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Modelling the Role of Topography and Basal Friction in the Collapse of the Minch Palaeo Ice Stream, Scotland

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The pattern and timing of retreat of the last British Irish Ice Sheet has been constrained in more detail than any other palaeo ice sheet, thanks to the efforts of the ongoing BRITICE-CHRONO project. An area of particular interest is The Minch Palaeo Ice Stream, which flowed northwest from the Scottish Highlands to the continental shelf edge. The timing of this ice stream is particularly well constrained, and began retreating 3ka before the rest of the ice sheet, and accelerated in retreat during deglaciation. By combining the glacial geomorphology and Quaternary geology data with numerical modelling, we test if topographic influence and Marine Ice Sheet Instability were influential during the retreat of the Minch Palaeo Ice Stream.

We use BISICLES, an ice sheet model capable of accurately and efficiently simulating marine ice sheets, to simulate the retreat of the Minch Palaeo Ice Stream. A series of model simulations were used to evaluate the influence of topography and basal friction as well as the role of ice shelves in the retreat of the ice stream. Experiments with a step-change perturbation in sub-ice shelf melt and surface melt reveal a non-linear volume and area response, caused by instabilities relating to basal topography and surface mass balance. We simulated an instability in ice stream retreat beginning at a point where bathymetry deepens and bed friction increases. This suggests that the process of marine ice sheet instability played a role in the timing and retreat dynamics of the Minch ice stream during the last deglaciation such that it retreated prior to the LGM.