

Project Summary: There is a consensus that incursion of warm water across the continental shelf is the main driver of contemporary retreat of Thwaites Glacier, which presents the greatest risk of future rapid global sea-level rise. Uncertainty in model projections of the future of Thwaites Glacier can be significantly reduced by a range of investigations seaward of the current grounding line, including extracting a record of decadal to millennial variations in warm water incursion and the history of pre-satellite era grounding line migration, and constraining the bathymetric pathways that control the flow of warm water to the grounding line. Sedimentary records and glacial landforms preserved on the seafloor will allow reconstruction of changes in drivers and the glacier's response to them over a range of timescales, thus providing reference data that can be used to initiate and evaluate the reliability of models. Such data will also provide insights on the influence of poorly understood processes – marine ice sheet dynamics.

The proposed project includes an integrated suite of marine and sub-ice shelf research activities aimed at establishing **boundary conditions** seaward of the Thwaites Glacier grounding line, obtaining records of the **external drivers of change**, improving knowledge of **processes leading to collapse** of Thwaites Glacier, and determining the history of **past change** in grounding line migration and conditions at the glacier base. These objectives will be achieved through high-resolution geophysical surveys of the seafloor and analysis of sediments collected in sediment cores and traps from the inner shelf seaward of the Thwaites Glacier grounding line using ship-based equipment and moorings, and also from beneath the ice shelf using the Autosub-3 AUV and a corer deployed through the ice shelf via hot water drill holes.

Intellectual Merit: This project will use a suite of marine geological and geophysical data from seaward of the modern grounding line, to derive records of drivers and pre-satellite era retreat history, and determine key boundary conditions that control Thwaites Glacier retreat. The data will be used to address three pairs of hypotheses about the behavior of Thwaites Glacier. The first pair of hypotheses address the impact of warm-water incursions on glacial stability, both the modern pathways for such incursions and the 20th century history of warm-water initiated retreats. The second pair of hypotheses address the role of subglacial meltwater on Thwaites Glacier stability, using a comparison of modern sediment flux rates to those recorded in cores to test the episodic nature of subglacial meltwater output, and of its influence on glacial stability. Finally, the third pair of hypotheses address the role the nature and topography of the bed and ice shelf pinning points have on stabilizing the grounding line.

Broader Impacts: The project will focus on a question of major societal importance regarding ice sheet contributions to sea level by specifically addressing the controls and resulting behavior of a vulnerable sector of the West Antarctic Ice Sheet. We plan to have a PolarTrek teacher participate in the first cruise and actively engage with schools before, during, and after the field season. An Earth2class teacher training workshop based on the project will be held at LDEO-Columbia University. A science writer from Rice University will participate in the third cruise to provide direct public outreach initiatives, including a daily blog, interviews with scientists and video of onboard research activities, and post-cruise development of educational and outreach materials. An adapted version of the popular ice sheet model-based computer game 'Ice Flows' will be developed specifically for the Thwaites-Pine Island region and distributed to the public. PIs will involve graduate and undergraduate students at their institutions in developing outreach content such as museum special exhibits, documentary films, and science briefs. The scientific goals of this work are shared with those of many other proposals and the data collected in the field will be made public for other researchers to use as part of integrated, interdisciplinary projects. The project is based on broad international collaboration and will support early career and female researchers from universities with diverse student populations. It will provide seagoing field experience for several graduate and undergraduate students as well as two postdoctoral researchers.

This proposal requires fieldwork in the Antarctic.