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SCOR Proceedings, Volume 49  
REPORT OF THE 41<sup>st</sup> SCOR EXECUTIVE GENERAL MEETING

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# **41<sup>st</sup> SCOR EXECUTIVE COMMITTEE MEETING**

## **Wellington, New Zealand**

25-27 November 2013

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### **1.0 OPENING**

#### **1.1 Opening Remarks and Administrative Arrangements**

SCOR President Peter Burkill opened the meeting and introduced Diane McCarthy, the Chief Executive of the Royal Society of New Zealand. She welcomed participants to the meeting, and noted that there were representatives from 13 different countries present. McCarthy wished participants a good visit and a chance to see the country. It is a special honor that SCOR is meeting at the Royal Society Headquarters. The Royal Society was founded almost 150 years ago. At its core is the National Academy of Scholars, elected by their peers. The Royal Society embraces all disciplines. It administers a large number of government grants, including the Marsden Fund, for “blue skies” research. The Royal Society promotes international research collaborations and administers memberships for international organizations. The Royal Society is a member body of the International Council for Science (ICSU), of which SCOR was the first interdisciplinary body. The next ICSU General Assembly, in 2014, will be held in Auckland for the first time. McCarthy finished by thanking SCOR for coming to the Royal Society.

Julie Hall, a SCOR Nominated Member from New Zealand, welcomed everyone to Wellington and provided some logistical information. There would be a reception at NIWA after the first night of the meeting to make it possible for SCOR visitors to meet some local ocean scientists.

Peter Burkill continued by honoring 6 scientists who had been involved in SCOR and had passed away since last year’s SCOR meeting: Eberhard Fahrback, Carlo Heip, John Steele, Tore Vorren, C.S. Wong, and Mingyuan Zhu. Burkill briefly described how each individual had contributed to SCOR and called for a moment of silence. Afterward, everyone introduced themselves.

#### **1.2 Approval of the Agenda**

Additions or modifications to the agenda as distributed may be suggested prior to approval of the final version. Peter Burkill asked if any changes to agenda were needed. No changes were requested.

#### **1.3 Report of the President of SCOR**

Peter Burkill reviewed his activities as SCOR President since the SCOR General Meeting in October 2012 in Halifax, Canada, and gave a few thoughts about his view of the important issues for SCOR. Three major issues face SCOR in the next few years. The first is the future of two SCOR-sponsored projects, the Integrated Marine Biogeochemistry and Ecosystem Research (IMBER) project and the Surface Ocean – Lower Atmosphere Study (SOLAS). Both projects

wish to continue beyond their first 10 years, which will require the projects to produce descriptions of their achievements and plans for their extensions. The second issue is the transition from the International Geosphere-Biosphere Programme (IGBP) to the Future Earth initiative. IGBP has been a major partner with SCOR in sponsoring large-scale ocean research projects since 1989. The path of Future Earth and how this will affect projects like IMBER and SOLAS will not be clear for several more years. Finally, ICSU will review SCOR in the next year or two. ICSU reviews each of its scientific organizations on a periodic basis, but SCOR's last full review was in 1992. The main issue with the review is that it requires a significant amount of time from the SCOR President, Executive Committee, and Executive Director in terms of answering review questions and preparing materials.

Burkill continued by stating that he has identified a topic to which he would like to give extra attention during his term as SCOR President: research in the Indian Ocean. SCOR's first major activity, for which planning started at the first SCOR meeting in 1957, was the International Indian Ocean Expedition. Burkill noted that the Indian Ocean is still one of the most understudied ocean basins, there is much interesting ocean science to pursue there, and the results of the research are directly applicable to the nations surrounding the Indian Ocean. The scientific capacity of the nations of that region is higher than in the early 1960s, but there are still significant opportunities for capacity building in the region. As described later in the meeting, SCOR will work with the Intergovernmental Oceanographic Commission (IOC) on several activities to stimulate new research in the Indian Ocean.

The SCOR President's responsibilities require representing SCOR at various meetings through the year. Burkill described his representation of SCOR through the past year:

- Shortly after becoming the SCOR President, Burkill attended a meeting of the London Convention/London Protocol to make a presentation about SCOR in support of SCOR's application for official observer status to these organizations. Unfortunately, the application was eventually blocked for political reasons and the SCOR Executive Committee decided to withdraw SCOR's application for observer status.
- Burkill attended the IMBER Imbizio in Goa, India in his personal capacity to give a scientific presentation, but used the opportunity to meet with the IMBER and SOLAS chairs and others to discuss their plans to request extensions and to apply to Future Earth for co-sponsorship.
- Burkill arranged a workshop in his home city of Plymouth, UK to draw attention to SCOR activities among the ocean science community in Plymouth.
- Burkill represented SCOR at the annual IGBP Science Committee meeting in Bern, Switzerland, and presented SCOR's views of Future Earth there.
- The Indian National Centre for Ocean Information Services (INCOIS) hosted the first meeting of the Reference Group for the IIOE-2 in Hyderabad, India. Burkill and Ed Urban participated.
- Burkill and Urban also represented SCOR at the General Assembly of IOC in Paris, France. While in Paris for the IOC meeting, Burkill and Urban also met with the ICSU Executive Director, Steven Wilson, to discuss Future Earth and met with the French SCOR Committee.



- Finally, Burkill participated in a meeting of the UK SCOR Committee and enlisted its help in seeking funding from the Royal Society for a brainstorming meeting in 2014 related to participation of UK scientists in IIOE-2.

#### 1.4 Report of SCOR Executive Director

Ed Urban reported on his activities as SCOR Executive Director since the 2012 SCOR meeting, and on the current condition of SCOR.

**Finances:** Most countries have paid their 2013 dues and it appears that we can afford to support two new working groups and other short-term activities for start in 2014. The uncertainty in U.S. government budgets has not significantly affected SCOR. SCOR maintains a healthy surplus to counteract any future shortfalls in income from dues.

**Working Groups:** Most groups continue to make progress toward fulfilling their terms of reference on time, although a few groups have postponed activities.

**Research Projects:** Several projects are reaching the end of their 10-year lives. Two (SOLAS and IMBER) will be requesting extensions. GEOTRACES continues to deploy several national research cruises each year. The IQOE project is under consideration.

**Partner Organizations:** There is some uncertainty in the ability of partner organizations to contribute adequate finances for joint projects, due to the transition from IGBP to Future Earth and a significant cut in funding by IOC for joint projects because of changes in their finances.

**SCOR Secretariat:** SCOR lost one part-time staff member this year, Lora Carter. Urban is considering sustainable replacement options and potential outsourcing of some tasks. The SCOR Secretariat will be moving to the main building of its host college early in 2014.

**Outreach:** Urban is working on improving the appearance of SCOR products and is trying new means of outreach, such as a booth at Ocean Sciences 2014. The booth will include posters from IMBER, GEOTRACES, SCOR, SOLAS, and SOOS.

Urban showed a graph of the percentage participation of developing country scientists and female scientists on SCOR groups from 2004 to 2013. The percentage of developing country scientists has varied between 20% and 25%. However, the percentage of female sciences has increased from 20% in 2004 to about 33% in 2012. This increase has not been due to any strict requirement for a minimum percentage of female scientists; it has been more of an organic increase based on increased participation of women in ocean science and more attention to identifying qualified female scientists to serve on SCOR activities.

#### 1.5 Appointment of an *ad hoc* Finance Committee

The SCOR Constitution requires that a Finance Committee be appointed at every SCOR meeting. It must consist of three members of SCOR who are not members of the Executive Committee. The Executive Committee approved Colin Devey (Germany), Karen Heywood (UK), and Motoyoshi Ikeda (Japan) as the three members in advance of the meeting. The Finance Committee reviewed the administration of SCOR finances during 2012 and 2013, and proposed a budget for 2014 activities. The Committee's report is given in Section 8.3. Peter Burkill mentioned that Ed Urban will help the committee, as needed.

## **1.6 2014 Elections for SCOR Officers**

The SCOR Secretary and all three Vice-President positions are open for nominations for the 2014 elections. Wolfgang Fennel, as SCOR Past-President, will chair the Nominating Committee. He noted that a committee should be formed by the end of this meeting, with balance geographically, by gender, and by expertise. Peter Burkill asked participants to contact Fennel with suggestions. By the end of the meeting, the following members had been nominated for the committee and were approved: Wolfgang Fennel (Germany), Julie Hall (New Zealand), Bjørn Sundby (Canada), and Sinjae Yoo (Korea).

## **2.0 WORKING GROUPS**

### **2.1 Disbanded Working Groups**

#### **2.1.1 SCOR WG 131 on The Legacy of in situ Iron Enrichment: Data Compilation and Modeling**

The group publicized its database through an article in *Oceanography* magazine.<sup>1</sup> The co-chairs were thanked for their work and the group was disbanded.

#### **2.1.2 SCOR/LOICZ WG 132 on Land-based Nutrient Pollution and the Relationship to Harmful Algal Blooms in Coastal Marine Systems**

Satoru Taguchi reported that the group has two final papers in review based on its work. The group members were thanked for their work and the group was disbanded.

