PROJECT SUMMARY

Overview:

Thwaites and neighboring glaciers in the Amundsen Sea Embayment (ASE) are rapidly losing mass in response to recent climate warming and related changes in ocean circulation. Ice-sheet models suggest that the mass loss from the ASE will accelerate in the near future, initiating an eventual collapse of the West Antarctic Ice Sheet (WAIS), raising the global sea level by up to 2.5 meters in as short as 500 years. Such model predictions, however, still lack understanding of the dominant processes at and near grounding zones, especially their spatial and temporal variability, as well as atmospheric and oceanic drivers of these processes. TARSAN aims to constrain these processes for the Thwaites and the Dotson Ice Shelves. Specific objectives are: 1) to install atmosphere-ice-ocean multi-sensor remote autonomous stations (AMIGOS) on the ice shelves for two years to provide sub-daily continuous observations of concurrent oceanic, glaciologic, and atmospheric conditions; 2) measure ocean properties on the continental shelf adjacent to ice-shelf fronts (seal tagging, glider-based and ship-based surveys and existing moored and CTD-cast data) and into sub-ice-shelf cavities (Autonomous Underwater Vehicles AUVs) to detail ocean transports and heat fluxes; and 3) constrain current ice-shelf and sub-ice-shelf cavity geometry, ice flow, and firn properties for the ice-shelves (using radar, active-source seismic and gravimetric methods) to better understand the impact of ocean and atmosphere on the ice-sheet change.

Intellectual Merit:

Current and anticipated near-future mass loss from Thwaites Glacier and nearby ASE region is mainly attributed to reduction in ice-shelf buttressing due to sub-ice-shelf melting by intrusion of relatively warm Circumpolar Deep Water (CDW) into sub-ice-shelf cavities. Thwaites Glacier and Dotson Ice Shelf systems are connected through upstream ice dynamics, but influenced by different submarine troughs. Constraints on sub-ice-shelf cavity geometry and ocean circulation within these two systems are currently lacking. The seasonality of CDW properties is still unknown, because most measurements are taken during summer sea-ice minimum. Also, the relative importance of the two different troughs leading to Thwaites and Dotson Ice Shelves is still unknown. Geophysical surveys on Thwaites and Dotson Ice Shelves and exploration beneath them by AUVs will, for the first time, obtain the detailed ice-shelf and sub-ice-shelf cavity geometry for these ice shelves. Oceanographic measurements will elucidate processes that influence exchange of heat and water masses (including melt water) between the Amundsen Sea continental shelf and sub-ice-shelf cavities. And two-year observations above, within, and below ice shelves by AMIGOS, along with overwinter ocean measurements near ice-shelf fronts and on the continental shelf by seal tagging and moorings will provide seasonal variations of the CDW and connections to their suggested atmospheric drivers. TARSAN will study the intrusion of CDW and its interaction with ice at the grounding line and in the sub-ice-shelf cavity for both of these trough systems, to distinguish local geometric effects from regional CDW circulation patterns; information that will be critical to understanding the CDW impact as the geometry of Thwaites changes with retreat and applying our understanding of the key processes to other ice shelves.

Broader Impacts:

TARSAN will improve our understanding of the connections between Antarctic climate change, global climate change, and rates of sea-level rise. The AMIGOS stations (based on successfully deployed, robust systems) are a major step forward in ice-ocean system monitoring, providing a wide array of data from an integrated, intelligent, and logistically undemanding system. To facilitate wide-reaching public communication, we will have an embedded highly respected science writer. The AMIGOS stations and the tagged seals will be used as a basis for an outreach effort to engage the public via social media and a website, "Live From The Ice" will allow the public to follow day-to-day events recorded by each station and seal, as well as larger patterns of ice, ocean, and climate in Antarctica. It will be hosted at NSIDC. The proposal team has an established record of public outreach on climate issues and scientific exploration of Antarctica. The project is led by two female lead PIs and supports undergraduate, graduate students, postdocs and early-career scientists.

This proposal requires fieldwork in Antarctica.