BIVALVE Project Summary

Overview

Decadal variability of Pacific sea surface temperatures (SSTs) plays an important role in terrestrial climate anomalies as well as global temperature trends. Unfortunately, the spectral character and magnitude of this variability is poorly constrained by instrumental or paleoclimate data, which is particularly sparse in the South Pacific. However, a type of marine bivalve, called geoducks, demonstrate a new pathway for generating annual data in regions of the Pacific critical to defining decadal variability. Recent work has used Pacific geoducks (*P. generosa*) to reconstruct North Pacific SSTs across much of the Common Era at annual resolution, and the New Zealand geoduck (*P. zelandica*) shows similar promise. Previous shell collections from fisheries research are readily available and a new pilot chronology proves both the viability of record development and broad spatial SST correlations. In the proposed research, called Browsing Intra-pacific Variability And Linked enVironmental Effects (BIVALVE), we will reconstruct South Pacific SSTs using this newly-developed proxy and explore both local climate and remote teleconnections in data and models. The proposed research will first develop several New Zealand geoduck growth-increment proxy records and sample $\delta^{18}O$ from existing shell collections to determine the prime location for a multiproxy, annual SST reconstruction. We will then collect dead shell samples from the seafloor to extend the geoduck climate archive into previous centuries. Together with data from corals and tree rings, we will reconstruct pan-Pacific SST patterns to provide insights into the range and spectral character of past variability. We will use this pan-Pacific reconstruction alongside continental climate proxies to assess the strength and stability of teleconnection patterns for economically and societally important regions. Finally, we will harness these new insights to test model skill in the pre-instrumental Pacific and provide an assessment of likely future behavior based on skillful models.

Intellectual Merit

We will develop the first high-resolution, in-situ sea surface temperature proxy record for the period prior to the 20th century and south of the subtropics. We have already produced the first evidence of crossdating and climate-growth relationships for *P. zelandica* and will continue to leverage the experience and tools gained from the related work with Pacific geoduck. We will utilize the Pacific and New Zealand geoduck chronologies alongside other annually resolved, multicentennial, SST proxies, exclusively employing records within regions of critical SST variability. Where disagreement among models as well as previous reconstructions is pronounced, this new reconstruction, defined by rigorous selection criteria, will add to our understanding of the natural variability in this system. Rather than rely on teleconnection patterns to reconstruct Pacific SSTs, our proxies' residence in the regions of interest will enable us to evaluate the consistency of these teleconnections.

Broader Impacts

Our skill assessments of climate models in relation to past IPO variability and teleconnection stability will enable policy makers to make better climate adaptation decisions. Decadal-scale SST variability around New Zealand is dominated by the IPO, and this climate index is a topic of interest for the government and people of New Zealand in relation to heat waves, pluvials, and droughts (Power et al., 1999; Salinger et al., 2020; Mullan et al., 2010). We will share population age data with geoduck fisheries researchers to help improve models of sustainable catch limits for this species (see letters of collaboration).

This project will support the laboratory work and research of undergraduates at both Iowa State University and Northern Arizona University, with opportunities for scientific discourse and paper-writing. This project will also support the work of ECRs, PI Thatcher and PI Edge.

PI Erb and PI Edge will continue to participate in the Flagstaff Festival of Science. We will visit a public K-12 school classroom to engage students with samples, photos, graphs, and stories to promote enthusiasm for science. PI Thatcher will continue an ongoing relationship with a local high school (Gilbert, IA) where she has led one day of activities each year since 2017 for Algebra II classes about natural logs and their utility in radiometric dating of shells, stalagmites and other geologic materials.