ANTARCTIC CLIMATE & ECOSYSTEMS
COOPERATIVE RESEARCH CENTRE

ACE CRC Intern Project for 2017/18

Project Title:
Biological controls on ocean productivity and CO_2 uptake at the Southern Ocean Time Series (SOTS): 2. Developing bio-optical approaches to characterizing ecosystem structure

Supervisors: Tom Trull, Peter Jansen, Diana Davies

Background/context of project:
Biological process move carbon from the ocean surface to the ocean interior in a two-step process – fixation of CO_2 into organic matter by photo-synthesis and passage of this matter through the foodweb with a portion of it exported downward as sinking detrital particles. This export is strongly influenced by ecosystem structure, in particular the size of phytoplankton, because larger phytoplankton succeed to a greater degree than small phytoplankton in escaping consumption by zooplankton. This "decoupling" of the trophic levels is also strongly influenced by seasonal changes in environmental conditions, including light and nutrient availability, and thus requires high temporal resolution assessment over full annual cycles. Previous work on this problem at SOTS has determined the seasonal cycle of the air-sea flux of CO2 [*Shadwick et al.*, 2015], and biological net community production [*Weeding and Trull*, 2014], and the amounts of organic matter arriving in the ocean interior [*Trull et al.*, 2001]. This project will work to develop optical sensor based metrics for plankton community structure phenology, to understand the ecological links between this 3 previous components of the problem. Optical methods are affordable and scaleable, and notably are under rapid development for use in the implementation of the global Biogeochemical Argo autonomous profiling float array, e.g. [*Grenier et al.*, 2015]. They also offer information useful to the calibration of satellite remote sensing assessments of ocean phytoplankton populations [*Wojtasiewicz et al.*].

Project outline:
This project will combine three components:

i. Calculation of phytoplankton biomass and particulate organic matter concentrations from fluorescence and optical backscatter sensors deployed at SOTS in the period 2009-2016, using ship-based measurements from SOTS voyages, the extensive process study at the SOTS site during the SAZ-Sense program, and literature estimates.
ii. Use of these estimates to characterize the planktonic ecosystem structure in terms of simple metrics such as the autotrophic contribution to total biomass, the size of phytoplankton, and the expected magnitude of export.
iii. Comparison of these results to SOTS productivity and export results, and to satellite ocean colour estimates of phytoplankton functional types.

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Key deliverables:

- A quality controlled database of fluorescence and backscatter observations at SOTS expressed in terms of phytoplankton biomass and particulate matter with associated error estimates.
- Significant progress towards production of a manuscript for submission in a high quality peer reviewed journal.

Any specific skills required:

- This project is aimed at final year or honour level students with a physical sciences or mathematics background, although other applicants will be considered on merit.
- Computing skills, e.g. in Matlab, R, or Python are required.
- Interest in oceanography, biogeochemistry and ecology, experience with instruments or sensors, and an aptitude for multi-disciplinary research, are all advantageous.

Contact details

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Citations:

Grenier, M., A. Della Penna, and T. W. Trull (2015), Autonomous profiling float observations of the high-biomass plume downstream of the Kerguelen Plateau in the Southern Ocean, *Biogeosciences*, *12*(9), 2707-2735, doi:10.5194/bg-12-2707-2015.

Shadwick, E. H., T. W. Trull, B. Tilbrook, A. J. Sutton, E. Schulz, and C. L. Sabine (2015), Seasonality of biological and physical controls on surface ocean CO2 from hourly observations at the Southern Ocean Time Series site south of Australia, *Global Biogeochemical Cycles*, 2014GB004906, 004901-004916, doi:10.1002/2014GB004906.

Trull, T., S. G. Bray, S. J. Manganini, S. Honjo, and R. Francois (2001), Moored sediment trap measurements of carbon export in the Subantarctic and Polar Frontal Zones of the Southern Ocean, south of Australia, *Journal of Geophysical Research*, *106*(C12), 31489-31509, doi:10.1029/2000JC000308.

Weeding, B., and T. Trull (2014), Hourly oxygen and total gas tension measurements at the Southern Ocean Time Series site reveal winter ventilation and spring net community production, *Journal of Geophysical Research: Oceans*, *119*(1), 348-358, doi:10.1002/2013JC009302.

Wojtasiewicz, B., N. Hardman-Mountford, D. Antoine, F. Dufois, D. Slawinski, and T. W. Trull Use of bio-optical profiling float data in validation of primary ocean colour satellite products in a remote ocean region, *Ocean Optics, in review*.