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Simultaneous reductive dissolution of iron oxide and oxidation of iodide in ice.

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Iron is an important trace element controlling the metabolism and growth of all kinds of living species. Especially, the bio-availability of iron has been regarded as the limiting factor for primary productivity in HNLC (High Nutrients Low Chlorophyll) regions including Southern ocean. The dissolution of iron oxide provides enhanced the bio-availability of iron for phytoplankton growth. The halogen chemistry in polar regions is related to various important environmental processes such as Antarctic Ozone Depletion Event(ODE), mercury depletion, oxidative processes in atmosphere, and the formation of CCN (Cloud Condensation Nuclei). In this study, we investigated the reductive dissolution of iron oxide particles to produce Fe(II)aq and simultaneous oxidation of I- (iodide) to I3- (tri-iodide) in ice phase under UV irradiation or dark condition. The reductive generation of Fe(II)aq from iron oxides and oxidation of iodide to I3- were negligible in water but significantly accelerated in frozen solution both in the presence and absence of light. The enhanced reductive generation of Fe(II)aq and oxidative formation of I3- in ice were observed regardless of the various types of iron oxides [hematite (α-Fe2O_3) maghemite (γ- Fe2O_3), goethite (α-FeOOH), lepidocrocite (γ-FeOOH) and, magnetite (Fe3O4)]. We explained that the enhanced redox production of Fe(II)aq and I3- in ice is contributed to the freeze concentration of iodides, protons, and dissolved oxygen in the unfrozen solution. When the concentration of both iodides and protons were raised by 10-fold each, the formation of Fe(II)aq in water under UV irradiation was approached to those in ice. The outdoor experiments were carried out under ambient solar radiation in winter season of mid-latitude (Pohang, Korea: 36°N latitude) and also confirmed that the production of Fe(II)aq via reductive dissolution of iron oxide and I3- generation via I- oxidation were enhanced in frozen solution. These results suggest that iron oxide particles in mineral dust and iodide trapped in ice or snow media (acidic aerosol, ice/snow on sea ice, icebergs, ice sheets, etc) might follow ice (photo-)chemical processes and can provide bioavailable iron and active iodine species when they melt.