 4 as well as other results.
- It may be better to show the difference in terms of percentage (relative values) in Figure 4.
- There is an unclear description about particle size distribution (PSD) of ice clouds. Authors state that they utilize 14408 groups of microphysical data. Do authors use a single or multiple PSD function in this paper? For clarity, it is important to describe how PSD function is derived from 14408 groups of data to use in this study. If possible, PSD is suggested to be shown. If not possible, authors may tabulate the parameters of PSD function(s) used in this study.
- Figure 2 is not clear. It may be removed or improved. The methodology is well understood even without Figure 2.
- Equations are described in the text very randomly. For example, in section 3, Eq. 7 is described after Eq. 2. Equations and Figures are needed to appear in the text ascending order.
- What is the necessity to integrate over wavelength in Eq. (7) ?

- Eqs. 11-13: Equations corresponding to long wavelength bands need to be rewritten or a symbol to represent S and J may be used and stated below those equations.
- Authors state that the wavelength range is from 0.2 micron to 15 micron for Voronoi database and they assumed unchanged properties for wavelength larger than 15 micron. What about database for other cloud models? Do they also have such assumption? If such assumption is only for Voronoi database, what are the effects in results shown in Figure 3 and onward?
- Authors discuss about cloud forcing in Eq. (14). Can authors also discuss about the comparison of downwelling and/or upwelling fluxes for cloudy scenario between CERES and each cloud scheme? I guess comparison of fluxes rather than cloud forcing may help to better understand the performance of each model.
- How water cloud is treated here is not clear. Authors may describe a more about water cloud properties and how they are merged with ice clouds in the simulation. Authors may add information (height, properties etc) related water cloud in Table 2.
- What is Downward flux in Figure 5. Is it Direct+Diffuse flux? please clarify. If it is Direct+diffuse flux, why is it largely different than Difdown flux for a cloudy condition? Are clouds optically very thin for such difference?