Year-round dual isotope-based observation and model comparison of black carbon in the Arctic

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Black carbon (BC) aerosols are co-emitted with organic carbon, in processes of incomplete combustion of fossil fuel and biomass. Transported into the Arctic, BC contributes to climate warming. However, there are still large uncertainties related to the climate effects of BC, including aspects of radiative properties, mixing state of the particles, transport, atmospheric lifetime and sources. Our work aims to reduce uncertainties by comparing a top-down (observational) source-diagnostic isotope approach (at several Arctic sites) to bottom-up (modeling) emission inventories, to better constrain the source types and source regions. The use of natural abundance radiocarbon ($\Delta^{14}C$) is a powerful geochemical tool to distinguish between fossil (void of ^{14}C) and biomass (contemporary ^{14}C) combustion sources. Due to the well-defined end-members, ^{14}C-measurements (alone) provide high precision source constraints. The ^{14}C-based source characterization is performed directly on elemental carbon (EC), a methodically defined form of BC. Additionally, to the ^{14}C-characterization, source information can be obtained from analysis of the stable carbon ($^{13}C/^{12}C$) signature.

The present study is focusing on year-round observation of BC in the European Arctic (Abisko, Sweden) compared with time-and-space matched predictions by the FLEXPART transport model, driven by monthly-resolved anthropogenic BC emissions from the ECLIPSE inventory, and daily satellite-derived estimates of BC emissions from vegetation fires. The predictions were in close agreement with observations. Seasonalities in both BC concentrations and sources were well captured. The near-closure for this gateway site of the European Arctic suggests that parameterization of emissions is a key ingredient, together with emulating the proper physical processes, in matching model predictions with actual observations. Preliminary results will be given for Tiksi (Russia) and Ny-Ålesund (Norway).