

Interactive comment on “Satellite-based radiative forcing by light-absorbing particles in snow across the Northern Hemisphere” by Jiecan Cui et al.

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Aside from the Data Statement section, the authors responded to my comments, but did not make changes to the manuscript addressing my suggestions in my Access Review. Given the preliminary nature of the Access Review, that's fine with me, but during this formal review stage I ask that my comments be addressed in the manuscript. I have provided a copy of the Access Review below.

Limitations:

In the manuscript, the authors have not addressed the problem of distinguishing be-

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tween absorbers in the air and on the snowpack as stated by Warren (2013). Some of the regions examined have extensive air pollution. The MCD43C3 albedo product used relies on MOD09 surface reflectance which masks out snow when estimating aerosol optical thickness. Snow is difficult to mask, and the “dark and dense vegetation technique” used to estimate aerosol optical thickness (Vermote & Saleous, 2006) has shown errors over snow cover in the past that have supposedly been addressed (Vermote et al., 2002). However, one can still find errors. For example, MOD09 surface spectra sometimes show strong hook features over relatively clean fully-snow covered pixels in the visible wavelengths that are not present in the top of atmosphere reflectances and can only be ascribed to problems with atmospheric correction. I’m not suggesting that the MCD43C3 product is unsuitable, rather I’d like to see its limitations over snow discussed in the manuscript. Saying that “more [sic] in-situ observations and hyperspectral imagery are needed..” is not a sufficient response.

MYD10C1 does not use spectral unmixing; it uses the 2-band NDSI which shows high scatter when converted to fractional snow cover using Equation 5. Thus, the fractional snow cover filter used is an undiscussed bias in the approach, where LAP could be mistaken for non-snow objects and vice-versa.

Note that MODIS is a multispectral, not a hyperspectral sensor.

Exclusion of midlatitude mountains and other vast snow-covered areas in the Northern Hemisphere is substantial and should be stated in the Abstract. As Referee #1 and #2 both point out, the domain (non-vegetated & non-mountainous areas) and time periods (Jan-Feb) are limited. These limitations undermine global application (e.g. p3 l1 & p6 l2).

NB 5/20/2020

_____ Access Review from 4/4/2020

Further discuss limitations

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Consider addressing the challenges in measuring LAP stated in Warren (2013) directly, such as distinguishing between absorbers in the air and those in the snowpack.

Equation 5 when applied in the MOD10A1 product shows an RMSE of 0.227 and a positive bias of 0.11 (Rittger et al., 2013). These errors and biases are important because darker objects at visible wavelength in mixed snow-covered pixels (e.g. shadows and vegetation) can be misidentified as LAP.

Section 3.2.3

This basis for the snow grain size retrievals cites studies (Nolin & Dozier, 2000; Painter et al., 2013; Seidel et al., 2016) which use hyperspectral imagery at an more than order magnitude greater spatial and spectral resolution than a multispectral instrument like MODIS. The authors are relying on the albedo retrieval from a single MODIS band at 1.24 μm to estimate grain size. This approach has high uncertainty due to errors in albedo retrievals from MODIS. In a previous study, Pu et al. (2019) state the MAE is 71 μm or 3 times greater than in the studies cited above using hyperspectral instruments.

The previous two comments suggest why substantial correction factors for the remotely-sensed measurements (Section 4.3) are needed.

Section 4.1

The study area does not include most of the midlatitude mountains in the northern hemisphere. Snow and ice melt in these areas provides a valuable water resource to over 1B people worldwide (Barnett et al., 2005) and studies cited by the authors in the Introduction (Painter et al., 2012; Seidel et al., 2016) show this snow is heavily affected by LAP.

Data availability

No data statement is provided. Please see the ACP Data Policy which requires a statement of how the data can be accessed.

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