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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Measured black carbon deposition on the Sierra Nevada snow pack and implication for snow pack retreat" *by* O. L. Hadley et al.

Anonymous Referee #1

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General comment

This paper by Hadley et al. addresses important observations on the processes of black carbon (BC) removals by snow and rain. In addition, they discussed related possible snow albedo reductions. In my understanding, still not so many black carbon observations in snow have been carried out in the world rather than other aerosol studies in snow. The knowledge obtained from this study will be useful to compare with other related studies on BC concentrations in snow and wet deposition process of BC. Hence, this study is worth publishing in ACP. However, still some points have not been clear and the authors should clarify those points before published.

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Specific comments

1. The BC concentrations of mostly less than 10 ng g-1 in snow at 3 sites in Table 1 are in general lower levels of BC concentration. Then, measurement or sample treatment contaminations may impact on these lower concentrations of BC to some extent. The authors briefly mentioned the instrument, RWS, for rain water samplings, but still I do not know how much contaminations come up in the process collecting snow or rain samples. For example, I think tubes used in the instruments for melt water flowing may be always the same. If some cleaning processes have been carried out every sampling, the contaminations will be reduced. If not, some contaminations from the previous sample affect the next sample to some extent. In addition, the authors mentioned capture efficiency of BC. However, totally estimated measurement errors on BC concentrations shown in Table 1 in rain or snow samples were not mentioned. How much was the estimated measurement error in this study on BC concentration in snow or rain samples? The authors should explain these things.

2. The authors mentioned (p.10469, lines 9-13) dilution effects by required large amount of water on the measurement. If the BC concentrations in the atmosphere are close to constant together with increasing pure (or less contaminated) rain or snow, this discussion may be true. However, if there are continuous contributions of polluted air masses by advection during rainfall or snowfall, this discussion is not always true. In those cases, existing polluted air in the atmosphere interrupt reducing dilution effect to some extent because it may contribute to increase BC concentration in snow by increasing wet depositions of BC. I can see some cases of relatively higher BC concentrations in snow together with less precipitation in Table 1. I think these cases imply the polluted air advections in the atmosphere occurred and that is why higher BC concentrations in snow were seen even if less precipitation were observed. To make your discussion clearer, I recommend authors to carry out a few days backward trajectory analysis by HYSPLIT or other trajectory tools for each time of rain or snow samplings. If the air mass was directly coming from non BC-generated areas such as ocean, the BC

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contributions should be less. Then the authors can understand whether each sample was affected by dilution effect or not.

3. In Sect. 4, the authors estimated how much snow albedo can reduce due to the BC concentration in snowpack as shown in Fig. 2. They initialized the model setting for the calculation timing at the end of March. That was melting season and snow grain size may be larger than snow accumulation season. The period for the snow samplings included both snow accumulation and melting periods. However, they used the assumption of snow grain size of 100 μm for fresh snow. Mixed situations of fresh and old snows are confusing. The authors should separate the plots into new and old snow cases. In addition, snow samples corresponding to snow accumulation and melting periods should be also separated for the plots. Just before the authors' paper was published in ACPD, a paper by Yasunari et al. (2010) on the relationship between snow albedo reductions and BC concentrations in snow over Himalayas had been published in ACPD too. In their paper, they showed the regression equations between snow albedo reductions and BC concentrations for the cases of external and internal mixtures of BC together with fresh and old snow cases based on the previous studies such as Hansen and Nazarenko (2004), Warren and Wiscombe (1985), etc. These equations in their paper may be also useful to discuss above.

4. The authors mentioned (p.10472, lines 19-27) some previous studies on BC/dust ratio. However, the authors only showed the values of Asian BC/Total BC ratio. It is confusing me. They used Eq.2 to estimate total soil mass concentration. Hence, first they should estimate BC/dust ratio to directly compare with the previous studies. How much BC included in total dust mass concentration observed at the sites?

Minor comments

1. P.10465, lines 5-10: No references were cited. Cite some references such as Warren and Wiscombe (1980), Wiscombe and Warren (1980), Aoki et al. (1999), Flanner et al. (2007), etc. In addition, check the other parts in Sect. 1 that cited proper references.

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2. P. 10470, line 4: Albedo reductions of 0.3% and 1.2% corresponding to what?

3. P. 10471, line 4: Why did the authors choose 6 hours (not 1, 2, 3, . . ., or 24 hours) prior to the onset of precipitation?

Interactive comment on Atmos. Chem. Phys. Discuss., 10, 10463, 2010.