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A one dimensional model study of the mechanism of halogen liberation and vertical transport in the polar troposphere

E. Lehrer[1], G. Hönninger[1,*], and U. Platt[1]
[1]Institut für Umweltphysik, Universität Heidelberg, Heidelberg, Germany
[*]now at: Meteorological Service of Canada, Toronto, Canada

Abstract. Sudden depletions of tropospheric ozone during spring were reported from the Arctic and also from Antarctic coastal sites. Field studies showed that those depletion events are caused by reactive halogen species, especially bromine compounds. However the source and seasonal variation of reactive halogen species is still not completely understood. There are several indications that the halogen mobilisation from the sea ice surface of the polar oceans may be the most important source for the necessary halogens. Here we present a one dimensional model study aimed at determining the primary source of reactive halogens. The model includes gas phase and heterogeneous bromine and chlorine chemistry as well as vertical transport between the surface and the top of the boundary layer. The autocatalytic Br release by photochemical processes (bromine explosion) and subsequent rapid bromine catalysed ozone depletion is well reproduced in the model and the major source of reactive bromine appears to be the sea ice surface. The sea salt aerosol alone is not sufficient to yield the high levels of reactive bromine in the gas phase necessary for fast ozone depletion. However, the aerosol efficiently "recycles" less reactive bromine species (e.g. HBr) and feeds them back into the ozone destruction cycle. Isolation of the boundary layer air from the free troposphere by a strong temperature inversion was found to be critical for boundary layer ozone depletion to happen. The combination of strong surface inversions and presence of sunlight occurs only during polar spring.

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