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Topic: Ocean-ice-atmosphere interactions

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ABSTRACT Subject :

Simulated Last Deglaciation oceanic circulation in the Ross Sea: ice-sheet-ocean interactions during the Antarctic Ice Sheet retreat.

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During the last deglaciation (21-0 ka), the Antarctic Ice Sheet (AIS) in the Ross Sea retreated from the continental shelf break, where it was grounded, to its present-day configuration. The pathways and timing of grounding line retreat, as suggested by sedimentological, geomorphological evidence and by ice sheet modelling, hint for a possible role of the ocean as a trigger for AIS retreat. Overall the role and dynamics of the ocean during the last deglaciation in the Ross Sea remains largely unexplored. We investigate this by simulating the evolution of oceanic circulation in the Ross Sea over the last deglaciation (21-0 ka), at intervals of 1000 years, starting at the Last Glacial Maximum (21 ka). The MITgcm, in a new regional implementation of the Ross Sea, including sub-ice shelf circulation, is forced by outputs of the global transient paleoclimate simulation TraCE-21ka, with a basin geometry consistent with the AIS configuration during retreat adapted from existing paleo ice-sheet simulations and geological evidence. During the early deglaciation (21-17 ka), geological evidence suggest that the AIS was grounded up to the continental shelf break, with the exception of ice shelves located in the Drygalski, the Joides and the Pennel troughs, and by 17 ka, an ice shelf developed also in the Whales Deep trough. In our oceanic simulations, cold, salty High Salinity Shelf Water (HSSW) fills the entire cavities in the Drygalski and Joides troughs, whereas the Pennel and Whales Deep ice shelves are frequently reached by relatively warm Circumpolar Deep Water (CDW). During the Meltwater Pulse 1A (14.6-14.3 ka), the release of meltwater and icebergs in the North Atlantic yields a slow-down of the Atlantic Meridional Overturning Circulation in the TraCE-21ka paleoclimate simulation, with subsequent warming of the deep ocean and freshening of intermediate waters in the Southern Ocean. This weakens the Antarctic Slope Front in our Ross Sea simulation, fostering warm CDW intrusions beneath the Whales Deep ice shelf, causing intense basal melting. At last, during the Holocene (11.8-0 ka), the AIS retreat and the Ross Ice Shelf gradual formation lead to an increasing open-marine portion of the continental shelf: cold and salty Shelf Water becomes widespread over the Ross Sea, reducing the intrusions of the CDW by strengthening the Antarctic Slope Front. HSSW production restores strongly only since the Middle Holocene (~6 ka)