#### **2.1.3 SCOR/WCRP/IAPSO Working Group 136 on the Climatic Importance of the Greater Agulhas System**

Ed Urban reported that the group held its final meeting in conjunction with a Chapman Conference that it proposed, on The Agulhas System and its Role in Changing Ocean Circulation, Climate, and Marine Ecosystems, which was held on 8–12 October 2012, in Stellenbosch, Western Cape, South Africa (see <http://www.agu.org/meetings/chapman/2012/ecall/>). Group members continue their work in promoting research and observations in the Agulhas Current region. Lisa Beal, one of the group's co-chairs, served as a SCOR Visiting Scholar in South Africa in early 2013.

### **2.2 Current Working Groups**

The Executive Committee Reporter for each working group presented an update on working group activities and progress, and made recommendations on actions to be taken. Meeting participants made preliminary decisions, based on the progress of working groups and the merits of the requests, about whether funding should be provided for 2014 activities of working groups that have funds remaining. The Finance Committee took into account the recommendations of meeting participants as it developed the 2014 SCOR budget, which was then subject to final approval by the meeting.

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<sup>1</sup>[Boyd, P.W., D.C.E. Bakker, and C. Chandler. 2012. A new database to explore the findings from large-scale ocean iron enrichment experiments. \*Oceanography\* 25:64-71.](#)

### **2.2.1 SCOR WG 134 on The Microbial Carbon Pump in the Ocean**

Some group members participated in one of the three theme sessions at the IMBER IMBIZO in early 2013. The group has a workshop accepted for the IMBER Open Science Conference in June 2014 and will participate in the International Symposium on Microbial Ecology (ISME-15) in Korea in August 2014, as the final activities of the group. It was agreed to disband the group and thank the members for their work when their activities are completed.

### **2.2.2 SCOR/InterRidge WG 135 on Hydrothermal Energy Transfer and its Impact on Ocean Carbon Cycles**

Athena Coustenis reported that the group's final activity will be a special session at the 2014 European Geosciences Union meeting and a final meeting of the group (this meeting was postponed from 2013). The group is preparing two publications, tentatively entitled "Coupled cycling of Fe and C<sub>org</sub> in submarine hydrothermal plumes: Potential for impact on the global deep-ocean carbon cycle" and "Hydrothermal energy transfer and the ocean carbon cycling: How to assess vent ecosystem productivity?" Funding was approved for the group's 2014 meeting.

### **2.2.3 WG 137: Patterns of Phytoplankton Dynamics in Coastal Ecosystems: Comparative Analysis of Time Series Observation**

John Volkman reported that the group is putting together datasets from around the world and looking for patterns. The group has developed a good Web site (see <http://wg137.net/>). It met for the third time in Hiroshima, Japan during 12-14 October 2012, in conjunction with the annual PICES meeting, and held its fourth meeting on 2-4 November 2013 in San Diego, California, USA in conjunction with the Coastal and Estuarine Research Federation (CERF) in November 2013. The group continues to work on an ambitious set of analyses and papers. It plans to meet next year, within its existing funding from SCOR, and it was approved by SCOR for the group to use the remainder of its funding for that meeting. There was some concern expressed that the group may want to go on forever. Volkman recommended that it would be good to give a message that they need to wrap up. Sinjae Yoo is an Associate Member of the group and noted that it will produce a special issue of the journal *Coastal, Estuarine and Shelf Science*. Fourteen papers have been identified for the special issue so far. The deadline for papers is in June 2014.

### **2.2.4 SCOR/IGBP WG 138: Modern Planktic Foraminifera and Ocean Changes**

Missy Feeley reported that this is a very active working group in its second year. Working Group members have been busy in the past year working toward individual products. An open-access eBook will be produced through Copernicus Press. A Web site has been developed for the group on the eForams platform ([http://www.eforams.org/index.php/WG138\\_Startpage](http://www.eforams.org/index.php/WG138_Startpage)) and is currently being filled with content. A taxonomic database and an annotated list of references also are being developed. The group held workshops in mid-2012 on (1) foraminifera taxonomy and (2) standardization of foraminifera collections. Funding was approved for the group's planned 2014 meeting.

### **2.2.5 WG 139: Organic Ligands – A Key Control on Trace Metal Biogeochemistry in the Ocean**

Ed Urban reported that this group met for the second time on 16 February 2013, immediately before the ASLO meeting in New Orleans. As with the first meeting, this minimized travel costs for the meeting. The group had a special session accepted for the ASLO meeting, on “Biogeochemistry of metal-binding organic ligands in the ocean: Sources, composition and impacts on trace metal cycling.” The third meeting of the group will be held in Honolulu, Hawaii in conjunction with the Ocean Sciences meeting in February 2014, at which they will also convene a special session. Funding was approved for the 2014 meeting of this group.

### **2.2.6 WG 140: Biogeochemical Exchange Processes at the Sea-Ice Interfaces**

John Volkman reported that the group held its first meeting in March 2013 in conjunction with the Gordon Research Conference on Polar Marine Science in Ventura, California, USA. The group has divided its work into three task groups (Methodologies and Intercomparisons, Data, and Modeling). Work is proceeding on each theme and the first papers citing the group’s work have already appeared.<sup>2</sup> Some concern was expressed about the rate of the group’s work and about their ability to make progress on their modeling tasks. A large number of people are mentioned in the report, but Volkman was unsure whether everyone is involved. The group is related to one of the SOLAS mid-term strategy elements. It will be good to keep an eye on the progress of this group. Funding was approved for the group’s 2014 meeting.

### **2.2.7 WG 141 on Sea-Surface Microlayers**

John Volkman noted that the group met for the first time in conjunction with the European Geosciences Union meeting in April 2013 in Vienna, Austria. The group is planning a workshop in Qingdao, China in 2014. The four-day workshop will have an open session for Chinese students, including training in microlayer sampling. A closed session of the workshop will focus on developing a paper that will highlight the role of microlayers in the changing ocean, aerosol chemistry, gas exchange, eutrophication, ecosystem health, and hydrophysical modeling. This paper is intended to help communicate the topic beyond specialists. The group is also planning a special issue, potentially of the *Journal of Geophysical Research*. Volkman noted that the group seems to be functioning well. They proposed some new Associate Members during the year, which were approved. The Qingdao meeting will be critical for the group’s work. Funding was approved for the 2014 meeting of the group.

### **2.2.8 WG 142 on Quality Control Procedures for Oxygen and Other Biogeochemical Sensors on Floats and Gliders**

Missy Feeley reported that the group did not meet in 2013, but is planning its first meeting in February 2014 in conjunction with the Ocean Sciences meeting in Honolulu, Hawaii. Feeley noted that this is another group that we have to key an eye on. It was agreed that the co-chairs need to submit an agenda for their meeting at Ocean Sciences before the SCOR funds will be committed.

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<sup>2</sup>E.g., Meiners, K.M., et al. 2012. Chlorophyll a in Antarctic sea ice from historical ice core data. *Geophys. Res. Lett.* 39, L21602, doi:10.1029/2012GL053478.

There was general agreement that working groups need to be provided guidance on report structure so that the working group reports are more standardized.

## **2.3 New Working Group Proposals**

Peter Burkill reported that SCOR received eleven working group proposals this year, which is good news. Much of the reputation of SCOR is based on the products of SCOR working groups. The expectation before the discussions was that two of the 11 proposals would probably be funded. The proposals were presented by the Executive Committee monitors in sequence and then discussed in turn.

### **2.3.1 SCOR Working Group on Zooplankton Production Measurement Methodologies and Their Application**

Wolfgang Fennel handled the discussion on this proposal because Peter Burkill was presenting the proposal. Burkill summarized the important aspects of the proposal and the comments from national committees. There was general agreement that there is a need to assess existing methodologies for determining production in zooplankton and developing new ones. However, national SCOR committees generally thought that there needs to be more research and technique development before a working group would be useful. The proposal describes more of a research project than a typical SCOR working group activity. The scientific justification for the group is not very convincing, and relies mostly on biochemical techniques, when it should consider a wider range of techniques, such as molecular and genetic methods. Also, it is unlikely that a single technique will be good for all zooplankton, from microzooplankton to gelatinous zooplankton, which are known to be important in many systems and may be increasing worldwide. It is questionable whether it is even possible to estimate secondary production in zooplankton. This topic needs more attention from PICES and ICES. The capacity building aspects of the proposal need to be thought out better. Some national committees thought there should be more women and/or developing country scientists on the proposed group.

Peter summarized that everyone is sympathetic to the issue, but the proposal is not ready to be funded. In order to have a SCOR working group funded at some point in the future, it would be necessary for additional research to be conducted to the point at which they are more experimental results to compare. Wolfgang Fennel summarized the consensus that this proposal should not be on the short list.

### **2.3.2 SCOR Working Group on Response of marine biota to complex global environmental change: co-ordination and harmonization of experimental approaches**

Corina Brussaard presented a summary of the proposal and the comments about the proposal from national SCOR committees. The proposal stimulated many comments from national committees, both positive and negative. Most committees felt that the topic is timely, but maybe not a priority for SCOR. However, some committees thought that a coordinating activity of this type could make a contribution, particularly if it uses the approach of providing guidelines after wide consultation with the community of scientists who are studying ocean acidification.

In terms of negative comments, the terms of reference may be too broad and the capacity building activity planned is inadequate. The approach is simplistic and many national SCOR committees did not think it would be helpful to be so proscriptive in techniques to study ocean acidification and to settle on one technique before consulting the global community. (It is not clear that creation of another best practices guide would be helpful, as the community does not strongly adhere to the existing one.) The “top-down approach” was viewed negatively by many national SCOR committees. The issue is perhaps too complex for a working group. The proposed membership did not include enough women. The members were generally male and senior.

