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Iodine and bromine speciation in snow and the effect of orographically induced precipitation

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Abstract. Iodine is an essential trace element for all mammals and may also influence climate through new aerosol formation. Atmospheric bromine cycling is also important due to its well-known ozone depletion capabilities. Despite precipitation being the ultimate source of iodine in the terrestrial environment, the processes effecting its distribution, speciation and transport are relatively unknown. The aim of this study was to determine the effect of orographically induced precipitation on iodine concentrations in snow and also to quantify the inorganic and organic iodine and bromine species. Snow samples were collected over an altitude profile (~840 m) from the northern Black Forest and were analysed by ion-chromatography - inductively coupled plasma mass spectrometry (IC-ICP-MS) for iodine and bromine species and trace metals (ICP-MS). All elements and species concentrations in snow showed significant (r^2>0.65) exponential decrease relationships with altitude despite the short (5 km) horizontal distance of the transect. In fact, total iodine more than halved (38 to 13 nmol/l) over the 840 m height change. The results suggest that orographic lifting and subsequent precipitation has a major influence on iodine concentrations in snow. This orographically induced removal effect may be more important than lateral distance from the ocean in determining iodine concentrations in terrestrial precipitation. The microphysical removal process was common to all elements indicating that the iodine and bromine are internally mixed within the snow crystals. We also show that organically bound iodine is the dominant iodine species in snow (61–75%), followed by iodide. Iodate was only found in two samples despite a detection limit of 0.3 nmol/l. Two unknown but most likely anionic organo-I species were also identified in IC-ICP-MS chromatograms and comprised 2–10% of the total iodine. The majority of the bromine was inorganic bromide with a max. of 32% organo-Br.

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