ILMATIETEEN LAITOS
METEOROLOGISKA INSTITUTET
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Soot on Snow experiments 2011-2013

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General

It is widely known that long-range transported soot and other absorbing materials decrease the snow albedo in the Arctic regions and enhance the melting of the snow. This produces a positive climate forcing, yet the magnitude of this forcing is not well known.
To measure these effects Finnish Meteorological Institute has together with the University of Helsinki conducted a series of Soot on Snow (SoS) experiments. In these experiments soot is deposited on top of natural snow pack, and then the albedo and melting of the snow is monitored through the whole melting season. Also snow samples are taken and analyzed for elemental carbon.
SoS 2011 and SoS 2012 were conducted in southern Finland, and SoS 2013 will be conducted in Finnish Lapland.

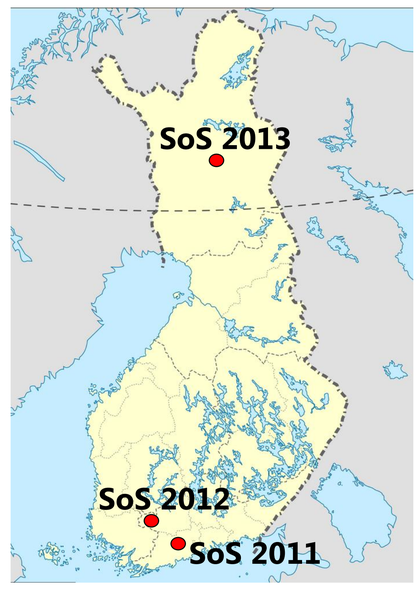

Fig 1. SoS campaign locations

Soot on Snow 2011

SoS 2011 was conducted at Nurmijärvi, southern Finland in spring 2011. We produced soot by burning rubber and let it deposit on snow at a semi-defined area. The albedo and depth of snow were monitored at two locations, one inside and the other outside the soot area. Snow samples were also taked from both areas.

In SoS 2011 we could see a clear difference in the albedo of the snow pack until the first snowfall. Even after that the albedo of the dirty snow was lower than that of the clean one. This resulted the dirty snow to melt approximately one week before the clean one. Also the temperature gradient was less steep in the dirty snow.

