The Southern Ocean Seasonal Cycle Experiment (SOSCEx)

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Project Description
The seasonal cycle is not only the strongest mode of natural variability but also the one that most strongly links climate and ecosystems through the lifecycle phenologies of the biosphere. However, the seasonal cycle characteristics or seasonality, are largely shaped by higher frequency intra-seasonal modes which not only define the response modes in physics, biogeochemistry and ecosystem components but also, we hypothesize, define the non-steady state magnitudes of integrated and mean annual carbon and primary productivity fluxes. The approach implies making links in the dynamics and scale sensitivities of atmospheric forcing, surface boundary layer physics, iron dynamics, primary production responses and CO2 fluxes. SOSCEx aims to explore the nature of this scale sensitivity with a particular focus on the seasonal cycle mode (Monteiro at al., 2011) as a test for the climate sensitivity of earth systems models in respect of the evolution of both atmospheric CO2 and ocean ecosystems in the 21st Century. This seasonal cycle experiment in the Southern Ocean builds on the experience gained in SOSCEx I & II, which were feasibility studies for high-resolution seasonal cycle experiments (Swart et al., 2012; Swart et al., 2014).

The scientific goals of SOSCEx are:
- What is the scale sensitivity of the Carbon – Climate and Ecosystem - Climate links in the Southern Ocean? What role do fine scale upper ocean dynamics (sub-seasonal and sub-mesoscale) play in regulating the links between carbon and climate and productivity and climate?
- What role do these fine scale dynamics in the Southern Ocean play in influencing the century scale evolution of ocean – atmosphere exchange of CO2?
- What role do these fine scale dynamics in the Southern Ocean play in influencing the contemporary variability and century scale evolution of primary productivity?
- Do fine scale dynamics contribute to resolving contemporary variability and long-term trends associated with non-steady state evolution of ocean carbon fluxes?

A novel aspect of SOSCEx is the integrated multi-platform approach - gliders, ships, floats, satellites and models - which we aim to use to explore new questions about both the process parametrization in models as well as the climate sensitivity of carbon and ecosystem dynamics.

SOOS Linkages:
The experimental approach of SOSCEx directly relates to the strategy of SOOS in terms of observing platform integration, the multi-national collaboration and multi-disciplinary nature (contributing directly to SOOS Science Themes 1, 2, 4 & 6) of the research undertaken. These expanded experiments made using robotics in the Southern Ocean highlight the value these platforms have in establishing an observing system in the Southern Ocean. The combined effect of the remote, harsh environment and the lack of continuous

observations made outside of the austral summer sampling window in the Southern Ocean, make these robots ideal platforms to support SOOS and its 20-year vision (Meredith et al., 2013).

There are strong capacity building components to SOSCEx some of which include:
- new, high-resolution datasets developed by SOSCEx will be used in a number of MSc and PhD studies that spans over the observational to modeling domain of the research.
- SOSCEx expands and spurs current marine technological advancements. Ocean robotics (gliders) and sensor development are advanced by pioneering experiments like SOSCEx. The mentoring and training of young technicians, engineering interns and early career marine engineers are a crucial cog of the successful completion of SOSCEx
- The international collaborations that stem from the experiment directly imports advanced skills into the country by which in particular student and early career researchers benefit. We have an extensive cohort of international partners that allow for our students and researchers to undertake extended exchanges over several months at a time at leading international institutes (PMEL-NOAA, WHOI, CalTech., U. Paris, etc.) in order to be co-supervised, interact with postgraduate students and post-doctorates (network development) and attend advanced coursework.

Project Timeline
Mid 2015 – 2018

Key deliverables
The multi-platform element of the project (gliders, ships, floats and models) will obtain numerous datasets that extends over a number of disciplines, including physical oceanography, meteorology, carbon-climate, bio-optics, and biogeochemistry. These datasets will extend over new temporal scales (high resolution and continous multi-month extent). This data will form a key part of post-graduate MSc and PhD studies as well as publications in international, peer-reviewed journals and conferences.

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Linkages with other programmes
This study relates to ongoing field programs in the region such as the GoodHope Monitoring Programme (multi-national) and SAMOC (NRF, Brazil, USA, France). This study is propsed to be contributor to the AtlanTOS European Union H2020 proposal awaiting funding.

Data Management
Data stemming out of the project will undergo international standard quality control and calibration procedures. Initial access to unprocessed data will be available via the PIs to interested parties and collaborators. Following this, data will be submitted to the South African Data Centre for Oceanography (SADCO) and will be freely available after a preservation period of at least 3 years. Data will be distributed to the appropriate data streams to make it available to the global community, some of which include the SOOS Data Network and the European Glider Observatory Data Portal.