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Spatial and temporal variability of black carbon in snow measured with an SP2 around Ny-Ålesund

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Black carbon (BC) is only a minor contributor to aerosol mass but is clearly a significant short-lived climate forcer. BC particles, emitted during incomplete combustion of fossil fuels and biomass, are the major light absorbing component of atmospheric aerosol (Bond et al., 2013). Model studies of the Arctic climate system emphasise that BC in the lower atmosphere has high surface warming potential (Flanner, 2013). The result of aerosol sedimentation and scavenging within the Arctic is likely a deposition of BC in ice and snow that can darken the otherwise highly reflective surfaces directly, imposing a Arctic wide annual mean radiative forcing estimated to around +0.17 W/m^2 (Dou and Xiao, 2016). BC depositions induce further decay of surface albedo through accelerated snow metamorphism and melt (Jacobi et al., 2015; Meinander et al., 2014).

The BlaCkSnow-AHS campaign observed refractory BC concentrations in the area of Ny-Ålesund (West-Spitsbergen, 78°N) during the Arctic Haze season in March and April 2016. Atmospheric concentrations were monitored in the boundary layer with a Single Particle Soot Photometer (SP2, Droplet Measurement Technologies Inc.). A Marin 5 nebuliser (Teledyne CETAC Technologies) coupled to the same SP2 was used to derive size resolved measurements of refractory BC particles in snow. Over 100 surface and snow pit samples show the spatial variability of BC deposition in the snow along the shores of Kongsfjorden and on the glaciers Brøggerbreen and Austre Lovénbreen on Brøgger peninsula as well as on Mt. Zeppelin. Snow conditions at sea level were heterogenic and changing, however, the glacier sites provide a good record of the seasonal accumulation of snow and BC.

Atmospheric BC mass concentrations varied between 1 and 30 ng/m^3 in the upwind sector of Ny-Ålesund. Snow pit sampling with high vertical resolution showed up to 8 ng/g BC at 5-15 cm depth on the glaciers, while in the seasonal snow accumulation below 20 cm depth, BC concentrations were lower than 2 ng/g. At the BSRN radiation measurement site within the village, 2-4 ng/g are found in the top 5 cm and around 8 ng/g from 5 cm depth down to a solid ice crust on the ground at 11 cm depth. Vehicle traffic and wood-stove fires caused local pollution maxima in the atmosphere and in snow.

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