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Chemical processes in the atmosphere-snow-sea ice over the Weddell Sea, Antarctica during winter and spring

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Wintertime chemical processes in the atmosphere-snow-sea ice system of Antarctica are almost unknown because of a lack of in situ observations. During two cruises with the German research icebreaker R/V Polarstern we had the opportunity to perform measurements over and in the sea ice of the Weddell Sea from June to October 2013 covering the transition from winter to spring in the Southern Hemisphere. We performed atmospheric measurements of ozone, mercury, and reactive mercury compounds linked due to so-called ozone and mercury depletion events (ODEs and AMDEs), during which the two normally ubiquitous compounds ozone and mercury are efficiently removed from the atmosphere. Moreover, reactive halogenated compounds as the major cause of these depletion events were also observed in the atmosphere using remote sensing as well as in situ techniques. The observations demonstrated that the formation of reactive halogen compounds as well as depletions of ozone and mercury occurred as early as July potentially caused by a dark halogen activation mechanism. The activation of halogens further left their imprint also in the chemical composition of the snow on top of the sea ice, which showed occasionally a reduction in bromide. Elevated concentrations of halogenated compounds in the sea ice well above levels normally observed during the summer season indicate that active halogen chemistry was not limited to the atmosphere, but impacted the entire atmosphere-snow-sea ice system. Finally, aerosol measurements confirmed that the snow on sea ice constitutes an important surface for the mobilization and generation of atmospheric sea salt aerosol. As a result, sea salt aerosol significantly increased during and after blowing snow events, providing a potentially significant reservoir of atmospheric reactive halogens.