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Is sea salt in ice cores a proxy of past sea ice extent?

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A number of marine, coastal and ice core proxies have been used to try to assess the past extent of sea ice. Sea salt has been proposed as a proxy for past ice extent, at least in the Southern Ocean. The idea is that the sea ice surface itself holds a source of sea salt, that is stronger than the source from the open ocean it replaces. That a sea ice source exists is apparent from observations of the ratio of sulphate to sodium in coastal aerosol and snow samples. While the idea behind using sea salt as a proxy is attractive, and leads to sensible inferences, many doubts remain. Firstly the exact nature of the source remains uncertain, and secondly it is not clear if ice extent, as opposed to changes in atmospheric transport and lifetime, would dominate variability in the ice core record of sea salt. Here we use a model of atmospheric transport and chemistry (p-TOMCAT) to assess the consequences of a sea ice source, focussing particularly on a source that has been proposed to arise from the sublimation of salty blowing snow.

We will briefly report some new observations from a winter cruise, that will allow us to comment on the likelihood that blowing snow does pose a significant source. We will then present results from the model (implemented using existing parameters).

The model has been run with seasonally and interannually varying sea ice extent and meteorology for the Antarctic, tracking, at different ice core sites, the concentration that arises from the open ocean and sea ice sources. We have already shown that the model, after tuning, is able to reproduce the magnitude and seasonal cycle of sea salt at a range of sites globally. By varying each component separately we explore which factors (sea ice presence, wind speed at source, transporting winds) and which source regions control the delivery of sea salt to sites in Antarctica. Such work suggests that sea salt cannot be used as a sea ice proxy on interannual timescales, but may be suitable on longer timescales. By employing much larger sea ice extents, such as at the last glacial maximum (LGM), we find a strong increase in concentration at ice core sites when ice extent increases. The increase in modelled sea salt concentration tails off sharply as ice approaches the LGM extent, so that the sensitivity of the proxy is greater at lower ice extents, for example in interglacials. We will discuss the implications of this work for the proposed use of sea salt as a sea ice proxy.