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The Potential Importance of Frost Flowers for Ozone Depletion Events - A Model Study

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For more than 20 years, events with almost complete loss of ozone have been observed in the Arctic in the springtime. Reactive halogens play a major role in these ozone depletion events (ODE): the reaction of bromine atoms with ozone, followed by the self-reaction of bromine oxides (BrO) represents a catalytic loss mechanism for ozone in the polar boundary layer (PBL). However, the trigger of the so-called "bromine explosion" remains unclear. We examined the role that frost flowers (FF) play in bromine explosions, using the one-dimensional model MISTRA. In this model, a 4000m thick column of air is advected across a field of frost flowers, followed by an area of open ocean. Frost flowers grow on freshly formed sea ice under cold and calm conditions. During their formation, the brine at the surface of the ice is being sucked up onto the forming crystal branches, leading to high FF salinity. We observed that all the bromide from sea salt aerosols is efficiently released to the gas phase via the bromine explosion process. The boundary layer initially has a depth of 300m. It grows drastically due to a strong increase in temperature over the open lead and induces a strong mixing within this boundary layer. In the model the presence of open leads strongly facilitates the development of an ODE. Our results indicate that aerosols from frost flowers are probably not directly responsible for the bromine explosion and that additional cycles have to been taken into account.