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Elemental carbon in snow from Western Siberia and Northwestern European Russia during spring 2014, 2015 and 2016

Nikolaos Evangeliou (1), Vladimir Shevchenko (2), Karl Espen Yttri (1), Sabine Eckhardt (1), Espen Sollum (1), Oleg S. Pokrovsky (3), Vasily O. Kobelev (4), Vladimir B. Korobov (5), Andrey A. Lobanov (4), Dina P. Starodymova (2), Sergey N. Vorobyev (6), Rona Thompson (1), and Andreas Stohl (1)

(1) NILU - Norwegian Institute for Air Research, Department of Atmospheric and Climate Research (ATMOS), Kjeller, Norway (nikolaos.evangeliou@nilu.no), (2) Shirshov Institute of Oceanology, Russian Academy of Sciences, Nakhimovsky prospect 36, 117997 Moscow, Russia, (3) Geosciences Environment Toulouse, UMR 5563 CNRS, University of Toulouse, 14 Avenue Edouard Belin, 31400, Toulouse, France, (4) Arctic Research Center of the Yamalo-Nenets autonomous district, , , , Nadym, Russia., (5) North-Western Branch of Shirshov Institute of Oceanology, Russian Academy of Sciences, Naberezhnaya Severnoy Dviny 112/3, 163061, Arkhangelsk, Russia., (6) BIO-GEO-CLIM Laboratory, Tomsk State University, 36 Prospect Lenina, 634050, Tomsk, Russia.

We present measurements of Elemental Carbon (EC) concentrations in snow samples collected in spring 2014, 2015 and 2016 in Western Siberia, in the Kindo Peninsula and in Arkhangelsk (Northwestern European Russia). EC is often used as a proxy of BC [1], [2]. The use of the terms EC and BC has been under debate for several years. Recently, they were defined based on the analytical measurement method used [3]. Thermal or refractory analytical methods give EC, whereas optical methods give equivalent BC concentrations. The measurement data are compared to simulation results from the Langrangian particle dispersion model (LPDM) FLEXPART and subsequently use the model to quantify the sources contributing to BC in snow in Russia.

The highest EC concentrations in 2014 were observed in Western Siberia near Tomsk (147 to 219 ng g-1). FLEXPART emission sensitivities for these samples showed that the air was coming from the north and east. This explains these high concentrations of EC in snow well, as most of the anthropogenic BC sources are located in these regions. In the rest of snow samples, EC concentrations between 4 and 170 ng g-1 were observed. The highest concentrations were found near the Ob River with air masses mainly arriving from Europe. During the 2015 field campaign, EC concentrations were the highest near Archangelsk (175 ng g-1), for which FLEXPART showed that the air was coming from nearby areas. Therefore, it is likely that the samples were affected by direct emissions from the city or the port of Arkhangelsk. During the same campaign, snow samples collected in the Kindo peninsula (White Sea) showed high variability in EC concentrations (46 – 152 ng g-1, median = 70±37 ng g-1), while air masses were transported to Kindo peninsula from Central and Southern Europe. Finally in 2016, snow samples were collected outside Arkhangelsk, in the Kindo peninsula close to the Arctic Circle Dive Centre, as well as in the transect from Tomsk to Yamal in Western Siberia, likewise 2014 and 2015, to allow for interannual comparison. In Arkhangelsk, the spatial distribution of EC in snow showed highly variable concentrations in 2016 ranging from 31 to 161 ng g-1. However, the median concentration in this region was 61±45 ng g-1, far below 175 ng g-1 observed in 2015. This was also the case for the Kindo Peninsula, where EC was relatively constant in 2016 ranging between 25 and 35 ng g-1 (median = 28±4 ng g-1). EC in the Kindo Peninsula was more than 60% lower compared with the 2015 values (median = 70±37 ng g-1). Finally, between Tomsk and Yamal EC was highly variable (7 – 119 ng g-1) due to the different EC sources affecting snow (median = 50±38 ng g-1). For example, it is expected that gas flaring affects snow close to Yamal, while snow collected in the south (Tomsk) is likely influenced by sources in Europe. Nevertheless, the highest concentrations (>100 ng g-1) were observed north of 65°N (Yamal Peninsula).

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