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Arctic tropospheric bromine activation as seen from space and how it is related to meteorology, sea ice properties and surface observations

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Bromine monoxide (BrO) radicals are known to play an important role in the chemistry of the springtime polar troposphere. Their release by halogen activation processes leads to the almost complete destruction of near-surface ozone during ozone depletion events (ODEs) which may cover areas of up to several thousand square kilometres. The autocatalytic mechanisms, called Bromine Explosion, leading to halogen activation from saline surfaces, such as frost flowers and brine, are not well understood yet. Consequently, several theories explaining the evolution and dynamics of bromine activation exist in the literature. Here we compare the ability of some of these theories to explain our observations from space.

While satellites can not resolve the vertical distribution and have rather coarse horizontal resolution (GOME-2: 80x40 km), they may still provide important information on the large-scale horizontal distribution of BrO. A new algorithm is presented, which allows separation of the fraction of BrO in the activated boundary layer from the total BrO column based on only remotely measured properties. Our approach encompasses a careful study of the radiative transfer properties of the analysed atmosphere in order to assure sensitivity for BrO in the boundary layer. Our algorithm also delivers a statistical measure for the significance of bromine activation in the boundary layer, which may be used to investigate the correlation between bromine activation and other observable quantities.

Therefore our approach allows to study satellite observations of bromine activation more generally and for large data sets (rather than based on special events). Backward trajectories calculated for each satellite observation are merged with sea ice surface-data from observations by the AMSR-E instrument as well as potential frost flower (PFF) coverage. Also, the general dependency on surface wind speed and synoptic pressure systems will be discussed. Finally, the correlation with surface observations from two field campaigns conducted during the International Polar Year (IPY) complements our understanding of bromine activation in the Arctic.