

Fast-Track Initiative – ‘Upper Ocean Nutrient Limitation’

compiled by Mark Moore

Notes:

Reporting Period is January 2011 – December 2011

Information will be used for: reporting, fundraising, networking, strategic development & outreach

1. Key scientific SOLAS-relevant highlights/findings (you may include figures and references)
The key SOLAS relevant highlights resulting from the workshop will all be incorporated within the primary review paper which is nearing the submission stage. In particular, a novel meta-analyses of nutrient addition experiments and natural marine microbial responses within dust addition experiments will be included within this manuscript.
2. Activities/main accomplishments (research projects, cruises, special events, workshops, remote sensing used, model and data intercomparisons etc)
The main workshop related to the workshop was undertaken in November 2010, consequently the principal activity during 2011 has been preparation of the primary review paper resulting from the workshop. Progress of this has been a little slower than desirable, partly due to the large amount of new information to be incorporated. Novel data meta-analyses have been produced as part of generating the review paper and extensive work has been performed on these during the past 12 months. The third and hopefully final full draft is now nearing completion and submission to Nature Geoscience is planned for early 2012.
3. Human dimensions (outreach, capacity building, public engagement etc)
No specific outreach activities were performed during 2011. International capacity building continues through the involvement of researchers from economies in transition within the FTI.
4. Top 10 publications in 2011 (Reports, articles, models, datasets, products, website etc)
No peer reviewed publications were produced in 2011, work on the draft manuscript continues and all the pre-workshop reports were posted on the FTI website following the meeting in late 2010 (http://ocean.stanford.edu/IGBP_FT/products.html). Preliminary information related to the novel meta-analyses performed was posted on the website during 2011 (http://ocean.stanford.edu/IGBP_FT/working_groups.html) and will be disseminated further alongside the published manuscript. An article associated with the workshop was published in issue 12 of the SOLAS Newsletter ‘Workshop associated with the IGBP Fast Track Initiative (FTI) on “Upper Ocean Nutrient Limitation: Processes, Patterns and Potential for change” SOLAS News 12 page 28
5. International interactions and collaborations (including contributions to international assessments such as the IPCC, links with observation communities etc)
International interactions continue through collaborations with the workshop participants who represent 10 countries across 4 continents. Collaborations and links with other IGBP projects (AIMES, PAGES/NICOPP) and GEOTRACES. Unfortunately a joint application led by Cecile Giueu for a related session at the 2012 ‘Planet Under Pressure’ conference was unsuccessful.
6. Goals, priorities and plans for future activities/events
The major goal and priority over the coming months is the submission and guidance through the review process of the principal review paper. As mentioned above, this is planned within the next 2-3 months.
7. Other comments
The final report submitted to IGBP is attached and contains further details on much of the above.

IGBP-FTI: Upper ocean nutrient limitation: processes, patterns and potential for change

Co-ordinators: Dr. Mark Moore (NOCS, UK), Dr. Matt Mills (Stanford University, US), Dr. Emilie Brévière (SOLAS, Germany), Prof. Doug Wallace (SOLAS, IGBP SC liaison, Germany)

Final Report: 08-02-2011

Although the following represents the final report on the IGBP Fast Track Initiative (FTI) on Upper Ocean Nutrient Limitation which commenced in May 2009, activities relating to the FTI are ongoing and in particular publications are planned for the coming 6 months.

Introduction and objectives

The FTI was set up as a mechanism for providing a synthesis of the current state of knowledge concerning patterns of upper ocean nutrient limitation, alongside the subsequent importance of nutrient limitation for wider ocean biogeochemistry. In conceiving the FTI, it was recognised that a large number of observational, experimental and modelling studies had recently addressed issues related to patterns of nutrient limitation in the upper ocean. It was hence realised that an opportunity was available to attempt to review and synthesise this large body of work. In addition to establishing the current state of the art, the FTI also considered the conceptual constructs and techniques used in the evaluation of nutrient limitation and explicitly considered how nutrient limitation may have changed in past and may respond to potential future perturbation. More detailed background, rationale and objectives for the FTI were set out in the original proposal.

Progress

IGBP initially allocated 13k euro to the FTI. Subsequent successful applications to the US Ocean Carbon and Biogeochemistry programme (OCB), SCOR and EU-COST-735 secured an additional \$7k, \$5k and 2k euro respectively. The high level of support from IGBP and the other sources was much appreciated and facilitated the running of the main workshop at no additional cost to a highly international participant list (see appendix 1). Implementation of the FTI involved 2 principal activities:

The first was a special session at the joint AGU/ASLO Ocean sciences meeting in Oregon (February 2010) convened by Mills and Moore. These sessions attracted 27 abstracts from experimental oceanographers, modellers and paleoceanographers, full details of both the oral and poster sessions are available on-line:

(http://www.agu.org/meetings/os10/os10-sessions/os10_BO11C.html, oral)

(http://www.agu.org/meetings/os10/os10-sessions/os10_BO15G.html, poster).

Both sessions were well attended and generated considerable cross disciplinary interest.

