Geophysical Research Abstracts
Vol. 17, EGU2015-4726, 2015
EGU General Assembly 2015

The stabilizing effect of sea-ice on a freshwater perturbation

Mari F. Jensen (1,2), Kerim H. Nisancioglu (1,2), and Johan Nilsson (3)

(1) Department of Earth Science, University of Bergen, Bergen, Norway, (2) Bjerknes Centre for Climate Research, Bergen, Norway, (3) Department of Meteorology, Stockholm University, Stockholm, Sweden

A retreating sea-ice cover is one of the hypothesized mechanisms for the abrupt warming observed during Dansgaard-Oeschger events of the last glacial. It has been proposed that a warming of the subsurface ocean during cold stadials could explain the rapid retreating sea-ice cover in the Nordic Seas at the start of each interstadial (Dokken et al., 2013). The warming of the subsurface ocean would gradually weaken the vertical stratification and lead to a sudden convective overturning as the vertical density difference disappeared.

In this study, we show that the circulation can become unstable even before the vertical density difference vanishes. We study the stability of a salinity-dominated circulation to freshwater perturbations in the presence of sea-ice, by using a one-dimensional, analytical model. The model represents the sea-ice covered Nordic Seas, and consists of a sea-ice component and a two-layer ocean; a cold, fresh surface layer above a warm, salty deep ocean. The sea-ice thickness depends on the atmospheric energy fluxes as well as the ocean heat flux, and we impose a thickness-dependent sea-ice export.

The stabilizing effect of sea-ice to a freshwater perturbation is shown to depend on the representation of vertical mixing. In a system where the mixing increases with density differences, the sea-ice acts as a positive feedback to a freshwater perturbation. If the mixing decreases with density differences, the sea-ice acts as a negative feedback. However, both representations lead to a circulation that breaks down when the freshwater input at the surface is small. As a consequence, we get rapid changes in sea-ice. In addition to low freshwater values, increasing deep-ocean temperatures promote instability and the disappearance of sea-ice.

Dokken, T. M., Nisancioglu, K. H., Li, C., Battisti, D. S. and Kissel, C. (2013), 'Dansgaard Oeschger cycles: interactions between ocean and sea ice intrinsic to the Nordic Seas', Paleoceanography 28