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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Preliminary estimation of black carbon deposition from Nepal Climate Observatory-Pyramid data and its possible impact on snow albedo changes over Himalayan glaciers during the pre-monsoon season" *by* T. J. Yasunari et al.

Anonymous Referee #2

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This study applies observations of atmospheric black carbon (BC) concentrations from a remote high altitude observatory in Nepal to infer potential pre-monsoon snow albedo changes caused by BC. Starting with the observations, the authors make conservative assumptions of deposition velocity, mixing within surface snow, and BC-albedo reduction to argue for a lower bound on the effect of BC on Himalaya snow albedo and glacier runoff. Although numerous assumptions are made, this study has the benefit of starting from real observations, the applicable scope of the results is cautiously de-

fined (for the most part, see one exception below), the analysis is acknowledged to be preliminary, and there are several compelling reasons presented why the actual effect is larger than that quantified here. Overall, I think it is a useful study and should be published after (relatively minor) issues listed below are addressed.

I reviewed this study several months ago when it was submitted to a different journal. The authors have since bolstered their argument and elaborated considerably on their methods, addressing several concerns I originally had including: 1) quantification of dilution from any precipitation falling during the pre-monsoon season (they also quantified enrichment resulting from sublimation, which they show to be likely greater than precipitation during the pre-monsoon season), 2) some discussion of why 2cm was chosen as the particle mixing depth (although this assumption still seems somewhat arbitrary), 3) further justification/explanation for deriving deposition velocity from atmospheric concentrations, and 4) quantification of albedo perturbation using different assumptions of environmental conditions (snow grain size, etc).

Issues:

1) There is one important point which is made only in Conclusions, which I think needs to be raised earlier in the manuscript: (p9311,2): "Our results are applicable to white glaciers only (not for debris cover glacier)". This is a very important point because ablation zones of glaciers typically ARE debris covered, and this could significantly reduce the influence of BC (perhaps even beneath the current lower bound). I suggest stating this qualification earlier in the manuscript, and referring to "white" or "clean" or "non-debris covered" glaciers throughout the text (i.e., p9305,26: "our numbers are likely to underestimate the actual albedo reduction for Himalayan glaciers").

2) In the abstract and conclusion (and perhaps elsewhere) "dust deposition" is mentioned in context suggesting that neglecting it leads to a conservative estimate of the BC effect. However, the simultaneous presence of dust (as with debris) may DECREASE the influence of BC by absorbing photons in place of BC. Please describe

more clearly the likely (sign of) effect of neglecting dust on your lower bound estimate.

However, you also appear to have good justification for neglecting dust in your analysis, based on your statement (p9298,19) that "Marinoni et al (2010) found negligible dust contribution to aerosol absorption coefficient at NCO-P". If this is a robust result, you may wish to mention it in the context of excluding dust from your quantification of albedo reduction by BC.

But are low dust concentrations robust? p9308,19: "Highest concentration was detected from a dirty layer": Were other impurities contributing to the "dirtiness" of this layer? If not, wouldn't (by definition) the highest concentrations be detected in the dirtiest layer?

3) It is assumed that all BC depositing during March-May mixes within the top 2cm of snow, and that dilution occurs only through precipitation (and enrichment through sublimation). But what about snowmelt, especially during May when temperatures rise above freezing? Melt would certainly remove (from the top 2cm) some of the particles that deposited during the last several months (although it could also expose particles that deposited earlier in winter). Please include some discussion of the potential effects of melt on your estimates of BC concentration.

4) The discussion could be more concise in some places, which would improve readability.

Minor issues:

p9301,14: "direct depositions": I assume it is specifically DRY deposition which enhances the top-2cm concentration.

p9301,19: "deposited in 2-10cm snow": Maybe change to "concentrations in 2-10cm snow", as aerosols are not "deposited" directly in subsurface snow.

p9302,2-6: This passage is unclear to me.

p9306,7: Clarify/correct: "Ice surface is sometimes come up over glacier surface"

p9309,18-21: This passage needs to be clarified.

p9311,22: Please clarify the meaning of "equilibrium albedo reductions in the mixture of the impurities."

Fig 7: What do the symbols represent? Include this in the caption.

Fig 8: Should the runoff have units of timeˆ-1 (perhaps mm dayˆ-1)? The curve does not appear to be accumulated (time-integrated) runoff, so I assume the units should have time.

Interactive comment on Atmos. Chem. Phys. Discuss., 10, 9291, 2010.