

Second Review for Geoscientific Model Development (GMD)  
29 August 2022

Title: Impacts of Ice-Particle Size Distribution Shape Parameter on Climate Simulations with the Community Atmosphere Model Version 6 (CAM6)

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MS type: Model evaluation paper

Reviewer 1 response to the author's response concerning General Comments of 1<sup>st</sup> review:

The authors have done an outstanding job in replying to the review comments under General Comments. I recommend that a portion of this analysis provided by the authors be included in the final publication of their manuscript.

First, it's good news that, as the authors state, "We are in complete agreement that it would be more realistic and useful to evaluate the impact of changing  $\mu$  from 0 to  $-1$ ." Given this, there should be some discussion about this in the revised manuscript, providing a rationale for limiting the study to positive (or zero)  $\mu$  values.

The analysis provided in the author's response reveals a limitation in the use of gamma functions for representing ice cloud PSDs in climate and cloud-resolving models. I suspect most investigators are not aware of these limitations, and therefore recommend that Fig. R1 and an updated Fig. 1 (similar to Fig. R2) be included in the manuscript. However, I recommend using  $\mu = -0.5$  rather than  $\mu = -0.6$  (used in Fig. R1 and R2) to show that  $\mu = -0.5$  might be a reasonable lower limit for employing gamma functions to realistically approximate PSDs in ice clouds. That is,  $\mu = -0.6$  in Fig. R2 (left panel) indicates most of the ice particle number concentration  $N_i$  is associated with ice particles having a radius  $> 1$  micron, and this would be even more true for  $\mu = -0.5$ . Identifying this lower limit for  $\mu$  should be very useful information for investigators that parameterize ice PSD using gamma functions. As the authors noted,  $\mu = -0.9$  is unrealistic since it predicts  $\sim 2/3$  of the ice particles are having sizes  $< \sim 1$  micron, and such particles are generally counted as aerosol (not as ice crystals).

I have no further comments as the authors have satisfactorily addressed all of my other comments.