PROJECT SUMMARY

Overview:

We propose to obtain geological evidence from the Thwaites-Pine Island glacier system that will show whether glaciers were less extensive than they are at present, and, if so, when. Our goals are to: (i) determine whether previous grounding-line retreat-advance cycles, as suggested by existing geological evidence, occurred in the late Holocene; (ii) establish under what climate and sea-level boundary conditions they took place; and (iii) investigate whether this sector of the ice sheet collapsed during previous warm Pleistocene interglacial periods. Determining the conditions under which the Thwaites and Pine Island Glacier grounding lines have retreated and re-advanced in the past is critically relevant to determining whether or not present-day grounding-line retreat is irreversible.

We will utilize two approaches to achieve these goals. To reconstruct Holocene relative sea level, we will map and date raised marine and shoreline deposits throughout Pine Island Bay. To obtain geological evidence for past grounding-line retreat episodes, we will apply cosmogenic-nuclide exposure-dating of subglacial bedrock. Using drill systems recently developed for subglacial bedrock recovery and proven in the 2016-17 Antarctic field season, we will obtain subglacial bedrock from sites where ice thickness is dynamically linked to grounding line position in the Thwaites system. The observation of significant cosmogenic-nuclide concentrations in these samples would provide direct, unambiguous evidence for past episodes of thinning linked to grounding line retreat as well as constraints on their timing and duration.

To summarize, we will use geological data (e.g., records of Holocene sea-level change and glacier fluctuation) to derive boundary conditions necessary for forward model development, validation and testing. Our results will thus contribute to Program Themes 1 (Boundary Conditions), 2 (External Drivers of Change), and 4 (Past Change).

Intellectual Merit:

It is important to understand the full range of past glacier fluctuations due to concern that currently observed grounding line retreat in the Thwaites system may be effectively irreversible and lead to globally significant sea-level impacts. At present, evaluating this possibility relies on forward model predictions that are initialized with the current state of the glacier. In contrast, we will obtain information about past glacier changes that, we propose, can show whether the glacier system has been less extensive than it is at present under past climate conditions similar to or warmer than exist now, and, if so, under what conditions it readvanced. This knowledge will help to establish the limits of possible behaviour for the glacier system under climate conditions similar to or warmer than the present, and also provide records of past glacier change that can be used as model validation targets.

Broader Impacts:

Broader impacts will focus on (i) sea-level rise awareness and (ii) incorporation of underrepresented groups in science. In the United States, the primary broader impact will be public outreach on the topic of sea-level change. This outreach will be focused mainly at Tulane, the lead institution. Science, engineering, and communications students at Tulane University will develop a mobile sea-level visualization vehicle, along the lines of commercial promotional vehicles. This vehicle will participate in public gatherings in the New Orleans area. In the UK, the focus will be on engagement with young people to improve their understanding and participation in geochemistry and geophysics subjects in school, university, and beyond. This will be implemented via innovative school workshops involving an artist and team members, developing materials for teachers, and presentations at Science Festivals. Additionally, we will also have an embedded journalist with us during one of our subglacial bedrock drilling campaigns. The project will also support four PhD students (3 US, 1 UK) and one postdoctoral researcher.

This project requires field work in Antarctica.