The role of the ocean for Antarctic cryosphere dynamics during mid Miocene: a view from offshore Wilkes Land

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Abstract

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 Miocene Epoch encompasses 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.

We investigate the role of the ocean in the (in)stability of the Wilkes Land subglacial basin (East Antarctica) during the climatically highly variable mid-Miocene between ~17-11 million years [Ma] ago (albeit with a hiatus at around 13.4 Ma) by studying marine sediment cores from offshore Adélie Coast, retrieved during Integrated Ocean Drilling Program (IODP) Expedition 318 at Site U1356. Warm surface-ocean and continental temperatures, absence of sea-ice, and abundant soil formation and erosion along the coast imply that the East Antarctic ice sheet was reduced further than its terrestrial margin during the mid-Miocene Climatic Optimum (MCO; 17–15 Ma). After the MCO, a marine-based ice sheet developed, though sensitive to melting upon contact with warm ocean waters. Comparing these data with available reconstructions from

the Ross Sea (ANDRILL, AND-2A record) and the ODP Site 1171 (south of Tasmania), our results suggest that the mid-Miocene temperature gradient never resembled that of present-day and demonstrate a the importance of oceanic climate on Antarctic continental conditions. This study confirms present-day observations of Eastern Antarctic sub-glacial basins highly sensitive to ocean warming.

***Keywords**:* Miocene, Wilkes Land, palynology, ocean temperature, vegetation