

Geosci. Model Dev. Discuss., referee comment RC3
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Comment on gmd-2022-67

Anonymous Referee #3

Referee comment on "Improving snow albedo modeling in the E3SM land model (version 2.0) and assessing its impacts on snow and surface fluxes over the Tibetan Plateau" by Dalei Hao et al., Geosci. Model Dev. Discuss., <https://doi.org/10.5194/gmd-2022-67-RC3>, 2022

This study incorporates several new features into the representation of snow albedo in the E3SM model, including non-spherical snow grains, internally-mixed dust and black carbon within ice grains, and sub-grid topographic effects. The study assesses the impacts of these improvements on the simulated snow cover and surface energy budget, including impacts of individual effects as well as the combined effects of all model changes operating simultaneously. Overall, the paper is well-organized and very well-written. I have only a few minor comments, and I recommend that the manuscript be published after these are addressed.

Minor comments:

Section 4.3: In the sensitivity studies that apply internal mixing of LAPs, are all of the particles assumed to be internally-mixed, or only the proportion of deposited aerosol that was simulated to be internally-mixed? (And is that proportion actually simulated? My understanding is that the MAM aerosol model simulates the mixing state of aerosols, so that information could, in principle, be utilized, but it is not clear that such information is being extracted and utilized in the model experiments). Either way, please expand the discussion on this issue, including any implications for the magnitude of impact assessed in the sensitivity studies.

line 115: "... control ELM simulation with the default settings..." - Please clarify whether the default settings are the old or new default settings, i.e. with or without all of the changes described in this study. The use of "control" would generally imply the original configuration, before any changes are implemented.

Line 318: "... because LAP-induced SAR is larger in spring ..." - While the model SAR is

definitely larger in spring than winter, it is not totally clear from Figs 3 and 4 that the *observed* SAR is larger in spring. (And I am surprised that it is not, given the likelihood of melt-induced surface accumulation during spring and higher frequency of springtime dust storms in this region). Please comment on this.

Line 394: "Overall, the effects of mixing state of dust-snow are smaller than the effects of mixing state of BC-snow." - Why? Please explain.

Line 511: "... but the real snow grain shape may be more complicated and irregular..." - I think you can safely say that the real snow grain shape *is* more complicated and irregular.