There may be better approaches than a SCOR working group to handle the topic of techniques for studying ocean acidification, such as more open discussion groups and/or an open workshop.

### **2.3.3 SCOR Working Group on Dissolved N<sub>2</sub>O and CH<sub>4</sub> measurements: Working towards a global network of ocean time series measurements of N<sub>2</sub>O and CH<sub>4</sub>,**

John Volkman reviewed the proposal and presented the views of national SCOR committees. He stated that the proposal is relatively straightforward, is well written, and it is clear what the proponents propose to achieve. Some national committees expressed that improvement of data quality for measurements of these molecules is important enough to merit a working group. It has been recognized that methane and nitrous oxide are important greenhouse gases that have received less attention than carbon dioxide. Methane has come into focus because of gas hydrates in continental margins. (There will be a Gordon Research Conference on methane and hydrates.) Even though this may not be “sexy science”, it is important scientifically. The group would provide a forum for the community doing this kind of work, and extend its work beyond a technical exercise. The team proposed is capable of doing the described work.

There was some question about the capacity building plans in the proposal. Some nations thought the proposal was more technical than scientific. Similar intercalibration exercises have been carried out without SCOR in the past, so why is SCOR assistance required this time? There are other mechanisms to handle these kind of activities, for example, through SOLAS. However, SOLAS did provide a letter of support and SCOR has supported such working groups in the past that relate to SCOR-funded projects. There were some technical suggestions for the intercalibrations, such as describing the level of comparability for intercalibration (e.g., 1% or 1 nanomole) and measuring the isotopic ratios of carbon and nitrogen.

The group was accepted for funding. It was the most supported proposal, although there is room for some improvements. The accessibility of standards and data should be recommended. They could create an open-access e-book, peer-reviewed, methods manual. They should explore with the Global Ocean Observing System developments of essential ocean variables and with OceanSites related to time series already established. They need to make contact with the appropriate databases, such as the Carbon Dioxide Information Analysis Center (CDIAC), which handles data for other greenhouse gases, both atmospheric and aquatic. The membership should have more women and early-career scientists, if possible. They could add some developing countries to Associate Membership. It would be useful to know what will be the role of each member.

#### **2.3.4 SCOR Working Group on Climate and tsunami science with green repeaters on submarine cable systems**

Missy Feeley summarized the proposal and comments from national SCOR committees. The goal of the group is to develop science questions related to repeaters on submarine cables. A joint task force already exists to pursue the broader aspects of this topic, but not the more specific technical issues.

The proposal did not receive broad support from national SCOR committees. Many of the comments related to whether the data collected will be useful, and that this may be a case of a capability looking for a science question. These issues have been around since the early 1990s and are still looking for a science issue. The claims about the usefulness for climate studies were not convincing, although a stronger case might be made for tsunami warning, as DART buoys are not adequate. The green repeaters might solve many of the problems that buoys have. It was suggested that there should be a “proof of principle” before a working group proposal was considered, although a SCOR working group may not be the best mechanism to handle the tasks presented. It was not clear why the Task Force could not handle this work directly.

The proposed group includes too few female members and not many developing country members are proposed. The membership is missing some expertise in sensor technology.

#### **2.3.5 SCOR Working Group Towards harmonization of global oceanic nutrient data**

Robert Duce summarized the proposal and comments from national SCOR committees. This was the second year the proposal was reviewed, with some changes from last year. Reviewers agreed that this is a crucially important issue, as there is still a problem in comparison of nutrient data. The carbonate system has good reference materials provided by Andrew Dixon, but still no standard material for nutrient analysis. It is difficult to find resources for intercalibration exercises. A positive aspect of the proposal was the capacity building plan.

However, national SCOR committees were not enthusiastic about SCOR funding the proposed work, and thought that the work could be done outside of SCOR. It is not clear that a SCOR working group would be a good mechanism to continue the work that has already started. The terms of reference are weak and it is not clear that there is a defined scientific product and a scientific question at the center of the group. The expertise of the proposed members was good, but the gender balance and involvement of developing country scientists was inadequate. There was some confusion about what group would do. The people who know the most about the subject were the most negative about the proposal. Some technical issues were mentioned. For example, the proposal should have mentioned TEOS-10 instead of IAPSO Seawater. There was some discussion that it could be more fruitful to put the key people on a single ship to inter-compare their methods. Even if you have good reference materials, a lot of the measurement quality depends on who makes the measurement. It also depends on where the measurements are made and the nutrient levels in the water. It was not clear why an existing group (the IOC-ICES Study Group on Nutrients Standards: SGONS) was coming to SCOR now. Did they run out of funding from other sources? Was the process through IOC unsuccessful for some reason? If so, would a group under SCOR fare better?

There was some discussion about whether SCOR could help advance the topic outside the working group process, but no conclusion.

### **2.3.6 SCOR Working Group on Development of new methodologies for chemical and other branches of oceanography**

John Volkman presented the proposal and the comments from national SCOR committees. It was recognized that there would be value in bringing analytical chemists and chemical oceanographers together, but the proposal should be more specific about scientific goals of such meetings, in terms of what science might be improved through the interactions of the two communities. There was almost unanimous agreement that the proposal should not be funded in its current form, so Volkman asked for comments for improvement. Identifying likely scientific advances would be one improvement. An ability to understand the physical chemistry of important chemical reaction mechanisms could be important. Looking for funding sources should not be a term of reference. There should be a link to the GOOS community; starting with essential ocean variables could be important.

### **2.3.7 SCOR Working Group on Microbial Community Responses to Ocean Deoxygenation**

Corina Brussaard presented a summary of the proposal, and of the comments received from national SCOR committees. There was general agreement that the subject is timely, and that the topic is a priority for SCOR. The proposal describes a typical SCOR working group. This area of science is important, as some areas of the ocean are becoming increasingly deoxygenated (e.g., the northwest Pacific Ocean) and microbes are important in understanding this trend. The work of the group could unblock a bottleneck in biological oceanography. The assignment of specific people to lead different aspects of the working group seems like a good approach.

Some national committees noted weaknesses in the proposal. The capacity building aspects of the proposal are not well developed. In some ways, the proposal seems more like a research proposal and the topic might be premature. Some relevant national research programs are not represented among the proposed members. The membership needs to be more diverse, with no more than two members from any single nation. Some national committees thought that the focus of the proposed work is not clear and the terms of reference may be too broad. The work may be too ambitious. The proposed work would be improved if it included more genomics. The proposal has come obvious connections with the approved working group on Dissolved N<sub>2</sub>O and CH<sub>4</sub> measurements.

The group was approved for funding. Changes suggested included the following:

- Take out “leverage of funding opportunities” from terms of reference, as this is not appropriate for SCOR working groups.
- The terms of reference should be focused on the products, rather than the events that will be used to produce the products.
- The capacity building aspects of the proposal should be improved, which should be easy, given the topic and its relevance to many developing countries. The group can request support from SCOR for travel of developing country scientists to their events, hold a



meeting in a developing country, and/or assign a Full Member to lead capacity building activities.

- The group should consider whether they need another workshop in year 3 to test the developed standards.
- The proposed slate of Full Members should be revised to reduce the maximum number from any single country to two and to add at least one additional developing country member to the Full Member list. It would be helpful to add another genomics person to the membership, at least as an Associate Member. There was some concern expressed that such a high percentage of the proposed Associate Members are from the United States.

### **2.3.8 SCOR Working Group on Surface Waves in Ocean Circulation and Climate System**

Athena Coustenis reviewed the proposal and gave a summary of comments from national SCOR committees. The capacity building planned is good, but there are similar comments to last year's comments, as the proposal was not changed much from last year. This is an important topic, but there was a lot of disagreement that non-breaking waves are not taken into account in existing climate models. It was recognized, however, that swell-driven mixing may not yet be included properly in climate models. Some reviewers thought the proposal was premature. The proposed working group members are "believers" and no skeptics are included. Leading modelers are well aware of the issue, but handle it through parameterizations and the appropriate people who use parameterization techniques are not on the group.

There is no indication of the way forward in running these kinds of coupled models and some existing models were not mentioned. It is a problem that they don't use a closed energy budget. The majority of the community seems to be supporting broader initiatives. The membership should be more balanced in terms of gender. The products are not clearly described.

It was suggested that the most appropriate approach to this topic would be to hold a symposium in 2015 at the IAPSO General Assembly in Prague, where there will be a session on waves, or on some other occasion that would make it possible to expose the group's ideas to a broader portion of the community.

### **2.3.9 SCOR Working Group on Standard protocols for the development of an atlas of marine plankton biogeography**

Mark Costello presented a summary of the proposal and of the comments from national SCOR committees. Some national committees expressed that the topic is timely, suitable for a SCOR working group, and relevant to SCOR. The MAREDAT-1 database is not adequate for current needs. Success with this activity would make advances possible in many other areas, such as ecosystem ecology and theoretical ecology.

However, the proposal did not seem ready to fund in its current state. Most proposed members have already been involved in MAREDAT, so it is not clear what benefits SCOR involvement would bring. OBIS is relevant and should have been mentioned. Key people are missing. The proposal needs to be more concise, with more clear description of the group's goals. It was not clear how the 8 detailed questions correlated with the terms of reference. The proposed activity is more like a research project than a working group. The gender balance was good, although there

should not be two Full Members from the same institution. It was not clear how the MAREDAT data system interacts with other relevant systems. Large regions have not been included in the proposal. It would be helpful to conduct a gap analysis and to detail how missing data would be obtained. It is important to create databases that can be easily used in other areas of ocean science.

