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): 1. Developing bio-optical approaches to quantifying phytoplankton photosynthetic competency

Supervisors: Tom Trull, Peter Jansen, Christina Schallenberg

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 "biological carbon pump" is strongly influenced by phytoplankton productivity, which is the Southern Ocean is mainly controlled by the availability of iron as a limiting, essential, trace nutrient. Previous work [*Schuback et al.*, 2015] suggest that phytoplankton fluorescence may provide a way to assess iron stress, specifically via changes in the amount of fluorescence in response to insolation levels, a phenomenon known as non-photochemical quenching (NPQ) which reflects the cell's efforts to efficiently manage the radiation resource and its conversion into carbon fixation via electron transport and enzymatic processes that require iron. Previous work at SOTS on the availability of iron [*Sedwick et al.*, 2008] and light [*Eriksen et al.*, 2017] shows that both are highly seasonally variable and thus development of NPQ as a metric for phytoplankton health requires high temporal resolution assessment over full annual cycles. This project will work to develop an understanding of NPQ variability and its link to iron availability and photosynthetic competency. Importantly, this approach is potentially applicable to satellite remote sensing data streams, because insolation induced fluorescence is measurable from space.

Project outline:
This project will combine three components:

i. Calculation of NPQ from SOTS moored instruments, and comparison to ship-based measurements from SOTS voyages, the extensive process study at the SOTS site during the SAZ-Sense program, and literature estimates.
ii. Evaluation of the possible role of phytoplankton type in affecting NPQ, via compilation of results from the literature.
iii. Comparison of the sensor results to other estimates of phytoplankton photosynthetic competency, including fast repetition rate fluorescence and ^{14}C tracer techniques.

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Key deliverables:

- A quality controlled database of NPQ estimates at SOTS
- Estimates of iron stress from a simple model of NPQ dependence on light and iron levels.
- 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

Eriksen, R., T. W. Trull, D. Davies, P. Jansen, A. T. Davidson, K. Westwood, and R. Van den Enden (2017), Seasonal succession of plankton community structure from autonomous sampling at the Australian Southern Ocean Time Series site, *Marine Ecology Progress Series*, *in review*.

Schuback, N., C. Schallenberg, C. Duckham, M. T. Maldonado, and P. D. Tortell (2015), Interacting effects of light and iron availability on the coupling of photosynthetic electron transport and CO 2-assimilation in marine phytoplankton, *PloS one*, *10*(7), e0133235.

Sedwick, P. N., A. R. Bowie, and T. Trull (2008), Dissolved iron in the Australian sector of the Southern Ocean (CLIVAR SR3 section): Meridional and seasonal trends, *Deep Sea Research Part I: Oceanographic Research Papers*, *55*(8), 911-925, doi:10.1016/j.dsr.2008.03.011.