Interactive comment on "Elemental carbon in snow at Changbai Mountain, Northeastern China: concentrations, scavenging ratios and dry deposition velocities" by Z. W. Wang et al.

Anonymous Referee #2
Received and published: 11 July 2013

We would like to thank the anonymous referee#2 for his comments and suggestions. The manuscript has been more or less completely rewritten, with modifications as required and a new section has been added on the potential climate impact of such BC concentrations on the snow albedo. The effect of wet and dry deposition on snow albedo has been estimated using radiative transfer model and presented. We hope than this revisited version of our work will now satisfy the ACP standard.

Comments by referee#2 are in black and the corresponding answer is below in blue:

1. The quality of English used in the manuscript is very low.
The manuscript has been rewritten completely. The manuscript is now 2 pages longer due to adding of a new section and details about uncertainties requested by reviewer#2.

2. Recently, several studies are available in literature on atmospheric values of EC/BC as well as EC/BC in snow over Himalayan regions (even a special issue in ACP ON Himalayan aerosols). Surprisingly, despite being a study from high altitude location, the authors made very limited comparison of the observations in the present study with the reported values from Himalayas.
Thank you for that remark. We have added some values reported in Himalaya for comparison of EC in snow and deposition fluxes of EC. We would like to mention that our station is not on in an elevated area, only 738 m a.s.l., not comparable to the high Himalayan plateau. Moreover, our station is much closer to the source of BC so that it shows obviously much higher concentration in snow but we do agree that considering the few available data in Asia, such comparison are interesting anyway.

3. Details of the uncertainties in Particle Soot Absorption Photometer measurements and Thermal/Optical Carbon analyzer needs to be provided.
Thank you for that remark. We have added several comments on the uncertainty of such methods in the section and detailed much more the protocols that has been used. Overall, uncertainty on thermo optical methods is estimated to be 30% and 10% for the determination of atmospheric values.

4. Details on the estimation of dry deposition flux should be provided.
We add more details about measurements and estimates of uncertainties of the evaporation rate that potentially increases the EC concentration in snow surface. The same details have been added for the dry deposition fluxes. The difference between the previous results is the estimate of dry deposition flux that is in fact two times higher. Reason is that we realize that the snow density value used was 100 kg m^{-3}, close to the observed precipitating value. Snow density increases over time, unless sublimation happens but this process is taken into account separately. Thus, snow density increases

over time and values higher than the precipitating snow should be used, mainly because we estimate the dry deposition by sampling old snow. The value used in this new version is 200 kg m^{-3}, meaning that the dry deposition flux is increasing by a factor of 2 as it directly depends on the snow density. This obviously changes the results of dry deposition but does not change the fact that most of the EC in snow is dry deposited. Indeed, the previous results showed that 77% of EC was dry deposited while now we estimate that 87% of the EC is dry deposited.

5. Authors are requested to add a section on the possible climate implication on scavenging of EC/BC by snow over Changbai Mountain. (eg. Flanner et al., 2007; Yasunari e al., 2012,... etc)

6. Add estimates of the snow albedo changes due to the observed EC/BC in snow over Changbai Mountain. How far the radiative forcing due to the snow albedo changes compares with the direct radiative forcing of aerosols over the same region.

A complete new section on that topic has been added. We have been using two radiative transfer models to estimate the impact of such EC values and the effect of dry and wet EC deposition on the albedo of snow. The two models are Snicar_online (Flanner et al., 2007) and Disort (Stamnes et al., 1988). Reasons are that Snicar can't model the effect of dry deposition as this online version is a single snow layer model. We compared both model to ensure that the wet deposition produces similar results and then uses Disort to calculate the effect of dry deposition. Even if our modeling work is very theoretical, our results shows that the direct instantaneous local forcing can reach 25 W m^{-2}, much higher than most of the values of the direct aerosol forcing, lower than 0.5 W m^{-2}. This value is obtained by comparing the effect on snow albedo of dry deposition of 500 pbb of BC over the snowpack to the same mass that is wet deposited.