#### **2.3.10 SCOR Working Group on Studying Ocean Acidification Effects on Continental Margin Ecosystems**

Satoru Taguchi summarized the proposal's most important features and comments from national SCOR committees. Some committee felt that this is a highly important topic. The scientific questions are good and the work is timely, although most national committees did not think the proposal should be funded in its current form. The proposal is surprisingly short. There is already a guide to best practices for ocean acidification research, so it is not sure what this effort would add. On the positive side, this proposal presents a more-detailed plan for capacity building than presented by many of the other proposals.

The consensus of national committees is that the proposed membership of this group is too narrow, given the expertise available worldwide. In terms of membership, expertise in physical oceanography and benthic respiration is missing. It is not clear why only 7 Full Members were proposed.

The terms of reference outline only a brief plan and these need to be strengthened. It would be better to focus on how ocean acidification affects the chemistry of coastal systems. It is not clear that there are even enough data available for the work proposed. The SOLAS/IMBER Ocean Acidification group might be able to contribute to a working group on this topic.

It is important to try to assist scientists from countries that have not traditionally had successful proposals when they submit their proposals. Unfortunately, this proposal was submitted too late to provide feedback to the proponents.

#### **2.3.11 SCOR Working Group on Science and Technology Imperatives Created by Deep-Ocean Industrialization**

Wolfgang Fennel presented a summary of the proposal and comments from national SCOR committees. Unfortunately, most national comments were negative. The major issue is that there were not enough specific science questions posed and the capacity building plans were weak. Although documenting baselines is important, providing management advice is not really a SCOR priority. The products were not strong.

#### **2.3.12 General comments about proposals**

There was some general discussion about how to improve proposals and the process to evaluate them. There was strong agreement that the proposals should be more standardized through providing information on required sections of proposals, and word or page lengths for each section. It was suggested that the views of countries not attending should be read out by the Executive Committee monitor for each proposal. It was suggested that the proposals include a one-page CV for each Full Member.

There was discussion of whether SCOR should fund one-time workshops. Workshops may be more appropriate for some topics than are full working groups. The workshops should not be designed to produce a working group proposal. Any proposals for workshops should have approved terms of reference, products, etc. Perhaps SCOR should open a call for “emerging science workshops”. The Executive Committee would need to discuss this issue and circulate advice to national committees, if it decides to pursue this idea.

### **3.0 LARGE-SCALE SCIENTIFIC PROGRAMS**

SCOR currently sponsors four large-scale research projects; three of them are co-sponsored by other organizations. Each project has its own scientific steering committee (SSC) to manage the project on a day-to-day basis. SCOR and other co-sponsors are responsible to oversee the projects, which they do primarily through responsibility for the project SSC memberships and terms of reference, but also by overseeing the results of the projects’ activities. Any proposed changes in membership or terms of reference are considered by the SCOR Executive Committee, in partnership with other co-sponsors, throughout the year. SCOR does not use discretionary funds (funds from SCOR member nation dues) for the research projects it sponsors, instead writing grant proposals to fund meetings and other activities of the research projects. The SCOR Secretariat oversees the use of grant funds provided to the projects.

#### **3.1 SCOR/IOC Global Ecology and Oceanography of Harmful Algal Blooms (GEOHAB) Project**

Satoru Taguchi introduced the chair of the GEOHAB program, Raphael Kudela, who made a presentation about the project. GEOHAB held its final open science meeting in April 2013, at which was discussed accomplishments of the project and priorities for future HAB research. The GEOHAB SSC will meet for the final time on 3-5 December 2013 to work on synthesis products from the project and to discuss how SCOR and IOC will work together after 2013 in relation to the topic of harmful algal blooms. Creation of publications related to GEOHAB synthesis will continue into 2014.

Kudela reported that GEOHAB never had an International Project Office (IPO), so has relied on Ed Urban and Henrik Enevoldsen for IPO duties. Kudela presented a slide from the SCOR 50<sup>th</sup> anniversary meeting in 2008, which presented a structural goal and a scientific goal for GEOHAB. The structural goal was to expand GEOHAB to encompass the global ocean. GEOHAB was intended to be analogous to other projects, with national research projects contributing to the international framework. There have been large national research programs in the United States and in Asia, but programs national and regional projects were not initiated elsewhere in the world. GEOHAB has had to adapt and to look for opportunities to expand GEOHAB to the remainder of the world. The scientific goal was to begin to address the “big” questions, or at least develop a foundation to address such questions as

- Are HABs expanding globally?
- What is the impact of global climate change?
- How do we predict HAB outbreaks?

The *GEOHAB Science Plan* was published in 2001 and the *Implementation Plan* was published in 2003. Five Core Research Projects were developed. GEOHAB has been ahead of its time in its framework activities. GEOHAB co-sponsored a meeting on HAB observations (HABWatch) in 2003, which perhaps needs to be repeated because of the major initiatives that have been started since then. There are GEOHAB-endorsed projects in 20 countries. Climate change and its effects on HABs has come up as an increasingly important topic.

Progress was made in several CRPs in the past two years:

- The CRP on HABs in Fjords and Coastal Embayments held a workshop in May 2012, resulting in an update of the science directions for the CRP (see [www.scor-int.org/Publications/GEOHAB\\_F&CE\\_2013.pdf](http://www.scor-int.org/Publications/GEOHAB_F&CE_2013.pdf)). The major goals of this meeting were to highlight the progress accomplished since the first OSM and to focus attention on the importance of a comparative approach in conducting ecosystem studies to improve our understanding of HABs.
- The CRP on Stratified Systems held a workshop in August 2012. The goals of the meeting were to review the current understanding of the processes governing the structure and dynamics of HABs in stratified systems, and to identify gaps in our knowledge in order to orient future research for their improved understanding, modeling, and prediction. A key question for the workshop was why biology has not kept up with physics in terms of measurements and modeling. GEOHAB researchers are developing a conceptual model or “roadmap” of where biological, physical, and chemical measurements of HABs in stratified systems should be headed during the next 10 years, as well as a manuscript synthesizing the findings from this meeting. This setting will eventually lead to collaborative proposals to conduct a multidisciplinary field experiment addressing this subject. These proposals would most likely involve international collaborations. A special issue of *Deep-Sea Research* is planned from the workshop.<sup>3</sup>
- The CRP on Benthic HABs co-sponsored a BHAB training session in Malaysia in May 2012, which brought together students from Southeast Asia to learn standardized sampling, identification, and other important aspects of monitoring and studying ciguatera-causing BHABs. These species create significant economic and health issues in tropical regions, as does another benthic HAB genus (*Osteopsis*) in temperate regions.

Other GEOHAB activities have also progressed:

- A joint group with IOCCG is addressing the question about whether satellite remote sensing is useful for monitoring HABs. The group met twice and is working on a special journal issue and a monograph for IOCCG. This activity has been working with the GEO Blue Planet program.
- A workshop was held in April 2013 on Harmful Algal Blooms in a Changing World. The goal of the meeting was to prepare for an open science meeting on the topic in 2015, co-sponsored by IOC, PICES, and ICES.

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<sup>3</sup>Raine, R., E. Berdalet, M. McManus, and H. Yamazaki (eds.). 2014. Harmful algal blooms in stratified systems. *Deep Sea Research Part II: Topical Studies in Oceanography* 101:1-254.

Kudela showed a graph of cumulative GEOHAB publications, which have totaled about 260 since the inception of GEOHAB. The output of papers is smaller for GEOHAB than for GLOBEC (less by a factor of 4), but this is not surprising based on the lack of an IPO and a much smaller budget for GEOHAB.

Kudela summarized the content and outcomes of the final GEOHAB Open Science Meeting (OSM). A synthesis of GEOHAB activities was presented at the meeting. Fifteen concept papers related to current and future activities were discussed. A series of forward-looking presentations described the role of a GEOHAB-like activity beyond 2013. The HAB research community values having a science-based HAB group not based on national representation. OSM participants endorsed the idea of a follow-on research project called GlobalHAB. Meeting participants concluded that

- GEOHAB has helped to build and maintain a global community focusing on sound science leading to better understanding and prediction of HABs.
- The OSMs, reports, and workshops were highly successful and valuable, particularly HABWatch and the Modeling Workshop.
- A process for endorsing programs and projects from the community was also highly valuable.
- The emphasis on technology development, capacity building, and training of young scientists was helpful.
- GEOHAB chose not to address some issues, including human health, toxins, freshwater HABs, and socio-economic impacts.

The project is now in its synthesis phase, and SCOR and IOC have given GEOHAB synthesis tasks. The GEOHAB SSC will keep the existing *Science Plan* and modify the *Implementation Plan*. It would like to maintain a core budget for an annual meeting. The new project could work more like IOCCP, given that SCOR has not approved a follow-on research project. The synthesis will include the following aspects:

- Summarize GEOHAB contributions, successes, and yet-to-be achieved objectives;
- Evaluate the need for new scientific foci (as framework activities or new CRPs) in consultation with SCOR;
- Gather input from the international community by utilizing meetings such as ICHA 2012, ASLO 2012, and the Open Science Meeting in 2013; and
- Present to IPHAB-XI a revised Science Plan and outline of an implementation plan for GEOHAB beyond 2013.

