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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Black carbon-induced snow albedo reduction over the Tibetan Plateau: Uncertainties from snow grain shape and aerosol-snow mixing state based on an updated SNICAR model" *by* Cenlin He et al.

Anonymous Referee #2

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In this paper, the authors study the impact of snow grain shape and black carbon (BC)-in-snow mixing state on snow albedo and BC-snow radiative effects. The authors update the SNICAR model by introducing new sets of parameterizations for snow optical properties based on snow grain shape and BC-in-snow mixing state. The updated SNICAR model is used to reproduce spectral observations of pure and BC-contaminated snow, and is applied to field observations across Tibetan Plateau to illustrate the impact of snow grain shape and BC-in-snow mixing state on regional BC-snow radiative effects. The discussions and figures are clear and well organized in

general.

Specific comments:

1. Table 1: For field observations that did not measure underlying ground albedo, the authors assume an albedo of 0 for SNICAR computation; while the underlying ground albedo rarely reach 0 even for dark soil. The snow depth for some of these measurements is shallow, that some light may penetrate through the snowpack. Is there any reason that the authors assigned 0? Perhaps consider adjusting underlying ground albedo to see if this will impact the comparisons show in Figure 6 and 7.

2. Table 1: For field studies that report snow effective radius, how did they define/measure/derive the snow effective radius? Do they use similar assumptions as the spherical snow grain in SNICAR?

3. Lines 325-326: the authors say they "... made reasonable assumptions for cases when measurements are absent". The readers may wonder what are these "reasonable assumptions" and how did authors justified these assumptions. Perhaps including some details on, for example, how to assign underlying ground albedo (comment 1) when measurement is absent, and etc.

4. Table 2: The zeros in albedo reduction values can be distracting that prevent direct comparisons across regions; perhaps consider keeping only the non-zero digits and modify the unit.

5. Lines 340-342: in Figure 6a, as the authors mentioned, the snow grains created in Hadley and Kirchstetter (2012) tend to be spherical, yet the nonspherical grain assumption yields better results. What does this imply for future modeling/field works regarding snow grain shape and snow grain size? Does this mean even if the snow grain shape is relatively well observed in the field, the snow radiative transfer modeling based off the observed grain shape may not improve the snow modeling? Or in another word, to what extend should radiative modeling rely on field observed snow grain

shapes since it seems, from figure 6b, the model can always adjust snow grain size to match observations, no matter what grain shape it adopted.

6. Figure 6b and 7d: it seems that the model simulations fail to capture the drop of snow albedo around 0.25 um observed by Brandt et al., 2011. Is there any explanation?

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