Geophysical Research Abstracts
Vol. 19, EGU2017-7536, 2017
EGU General Assembly 2017

Soot on snow in Iceland: First results on black carbon and organic carbon in Iceland 2016 snow and ice samples, including the glacier Solheimajökull

Outi Meinander (1), Pavla Dagsson-Waldhauserova (2,3), Maria Gritsevich (4), Minna Aurela (1), Olafur Arnalds (3), Monika Dragosics (2), Aki Virkkula (1), Jonas Svensson (1), Jouni Peltoniemi (5), Anna Kontu (6), Niku Kivekäs (1), Matti Leppäranta (4), Gerrit de Leeuw (1), Ari Laaksonen (1), Heikki Lihavainen (1), Ali N. Arslan (1), and Jussi Paatero (1)

(1) Finnish Meteorological Institute, Helsinki, Finland (outi.meinander@fmi.fi), (2) University of Iceland, Háskóli Íslands, Iceland, (3) Agricultural University of Iceland, Landbúnaðarháskólinn, Iceland, (4) Department of Physics, University of Helsinki, Finland , (5) Finnish Geospatial Research Institute, Masala, Finland, (6) Arctic Research Center, Finnish Meteorological Institute, Sodankylä, Finland

New results on black carbon (BC) and organic carbon (OC) on snow and ice in Iceland in 2016 will be presented in connection to our earlier results on BC and OC on Arctic seasonal snow surface, and in connection to our 2013 and 2016 experiments on effects of light absorbing impurities, including Icelandic dust, on snow albedo, melt and density. Our sampling included the glacier Solheimajökull in Iceland. The mass balance of this glacier is negative and it has been shrinking during the last 20 years by 900 meters from its southwestern corner.

Icelandic snow and ice samples were not expected to contain high concentrations of BC, as power generation with domestic renewable water and geothermal power energy sources cover 80 % of the total energy consumption in Iceland. Our BC results on filters analyzed with a Thermal/Optical Carbon Aerosol Analyzer (OC/EC) confirm this assumption. Other potential soot sources in Iceland include agricultural burning, industry (aluminum and ferroalloy production and fishing industry), open burning, residential heating and transport (shipping, road traffic, aviation).

On the contrary to low BC, we have found high concentrations of organic carbon in our Iceland 2016 samples. Some of the possible reasons for those will be discussed in this presentation.

Earlier, we have measured and reported unexpectedly low snow albedo values of Arctic seasonally melting snow in Sodankylä, north of Arctic Circle. Our low albedo results of melting snow have been confirmed by three independent data sets. We have explained these low values to be due to: (i) large snow grain sizes up to $\sim$3 mm in diameter (seasonally melting snow); (ii) meltwater surrounding the grains and increasing the effective grain size; (iii) absorption caused by impurities in the snow, with concentration of elemental carbon (black carbon) in snow of 87 ppb, and organic carbon 2894 ppb. The high concentrations of carbon were due to air masses originating from the Kola Peninsula, Russia, where mining and refining industries are located. SNICAR-model showed that the impurities absorb irradiance the more the shorter the wavelength. We have also presented a hypothesis that soot can decrease the liquid-water retention capacity of melting snow. There we also presented data, where both the snow density and elemental carbon content were measured. In our snow density related experiments, artificially added light-absorbing impurities decreased the density of seasonally melting natural snow. No relationship was found in case of natural non-melting snow. Our experimental results on Icelandic volcanic ash have showed that Eyjafjällajökull ash with grain size smaller than 500 μm insulated the ice below at a thickness of 9–15 mm (called as ‘critical thickness’). For the 90 μm grain size, the insulation thickness was 13 mm. The maximum melt occurred at thickness of 1mm for the larger particles, and at the thickness of < 1–2 mm for the smaller particles (called as ‘effective thickness’). Earlier, similar threshold dust layer thickness values have been given for Mt St Helens (1980) ash, and Hekla (1947) tephra, but our results were the first ones reported for the Eyjafjällajökull ash. In Iceland, the dust layers in the nature can be from mm scale up to tens of meters.

Our results clearly demonstrate how important it is in the Arctic to perform measurements of BC, OC, and dust in the snow to fully understand the effects of light absorbing impurities on the cryosphere.