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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Sensitivity studies on the impacts of Tibetan Plateau snowpack pollution on the Asian hydrological cycle and monsoon climate" *by* Y. Qian et al.

Anonymous Referee #2

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General Comments The manuscript is a valuable contribution that uses a series of numerical experiments to investigate various scenarios of black carbon, organic matter and dust in the atmosphere and deposited in snow vs. CO2 and the associated radiative impacts. While revisions are necessary to more fully address the treatment of dust in the experiments, the ability of the model to produce actual snow cover distribution, and the seasonality of snow cover fraction and snow water equivalent, the study is valuable towards assessing the role of absorbing impurities on the snowpack and hydrological cycle. Detailed comments/ suggestions are provided below.

Section 2.2 model evaluation: The authors overstate the ability of the model to capture

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the snow cover fraction (specifically p. 22863 ln 8). The model overestimates SCF for much of the plateau, which needs to be more clearly addressed in the text. Later results in the paper are based on seasonal variations for SCF, and also for regions that extend beyond that presented in Fig. 2. To be able to more fully assess the results presented in the paper, seasonal SCF variability (ideally modeled and from MODIS) must be presented, and needs to be expanded to encompass the full region presented in most figures (e.g., Figures 5, 7, 9 etc). Currently Fig. 2 only presents SCF for MAM, but SCF for other seasons are addressed in the manuscript without information on seasonally simulated SCF.

p. 22863 ln 12. BC content in snow is reported in ug/kg, but more information needs to be provided regarding what the authors mean by BC. Based on the concentrations provided I assume the authors are referring to BC as including refractory BC plus a portion of colored organics rather than refractory BC alone (which would have lower BC concentrations in this region). The ice core BC concentrations presented by Xu and Ming (which are used for comparison with the simulated BC) are based on methods that assign BC as refractory BC plus a component of colored organics (not just refractory BC).

p. 22863 ln 17. The assertion that the Indian summer monsoon transports BC to the S. slope of the Himalayas is incorrect (also on p. 22865 ln. 3). Observational studies (e.g., Marinoni et al., 2010) clearly show very low BC concentrations during the monsoon season (due to wet removal of aerosols during higher precipitation periods). The westerlies do transport absorbing aerosols during the winter-spring to this region.

Section 3.1. -How is dust defined and simulated? There is scarce information on dust in the manuscript- more details regarding dust are needed. More attention in general needs to be paid to the seasonality of aerosols (BC and dust) rather than just SCF. -BC and dust deposition in the Himalaya and TP peak during the winter and spring and have very low concentrations during the summer monsoon season. I'd like to see the manuscript more fully address that the seasonal importance of impurities in

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the snowpack is driven both by seasonality of snow on the ground and the timing of aerosol deposition. Summer monsoon precipitation has a very low aerosol loading. This is briefly addressed at the end of section 3.1 related to dust, but not to BC.

Section 3.3. The manuscript reports seasonal changes in SCF and SWE under the various scenarios, but never reports what the assumed initial SCF and SWE are. Authors need to provide information on inputs into the model of SWE and SCF for the full region interpreted in the figures, including seasonality.

p. 22869 ln 3 related to greater precipitation coming in the form of rain rather than snow. Relative changes are presented in the manuscript of changes in temp and SCF and SWE- is there substantial information to determine that more precipitation would occur as rain rather than snow? Many regions of the study area are at very high elevations where rain occurs infrequently (or never).

Tables and Figures: more detailed figure and table captions are needed. For example Fig 13 caption refers to Fig 12, which refers to Fig 7. This makes discerning what the figures are showing difficult. While each figure doesn't need to explain the model scenarios, the parameters shown in the figure should be clear from the caption, including seasons. So many captions referring to 'same as in Fig X' made it difficult to determine what was shown in the figures, and for which season (or months).

Specific Comments p. 22857 ln 24- reference needed for soot reduction of albedo. p. 22858 ln 1- local RF from soot in snow can be much higher ln. 10- sentence not clear- restructure portion related to TP above 2000m p. 22859 ln 9- observational or modeling studies? Section 2.1 ln 14- what is meant by annually repeating emissions? Is the seasonality of aerosols in the atmosphere included in the model? What is used for dust inputs? p. 22861 ln 17- include justification for multiplying organic carbon emissions by 1.4. p. 22863 ln 29 include references for measured BC in snow (and as stated prior it should be clear what is meant by BC). Section 3.2 and Figure 7. The greatest amount of warming occurs in NE China (as mentioned in text). Is this what is expected

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in reality? Without including information on SCF for this region this is harder to assess, but surprising that the warming in this region would be greater than that on the Plateau. Is this an artifact of the model, or is greater warming expected here? p.22868 ln 13. Again, if NE China is included in discussion of SCF, the manuscript needs to provide information on SCF for this region in Fig. 2. On numerous occasions in the manuscript the authors use the wording "We can find". Rewrite these sentences to avoid this wording- writing will be more succinct. p. 22873 ln 13- mean fig 12 (as opposed to fig 13)? p. 22873 ln 17- True during spring, but again, aerosol loading associated with the summer monsoon season is very low- well established in the observational record. p. 22875 ln 5- SH and LH need to be defined (sensible and latent) p. 22879- paragraph beginning line 8- how well constrained do the authors consider the seasonality of aerosol deposition, SCF and SWE? While improved models and higher grid resolution are key to improving this type of study, improved observational data is also needed to assess the validity of the model results. Observational data are currently scarce. Table 1- define PI and PD. Fig 2- needs to be expanded to encompass full study area, and show seasonality of SCF and SWE (not just MAM since other periods discussed elsewhere in manuscript). Fig 3- what is meant by in cycle? Is BC in snow data based on Xu and Ming, and if so, where does the data reflect (average concentration from cores; from which period?)? Fig 4 and p. 22864 ln 20- figure caption says annual forcing, text refers to MAM. Revise to make consistent. Fig 9- units needed for color bar. Is this %? Fig 11. Why are Sep-Dec excluded?

Interactive comment on Atmos. Chem. Phys. Discuss., 10, 22855, 2010.