The Cryosphere Discuss., 8, C239–C241, 2014
www.the-cryosphere-discuss.net/8/C239/2014/

The Cryosphere Discussions
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8, C239–C241, 2014

Interactive comment on "The effect of snow/sea ice type on the response of albedo and light penetration depth (e-folding depth) to increasing black carbon" *by* A. A. Marks and M. D. King

Anonymous Referee #2

Received and published: 15 March 2014

Review of "The effect of snow/sea ice type on the response of albedo and light penetration depth (e-folding depth) to increasing black carbon," by Marks and King, submitted to The Cryosphere.

This paper discusses the response of albedo and e-folding depth of three different types of snow and three types of sea ice to increasing black carbon using a coupled atmosphere–snow/sea ice radiative transfer model. While the study is straightforward and the literature review almost complete, there are some issues related to the inconsistency among parameters chosen. As such, I will recommend that the authors reconsider the scenarios they chose to remove this inconsistency and address the other comments below.

The asymmetry parameter equals the single-particle forward scattering efficiency divided by the single particle total scattering efficiency. The scattering cross section is also proportional to the single-particle scattering efficiency. Yet, Table 1 indicates that the same asymmetry parameter is assumed for different scattering cross sections. The asymmetry parameter should be calculated consistently with the scattering cross section and should not be independently varied.

Similarly, the density of snow or ice will depend on the grain size, which also affects the scattering cross section, asymmetry parameter, and optical depth through the snow. Yet, in Table 1, the authors are varying density independently of the other parameters, so there seems to be an inconsistency. In other words, it is probably not realistic that one would find the conditions of density, asymmetry parameter, and scattering cross section that the authors assume in Table 1. The authors should define the most basic input parameters (e.g., grain size, refractive index, mass concentration of black carbon, size of black carbon inclusion), and calculate all output parameters from those (e.g., scattering and absorption cross sections, density, asymmetry parameter, single-scattering albedo, etc.).

The authors should compare their prediction of spectral albedo for some base case with predictions from another study or data to ground-truth their model.

How does the refractive index of black carbon used compare with that recommended in Bond et al. (2013)?

Solving for surface albedos with upward divided by downward surface irradiances over snow and sea ice with an atmosphere-snow-sea-ice radiative transfer model treating black carbon inclusions in and between snow and sea ice grains was previously done in Jacobson (2004). Calculated albedos over both sea ice and snow for different conditions, including grain size, were given in Figure 1 of that paper. It seems the methodology used in the present study is quite similar but the tests were different and the method of calculating optical properties was different. Please indicate whether this is the case.

Interactive comment on The Cryosphere Discuss., 8, 1023, 2014.