Anonymous Referee #1

General comments:

- ***The paper has been sufficiently revised that it is very nearly suitable for publication. Overall the paper could use some editing for English/clarity/flow by ACP, as well as a few other very small changes. I note some examples of corrections to English below, but a more careful job by an editor would be very beneficial.***

We thank the further comments and editing from the reviewer. Text is revised as the reviewer suggested.

Specific comments:

- ***Both reviewers found the very large range in simulated BCS (Fig 7) surprising. In the replies to reviews, the authors explain why these values exist in the simulated BCS values but no such explanation has been added to the paper itself. I think the fact that both reviewers found this surprising means other will too, and therefore it merits some explanation in the paper itself. In the explanatory example shown in the reply (Figure r3), the large range in BCS is a result of there being effectively no new snow added to the snowpack after an initial snowfall (days 1-2 of the simulation). During the approx. 4 days following a snowfall event, there is a step-wise loss of snow water (presumably to a combination of sublimation and melt) and the addition of BC (presumably through dry deposition). In the model, I understand that when the top layer thickness decreases sufficiently, snow and the BC mixed with that snow from the layer below the surface are re-combined into the model top snow layer. However, before reaching this threshold that triggers layer "recombination", snow water is lost as an increasingly thin layer of the snowpack is being included in the "top layer". Thus, this thin layer will preferentially have snow water removed and BC added. So a question is whether some of the change (here, an increase) in BCS is due to the top layer becoming thinner and thinner, with this thinning top layer retaining most of its BC but losing its snow water. In other words: Would this same range in BCS be seen if the "top snow layer" was defined over a fixed snow depth? I don't actually expect the authors to conduct a full analysis to answer this question, but I do think they should point out what is shown in Figure r3 in terms of the***

mechanisms that drive the large range in BCS in a short period of time. They should also note the possible effects of having a variable depth to the "top snow layer" on "top layer BCS".

We agree that the large temporal variation of BCS is partly due to the top snow layer becoming thinner and thinner. This thinning top layer retains most of its BC but losing its snow water, which makes large BCS values. The large temporal variation of simulated BCS might be sometimes due to the artifact introduced by the discretization of snowpack into layers for numerical solutions. This cautions the comparison of simulated BCS with the measurements that sampled 2-5 cm snowpack as the top snow layer. It is now clarified in the text "This large temporal variation of BCS is partly driven by the evolution process of snow and its BC content in the model. When snow starts accumulating on the ground, the BC mass in snow is much less than the snow mass (minimum BCS value). Then, BCS increases with the accumulation of snow due to both dry and wet deposition. When snow starts melting, BCS keeps increasing due to dry deposition till the snow disappears. Nevertheless, we would also like to point out that this large temporal variation of simulated BCS might be sometimes due to the artifact introduced by the discretization of snowpack into layers for numerical solutions. As the top snow layer becoming thinner and thinner, it retains most of its BC but losing its snow water, and therefore results in large BCS values. We therefore caution the comparison of simulated BCS with the measurements that sampled 2-5 cm snowpack as the top snow layer."

Minor Comments:

- ***Section 2.1.1 and 2.1.2 titles need to be capitalized***

Done.

- ***line 365: As noted in my original review, it should be made very clear up front that this data set is someone else's work. One still gets the initial impression the field measurements are part of the work being reported. e.g., the first sentence could be revised as follows: "The primary observational dataset used in this study to evaluate the model simulations of snow and BC content in snow is from a field campaign***

described by Huang et al. (2011), where they collected seasonal snow in January/February 2010 on a road trip at 46 sites in North China."

Done.

- ***line 387: "NCC" needs to be defined or (better), get rid of this acronym. It is only used 6 times and readability would be improved by instead just spelling out "the North China campaign".***

Done.

- ***line 470: "There was no BCS data available for sites 41-46". I believe you mean "Estimates of BC in snow were not available for sites 41-46". (Other data/parameters are available for these sites).***

Clarified.

- ***line 475: A period is missing at the end of this sentence.***

Corrected.

- ***line 586: please replace "SSA complements" with "co-albedo"***

Done.

- ***line 588: "… unlike BC that always reduces snow albedo" --> "…unlike BC, which always reduces snow albedo"***

Done.

- ***line 606: "Although, dust is much less…" --> remove the comma after "Although"***

Done.

- ***line 611->612: "reduce radiation reaching surface" --> "reduce radiation reaching the surface"***

Done.

- ***line 613: "warming in snow shows higher magnitude in south than in north" --> "warming in snow shows higher magnitude in the south than in the north***

Done.