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Discussions

Interactive comment on "Seasonality of halogen deposition in polar snow and ice" *by* A Spolaor et al.

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We agree with the referee that this is an interesting and somewhat perplexing problem. As explained below, it appears that we can reasonably explain the bromine pattern at Law Dome. Instead it is the record of iodine that we find to be intriguing and unexpected. We identify two phenomena that need to be considered to explain our observations of bromine and iodine in Antarctic ice: seasonality of emission and sensitivity to re-emission from surface snow. This is not a comprehensive explanation but rather a guide to future investigations.

Regarding the seasonality of emission, ground-based observations at Halley station (Saiz-Lopez et al., 2007) show similar patterns of boundary layer BrO and IO concentrations, with a large peak in early spring and a smaller peak in late autumn. This pattern matches well with our observations of bromine enrichment and nssBr in Law Dome ice. In contrast, the pattern of iodine concentrations in Law Dome ice is quite different. For iodine, the main processes of atmospheric emission are still to be resolved. For example, it is not yet established whether iodine is primarily emitted from the open ocean in organic (CH3I, CH2I2, CH2ICl) or inorganic (I2, HOI) form. The importance of iodocarbons produced by plankton colonies located under sea ice is also still to be quantified. While it is not well known how iodine is transferred from the ocean to the sea ice surface, the similar atmospheric concentration patterns of iodine and bromine suggest that both halogens are similarly photolysed over the austral polar day. Despite similar patterns in the atmosphere, the different patterns of iodine and bromine in Antarctic ice suggest that post-depositional remobilization is more important for iodine than for bromine.

Considering the re-emission of iodine and bromine in surface snow exposed to sunlight, there is no indication of strong remobilization of bromine from summer snow strata. The autumn peak observed for Br (denoted by vertical grey bars in Figure 3) may be due to deposition of boundary layer Br at the end of the polar day and/or the early formation of fresh sea ice. We initially speculated that this process may be involved in the formation of the iodine winter peak, but it is not supported by the consistent presence of an iodine peak throughout the winter ice strata. Instead, it is clear from Figure 3 that the late-summer bromine peak ends exactly when iodine concentrations increase. The termination of polar day is quite consistent with the final deposition of bromine and the initiation of iodine retention in snow. Our results confirm that iodine is efficiently remobilized from the snow surface in the presence of sunlight, as proposed by Frieß et al. (2010). The annual cycles of iodine in Neumayer snow and Law Dome ice suggest that iodine is reliably retained in winter snow strata.

The seasonal variability of Antarctic bromine and iodine in the boundary layer and in snow deposition are now reasonably well characterised, but further study is required to accurately quantify the transfer of iodine from the ocean to the boundary layer, as well as the amount of atmospheric bromine retained in summer snow strata. Considering that satellite-based sensors require sunlight to detect halogens, a dedicated year-round observation campaign with active DOAS instruments and fortnightly aerosol sampling, combined with chemical transport modelling, will be required to advance the current state of knowledge regarding polar halogens.

Interactive comment on Atmos. Chem. Phys. Discuss., 14, 8185, 2014.