

## ***Interactive comment on “Investigating the Impact of Aerosol Deposition on Snow Melt over the Greenland Ice Sheet Using a Large-Ensemble Kernel” by Yang Li and Mark G. Flanner***

### **Anonymous Referee #2**

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This paper presents the results of a high number of model simulations performed to derive runoff from Greenland Ice Sheet as a function of black carbon deposition. The model is using state-of-the art snow model, which includes interactions of Light Absorbing Impurities (LAI) with solar radiation, as well as scavenging by meltwater. They also provide linear equations that relate the increase of total runoff to black carbon deposition. Their results could be used by climate models, which don't have a sophisticated snow model but would like to estimate total runoff from Greenland for a given black carbon deposition rate.

The paper is well written, their approach valid, and their results interesting. I have only

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few minor comments.

Minor comments: All the figures showing time series with one line per month would gain in clarity by reducing to one month per season.

Are you assuming linearity of surface albedo change by black carbon deposition and metamorphism of snow grains? Should there not be another entry in the kernel for surface temperature?

It is unclear if the timestep of the snow model is one month, or sub-daily with the kernel data calculated as mean monthly values. If the timestep is monthly then the results for sub-daily timestep may have been quite different. At least an estimated error should be provided in such case.

Another needed precision is about spatial resolution. Line 98 we learned that CRUNCEP input data is 0.5 degree resolution. Is it the same for CLM and the kernel data?

Line 141 “dry” should be “wet”

Line 177: “. . . as new snowfall dilutes the contaminated snow”. Are you mixing layers and not superimposing them? LAI cannot move up in your model, right?

Lines 249-252: Is this due to an amplification effect by metamorphism of snow?

Line 262: “runoff . . . higher temperature” Is this increase of runoff by higher temperature due to darkening by black carbon or larger grain size?

Lines 279-280: “higher light absorptivity of hydrophilic BC” seems to contradict the values of single scattering albedo provided for black carbon in Table 3.5 of Oleson et al. (2013). The single scattering albedo of hydrophobic black carbon is lower than hydrophilic black carbon, indicative of stronger absorption by hydrophobic BC.

Line 281: “weakly-absorbing sulfate” Sulfate is purely scattering.

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