

Salt concentrations in ice cores could unveil DO events' recipe

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It is one thing to know that Earth has already faced abrupt climate changes—also known as Dansgaard–Oeschger (DO) events—in the past. But finding out the reasons for these dramatic and rather short term changes is another story, one that Dr Rachael Rhodes from the University of Cambridge is reconstructing using chemistry records from ice cores taken from Greenland.

A common assumption with past DO events is that their occurrence was closely linked to major changes in Arctic sea ice extent: such changes feedback positively on Arctic temperature, and finding out exactly how this relationship works could be key to predicting how Arctic ice will react to ongoing climate change.

Within the framework of her SEADOG (Sea ice across Dansgaard-Oeschger events in Greenland) research, Dr Rhodes is analysing records of sea salt and methane sulphonic acid in Greenland ice cores with a view to defining whether they can be used as proxies for Arctic sea ice extent. She is investigating four ice core records for spatial and temporal variability across DO events, and exploring the controls on marine aerosol deposition over the Greenland Ice Sheet thanks to the p-TOMCAT chemical transport model.

Thanks to her findings, Dr Rhodes has optimised the p-TOMCAT model to represent modern-day sea salt aerosol deposition across Greenland. Ongoing work will identify scenarios of sea ice change consistent with ice core chemistry data across DO events.

What are DO events and why is it important to better understand them?

DO events are rapid and abrupt changes in the climate of the Northern high latitudes that occurred during the Last Glacial Period. They are named after two famous ice core scientists: Willi Dansgaard (Denmark) and Hans Oeschger (Switzerland) who first recognised these events in the stable isotopic ratios of water (a proxy temperature) of Greenland ice cores.

How come we don't know more about these events yet?

We know quite a lot about them. For example, from Greenland ice cores, we can decipher that temperatures changes of 5-16.5°C occurred within centuries over Greenland. However, we still don't understand what ultimately caused these events. Several theories involve major changes to Arctic sea ice extent but there is little evidence from the paleoclimate archives to constrain this.

How did you proceed to gather the desired information from ice cores?

I am using sea salt (NaCl) concentrations measured on Greenland ice cores. Sea salt concentrations are relatively easy to measure but difficult to interpret in terms of climatic or environmental changes because many other factors can influence the signal that is eventually preserved in ice cores. In particular, variations in meteorology, such as the weather systems that transport the sea salt aerosol through the atmosphere to the ice core site, are known to impact the signal.

I am using an atmospheric chemical transport model called p-TOMCAT to investigate to what extent ice core sea salt signals are influenced by sea ice area and by meteorology. This will help answer the question of whether or not the abrupt sea salt concentration changes across DO events can be linked to Arctic sea ice conditions.

What can you tell us about your main findings so far?

My initial work has focused on understanding the processes controlling Greenland ice core sea salt signal in the present-day. I have modified p-TOMCAT to calculate sea salt concentrations in the deposited snow and the model is doing a great job of replicating both the concentrations and seasonality of sea salt records preserved in ice cores. Results indicate that meteorology is the dominant factor affecting ice core sea salt signals at the inter-annual scale, but that sea ice conditions do exert some influence. I am testing how great a change in sea ice area is needed to override meteorology and become the dominant influence.

How can these results help predict the future evolution of Arctic sea ice?

This work will help us understand if/how sea salt concentration records in Greenland ice cores can be used as a proxy for Arctic [sea ice extent](#). A positive result would disentangle the effects of sea ice-related and meteorology-related sea salt change, allowing sea salt concentrations to be employed as a sea ice proxy with confidence. Reconstruction of Arctic sea ice changes across the abrupt DO events is important because we ultimately need to understand how Arctic sea ice reacts to rapid climate change, like the one we are witnessing occurring right now.

What do you still need to achieve before the end of the project next year?

Now that the processes leading to ice core sea salt signals are well-understood for present-day Arctic conditions, I am adapting the model to run tests using meteorology and sea ice typical of the Last Glacial Period when DO events occurred. It will be interesting to test how the simulated sea salt signals respond to the huge changes in climate and sea ice thought to happen during DO events.

More information: Project page: cordis.europa.eu/project/rcn/195554

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