The GEOHAB SSC recommended that SCOR and IOC

- Keep the existing *GEOHAB Science Plan*. This document lays out a multi-decade effort based on five very broad Program Elements. Rewriting or modifying this document is beyond the scope of the SSC.
- Modify the existing *Implementation Plan* to move to a “hybrid” program that provides more flexibility and accountability to the community, sponsors, and end-users.
- Maintain a GlobalHAB SSC and core budget for an annual meeting.

- Allow the existing CRPs to continue so long as they have momentum and external funding.
- Develop a Working Group model (designed similar to SCOR) where topics of interest identified by the community, IPHAB, etc. would be eligible for core funding. Alternatively, develop a model similar to the International Ocean Carbon Coordination Project (IOCCP).

The Intergovernmental Panel on Harmful Algal Blooms (IPHAB) recommended that a new international program be formed on the foundations of the GEOHAB project. This recommendation was adopted by IOC, and endorsed by IAEA and by the ICES-IOC Working Group on HAB Dynamics. SCOR was invited to participate in GlobalHAB.

Kudela finished by presenting some scientific results showing how technology is being used to improve understanding of HABs to the extent that they can be predicted better. Taguchi thanked Kudela. Diane Greenslade asked whether GEOHAB has spoken with Future Earth about co-sponsorship. Kudela answered that the future of GlobalHAB depends on recommendations from SCOR and IOC.

### **3.2 SCOR/IGBP Integrated Marine Biogeochemistry and Ecosystem Research (IMBER) Project**

Julie Hall reported on IMBER. (She is a former chair of the project.) The project was designed to bridge the scientific gap between the Joint Global Ocean Flux Study (JGOFS), which had ended by the time IMBER started, and the Global Ocean Ecosystem Dynamics (GLOBEC) project, which ended some years later and had some of its ongoing projects folded into IMBER.

The major IMBER activity since the 2012 SCOR annual meeting was the IMBIZO III meeting in January 2013 in Goa, India. The overall theme of the meeting was to explore the future of marine biogeochemistry, ecosystems, and societies, using multi-dimensional approaches to the challenges of global change in continental margins and open ocean systems. Three specific areas were focused on:

1. Changing continental margins
2. Anthropogenic perturbations to the open ocean
3. Human-ocean interactions

A summary of IMBIZO III was published in *Eos*<sup>4</sup>, and a manuscript is being prepared for the Breaking Waves section of *Oceanography* magazine.

IMBER's work is implemented through working groups and task teams, regional programs, and endorsed projects.

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<sup>4</sup>Bundy, A., K.-K. Liu, and H. Thomas. 2013. The Future of Marine Biogeochemistry, Ecosystems, and Societies. *Eos* 94(20):184.

### Working Groups and Task Teams

**Human Dimensions:** The goal of this working group is to understand the feedbacks between human and ocean systems, and to explore what human institutions can do to mitigate anthropogenic perturbations of the ocean system, or to adapt to such changes. The group convened IMBIZO III Workshop 3 to analyze the vulnerability and adaptation of marine-dependent communities to global change and governance response, develop the HDWG work plan for the next five years and the ADaPT conceptual framework and template for case studies, focusing on fisheries and aquaculture, from a diversity of social, natural and governance systems. ADaPT is Assessment of Responses based on Description, Appraisal and Typology: A rapid integrated assessment and decision support tool to respond to global change in marine and coastal regions. The first ADaPT phase is to be completed by 2015.

Sinjaee Yoo noted that the Human Dimensions Working Group (HDWG) has been quite active since established. PICES established an expert group on human dimensions around the same time and Yoo expects the topic to expand well in the future. A co-chair of IMBER HDWG has joined the PICES group.

**Carbon Research** (with SOLAS): Coordinate and synthesize ocean carbon research in the surface ocean, interior ocean, and ocean acidification, through three working groups. The Surface Ocean Systems (SIC!-SOS) WG focuses on data synthesis for carbon in surface ocean systems, and on instrumentation and technology development, Voluntary Observing Ships (VOS), and mixed-layer sampling strategy. The Interior Ocean Carbon (SIC!-IOC) WG focuses on interior ocean changes in carbon and biogeochemistry, undertakes synthesis activities, and aims to develop sustainable observing systems, including the addition of oxygen sensors to the international Argo float program. Its activities are related to SCOR WG 142. The SOLAS-IMBER Ocean Acidification (SIOA) WG coordinates international research and synthesis activities in ocean acidification and played a role in creation of the Ocean Acidification International Coordination Centre (OA-ICC) established in Monaco in mid-2012.

**Continental Margins** (with LOICZ): Linking ecosystems and impacts of global, local, and human influences on biogeochemical cycles and ecosystems in key continental margins. This group is developing a plan for new continental margin research activities and transition of ongoing continental margin projects within the Future Earth framework. It is also developing a paper on “Living on the Margin in the Anthropocene: From Frontier to Engagement Arenas for Global Sustainability”. The group convened IMBIZO III Workshop 1 on “Biogeochemistry – ecosystem interactions on changing continental margins”. A special issue on “Biogeochemistry-ecosystems interaction in changing continental margins in the Anthropocene”, has been accepted by the *Journal of Marine Systems*.

**Data Management:** Encourages the use of good data management practices in all aspects of IMBER research. The Data Management Committee has been active in promoting proactive data management at major IMBER meetings and created a Data Management Cookbook (available in English and Spanish at <http://www.imber.info/index.php/Science/Working-Groups/Data-Management/Cookbook>). The group held a training course and workshop before IMBIZO III to begin addressing emerging challenges of the social and natural marine science integration and management of new types of marine data. The group is considering a revision/addendum for the

IMBER Data Management Cookbook (IMBER Report #3) for new marine data related to –omics research (e.g., genomics, proteomics) and social science research.

**Capacity Building:** To enhance research capabilities in developing countries and to strengthen graduate education in ocean sciences. The Capacity Building group produced a report for the Asia-Pacific Network for Global Change Research (APN) from an APN-funded meeting, which served as the basis for an article in *Marine Pollution Bulletin*.<sup>5</sup>

#### Regional Programs

**Integrating Climate and Ecosystem Dynamics in the Southern Ocean (ICED):** ICED coordinates circumpolar research to better understand climate interactions with Southern Ocean ecosystem dynamics, in the context of sustainable management plans. ICED created an online fieldwork mapping tool to coordinate fieldwork with cruise information and data rescue (see [www.iced.ac.uk/science/fieldworkmap.htm](http://www.iced.ac.uk/science/fieldworkmap.htm)). Program participants contributed to the book, “Antarctic Ecosystems: An Extreme Environment in a Changing World”. The program held two workshops on Polar Ecosystem Change and Synthesis, in Nov. 2012 (in Germany) and in May 2013 (in Belgium).

**Sustained Indian Ocean Biogeochemical and Ecological Research (SIBER):** SIBER coordinates international Indian Ocean research to understand the interactions between biogeochemical cycles and marine ecosystem dynamics in the Indian Ocean. SIBER has strong cooperation with the CLIVAR Indian Ocean Panel (IOP), the Indian Ocean Global Ocean Observing System (IOGOOS), and the IndoOS Resource Forum (IRF). SIBER is involved in organization of the International Indian Ocean Expedition-2 (IIOE-2). And, SIBER is involved in design and deployment of biogeochemical sensors on Indian Ocean Observing System (IndOOS)/Research Moored Array for African-Asian-Australian Monsoon Analysis and Prediction (RAMA) for physical and biogeochemical observatories.

**Climate Impacts on Oceanic Top Predators (CLIOTOP):** CLIOTOP uses a worldwide comparative approach to understand the impact of climate variability and fisheries on open-ocean pelagic ecosystems and their top predator species, in support of oceanic ecosystem governance. CLIOTOP convened an Open Science Symposium on “Certainty of Change in Pelagic Systems - detection, attribution, prediction and adaptation” in New Caledonia, in Feb. 2013.

**Ecosystem Studies of Sub-Arctic Seas (ESSAS):** ESSAS conducts research to compare, quantify, and predict the impacts of climate change on Sub-Arctic marine ecosystems and their productivity and sustainability. ESSAS helped organize the 28<sup>th</sup> Lowell Wakefield Fisheries Symposium, Responses of Arctic Marine Ecosystems to Climate Change (March 2013, Anchorage, Alaska). ESSAS also produced a special issue of *Progress in Oceanography* on modeling and observational approaches to understanding marine ecosystem dynamics, dedicated

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<sup>5</sup>Morrison, R.J., J. Zhang, E.R. Urban Jr., J. Hall, V. Ittekkot, B. Avril, L. Hu, G.H. Hong, S. Kidwai, C.B. Lange, V. Lobanov, J. Machiwa, M.L. San Diego-McGlone, T. Oguz, F.G. Plumley, T. Yeemin, W. Zhu, and F. Zuo. 2013. Developing human capital for successful implementation of international marine scientific research projects. *Marine Pollution Bulletin* 77:11-22.



to Bernard Megrey (former ESSAS SSC member). The next major activity will be the IMBER Open Science Conference in Norway.