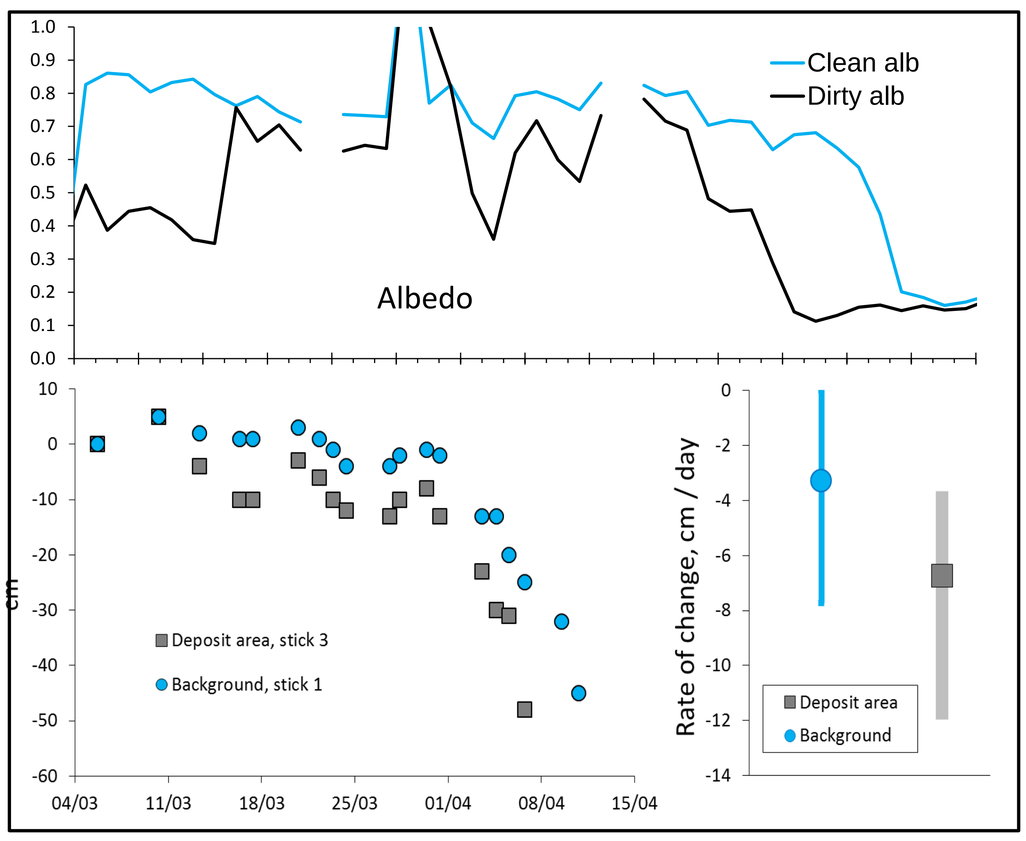

Fig 2. Albedo and snow depth during SoS 2011 in the sooted area and in reference area. Also the rate of change of snow depth during the period of fastest melting (lower right).

Soot on Snow 2012

SoS 2012 was counducted at Jokioinen, southern Finland in spring 2012. This time we used soot collected by chimney cleaners in Helsinki. We produced four spots (4m diameter each) with different soot concentrations on snow. The albedo and snow depth, as well as the transmittance of light through the snow were monitored over the entire melting season, and snow samples were taken and analyzed for organic and elemental carbon.

In SoS 2012 we experienced a heavy snow storm soon after the soot spots were made. The new snow covered the soot areas unevenly, and we could not observe significant differences in the albedo or melting of snow, that we could connect to the different concentrations of soot.

A later set of snow samples (taken one month after the soot spots were made) revealed that there were no clear soot layer left in the snow pack. The soot had assumably melted its way through the snow pack. Some differences in the snow pach structure were observed.

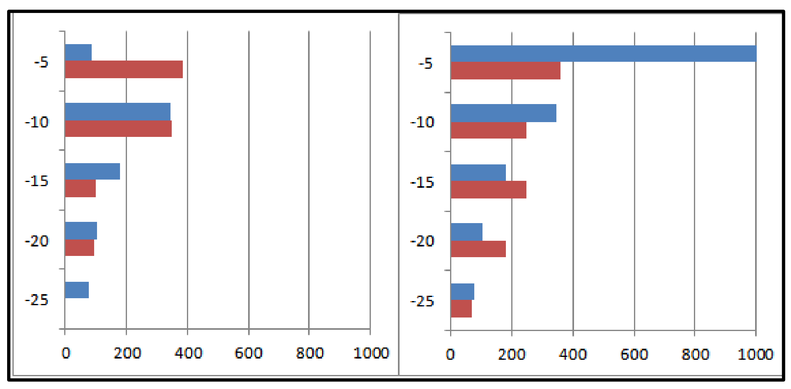

Fig 3: The soot concentrations (µg/l) in the reference spot (left) and in the dirtiest spot (right) at different snow depths (from snow surface). The blue bars represent samples taken right after the soot spots were made (Feb 16.) and the red ones one month later (Mar 15.) The first blue bar on the right hand figure goes over the scale (4900 µg/l).

Fig 4. Our team at SoS 2012 and the first soot spot.

Soot on Snow 2013

SoS 2013 is planned to take place in march-May 2013 at Sodankylä in Finnish Lapland. Main differences from SoS 2012:

There is more snow and the conditions represent better those in Arctic areas.

Snow samples will be taken at regular intervals, and snow structure will be monitored more closely.

Besides soot, also volcanic ash and dust will be used.