The main implementation activity followed later in the same year. A dedicated workshop was run from 3rd-5th November 2010 at the National Oceanography Centre, Southampton, UK. A total of 19 participants from 10 countries attended, with a further 2 having to withdraw at the last minute due to illness (see appendix 1). The range of different disciplines and level of expertise facilitated a dynamic environment for stimulating and productive cross disciplinary discussions. A total of 9 pre-workshop reports were prepared by working subgroups and disseminated prior to the workshop. The titles of these reports can be viewed on the dedicated webpage which was set up to facilitate communication and interest for the FTI (http://ocean.stanford.edu/IGBP_FT/). Following the workshop, full texts of all the reports and presentations were also made available to all participants within a secure region of the website.

The first day of the workshop was devoted to the presentation and subsequent discussion of the material within the pre meeting reports. A wide range of collated information was considered in detail and it was recognised that the reports would be a vital resource for informing a proposed major review paper (see below). Potential wider dissemination of the reports is still under consideration, although transfer of information to the review paper may make this unnecessary. Subgroups met to further consider emerging unifying themes on day 2 of the workshop. In particular *concepts and definitions of nutrient limitation, current patterns of limitation, expected changes in the future and implications of changes*, were all discussed in detail. A novel meta-analysis of results from nutrient perturbation experiments was also conceived and the subsequent data-base will become a key aspect of a review manuscript. The data base is likely to represent a highly

useful resource for the biogeochemical modelling community and hence will be disseminated alongside the review paper, for example as 'supplementary information'. We are also investigating independent dissemination via the website following publication. After consideration the group felt that an overview manuscript covering the breadth of material, written for a high profile journal and a general (biogeo-)science audience, was the overall preferred method for dissemination. The majority of the final day thus involved initial condensation of the large volume of information already collected into material suitable for this principal product. The scope of such a manuscript will necessarily leave some material unused. Consequently a number of sub-groups have already indicated interest in developing more specialist manuscripts following completion of the overview.

Outputs

The working papers, presentations and ongoing data-base development constitute major scientific outcomes. The synthesis of this material, initiated at the meeting, will form the basis of a review which should mark a significant statement on the current state of the art. Discussions with the editor of *Nature Geoscience* on whether they would consider such a review article remain very positive. Writing work on this principal product is well advanced with the first complete draft having been disseminated to all workshop participants/coauthors. Incorporation of subsequent substantial comments/suggestions into the second complete draft is nearly complete and one more round of comments will be solicited from the co-authors before subsequent submission to *Nature Geoscience* hopefully within 2 months. A meeting report was also prepared for the SOLAS newsletter. Reports were also delivered to OCB and EU-COST 735. As mentioned above, further products in the form of specialist reviews may follow submission of the overview manuscript. The completed data base will also represent a substantial resource for the community.

Timeline

- Feb 22nd-26th 2010: Special Session at Ocean Sciences meeting *Complete*
- Nov 3rd-5th 2010: Dedicated workshop, NOCS UK *Complete*
- March 2011: Preparation of 1st draft of principal manuscript *Complete*
- Current Preparation of 2nd draft of principal manuscript *Ongoing*
- September 2011: Submission of manuscript to *Nature Geoscience* *Projected*

Appendix 1

List of workshop attendees alongside specialisms with affiliations to other projects:

Name Discipline/specialism (Country, Gender) Other affiliation

Illana Berman-Frank *Nutrient limitation of diazotrophs* (Israel, Female)

Laurent Bopp *Modelling* (France, Male) **AIMES SSC**

Eric Galbraith *Paleoceanography, modelling* (Canada, Male) **NICOPP/PAGES**

Richard Geider *Phytoplankton physiology and stoichiometry* (UK, Male)

Cecil Guieu *Nutrient limitation, atmospheric inputs* (France, Female) **SOLAS SSC**

Samuel Jaccard *Paleoceanography, modelling* (Switzerland, Male) **NICOPP**

Tim Jickells *Atmospheric nutrient inputs* (UK, Male)

Julie La Roche *Diazotroph nutrient limitation* (Germany, Female)

Tim Lenton *Modelling, nutrient stoichiometry* (UK, Male)

Emilio Maranon *Phytoplankton ecology and physiology* (Spain, Male)

Irina Marinov *Nutrient biogeochemistry, modelling* (US, Female)

Mark Moore *Phytoplankton ecology and physiology* (UK, Male)

Matt Mills *Microbial biogeochemistry* (US, Male)

Takeshi Nakatsuka *Paleoclimatology, Paleoceanography* (Japan, Male) **PAGES SSC**

Andreas Oschlies *Biogeochemistry, Modelling* (Germany, Male)

Mak Saito *Nutrient co-limitation, trace metal bioavailability* (US, Male)

Frede Thingstad *Bacterial resource limitation* (Norway, Male)

Atsushi Tsuda *Iron limitation, trophic interactions* (Japan, Male)

Oswaldo Ulloa *Phytoplankton ecology and biogeochemistry* (Chile, Male)

The following people who unfortunately were unable to attend were all involved in the preparation of pre-workshop reports and continue to be involved in post-workshop manuscript preparation:

Kevin Arrigo *Phytoplankton ecophysiology* (US Male)

Phil Boyd *Phytoplankton Fe limitation* (New Zealand, Male) **GEOTRACES SC**

Natalie Mahowald *Atmospheric nutrient inputs* (US, Female)

Keith Moore *Modelling multiple limiting nutrients* (US, Male)

Doug Wallace *Marine biogeochemistry* (Germany, Male)