The IMBER International Project Office (IPO) is currently hosted in Bergen, Norway at the Institute for Marine Research. A Regional Project Office (RPO) is hosted in Shanghai, China at East China Normal University. The RPO provides regional assistance, as well as help with capacity building, the IMBER newsletter, etc. The RPO has been an essential facilitator in the IMBER efforts to reach out to the related research community in the Asia-Pacific region, and is a very active partner of the IMBER IPO in many of its activities. The RPO also supported the 6<sup>th</sup> China-Japan-Korea (CJK) IMBER Symposium on “Ocean Ecosystem Dynamics and Integrated Marine Biogeochemistry and Ecosystem Research” in October 2013, Tokyo, Japan. The China-Japan-Korea (CJK) IMBER Symposium series provides the three countries’ scientists opportunities to collaborate, and share and exchange research results and ideas. The RPO was renewed in 2013 for 3 years, to 2016.

IMBER has established a collaboration with the CLIVAR project of the World Climate Research Program. An informal IMBER-CLIVAR working team was assembled in early 2013 to consider possible research questions that an upwelling research initiative should address. SIBER is working with the CLIVAR Indian Ocean Panel on an upwelling project in the eastern Indian Ocean. ICED and the Southern Ocean Panel of CLIVAR are communicating on activities of mutual interest. CLIVAR has been a sponsor of IMBER summer schools and is a co-convenor of ClimEco4.

The IMBER SSC met most recently in June 2013 in Las Palmas, Canary Islands, Spain. SCOR and IGBP approved the addition of Edward Allison (USA), Katrin Rehdanz (Germany), Gerhard Herndl (Austria), and Laurent Bopp (France) to the IMBER SSC in 2013. The IMBER SSC is working on its plans for project extension and determining how it might interact with the Future Earth initiative.

In terms of plans for 2014, IMBER will hold its first open science conference (OSC) in Bergen on 23-27 June, on “Future Oceans: Research for Marine Sustainability: Multiple Stressors, Drivers, Challenges and Solutions.” The OSC will highlight key findings of IMBER-relevant research, promote IMBER integrated syntheses, and develop a new research agenda to guide future marine research. Nine workshops and 24 sessions have been accepted. Key Topical Clusters for sessions include Ocean Observations and Modelling; IMBER Regional Programmes – Synthesis and New Research Directions; Lower Trophic Level Processes, Dynamics; Higher Trophic Level Processes Dynamics; Other Regional Studies – Responses to Stressors; and Ocean Sustainability. The OSC is intended to synthesize and integrate IMBER science to provide a basis for transition to a new marine research project in Future Earth.

The ClimEco4 summer school will be held on 4-9 August 2014 in Shanghai, China. It will focus on indicators to evaluate marine ecosystems and human populations who depend on them in the context of climate change. Topics for the summer school will include the following:

- Climate pressures on marine systems from bio-physical and human perspectives
- Modelling complex systems

- Data access and analysis
- The role of indicators
- Using and communicating different indices for policy
- Daily ‘hands-on’ sessions with databases (Bring Your Own), indices and models

In terms of the Future Earth initiative, IMBER contributions will primarily be to the “Dynamic Planet” research theme. IMBER also has interests in the “Global Development” research theme (especially via the IMBER Human Dimensions Working Group) and, to some extent, in the “Transformations toward Sustainability” research theme. IMBER science is based on community-driven research and is integrated across disciplines to provide the knowledge needed for better management of marine resources and for human well-being in a changing global marine environment. IMBER anticipates that Future Earth will assist the IMBER-related research community in its continuation of disciplinary and integrated research, and in building new IMBER activities, especially at the interface between human and natural sciences. Future Earth will help IMBER strengthen the further integration of the natural and social science communities, and will facilitate a smooth transition in project sponsorship with SCOR and after IGBP, and to secure financial and in-kind support at least at the same level as the core funding provided by SCOR. Future Earth will provide a stable and supportive structure and help further communicate IMBER outputs widely, secure the engagement of new partners, and secure additional external funding, especially for new activities.

Julie Hall thanked SCOR on behalf of IMBER for support to the IMBER community and especially to researchers from developing countries for IMBIZO III and OSC 2014. IMBER requested support from SCOR for participants from developing and emerging economies to attend the ClimEco4 summer school. IMBER requested guidance from SCOR about future development of IMBER science and in IMBER–Future Earth dialogue, especially regarding the agreement for IMBER inclusion in Future Earth and for Future Earth becoming an IMBER co-sponsor with marked added value. A request will be sent to SCOR for a ten-year extension of IMBER to allow especially the following activities:

- continuation of activities of regional programs, for example, ICED and SIBER, through 2020 and beyond, and CLIOTOP is developing a strategy for the next 10 years;
- continuation of HDWG activities – IMBER is making significant advances in developing research at interface of human-natural systems;
- further IMBER science in areas of biogeochemistry and food web linkages; and
- position IMBER to take the lead in the marine research components of Future Earth.

Sinja Yoo is a member of the IMBER SSC and commented that Hall covered the project well.

### **3.3 GEOTRACES Project**

John Volkman gave the report for GEOTRACES, provided by the GEOTRACES IPO. He noted that he was very impressed by the one GEOTRACES-related meeting he had attended.

GEOTRACES is an international project that aims to improve the understanding of biogeochemical cycles and large-scale distribution of trace elements and their isotopes in the marine environment. Scientists from approximately 35 nations have been involved in the

program, which is designed to study all major ocean basins over the next decade. Forty-nine GEOTRACES-related cruises have been completed so far. There has been a high level of activity by the GEOTRACES SSC and its subgroups. GEOTRACES cruises were conducted in the Mediterranean Sea, Black Sea, Indian Ocean, and Pacific Ocean since the 2012 SCOR annual meeting. Significant activity is going on in planning for Arctic Ocean cruises, with planning meetings having been held in Canada and Russia. The Canadian GEOTRACES community has had a large program funded and a U.S. program is in the planning phase. Germany, Russia, Sweden, and the United Kingdom are also planning Arctic activities. GEOTRACES gathered scientists from Latin America in November 2012 to discuss potential research projects in the Latin American region.

Volkman provided examples of the scientific achievements of GEOTRACES thus far:

- A three-dimensional animation has been created for Thorium-230 along GEOTRACES North Atlantic sections (see <http://vimeo.com/69990808>).
- GEOTRACES scientists have discovered new variability in iron supply to the oceans, which has implications for global climate and models of climate.<sup>6</sup>
- GEOTRACES scientists have created a global compilation of dissolved iron measurements, with a focus on distributions and processes in the Southern Ocean.<sup>7</sup>
- Substantial intra-basin variation of the dissolved metal/phosphorus ratio have been found in the different water masses of the Indian Ocean.<sup>8</sup>
- Significant variations in the oxidation state and composition of iron particles have been discovered between the coasts of South Africa and Antarctica.<sup>9</sup>

Two scientific workshops were co-sponsored by GEOTRACES in the past year:

- Workshop on Stable Isotopes of Biologically Important Metals, held in London, UK, in September 2012
- Workshop on Voltammetry and GEOTRACES, held in Šibenik, Croatia in October 2012

For all ocean basins, “cross-over sites” will be occupied by more than one cruise to help with intercalibration of data. (GEOTRACES has devoted much attention to intercalibration.) The GEOTRACES Scientific Steering Committee held its seventh meeting in Goa, India in November 2012, immediately after a meeting of the GEOTRACES Data Management Committee. The SSC, Data Management Committee, and Standards and Intercalibration committee met together in Bremerhaven, Germany, on 30 Sept.-4 October 2013. GEOTRACES will release its first Intermediate Data Product in 2014, which will primarily include data from the Atlantic Ocean cruises carried out so far, as well as GEOTRACES cruises that were part of

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<sup>6</sup>Homoky, W.B. et al. 2013. Distinct iron isotopic signatures and supply from marine sediment dissolution. *Nature Communications* 4:2143, DOI: 10.1038/ncomms3143

<sup>7</sup>Tagliabue, A., et al. 2012. A global compilation of dissolved iron measurements: focus on distributions and processes in the Southern Ocean. *Biogeosciences* 9:2333-2349, doi:10.5194/bg-9-2333-2012.

<sup>8</sup>Thi Dieu Vu, H., and Y. Sohrin. 2013. Diverse stoichiometry of dissolved trace metals in the Indian Ocean. *Scientific Reports* 3, DOI: 10.1038/srep01745.

<sup>9</sup>B.P. von der Heyden, A.N. Roychoudhury, T.N. Mtshali, T. Tyliszczak, and S.C.B. Myneni. 2012. Chemically and geographically distinct solid-phase iron pools in the Southern Ocean. *Science* 338 (6111):1199-1201.

the International Polar Year. The IDP will be available on-line and will be launched at the Ocean Sciences meeting in February 2014. The SCOR Executive Committee approved the addition of Luidmila Demina (Russia) to the GEOTRACES SSC in 2013, and second terms for Pinghe Cai (China-Beijing), Angela Wegener (Brazil), Andrew Bowie (Australia), and Olivier Marchal (USA). So far, 228 GEOTRACES-related peer-reviewed papers are included in the GEOTRACES Database available on the GEOTRACES site (<http://www.geotraces.org/library/scientific-publications/peer-reviewed-papers>). Two special issues have been produced:

- “Intercalibration in Chemical Oceanography” in *Limnology and Oceanography: Methods* (see <http://www.aslo.org/lomethods/si/intercal2012.html>)
- “2011 GEOTRACES Data Model Synergy Workshop” in *Progress in Oceanography* (in preparation)

The GEOTRACES IPO established an eNewsletter in 2013 (see <http://www.geotraces.org/outreach/geotraces-enewsletter#>).

