

## ***Interactive comment on “Boreal snow cover variations induced by aerosol emissions in the middle of the 21st century” by M. Ménégoz et al.***

**Anonymous Referee #4**

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Review on Boreal snow cover variations induced by aerosol emissions in the middle of the 21st century

The authors present a study based on a coupled atmosphere-chemistry-land model to explore effects of changing aerosol emissions on snow cover duration, snow mass and precipitation especially during spring for a present and a future scenario. In addition to the RCP 8.5 emission scenario for 2050, the authors explore the possible impact of emitted aerosols due to changing shipping routes and enhanced wild fires in the Northern Hemisphere. Results demonstrate that snow cover duration on the surface will decrease and that the additional scenarios have different impact on the outcome for the future scenarios. Since the authors argue that the presence of aerosols and the deposition of BC affect the snow cover in spring the most, a more in depth analysis is

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performed for that period of the year. BC deposition, SWE and spring snowfalls are investigated in more detail. Black carbon deposition is thought to decrease over the entire Northern Hemisphere with exception to Alaska and central Asia. While for large parts of Eurasia only slight decreases in SWE was modelled, few locations in West America and Scandinavia experience a larger loss of snow mass (> 100 mm). Spring snowfalls are also expected to decrease dramatically (-50%).

The manuscript is valuable as it presents detailed spatial information on the role of aerosol emission and BC deposition on snow covers for a future scenario. I suggest minor revisions

Langue and structure of the manuscript The language is concise and fluent, symbols and units are correctly defined. The structure of the manuscript is decent, but requires some improvements on the Methods section. I am a bit surprised how the authors decided to differentiate between the Results and the Discussion section. Some of the Results are discussed and explained in detail, while parts of the Discussion seem more suited for the Results.

Major points Regarding the content I have two major points, which the authors should address:

1. Since large parts of your simulation are dependent on the calculation of the snow cover and its albedo, I was a bit disappointed by the short explanation of how the albedo is calculated in the model. - Did you use grain size and grain type within the snow cover module? - Did you account for liquid water – which will alter the albedo a lot? - How did you include the age effect of snow (fresh snow vs. old snow)? - Please show the change of melt patterns Please include a more detailed description on that.
2. I am confused by your explanation of why SWE and the mass of spring snowfalls are changed by the deposition of BC. Do you have an explanation why West America and Scandinavia will have such a strong decrease in SWE? For both cases, SWE and snowfall, you mention that rising air temperatures are the main causes. I want to see

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a more detailed and quantitative discussion on how much rising air temperature or BC deposition will affect the changes on SWE and spring snowfall.

Minor points

Title The title includes the term “boreal”, but maps show large parts of Central Europe which I do not believe are suited for the term “boreal”

Abstract Please shorten the Abstract

Figures Please add to each colour ramp a legend, e.g. in Figure 2 → days It is often very hard to see the underlying information if differences were statistically significant

Figure2: Your colour ramp includes more than 365 days

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Interactive comment on The Cryosphere Discuss., 6, 4733, 2012.