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Snowpack Halogen Production in the Springtime Arctic

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Rapid transformation and loss of sea ice due to climate change is already causing observable changes in the Arctic region. Due to feedbacks between the Arctic Ocean surface and the atmosphere, there is an urgent need to characterize the unique atmospheric chemistry due to interactions at the frozen snow-covered sea ice surface. Snowpack photochemistry is an efficient source of molecular bromine (Br2) to the Arctic troposphere with significant impacts on the oxidation of ozone and mercury. Recent work has highlighted the abundance of Cl2, from which Cl atoms accelerate the oxidation of hydrocarbon pollutants, including the greenhouse gas methane. Through measurements near Utqiagvik (Barrow), Alaska in winter-spring, we have investigated the coastal snowpack as a source of molecular halogens, focusing on Br2, Cl2, BrCl, and I2 production using chemical ionization mass spectrometry. Both sunlit and artificial light experiments were conducted to study the potential for photochemical halogen production. The conditions of observed molecular halogen production provide insights into prevalent chemical mechanisms. Numerical modeling is utilized to examine the resulting snowpack interstitial air and near-surface chemistry.