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Modelling the reversibility of Pine Island Glacier

Bradley Reed[1], Hilmar Gudmundsson[2], Mattias Green[1], and Adrian Jenkins[2]
[1]Bangor University, Ocean Sciences, Menai Bridge, United Kingdom of Great Britain – England, Scotland, Wales (bradley.reed@bangor.ac.uk)
[2]Northumbria University, Geography and Environmental Sciences, United Kingdom of Great Britain – England, Scotland, Wales

Pine Island Glacier (PIG), in West Antarctica, has undergone dramatic changes in the last few decades, where flow speeds have increased by 75% and grounding lines have retreated over 30km. These recent changes are part of a long term trend of mass loss, believed to have been initiated following climate anomalies in the 1940s and 1970s. The ice shelf cavity first opened around 1945, shortly after a strong El Niño event, and PIG eventually ungrounded from a submarine ridge in the early 1970s, following another notable warm period. Observational records show that intermittent periods of cooler ocean conditions likely slowed the subsequent retreat but were not enough to reverse its progress.

Here we use the ice-flow model Úa to study the recent transient evolution of PIG over the last several decades with the aim of identifying the drivers of observed changes in geometry and grounding line position. We use a depth-dependent melt rate parameterisation driven by present day melt values to represent warm conditions, while experimenting with various cold parameterisations. We ask what happens when the model is forced with alternating periods of cool and warm conditions when PIG is grounded at the submarine ridge. We hypothesise that warm ocean conditions will force the ice stream off the ridge and cooler conditions will slow but not stop the retreat. This work will improve the understanding of how glaciers respond to short, intense warm intervals particularly as El Niño events become more frequent in a warming future. We present the results from the initial investigations into how PIG responds to ocean forcing using an ice flow model.