### **3.4 SCOR/IGBP/WCRP/CACGP Surface Ocean-Lower Atmosphere Study**

Athena Coustenis introduced Cliff Law, who made the presentation. The primary objective of SOLAS is “to achieve quantitative understanding of the key biogeochemical-physical interactions and feedbacks between the ocean and atmosphere, and how this coupled system affects and is affected by climate and environmental change.” It does this by

- Providing a forum for international interaction
- Developing new research questions and implementation strategies by responding to and coordinating community initiatives
- Building capacity/training - the next generation of SOLAS scientists
- Promoting facility, standards, and data sharing

SOLAS has involved about 2,500 scientists from 75 different countries..

SOLAS held its sixth summer school in 2013, in a new location, at Xiamen University in China. The school used the same format and style as the five previous successful schools that were held at Cargese, Corsica, France. Sixty-nine students from 24 countries participated in the 2013 Summer School. Support for the school was obtained from numerous Chinese and international sponsors, including SCOR. Some former summer school participants are on the SOLAS SSC.

Several SOLAS-related workshops were held in 2013:

- “Towards an integrative regional coupling in the Eastern Boundary Upwelling Systems”, 26-28 November 2012, Lima, Peru
- “Marine gels effects on clouds”, 11-13 December 2012, Kiel, Germany
- ‘HitT – Climate impact of seasalt-derived Cl atoms’, 17-19 December 2012, Kiel, Germany

SOLAS has begun planning for its 2015 Open Science Conference, which will be held on 7-11 September 2015.

SOLAS is involved in several joint activities:

- SOLAS-IMBER Carbon (SIC) Group, in conjunction with IMBER and the International Ocean Carbon Coordination Group (IOCCP). This group has three subgroups, WG1 on Surface Ocean Systems, WG2 on Interior Ocean, and WG3 on Ocean Acidification. WG1's main product in the past year was SOCAT version 2, which was released in June 2013. This revised database includes about 10.1 million data points from 2,660 voyages. WG2 is continuing work on its global synthesis of data from repeat hydrography cruises, with completion expected in mid-2014. WG3's major activity has been meetings on a global network for observation of ocean acidification.
- OceanFlux is a collaboration between the European Space Agency (ESA) and SOLAS, which is studying processes at the air-sea interface using satellite observations. Three projects were included: (1) Ocean-derived aerosols: production, evolution and impacts, (2) Air-sea flux of CO<sub>2</sub> and other long-lived radiatively active gases, and (3) Air-sea gas fluxes at eastern boundary upwelling and oxygen minimum zones. The projects were completed, but ESA is interested in continuing collaboration, though additional funding depends on its budget.
- SOLAS received EU COST funds for a project that developed global air-sea flux data sets of gases and aerosols. A book entitled *Ocean-Atmosphere Interactions of Gases and Particles*<sup>10</sup> resulted from the activity.

Law noted that three current SCOR working groups are of great interest to SOLAS: (1) WG 140 on Biogeochemical Exchange Processes at the Sea-Ice Interfaces (BEPSII), (2) WG 141 on Sea-Surface Microlayers, and (3) WG 142 on Quality Control Procedures for Oxygen and Other Biogeochemical Sensors on Floats and Gliders.

SOLAS has evolved significantly since publication of the *SOLAS Science Plan/Implementation Strategy* in 2004. Since that time, SOLAS produced white papers that formed the basis for the elements of the SOLAS Mid-Term Strategy (MTS). Significant progress has been made on several of the MTS elements in the past year. The work of the MTS element on "Sea-ice biogeochemistry and interactions with the atmosphere" is being carried out by SCOR WG 140 on Biogeochemical Exchange Processes at the Sea-Ice Interfaces (BEPSII). The MTS element on "Air-sea gas fluxes at Eastern Boundary upwelling systems" has been implemented through several meetings, national research cruises, moorings, and mesocosm experiments. The MTS element on "Atmospheric control of nutrient cycling and production in the surface ocean" has been implemented through a COST Action workshop, which has resulted in a paper being developed. The MTS element on "Ocean-derived aerosols: production, evolution and impacts" has advanced through several meetings, and upcoming research cruises will contribute new information. SCOR WG 141 on Sea-Surface Microlayers will also contribute to this MTS element. The next step in SOLAS evolution will be development and approval of its plan for 10

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<sup>10</sup>Liss, P. and M.T. Johnson (eds.). 2014. *Ocean-Atmosphere Interactions of Gases and Particles*. Springer.

additional years of the project. SCOR will be requested to continue as a sponsor and Future Earth as a new sponsor, in addition to WCRP and iCACGP.

SOLAS made requests for support for developing country scientists to participate in three different activities. This support was recommended by the SCOR Committee on Capacity Building and approved by meeting participants. Urban mentioned that SCOR approved \$10,000 for SOLAS capacity building and that this should be added by SOLAS to its table of funding presented.

The SOLAS Scientific Steering Committee (SSC) met in Tsukuba, Japan in May 2013. The project co-sponsors approved Ilan Koren (Israel) as a new SSC member and the re-appointment of Yukihiro Nojiri and Christoph Heinze. Alfonso Saiz-Lopez (Spain) will join the SSC in January 2014. The SOLAS SSC is working on its plans for project extension and determining how it might interact with the Future Earth initiative.

Burkill thanked Law for the presentation and asked whether SOLAS has looked at geoengineering. Law answered that they have to tread carefully there. Iron fertilization experiments led to interest in geoengineering and selling carbon credits.

## **4.0 OCEAN CARBON AND OTHER ACTIVITIES**

### **4.1 SCOR/IOC International Ocean Carbon Coordination Project (IOCCP)**

Wolfgang Fennel introduced Ed Urban, who made a presentation about IOCCP provided by the IOCCP Project Director, Maciej Telszewski. IOCCP is jointly sponsored and funded by SCOR and IOC. It continues to focus on coordination of carbon data, from collection through serving the data, through the Global Ocean Ship-based Hydrographic Investigations Panel (GO-SHIP), the Surface Ocean CO<sub>2</sub> Atlas (SOCAT) project, and the GLObal Ocean Data Analysis Product (GLODAP) project. IOCCP is assisting the Global Ocean Observing System on developing biogeochemical Essential Ocean Variables. The U.S. National Science Foundation is the primary financial sponsor of IOCCP (through SCOR), although IOCCP also receives financial support from IOC and in-kind support from its host institution in Poland.

IOCCP's mission is to help develop a sustained global ocean observing network for marine biogeochemistry, in line with the Framework for Ocean Observations. IOCCP has several themes, each led by one or two members of the IOCCP Scientific Steering Group:

- **Interior Ocean Observations**—The GO-SHIP program is the primary manifestation of this theme. GO-SHIP is the latest version of global repeat hydrography, following WOCE and CLIVAR. The latest 10-year occupation of the global network of sections was completed in 2013. One-third of a staff person's time from the WMO-IOC Joint Technical Commission for Oceanography and Marine Meteorology's In-situ Observing Platform Support Centre (JCOMMOPPS) has been assigned to assist GO-SHIP, a welcome addition to the program.
- **Interior Ocean Data**—The major effort over the past 12 months was to assemble and quality control the Global Ocean Data Analysis Product version 2 (GLODAPv2). This

new global ocean interior carbon data product aims at assembling all the existing interior ocean carbon data synthesis products into one harmonized data package. With substantial help from IOCCP, the group met two times over the past 12 months for hands-on quality-control workshops. GLODAPv2 will be released at the Ocean Sciences Meeting in Honolulu in February 2014. It will significantly improve data access for scientists interested in the ocean interior carbon variables. Potential applications include creation of carbon budgets, studies of seasonal, inter-annual and decadal variations in ocean interior carbon variables and of the processes driving these.

- **Surface Ocean Observations**—The major effort over the past 12 months was to pursue various coordination actions aiming at engaging the shipping industry and a wider set of industrial ocean users in ocean monitoring efforts. Little progress has been achieved on this goal so far. IOCCP will work with other organizations interested in new observations from commercial ships to approach the IMO directly in order to negotiate some level of support (e.g., space, routing information, basic instrument monitoring) for the Global Ocean Observing System.
- **Surface Ocean Data**—IOCCP efforts in relation to surface ocean data have been focused on the Surface Ocean CO<sub>2</sub> Atlas (SOCAT) effort. SOCAT Version 2 was released on 4 June 2013 during a lunch-time side event at the 9<sup>th</sup> International Carbon Dioxide Conference in Beijing, China. V2 consists of 10.1 million fCO<sub>2</sub> data (a 60% increase from version 1.5) on more than 2,660 cruises (a 55% increase) covering the years 1968-2011. All data are citable using a digital object identifier (DOI) (individual cruise files, synthesis products, gridded products). See [www.SOCAT.info](http://www.SOCAT.info) for data and publications.
- **Time-Series stations**—Long-term time-series measurements are critical for characterizing the natural variability and trends in the ocean biogeochemistry and for determining the physical and biological mechanisms controlling the system. No global strategy exists for networking ship-based ocean carbon time-series stations. Currently, there are estimated to be 38 sustained programs in 18 countries making ocean carbon time-series measurements on almost 150 fixed-point ship stations and ship sections. The IOCCP and U.S. Ocean Carbon and Biogeochemistry program recently held an International Time-Series Methods Workshop dedicated to unifying methodology and procedures applied by time-series scientists worldwide. The purpose of the workshop was to review current shipboard biogeochemical time-series sampling and analytical protocols and improve data inter-comparability among time series. The report of the workshop can be found at [http://www.us-ocb.org/publications/TS\\_Workshop\\_report\\_FINAL.pdf](http://www.us-ocb.org/publications/TS_Workshop_report_FINAL.pdf).
- **Ocean Acidification**—The need for coordinated, worldwide information gathering on ocean acidification and its ecological impacts is now widely recognized. Building on the first international meeting to focus on this issue, held at the University of Washington, Seattle in June 2012, a second workshop to plan a global observing network for ocean acidification was held at St. Andrews, UK, on 24-26 July 2013. A total of 87 participants from 26 countries and 4 international bodies attended. The meeting was sponsored by the UK Ocean Acidification program, IOCCP, the NOAA Ocean Acidification program, IOC and GOOS. At the end of the St. Andrews workshop, the participants declared the Global Ocean Acidification Observing Network (GOA-ON) to be established. The overarching goal of the second meeting was to refine the vision for the structure of GOA-ON, with emphasis on standardizing the monitoring of ecosystem impacts of ocean acidification in

shelf and coastal seas. The main product from the St. Andrews meeting will be the GOA-ON Plan, due for release in January 2014.

