Geophysical Research Abstracts
Vol. 15, EGU2013-5135, 2013
EGU General Assembly 2013

Exploring controls on LGM ice-stream grounding-line retreat in a dynamic numerical model of Marguerite Bay, Antarctica

Stewart Jamieson (1), Andreas Vieli (1,2), Stephen Livingstone (3), Chris Stokes (1), Colm Ó Cofaigh (1), and Claus-Dieter Hillenbrand (4)

(1) Department of Geography, Durham University, Durham, UK., (2) Department of Geography, University of Zurich, Zurich, Switzerland., (3) Department of Geography, University of Sheffield, Sheffield, UK., (4) British Antarctic Survey, Cambridge, UK.

Ice stream retreat in Marguerite Bay, Antarctic Peninsula, was rapid during the last deglaciation. However, in this region and beyond, deglacial retreat patterns and timings are not synchronous, creating uncertainty regarding the drivers of palaeo-ice stream retreat. Our aim is to understand the controls on the retreat of Marguerite Bay Palaeo Ice Stream (MBIS).

Geophysical mapping of the sea floor in Marguerite Bay provides a detailed landform record of the MBIS. Within this landsystem a series of grounding-zone wedges have been identified which represent the locations of palaeo grounding lines during retreat. Their spatial arrangement indicates that the retreat rate of the ice stream grounding line slowed down or stopped multiple times on a bed that deepens inland. These perturbations in retreat rate are unexpected, particularly during a phase of rapid retreat.

We use a numerical ice stream flow-band model which can robustly calculate grounding-line behaviour over time to simulate the retreat of the MBIS. Expanding on our previous work, the model incorporates an ice shelf and simple ocean-driven melting and retreat is forced by fluctuations in sea-level, temperature, ice-shelf melting and ice-shelf debuttressing. Geophysical data controls the geometry of the model domain, and the locations of grounding-zone wedges are used to independently test the fit of our model to the retreat record. We conduct a series of sensitivity tests using simplified retreat forcings to determine the key controls on grounding-line retreat. Results suggest that, regardless of the pattern of the retreat forcing (e.g. linear, nonlinear, stepped), the motion of the grounding line consistently slows or speeds up in the same locations. The positions of retreat slowdowns are consistent with the mapped grounding-zone wedges and the most significant reduction in retreat rate occurs on the steepest portion of the reverse-sloping ice stream bed, which coincides with a pronounced narrowing of the ice stream trough.

Further sensitivity analysis indicates that the MBIS is most responsive to melting at the ice-ocean interface as a mechanism to initiate and drive retreat. Moreover, when the buttressing effect of an ice shelf is removed, the model simulates the known retreat history less closely, suggesting that an ice shelf remained present during a significant portion of post-LGM retreat. Our findings have implications for understanding past retreat dynamics in other regions in that the local width of the topography preconditions the pattern of ice-stream retreat. Furthermore, topography strongly overprints minor climatic or oceanic fluctuations during the retreat phase.