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Satellite calibration of bromine enrichment records in Arctic ice cores: a novel method for sea ice reconstructions.

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Paleo-records such as marine sediments and ice cores are commonly used to extend our knowledge about past sea-ice cover during the period prior to instrumental observations.
Several studies (Spolaor et al., 2016, Saiz Lopez and Von Glasow, 2012) have identified bromine in ice cores as a potential proxy for past sea ice conditions. During polar springtime, in fact, the photochemical recycling of bromine is extremely efficient over first year sea ice (FYSI), resulting in enhanced concentrations of inorganic gas phase bromine (e.g. BrO) compared to the ocean surface, multi-year sea ice or snow-covered land. This process is known as "bromine explosion" and is detected by satellite sensors and in-situ observations from early March to late May. After emission, the BrO plume is frequently carried for several days by high-latitude cyclones in the lower troposphere until it reaches land and falls in the form of bromine enriched snow compared to seawater Br/Na ratio.
In this study we aim to validate and quantify this mechanism by combining NSIDC Sea Ice Age maps (12.5 km grid resolution) with modern bromine enrichment records (Br_enr) from several Arctic ice cores. Secondly, we refined our analysis by superimposing sea ice age maps and 3 day travel-time backtrajectories (calculated with NOAA Hysplit Model) identifying the bromine source area for each year of the period 1984-2014.
From spatial analysis we found that Br_enr in ice cores is statistically correlated with FYSI while there is no significant correlation when >1 year sea ice is considered. This result demonstrates that only seasonal sea ice constitutes an efficient substrate for springtime emission of inorganic bromine. Furthermore, taking into account the air mass frequency, the correlation notably increased highlighting the importance of transport in modulating the glaciochemical signal of an ice core.
To conclude, even though this work investigated only the last 4 decades, the application of this novel technique to longer ice core records might provide essential data to explore the wide spectrum of sea ice variability under natural forcing and, by extension, to improve the skill of advanced Earth System Models.