Photosynthetic response of Southern Ocean phytoplankton to Iron and Light limitations: Bioassay experiments

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Introduction

- Phytoplankton productivity is regulated by iron and light both of which are limiting factors in the Southern Ocean(SO)[1]
- The SO is known as the largest High Nutrient Low Chlorophyll (HNLC) region in which iron largely impacts phytoplankton growth and is important due to its impact on Net Primary Productivity (NPP) and the Biological Carbon Pump (BCP) which influences atmospheric carbon dioxide[2,3]

Objectives and Aim

- To investigate the significance of iron and light as limiting and co-limiting factors within the Subsurface Chlorophyll (30-60m depth) in the SO
- To understand how SO phytoplankton communities respond and adapt to iron and light limitations
- To test the following hypotheses:
  - SO Phytoplankton shows variability in their photosynthetic capacity as a result of gradients in iron and light
  - Antarctic phytoplankton communities show different responses to iron and light limitations than sub-Antarctic communities

Method

- Shipboard iron/light bioassay experiments were conducted during SANAE 53 voyage
- All sampling, from Geotraces Goflo bottles, for bioassay experiments was conducted in trace metal clean container-laboratories (see Fig. 1)
- Stations at which bioassay samples were taken (see Fig. 2): Experiment 1 - 65°S, 000°E; Experiment 2 - 50°S, 001°E and Experiment 3 - 45°S, 0 06°E.
- Sampling was carried out with a Geotraces CTD at depths betwwen 30 – 60m.
- Bioassay experiments were done under 4 treatments (see Fig. 3)
- Experiments were run in light and temperature modulated incubators (see Fig. 4)
- Analysis done: Photosynthetic response, physiological/chemical response; phytoplankton community characterisation

Figure 1: Class 10 trace metal clean sampling container-laboratory on board SA Agulhas II

Sampling stations

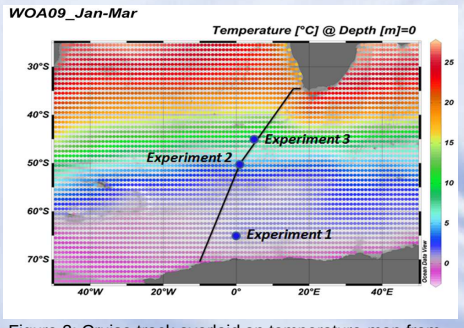

Figure 2: Cruise track overlaid on temperature map from U.S. NODC World Ocean Atlas 2009
Plotted with Ocean Data View 4.5.6, Schlitzer 2011
Stations = blue dots

Chlorophyll growth rates

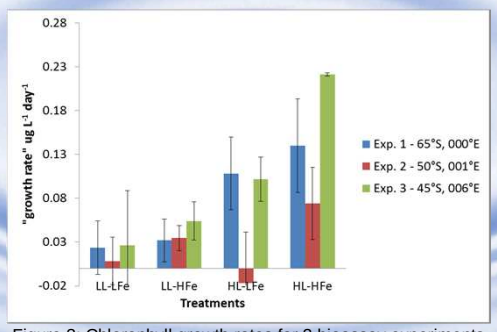

Figure 3: Chlorophyll growth rates for 3 bioassay experiments conducted during SANAE 53
Columns = averages; error bars = standard deviation
LL-LFe: Low Light-Low Iron LL-HFe: Low Light-High Iron
HL-LFe: High Light-Low Iron HL-HFe: High Light-High Iron

Figure 4: Light and temperature modulated incubators used for bioassay experiments

Chlorophyll trend

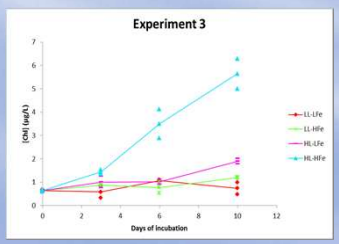

Figure 5: Average chlorophyll trends of 4 treatments for bioassay sampled at 45°S, 006°E

Nitrate uptake trend

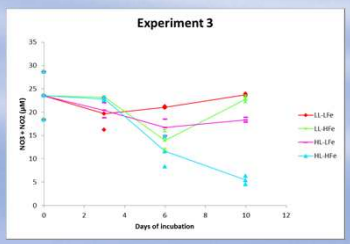

Figure 6: Average nitrate uptake trends of 4 treatments for bioassay sampled at 45°S, 006°E

Fv/Fm trend

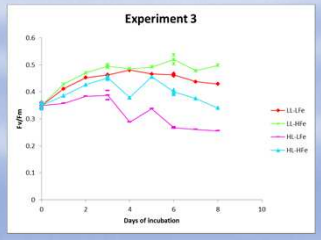

Figure 7: Average Fv/Fm trends of 4 treatments for bioassay sampled at 45°S, 006°E

Discussion

- Chlorophyll growth rates indicate a significant difference in phytoplankton communities for the 3 water masses as well as a marked variability in the response to light and iron limitations.
- Chlorophyll trend shows a strong similarity to a previous bioassay experiment conducted during the SOSCEx voyage during March 2013, where the high light-high iron treatment too yielded the largest response.
- Nitrate uptake trend supports trend seen in chlorophyll concentrations.
- Fv/Fm trend indicates that the addition of iron contributes to an increase in the photosynthetic ability of cells.

Acknowledgements

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References

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