

## **Review of the paper Soot on snow experiment: Light-absorbing impurities effect on the natural snowpack, by J. Svensson et al.**

The manuscript by Svensson et al. is about the effect soot has on a natural snowpack. This manuscript is adding to the still limited literature of validating the effect soot in snow has on the snow pack physical and optical properties. Svensson and his group have performed experiments in the nature where they have added soot particles to the natural snow pack during three different times at three different locations in Finland. Each of the experiments has been different, both regarding the set-up, the soot applied and the measurements performed. After the initial soot deposition, the group has measured snow albedo, soot concentrations and snow physical properties at specific intervals.

Despite soot on snow has been on the agenda, both politically and scientifically for almost two decades, we still have limited information on the evolution of the snow pack after soot deposition events. Almost all of the existing work is based on models, and little work exists to validate the models with real measurements, with a few exceptions, including this manuscript. Despite this, the manuscript has some major drawbacks connected to it, regarding the available measurements for answering these questions, but mainly due to the performed data analysis. It will require a major revision to prepare this manuscript for publication in TC, but if the authors did the job, I think this could be an interesting addition to the literature.

### **General comments to the authors**

- The value with this experiment is all the measured quantities. You should provide an overview of the three experiments, with photographs, timeseries or tables (as most suitable) of the available data. Table 1-2 is a start for BC concentrations for SoS2013, and Fig. 3 for albedo and met data for SoS2011 and SoS2013. By providing the measurements in a more consistent form, other scientists more easily get an overview on what's available and can be used for other purposes as well.
- The soot concentrations are used in a wrong manner, eg. by adding concentrations without taking into account the depth or snow amounts these concentrations were calculated for. This needs to be corrected. If you have the concentrations for all layers, please make up bulk concentrations/amounts. If not the concentrations have to be used with cautions as they are of course dependent on the amount of snowfall.
- It would be useful to have some words on the bias and uncertainties connected with the albedo measurements, in a similar manner as is done with the BC measurements (Sec 2.4.1). In addition you need to describe the field of view and the height of the sensor, hence how large is the area the optical sensor sees. Then you need a description on the homogeneity of the deposited soot for such a spatial scale.
- Why compare to the single layer model SNICAR when you have measurements from several snow layers, and you are interested in how the BC percolates through the snow pack? There are other options available.
- Why are the spectral albedos not used in this paper? Since the BC affects the spectral albedo mostly at the shorter wavelengths, investigating a range of wavelengths would make it easier to separate the effect soot has on the snow albedo compared to snow grain size or solar zenith angle.
- It is extremely important to have a record on the snow physical and optical properties of both the reference site and the experiment site before the soot was deposited on the snow due to the snow heterogeneity. Please discuss more about this, and compare the sites where you have this. For ex. page 1245, line 15: Where these sites compared and studied in detail prior to the soot deposition?
- Can you please elaborate how you dealt with the inhomogeneity of the soot in the 2011 experiment? My experience is that even for natural deposited BC we see large spatial variability, 30-50% within meter-scale.

### **Some more specific comments**

- Sec 2.3: What else did the soot consist of except BC?
- Sec. 2.4.3: How does the reported snow grain size compare with the optical grain size?
- Page 1244, line 15 and about: It would have been useful to see the actual measurements from this event, not only the qualitative description.
- The literature clearly shows a non-linear relation between albedo and BC in snow. Why do you use a linear relation in Fig. 4?
- Page 1238: There is a full paragraph (line 10-20) explaining measurements that are not used.
- Page 1234: Line 18: How was this snow sample collected? Only surface sample or bulk sample? Please elaborate, and discuss this against the stated sentences. The new snowfall should not exclude this experiment from the analysis, IF the bulk (total depth) samples were collected.