Late Holocene sea ice dynamics and potential forcing mechanisms in the Indian sector of the Southern Ocean

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Abstract

Antarctic sea ice exerts a strong control on Southern Hemisphere climate system. However, Antarctic sea-ice regional trends over recent decades, reconstructed from historical and instrumental data, cannot be unambiguously attributed to forced or natural climate variability. Therefore, high resolution investigations of past Antarctic sea-ice conditions over the recent past are essential to better assess changes in ocean surface conditions and their natural climate forcing mechanisms. Here, we present new well-dated sea-ice and sea-surface temperature records covering the last 2000 years in two cores: the Integrated Ocean Discovery Program (IODP) Site U1357B, retrieved on the continental shelf off Adélie Land, East Antarctica, and COR1GC, retrieved from the Conrad Rise in the western Indian sector of the Southern Ocean.
Diatom assemblages and diatom-specific lipid biomarkers allow the identification of four multi-centennial intervals in both cores. However cold and icy periods in IODP U1357B (0-480 C.E. and 825-1550 C.E.) are congruent to warm periods in the Polar Front Zone, and inversely (480-825 C.E. and 1550-1850 C.E). We attribute this opposite climate variability, expressed at centennial to multi-centennial timescale, to changes in large scale atmospheric and oceanic circulations and as a response to external forcing and dominant climate modes of the SH such as the long-term expression of ENSO and SAM. Poleward Southern Hemisphere Westerlies, observed during positive SAM and El Niño phases, conducted to weaker katabatic winds (more sea ice off Adélie Land due to less sea ice transport northward) and stronger subtropical water intrusion (reduced sea ice extent and warmer Polar Front Zone). Resulting reduced Antarctic Bottom Water formation along with enhanced Southern Ocean meridional circulation may have intensified the Atlantic Meridional Oceanic Circulation, thus warming the North Atlantic.

Keywords: Sea ice, Last 2000 years, Climate modes, AMOC