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The effect of millennial scale glacial climate variability on the Antarctic Ice Sheet

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The Last Glacial Period was marked by two types of abrupt climate events in the Northern Hemisphere: Dansgaard-Oeschger (D/O) and Heinrich (H) events. D/O events are characterized by a rapid warming of more than ten degrees on a decadal scale, followed by a slow cooling which can last several centuries. H events are massive iceberg discharges from the Laurentide Ice Sheet registered in form of Ice Rafted Debris (IRD) in marine proxies. Although their ultimate cause is not fully understood, it is generally accepted that changes in ocean circulation played a major role in driving those abrupt climate changes. In the Southern Hemisphere temperatures start to rise before the abrupt increase begins in the Northern Hemisphere. Also, evidence of the deposition of IRD in the Southern Hemisphere is not well defined and the role of the southern oceanic circulation is unclear. For these reasons, the majority of studies have focused on the millennial-scale variability and the effect of ice sheet-ocean interactions in the North. Here we aim to study the response of the Antarctic Ice Sheet (AIS) to millennial-scale climate variability and search for a potential imprint of the AIS. We use a hybrid, three-dimensional, thermomechanical ice-sheet model capable of solving slow moving ice dynamics using the Shallow Ice Approximation and fast flowing ice streams and ice shelves through the Shallow Shelf Approximation, together with a basal melting parametrization based on oceanic temperature anomalies. The model is spun-up from the previous glacial cycle and then millennial-scale perturbations are applied to the constant LGM background climate field. Millennial variability is derived from the ice-core temperature reconstruction in Dome C and filtered between 1kyr and 19kyr to avoid orbital trends and noise. Because this time series reflects atmospheric temperature anomalies, we additionally assume a linear relationship between atmospheric and oceanic forcing, as well as spatially homogeneous oceanic warming. Our results show that while atmospheric perturbations have a negligible effect on the ice sheet, variations in oceanic temperatures play an important role on the AIS, contributing to sea-level changes and calving events.