

Non-biological production of active iodine in ice and its implication in polar region

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Reactive halogens play various key roles in the global environment. In particular, the presence of gaseous halogens in the polar and marine boundary layers is of great interest as these highly reactive species can affect the oxidative capacity of Earth's atmosphere. The sources and impacts of iodine in polar atmospheric chemistry are much less understood in comparison with chlorine and bromine. Although the active iodine compound in the polar regions have been observed by ground and satellite based techniques, the sources and mechanisms of this large iodine burden are still being debated. Especially, abiotic sources of atmospheric iodine in Antarctic is less understood compared to biological iodine sources from micro- or macro algae. In this investigation, we shows that the production of triiodide (I₃⁻) via iodide (photo-)oxidation, which is negligible in aqueous solution, is significantly accelerated in frozen solution – both in the presence and absence of solar irradiation. Outdoor experiments carried out in the Antarctic region (King George Island, 62°13'S 58°47'W) also showed that the production of triiodide via solar photooxidation is accelerated when iodide contained solution is solidified. We used CRDS(Cavity Ring Down Spectroscopy) for measurement of gaseous I₂ emission upon thawing the irradiated frozen solution of iodide. A modeling study was also carried out to reproduce the experimental results. The enhanced (photo)oxidation of iodide and the subsequent formation of triiodide and I₂ in ice are ascribed to the freeze concentration phenomenon of iodide and dissolved O₂ trapped in the ice crystal grain boundaries. These findings propose that an enhanced abiotic transformation of iodide to I₃⁻ and gaseous I₂ in ice media provides a previously unknown generation mechanism of active iodine compounds in the polar atmosphere.