Geophysical Research Abstracts
Vol. 15, EGU2013-4684, 2013
EGU General Assembly 2013

Late glacial and interglacial sea ice variability in the Arctic Ocean: new insights from proxy and numerical modelling data

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The importance of Arctic Ocean sea ice coverage for global climate (change) is widely acknowledged. Due to its high albedo and its capacity to insulate the sea surface from the atmosphere the ice directly impacts on the oceanic and atmospheric heat and moisture balance and thus affects large-scale circulation patterns. At the same time, sea ice displays a sensitive responder to changes in 1) orbital forcing (i.e. insolation), 2) large-scale wind patterns (governing ice drift) and 3) ocean temperature (e.g. due to fluctuations in the Atlantic water advection). Among climate proxies preserved within marine sediments the IP25 sea ice biomarker and the novel PIP25 index derived therefrom seem to be most promising means for sea ice reconstructions in the Arctic (Belt et al., 2007; Müller et al., 2011). The identification of this molecule in marine sediment cores thus enables the assessment of spatial and temporal variations in sea ice coverage through time. Among numerical climate models the high-resolution regional ocean-sea ice model NAOSIM repeatedly has been applied for palaeo sea ice modelling studies (e.g. Stärz et al., 2012).
Here we present and discuss biomarker-based sea ice reconstructions with an unusual high temporal resolution covering the past glacial, deglacial and the Holocene climate history of eastern Fram Strait. These proxy results are complemented by model data obtained from NAOSIM. The documentation of changing sea ice conditions that accompanied the transition from the last glacial to interglacial climate mode contributes to the understanding of oceanic and atmospheric driving and feedback mechanisms associated with this large-scale climate shift. Furthermore, the continuous biomarker records from Fram Strait enable the assessment of how fast sea surface conditions (i.e. sea ice cover) responded to climate perturbations. Events of abruptly retreating or advancing sea ice cover as well as long-term trends are observable. Comparison of these proxy reconstructions with numerical modelling data (i.e. time-slice experiments) also allows for a cross-evaluation of both approaches and provides information about potential weak points and the benefit of coupling biomarker and NAOSIM sea ice studies.

References

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