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The mechanism of bromine release from polar frost flowers

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Several times every spring measured surface ozone concentrations in polar regions drop below the detection limit. It is known that these ozone depletion events (ODEs) are connected to increased concentrations of bromine. Frost flowers seem to be the source of the halogens. However, it is still unclear how the inert bromide anions from the alkaline sea water in the frost flowers are converted to reactive BrO. Acidity from anthropogenic pollution may explain some ODEs in the Arctic. However, ODEs also occur in the Antarctic where concentrations of acids are much lower. Previous model studies either did not consider aqueous-phase chemistry at all, assumed emissions of already activated bromine, or artificially acidified the model aerosol. Here, we present box model studies using the atmospheric chemistry model MECCA, which was adapted to conditions typical for the polar boundary layer in spring. Considering $CaCO_3$ precipitation from sea water below -2.2 °C, we can successfully model the transformation of inert bromide to reactive bromine oxide and the subsequent ODE. Further results of our study are: 1) Halogen activation is limited by both salt content and acidity. 2) During the ODE, bromine is activated first. Chlorine activation only starts when the particles have lost almost all their bromide. 3) Production of chlorine atoms from Cl_2 is small. Most of the chlorine stems from the photolysis of BrCl.