Ocean temperature impact on ice shelf instability along the eastern Antarctic Peninsula margin

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Abstract

There is growing evidence that the antarctic glaciers and ice shelves thinning and retreat during the last decades is not solely governed by the atmospheric temperatures but also, and mostly, driven by subsurface ocean temperatures. However, it remains hardly predictable to which extent and on which timescale the ocean forcing affects the grounding and floating ice cap due the lack of long-enough direct observation-based estimates as well as the limitation of climate and ice shelf models. Better evaluating its impact is particularly crucial in the East Antarctic Peninsula (EAP) where a series of major ice shelf collapse are associated with the current climate change. In this study, we first use the EN4 and GLORYS observation-based estimates of subsurface ocean temperatures (SOTs) (50-400m) in the EAP region spanning the instrumental period before applying the TEX_{86}^{L} proxy (TetraEther Index of tetraethers with 86 carbons) for low temperatures at the well-dated marine core JPC-38, drilled within the Vega Drift in the northern Prince Gustave Channel, to scrutinize SOT variability over the last 9,000 years before present. We find that increasing ocean thermal content during both observation period and the Holocene, tied to enhanced supply of relatively warm modified Circumpolar Deep Water onto the ice shelf, was strongly connected to all the episodes of Larsen's ice shelf disintegration. We therefore conclude that the ocean thermal forcing has always played a key role in regional ice shelf instability at millennial-to-decadal timescales. When simulating the worst Intergovernmental Panel on Climate Change (IPCC) emission scenario, we demonstrate that a regional subsurface ocean warming, most likely underestimated owing to model uncertainties, will lead to an accentuated erosion of the EAP and southernmost ice shelves by the end of the 21st century.

Keywords: Holocene, Eastern Antarctic Peninsula, ice shelf, subsurface ocean temperatures