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Retreat of Pine Island Glacier: The impact of El Nino Southern Oscillation events

Bradley Reed[1], Mattias Green[1], Hilmar Gudmundsson[2], 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

The Amundsen Sea sector in West Antarctica is undergoing dramatic changes, with thinning ice shelves and accelerating, retreating glaciers. One of the largest and fastest flowing ice streams in the region is Pine Island Glacier (PIG). In recent decades it has retreated over 30 km, experienced a 75% increase in velocity and thinned by more than 100m. However, these changes have not been constant, there have been alternating periods of acceleration and stabilisation since the start of the observational era in the 1970s. This has been attributed to variable ocean conditions, where interannual and decadal changes in the Circumpolar Deep Water layer have been linked to large-scale climate variability. The initial ungrounding and subsequent retreat of PIG from a submarine ridge is believed to have been caused by extreme changes in ocean conditions linked to El Niño Southern Oscillation (ENSO) events during the 1940s and 1970s. However, the exact role that these events have played over the last century is not fully understood.

In this study the ice flow model Úa is used to assess how the retreat of PIG has been impacted by ENSO events. During these events, variations in thermocline depth affect the amount of heat available for basal melting beneath the ice shelf. To represent these changing ocean conditions a melt rate parameterisation based on a 1D plume model is used, which depends on ice shelf geometry, grounding line depth and ambient ocean properties. Results will show if a gradually warming ocean is enough to initiate grounding line retreat or if brief, large changes in temperature are required. Further investigations will determine whether cooler years contributed to a slow down of the ice stream. This work will help us understand and model the response of other glaciers to extreme changes in ocean conditions caused by ENSO events in a warming future.