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The Greenland Ice Sheet sensitivity to oceanic forcing on a glacial-interglacial timescale

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The enhanced ice mass loss experienced by the Greenland Ice Sheet (GrIS) in the past decades is thought to be directly connected to the increasing North Atlantic temperatures, which contribute to melt the remaining GrIS outlet glaciers, to drive grounding-line retreat and to increase ice outflow from the interior. These features point to the ocean as a relevant factor to be taken into account when modeling the GrIS evolution. Because of its land-based configuration constraint, the impact of the ocean on the GrIS is stronger during the ice-sheet glacial expansion. This assumption is supported by reconstructions for the Last Glacial Maximum (LGM) indicating a considerable increase of its marine-based region which lead the GrIS to be directly influenced by the surrounding ocean. Here the GrIS response to glacial-interglacial climate variability has been analysed using a three-dimensional hybrid ice-sheet-shelf model, which merges the Shallow Ice Approximation (SIA) for slow deformational flow of grounded ice with the Shallow Shelf Approximation (SSA) for grounded and floating fast-moving areas. The impact of the oceanic temperatures variation on the GrIS evolution is assessed through changes in melting at the base of the ice shelves and across the grounding line. The results for the two last glacial cycles show a highly sensitive GrIS to changing oceanic conditions. In glacial (interglacial) times, mild oceanic temperature variations favor a rapid expansion (retreat) of the GrIS borders, which forces the evolution of the whole GrIS by inducing a dynamic reorganization of the grounded ice. Our results suggest paleo ice-sheet models should include the ocean as an active forcing in order to accurately simulate the ice-sheet evolution at these timescales.