Geophysical Research Abstracts
Vol. 18, EGU2016-5078, 2016
EGU General Assembly 2016

Oceanographic changes in the Southern Ocean and Antarctic cryosphere dynamics during the Oligocene and Miocene: a view from offshore Wilkes Land

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With the ongoing increase in atmospheric CO_2 and global temperatures, a fundamental scientific and societal question arises concerning the stability of the Antarctic cryosphere. Modern observational data indicate the Southern Ocean has experienced significant warming, with oceanic fronts being pushed several tenth of km closer to the continent. Moreover, basal melt of ice shelves from warming oceans is causing accelerated grounding line retreat of the Antarctic ice sheets and shelves. However, monitoring data are available for the last few decades only, which prevents the evaluation of long-term changes in ice mass balance. Studying intervals in Earth's past history, which represent the best possible analogues of (near) future conditions, becomes thus essential.
The Oligocene and Miocene Epochs encompass periods with CO_2 concentrations between today's and those expected for the (near) future. It has also become clear that ice-proximal oceanographic regime is a critical factor for the stability and mass balance of ice sheets.
Integrated Ocean Drilling Program (IODP) Expedition 318 offshore Wilkes Land (East Antarctica) Site U1356 satisfies both requirements of being ice-proximal and having a relative complete, stratigraphically well-resolved Oligocene-Miocene sequence (albeit with a possible 5-Myrs gap between Late Oligocene and Early Miocene). This allows for the first time studying oceanographic changes and cryosphere dynamics in the interval ~34-13 Myrs. Thus far, ice-proximal reconstructions were hindered by the paucity of suitable sedimentary archives around Antarctica and/or poor stratigraphic constraints.
We reconstructed changes in surface oceanography and seawater temperatures by means of dinoflagellate cyst assemblages and TEX86 paleothermometry. The dinocyst data suggest (summer) sea-ice occurrence at Site U1356 only for the first 1.5 Ma following the onset of full Antarctic glaciation and after the Mid-Miocene Climatic Optimum. In between, both dinocysts and ocean temperatures indicate generally mild conditions, with some episodic cooling and a major warming during the mid-Miocene Climatic Optimum. Our data suggest a dynamic Oligocene-Miocene icehouse, with a fundamentally different oceanographic regime, with generally higher than present-day latitudinal transport of warm waters southward. This had obvious implications for the stability of the continental cryosphere as indicated by other proxies investigated.

During this talk I will focus on the Wilkes Land record, while putting it into a latitudinal perspective by using available data from other Southern Ocean sites.