Goldschmidt 2022 Abstract
https://doi.org/10.46427/gold2022.13217

Seasonal changes in atmospheric deposition of halogen species in the Greenland EastGRIP snow pit

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The snow pit study from the East Greenland Ice Core Project (EastGRIP) site revealed the seasonal and/or inter-annual changes in atmospheric deposition of halogen species (Br and I) to the northeastern Greenland ice sheet. The 38 snow samples were recovered from the 1.9m hand-dug snow pit near to EastGRIP deep ice core drilling camp (75.6268°N, 35.9915°W) in July, 2017. The depth profiles of water stable isotopes ($\delta^{18}O$ and δD) and soluble ion species (Ca^{2+}, Na^{+}, MSA) indicate the 1.9m snow pit samples covered 3.5 years from 2013 to summer 2017. The Br in the EastGRIP snow pit samples showed clear seasonality. The high Br^{-} concentration peaks were observed during summer 2013 (3.52 ng g^{-1}), summer 2014 (2.52 ng g^{-1}) and spring 2015 (2.37 ng g^{-1}), while no clear increase of Br was found in 2016. In polar regions, atmospheric Br^{-} is known to be enhanced during springtime by autocatalytic release called Br explosions which is favorably occurs above first-year sea ice. However, Br deposition on the polar ice sheet is possibly influenced by transport and thus summer maxima are observed in the polar snow and ice [1]. This well meets the depth profiles of Br in the EastGRIP snow pit. In addition, inter-annual changes in the seasonal sea ice extent of Barents Sea during 2013~2017 was exactly same to the summer maxima values of Br enrichment in the EastGRIP snow pit. On the other hand, the I concentration in the EastGRIP snow pit generally increased coincide with Br concentration, but the seasonality is much less clear. This is probably due to iodine release via brine and/or non-linear biological responses to the sea ice conditions.

[1] Spolaor *et al*. (2014) *Atmos. Chem. Phys.* 14, 9613-9622.