The Cryosphere Discuss., 9, C278–C280, 2015
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The Cryosphere
Discussions
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Interactive comment on "The impact of Saharan dust and black carbon on albedo and long-term glacier mass balance" *by* J. Gabbi et al.

Anonymous Referee #2

Received and published: 29 March 2015

This paper uses impurity concentrations from ice cores, atmospheric data, and mass balance measurements to reconstruct the radiative impact of dust and black carbon on energy and mass balance at two sites on a glacier in the Swiss Alps. Overall I think this is well written paper that presents important research that contributes to a growing body of literature of the impacts of dust and black carbon on the cryosphere.

There are revisions that would improve this paper. 1) Given than the impurity concentrations, mass balance, and atmospheric forcing measurements did not come from the same location, and some highly simplifying assumptions were made, it is good a sensitivity study was carried out- but I found this section to be too brief, lacking in detail, and would benefit from expansion and clarity. 2) The location of the study should be added to title as the relative ratio of dust to black carbon estimated from the core

measurements is specific to the Swiss Alps, and would not be the same for glaciers in say, the Himalaya, or the Andes. 3) I found it very interesting that the impact on mass balance attributed to BC deposition falls within the mass balance impact in the Alps by BC in the 1900's put forth by Painter et al., 2013, a paper which suggested that black carbon was the driver behind the retreat of glaciers in the Alps at the end of the Little Ice Age. The results presented here helps to validate the claims made by this earlier paper, and the relevance of this paper could be greatly expanded by tying back the results of this study (to those in Painter et al., 2013) in the conclusion. 4) Don't be afraid of commas! I found many long sentences in this manuscript that could be clarified with the use of a few commas. 5) Description of radiative forcing calculations needs to be broadened/clarified.

Line by line revisions/comments: 1134, Line 4: Remove 'Saharan' qualifier here, it unnecessarily specific for the abstract

Abstract: Consider including impact on mass balance

1135 Line 6: Consider changing 'involving' to 'perturbing'

1135 Line 13: Long-range transported crustal impurities accounts for 2/3 of the dust... where does the rest come from? Local landscape?

1135 Line 22: Consider including Bond et al., 2013 as a reference in addition to Ramanathan and Carmichael, 2008 (DOI: 10.1002/jgrd.50171)

1136 Line 7: Consider including the region for the studies completed by Skiles and Painter (Colorado River Basin, Western US) as you do for the other cited studies

1136 Line 20: The sentence starting with 'We have chosen...' should be restructured with commas, split into two sentence, or rewritten.

1137 Line 9: Were density measurements made in the snow pits or with a SWE sampler?

1138 (study site and data): Please clarify how black carbon is estimated after 2002 and dust after 2007

Section 3.1.1, line 5-15: Consider clarifying here that study done by Kaspari et al., 2014 was carried out in the Himalaya, not the Alps. Also, this study used gravimetric mass for their analysis, but found that there is linear relationship between Fe concentration and gravimetric mass (using a very small set of samples).

Section 3.4 Line 19, 20: Reword this sentence. You used wet deposition in the model, this is fine, I suppose, but you should use caution in stating this is the predominant mechanism! This is not well known or well established. Dust deposition events in particular are almost pre-frontal, when wind speeds are high enough to transport dust from the source region.

Section 4.1.3 Lines 1-5: Rewrite. Basically you are trying to say there was more dust, but black carbon is more absorbing, but your wording is confusing.

Section 4.1.3 Line 9: 'Absorbent' to 'absorber'

Section 4.1.3 Line 9: The influence of BC is already stronger than dust. Reword.

1151, Lines 5-8: This sentence is circular and confusing- reword.

1153, Line 22: is the mountain snow cover of the Colorado River Basin, not the 'Colorado Plateau', which is a desert

End of Section 5.1: I think it would be sufficient to say the results are not directly comparable because dust/BC sources and melt dynamics are different. (I think you have an extra word ' often' on the last line of page 1153)

Section 5.2: Can you give an overall estimate of uncertainty?

Interactive comment on The Cryosphere Discuss., 9, 1133, 2015.