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Field experiments for studying the effects of Soot on Snow in Finland

<u>Aki Virkkula¹, Onni Järvinen², Antti Aarva¹, Niku Kivekäs¹, Jonas Svensson¹, Heikki Lihavainen¹, Antti Hyvärinen¹, David Brus¹, Kimmo Neitola¹, Outi Meinander¹, Riikka Väänänen², John Backman², Gerrit de Leeuw¹, Pavla D. Waldhauserová³ Henna-Reetta Hannula¹, Anna Kontu¹, Kati Anttila^{1,4}, Jouni Peltoniemi⁴, Maria Gritsevich⁴, Harri Kaartinen⁴, Panu Lahtinen¹</u>

¹Finnish Meteorological Institute, Helsinki, Finland ²Department of Physics, University of Helsinki, Helsinki, Finland ³University of Iceland, Reykjavik, Iceland ⁴Finnish Geodetic Institute, Masala, Finland



Soot on Snow (SoS) measurement campaigns

Main idea:

- 1. Deposit soot on natural snow pack in a controlled way
- 2. Measure the snow albedo, snow depth and other snow properties through the entire melting period

Three campaigns: 2011, 2012, 2013



Problems to study:

- □ Albedo as a function of BC
- □ Melting rate
- □ Effects on snow grains
- \Box Change of D_g(BC) after deposition to snow



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SoS 2011, Nurmijärvi









Rubber pellets from used tyres



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SoS 2011 Nurmijärvi



IR camera pictures





2011, Nurmijärvi, 35 km NW of Helsinki







Dirty snow just after new snowfall and a couple of days later





Reference area







Irradiance at the depth of 20cm in the clean and dirty snow pit and the ratio ($(I_{Dirty} / I_{Clean}) \times 100 \%)$





Snowpits 1 April 2011







Snow pit profiles

Snow crystal codes

CodeDescriptionSnotRGIrLarge rounded particlesFCsfFaceted crystals in surface layerFCxrRounding faceted particlesMFpcRounded polycrystals

Red line indicates hardness

"Clean" snow pit

Snow-type classication follows The International Classication for Seasonal Snow on the Ground (Fierz et al., 2009)

Dirty snow pit

Surface 0cm	Fist	4	1	р	k	Shape	Size (mm)	Sur	rface 0cm	Fist	4	1	P	k	Shape	Size (mm)
	rounded									rounded						
4	4					RGIr	0,5-0,7		2		2				RGIr	0,5
	faceted and some									rounden pol	ycrystals					
9	cup shaped					FCsf	2		5			5			MFpc	2
15	rounded pol	ycrystals		15		MFpc	2									
	refrozen lay	er, rounded	l crystals	16					I							
D								D	I							
E								E	I							
P								P	I	revende die el						
н	rounded by	meiting	1					L'		rounded por	ycrystais					
	some faceted still left															
							2		I							
45			45			FCxr			I							
50	rounded pol	ycrystals		50		MEas	1		35				35		MEnc	2
50				50		WIP DC	1		00							-



Snow samples





Snow samples melted and filtered through quartz filters \Rightarrow EC/OC







EC/OC analyzed with thermal methods







SoS 2012

- □ Farming field @ Jokioinen observatory, Finland
- Soot was collected earlier by chimney sweepers in Helsinki
- Portable closed deposition chamber
- □ Three soot spots and one reference spot



Soot blowing system in SoS 2012





Soot blowing system





Deposition chamber









SoS 2012, results

Albedo



There was a snow storm right after deposition, and the spots were covered unevenly with lots of new snow. No significant albedo effect could be observed



EC in snow one month after deposition

All spots had roughly the same amount of soot in respective depths. No added soot present anymore.

Reference spot









2013

- Sodankylä airport, Lapland
- Try to repeat 2012 with working instruments
- Modified blower
- Mixing fan in the chamber
- No walking around the spot: lifting the chamber with a cherrypicker

Blown impurities:

- Three types of soot
- Volcanic sand and glaciogenic silt from Iceland



















30 min after blowing





2013

River clay, silt from Iceland

Soot







Soot plots

Leica false color intensity image (soot4_4) 6th April 2013







Albedo

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Global radiation











What is under the snow (SoS-2013, 17.4.)?



Some vegetation

Melt water A < 0.2

Bare ground, Rocks etc. A(UV) < 0.05





EC, µg / g



SUMMARY & CONCLUSIONS

2011 experiment

- Clear albedo effect even after snowfall
- Faster melting
- Different temperature profile and snow pack structure

2012 experiment

- Albedo and melting effects not evident, most probably due to the snowstorm immediately after making the spots
- All transmittance measurements failed

2013 experiment

- Similar results to 2011 experiment
- Still missing: BC with SP2 comparison with EC
- Data analyses still to be done
- To be remembered for the next experiment: ground should be the same under all spots



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