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The Greenland Ice Sheet-ocean interaction in the past two glacial cycles.

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Observations suggest that during the last decades the Greenland Ice Sheet (GrIS) has lost a huge amount of ice, significantly contributing to current sea level rise. A portion of this intensified ice discharge is connected to the observed acceleration of Greenland's marine-terminating glaciers, which recent studies directly attribute to increasing North Atlantic temperatures, triggering melting of the GrIS outlet glaciers, grounding-line retreat, enhanced ice discharge into the ocean and potentially contributing to current sea level changes. Analysis of the past GrIS evolution is crucial for a better understanding of its current behavior and its sensitivity to future climate variations. Reconstructions suggest that in glacial times the GrIS expanded up to the continental shelf, while warmer interglacial climates led to its rapid retreat, triggering a fast discharge of ice into the ocean. In this work the response of the GrIS to past climate changes, in particular glacial cycles, has been studied using a three-dimensional hybrid ice-sheet/ice-shelf model. The model features the capability to simulate ice sheets, ice shelves and ice streams as it applies both the Shallow Ice Approximation (SIA), in grounded areas of the ice sheet moving under slow, deformational flow, and the Shallow Shelf Approximation (SSA), in ice shelves and ice streams. This has allowed us to assess the effect of the variation of oceanic temperatures on the GrIS evolution throughout the two last glacial cycles through changes in submarine melting, an aspect that has not been investigated up to now. The results show a very high-sensitivity of the GrIS to the changing oceanic properties, among which oceanic temperature and heat flux variations are found to be the main drivers of the GrIS expansion and retreat throughout the past climates. This work therefore confirms that the ice-ocean interaction is a crucial factor driving Greenland's marine-terminating ice adjustments and highlights the need for investigations in this direction to successfully understand the GrIS future evolution under climate changes.