PROJECT SUMMARY

"Palmer, Antarctica Long Term Ecological Research: Looking Back in Time Through Marine Ecosystem Space" 01 October, 2008 – 30 September, 2014. $4,920,000

Intellectual Merit. Since 1990, Palmer LTER (PAL) research has been guided by the hypothesis that variability in the polar marine ecosystem was mechanistically coupled to changes in the annual advance, retreat and spatial extent of sea ice. In our last proposal, we modified this fundamental hypothesis to incorporate a new paradigm, climate migration, the idea that a warm, moist climate regime was displacing the cold, dry polar climate of the PAL region, producing fundamental changes in food web structure and elemental cycling. New analyses of our long-term datasets clearly show that climate migration is occurring, is most evident in the north, is largely absent further south, is affecting all trophic levels and elemental cycling, and the primary mechanism of change involves match-mismatch dynamics. As a result, community composition and the status of populations are changing depending on whether the life histories of component species are ice-dependent or ice-intolerant. In the northern PAL region, therefore, where the effects of climate migration have been most evident, sub-polar species are replacing polar species, while in the southern PAL region these trends remain absent. In this proposal, we intend to build on our previous research, with a new emphasis on process studies and modeling to elucidate the mechanistic links between teleconnections, climate change, physical oceanographic forcing and ecosystem dynamics. To guide our research, we hypothesize that regional warming and sea ice decline associated with historical and on-going climate migration in the northern part of our study area have altered key phenological relationships, leading to changes in species distributions, increasing trophic mismatches and changes in habitat, food availability, ecosystem dynamics and biogeochemical cycling. Through targeted process studies linked to numerical model simulations, we will also test the hypothesis that deep cross-shelf canyons characterizing our core study region (200x600 km) are focal areas for ecosystem processes that result in predictable, elevated food resources for top-predators such as penguins, influencing their foraging ecology and distribution of breeding and wintering populations.

In this proposal, we add to our core group 3 new PIs: a zooplankton ecologist with expertise in biogeochemical fluxes, a phytoplankton ecologist focusing on bio-optics and autonomous observations and a numerical simulation modeler specializing in coupled global models of ocean circulation, plankton ecology and biogeochemical cycles. In addition to gliders and models, our program will add trace metal sampling and analysis, moored physical oceanographic sensors, a moored sediment trap in the south, drifting sediment traps and stable carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) isotope analyses. Missions lasting up to 45 days using gliders deployed before, during and after summer cruises will, along with moorings and satellite remote sensing of sea ice, ocean color, sea surface temperatures and wind fields, greatly extend the reach of our observations in space and time. Within this scope of observations, we also propose to extend our routine sampling activities further south into a region where the effects of climate change are less advanced than the northerly part of our study region. As the Northern area appears to be well on its way toward transitioning into a subpolar ecosystem, this southern extension of our sampling is designed to allow us to contrast ecosystem dynamics to a region with prevailing polar characteristics.

Broader Impacts: Since its inception, PAL has been a leader in Information Management aimed at understanding data practices in order to enable knowledge-building within and beyond the Antarctic, oceanographic and LTER communities. PAL has designed and deployed a new information infrastructure with a relational database architecture to facilitate data distribution and sharing. This includes new capabilities for data synthesis and integration both within PAL and throughout the LTER Network. Overall, we are placing increasing emphasis on improving our understanding of the dynamics required to develop improved predictive capabilities for ecological modeling and forecasting. Our Education and Outreach program capitalizes on the public's fascination with Antarctica to promote scientific literacy from kindergarten students to adult citizens concerned with climate change and environmental sustainability. Through communicating our results to the public and working with scientific assessment bodies (e.g., IPCC) and Antarctic Treaty parties to protect Earth's last frontier, we engage in contributing our science to the national scientific agenda and the greater public benefit.