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Bromine release from blowing snow and its impact on tropospheric chemistry

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In the last two decades, significant depletion of boundary layer ozone (ozone depletion events, ODEs) has been observed in both Arctic and Antarctic spring. ODEs are attributed to catalytic destruction by bromine radicals (Br plus BrO), especially during bromine explosion events (BEs), when high concentrations of BrO periodically occur.

The source of bromine and the mechanism that sustains the high BrO levels are still the subject of study. Recent work by Pratt et al. (2013) posits Br2 production within saline snow and sea ice which leads to sudden ODEs. Previously, Yang et al. (2008) suggested snow could provide a source of (depleted) sea-salt aerosol if wicked from the surface of ice. They suggest that rapid depletion of bromide from the aerosol will constitute a source of photochemical Bry. Given the large sea ice extent in polar regions, this may constitute a significant source of sea salt and bromine in the polar lower atmosphere.

While bromine release from blowing snow is perhaps less likely to trigger sudden ODEs, it may make a contribution to regional scale processes affecting ozone levels. Currently, the model parameterisations of Yang et al. assumes that rapid release of bromine occurs from fresh snow on sea ice during periods of strong wind. The parameterisation depends on an assumed sea-salt aerosol distribution generated via sublimation of the snow above the boundary layer, as well as taking into account the salinity of the snow.

In this work, we draw on recent measurements by scientists from the British Antarctic Survey during a cruise aboard the Polarstern in the southern oceans. This has provided an extensive set of measurements of the chemical and physical characteristics of blowing snow over sea ice, and of the aerosol associated with it. Based on the observations, we have developed an improved parameterisation of the release of bromine from blowing snow.

The paper presents results from the simulation performed using the United Kingdom Chemistry and Aerosols (UKCA) model, run as a component of the UK Met Office Unified Model, employing the updated parameterisation of Yang et al. We assess the performance of the parameterisation in simulating tropospheric BrO, a review of relevant parameters, as well as a quantitative assessment of the release of sea salt aerosol and its contribution to halogen chemistry in the polar and global atmosphere.