Geophysical Research Abstracts
Vol. 19, EGU2017-6873, 2017
EGU General Assembly 2017

Implications of polar ocean surface stratification changes on a warming climate

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In the North Polar oceans surface properties have a significant influence on regional climate development. Stratification and salinity in this area are not just strongly coupled, they directly affect North Atlantic deepwater production and, thus, the ventilation of the deep sea and global ocean circulation. Besides a direct feedback on surface heat transfer to the Polar North, the response of upper stratification in a crucial region such as the Nordic Seas to near-future hydrologic forcing as surface water in the polar ocean warms and freshens due to global temperature rise and glacier demise, is still largely unresolved. We paired bulk sediment δ15N isotopic signatures with planktic foraminiferal assemblages across three major interglacials, each of which could be viewed as an analogue of the present. The isotope vs. foraminifer comparison defines stratification-induced variations in nitrate utilization between and within all of these warm periods and signifies changes in the thickness of the mixed-layer throughout the previous interglacials. As the thickness directly controls the depth-level of Atlantic water inflow, the changes recorded here suggest that drastic variations in freshwater water input associated with each preceding glacial terminations caused the Atlantic water to flow at greater depth. Backed up by independent salinity reconstructions using hydrogen isotope composition in alkenones, an active involvement of both glacial ice sheet size and subsequent specific melting history on interglacial climate development is suggested. Although the results also call for caution when using older interglacials as future climate analogues, they do help to better understand the effect of freshwater input on climate-sensitive ocean sites. It is further indicated that any future increase in freshwater flux into the polar oceans would not necessarily stop by itself the poleward advection of Atlantic water.