Changes in Stratification at the Antarctic Peninsula (ChinStrAP)

Principle Investigator
Andrew Thompson (California Institute of Technology, USA)
Contact: andrewt@caltech.edu

Other key participants
J. Sprintall (Scripps Institution of Oceanography, USA)
S. Swart (CSIR – Southern Ocean Carbon & Climate, South Africa)

Project Description

In Southern Drake Passage the extension of the Antarctic Peninsula into the Antarctic Circumpolar Current (ACC) leads to the injection of Weddell Sea waters, with unique physical and biogeochemical properties, into the global circulation. Exchange between the Weddell Sea and the ACC depends intricately on a collection of interacting frontal currents that occupy the continental shelf and slope along the southern boundary of Drake Passage. Satellite and in situ observations suggest that mesoscale eddies and variability emanating from the Weddell Sea, or "Weddies," are prevalent, yet the physical processes that lead to their formation and evolution (e.g. baroclinic and barotropic instabilities, thermohaline intrusions, tides, interactions with bathymetry) remain uncertain. The objective of this proposal is to observe and quantify the dominant spatial and temporal scales of variability in this region as well as the physical mechanisms that give rise to it. We propose to continuously monitor the fronts in southern Drake Passage for a period of 15 weeks by deploying and piloting a pair of ocean gliders that will collect approximately 1000 profiles of temperature, salinity, dissolved oxygen, fluorescence and optical backscatter. Multiple reoccupations of two transects across the continental slope will allow tracking of the southern ACC fronts with unprecedented resolution and will permit direct calculation of cross-shelf eddy fluxes of heat and salinity. Analysis of the glider data in concert with ongoing and historical observations will provide key insight into the physical processes that control upwelling and ventilation along the southern boundary of the ACC in Drake Passage.

In addition to the ocean gliders, the field program will be augmented with a surface Waveglider, which will permit an analysis of how small-scale submesoscale dynamics influence mixed layer variability across the southern boundary of the ACC. A major driver of submesoscale variability is the interaction between atmospheric winds and oceanic surface velocities, especially at ocean fronts. At present direct measurements of wind velocities at the relevant temporal and spatial scales—typically 1 to 10 kilometers and one day—are extremely rare. The use of a surface Waveglider that includes a weather station will enable these direct measurements. An understanding of mixed layer dynamics in the southern region of Drake Passage is critical as this is a key site of isopycnal outcropping and thus carbon exchange with the atmosphere. Global estimates of carbon fluxes are typically based on infrequent ship-based transects and the range of variability in these fluxes are poorly constrained. This component of the project will be critical to improving models of mixed-layer variability that influence ventilation and air-sea exchange processes.

This work directly relates to SOOS Scientific Strategies in that it pushes towards a model of using a network of diverse autonomous vehicles in a Southern Ocean setting. The proposed 15 week deployment also moves towards a goal of sustained, persistent observing systems. While the initial focus is primarily on physical oceanography, a combination of physical and biological oceanographic data will be collected, along with meteorological data, which will promote interdisciplinary analysis of the data over the course of the project. The combined

use of a surface Waveglider and in situ buoyancy gliders has been relatively rare, especially in a coastal margin setting. Meteorological data has also been limited in the Southern Ocean. Thus on both the technological collection of the data and the type of data that will be collected, there is scope for substantial capacity building. This project will also lead to enhanced collaboration between US and S. African colleagues, including early career scientists Swart and Thompson and graduate students at both Caltech and CSIR.

Project Timeline
Dec 2014 – April 2015

Key deliverables
This project involves the deployment of two ocean gliders and a surface Waveglider along the southern boundary of Drake Passage. The gliders will sample for a period of 15 weeks before recovery. In addition to the gliders, 20 CTD stations will be carried out during the deployment cruise and approximately 12 CTD stations will be carried out during the recovery cruise. The main data products collected will be profiles of temperature, conductivity, dissolved oxygen, fluorescence and optical backscatter; depth-averaged velocities will also be collected by the gliders. The Waveglider will collect meteorological data from a weather station as well as surface hydrographic measurements. Underway profiles of temperature, salinity and velocities from a shipboard ADCP will also be collected. Data products resulting from this project will be time series of front positions in southern Drake Passage, mixed layer depth variability, maps of eddy kinetic energy and cross-shelf heat and salinity fluxes.

Funding
U.S. NSF Office of Polar Programs.

Linkages with other programmes
This study is closely related to previous field programs in the region, ADELIE and GENTOO, both funded by NERC in the UK.

Data Management
Access to the raw, unprocessed, data will be provided via contact from interested parties with the PIs. All data and metadata will be available on the PI's website for access and sharing as soon as is possible (expected to be 6 months) after processing and will be preserved for at least three years beyond the award period, as required by NSF guidelines. Within two years of the recovery cruise, both the glider and CTD data and associated metadata will be archived at the following locations: National Oceanographic Data Center (NODC), the LDEO Antarctic and Southern Ocean Data Portal, the NASA Global Change Master Directory and the U.S. Antarctic Program Data Coordination Center.