- **Nutrients**—Nutrients is a new theme of the IOCCP, building on efforts by the Study Group Of Nutrient Standards (SGONS). Currently, the accuracy of most nutrient measurements is not sufficient to detect long-term trends in the ocean. IOCCP will promote the development of certified reference materials for nutrients, and advocate their use on repeat hydrography lines. IOCCP will support intercomparison activities of nutrient measurements, including through an upcoming intercomparison cruise in 2014.
- **Instruments and sensors**—The availability and proper use of instruments and sensors for measuring carbon system parameters is still a constraint for adequate understanding of the ocean carbon cycle, including high-accuracy instruments for shipboard measurements, as well as biogeochemical sensors for autonomous platforms. IOCCP promotes standardization of data and meta-data reporting, and facilitates the use of sensors. IOCCP is planning a summer school on instruments and sensors. This will be a 10-day training course early in 2015 for about 30 participants, with lectures and at-sea hands-on experience to further the implementation of autonomous biogeochemical sensors worldwide, by tackling issues that span from basic usage of the technology to data reporting, standards, and protocols.
- **Data and Information Management**—The IOCCP works closely with numerous institutions and programs to ensure that
  - the observational coverage is sufficient to meet research needs for basin- and global-scale issues (and where it is inadequate, to identify and prioritize needs);
  - the data from individual activities are comparable (through development and use of reference materials, quality control and quality assurance procedures, standard practices, etc.); and
  - the data management practices of each program are compatible and coordinated, and that there are mechanisms in place to facilitate data sharing and data synthesis activities between programs.

Urban finished by noting that IOCCP launched a new Web site in the past year (see <http://www.ioccp.org/>) and that individuals interested in receiving updates can register on the Web site.

## 4.2 Symposia on The Ocean in a High-CO<sub>2</sub> World

John Volkman reported that a successful symposium was held in 2012. The SCOR team (Ed Urban and Elizabeth Gross) was instrumental in that meeting. A special issue of *Biogeosciences* has been developed from the meeting<sup>11</sup> and a paper in *Oceanography* magazine also resulted from the meeting.<sup>12</sup> An important issue for SCOR was whether to be involved in planning a fourth symposium. The SCOR Executive Committee decided not to lead planning on future symposia, as the meeting size has exceeded the staff resource in the SCOR Secretariat and SCOR's role is not primarily to organize meetings.

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<sup>11</sup> [http://www.biogeosciences.net/special\\_issue129.html](http://www.biogeosciences.net/special_issue129.html)

<sup>12</sup> [http://www.tos.org/oceanography/archive/26-2\\_urban.html](http://www.tos.org/oceanography/archive/26-2_urban.html)



IGBP is leading an effort to produce a Summary for Policymakers<sup>13</sup> from the 2012 symposium in Monterey, which will be released at the nineteenth session of the Conference of the Parties (COP 19) of the United Nations Framework Convention on Climate Change.

### **4.3 Other Activities**

#### **4.3.1 Data Publication Activity**

Ed Urban reported on the activity. Representatives from SCOR, IOC's International Oceanographic Data and Information Exchange (IODE), the MBLWHOI Library, the British Oceanographic Data Centre, and the U.S. National Oceanic and Atmospheric Administration have been working together for the past several years on a project to promote submission of data associated with research papers, as well as stand-alone data sets, to national and international data management systems in forms that can be cited. The group is conducting two pilot projects and the results of these pilot projects have been reported at meetings of ocean scientists, data managers, and ocean librarians. The group completed a "Cookbook"<sup>14</sup> describing implementation of the two pilot projects since last year's SCOR meeting and is looking for opportunities to implement the data publication system in new locations. Funding was approved for 2014 activities.

#### **4.3.2 SCOR/POGO International Quiet Ocean Experiment**

Missy Feeley reported that this activity arose from a meeting stimulated by Jesse Ausubel with funding from the Alfred P. Sloan Foundation. The Science Plan is in review. Feeley (for SCOR) and Mike Coffin (for POGO) are monitoring the review and the response to review, and will come back to SCOR and POGO when the response is completed, to make a recommendation about whether SCOR and POGO should accept the project as a co-sponsored activity. If approved, the next steps would be publication of the Science Plan, formation of a Scientific Steering Committee (SSC), and seeking funding for the SSC's work.

#### **4.3.3 Joint Committee on Seawater (SCOR/IAPWS/IAPSO)**

Eugene Morozov reported that SCOR agreed to form a Joint Subcommittee on Seawater with IAPSO and the International Association for the Properties of Water and Steam (IAPWS). This group is a follow-on to the SCOR/IAPSO Working Group 127 on the Thermodynamic Properties of Seawater. The SCOR Executive Committee approved membership of the group and funding for the JCS Executive Committee to attend IAPWS meetings in 2014. They do not anticipate having the entire group meet. The major activity of the group in the coming year is work on a special issue of the journal *Metrologia*.

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<sup>13</sup> [http://igbp.sv.internetborder.se/download/18.30566fc6142425d6c91140a/1385975160621/OA\\_spm2-FULL-lorenz.pdf](http://igbp.sv.internetborder.se/download/18.30566fc6142425d6c91140a/1385975160621/OA_spm2-FULL-lorenz.pdf)

<sup>14</sup> See [http://www.iode.org/index.php?option=com\\_oe&task=viewDocumentRecord&docID=10574](http://www.iode.org/index.php?option=com_oe&task=viewDocumentRecord&docID=10574).

## 5.0 CAPACITY-BUILDING ACTIVITIES

### 5.1 SCOR Committee on Capacity Building

Venu Ittekkot, the chair of the SCOR Committee on Capacity Building, reported on the meeting of the committee that took place on the day before the start of the SCOR meeting. There was discussion about the recommendations from Henties Bay report.<sup>15</sup> The SCOR Executive Committee noted the recommendations and will respond as it can. Mike Lucas suggested that SCOR could ask for matching funding from within the region, such as with help from national SCOR Committees.

Ittekkot reminded participants that SCOR maintains a portal to ocean science capacity building activities by many different organizations (see [http://www.scor-int.org/capacity\\_portal.htm](http://www.scor-int.org/capacity_portal.htm)) and the International Oceanographic Data and Information Exchange (IODE) maintains a compilation of ocean-related summer schools (see <http://www.oceansummerschools.org/>). He listed two capacity building articles in which members of the Committee on Capacity Building and SCOR staff were involved in the past year:

- Morrison, R.J., J. Zhang, E.R. Urban Jr., J. Hall, V. Ittekkot, B. Avril, L. Hu, G.H. Hong, S. Kidwai, C.B. Lange, V. Lobanov, J. Machiwa, M.L. San Diego-McGlone, T. Oguz, F.G. Plumley, T. Yeemin, W. Zhu, and F. Zuo. 2013. Developing human capital for successful implementation of international marine scientific research projects. *Marine Pollution Bulletin* 77:11-22.
- Urban, E.R. Jr., and R. Boscolo. 2013. Using scientific meetings to enhance the development of early career scientists. *Oceanography* 26(2):164–170, <http://dx.doi.org/10.5670/oceanog.2013.16>.

The Committee on Capacity Building made several recommendations for consideration by the Executive Committee meeting:

- Working Group proposals still need better descriptions of capacity building activities. It would be helpful to strengthen the instructions in relation to both developing country and early-career scientists.
- The call for SCOR Visiting Scholar applications should include more detail about reporting and evaluation requirements.
- SCOR should encourage national SCOR committees to involve younger scientists in SCOR working groups, such as by paying for their participation as Associate Members.

### 5.2 SCOR Visiting Scholars

SCOR started a program of SCOR Visiting Scholars in 2009 and has now appointed 13 different Visiting Scholars, including 6 in 2013 (due to some delays in Scholarships awarded in previous years). The program provides airfare and some funding for subsistence for ocean scientists to teach and mentor students for several weeks to months. Local hosts are expected to provide

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<sup>15</sup> See [http://www.scor-int.org/SCOR\\_CB/Regional\\_Graduate\\_Network\\_of\\_Oceanography\\_for\\_Southern\\_Africa.pdf](http://www.scor-int.org/SCOR_CB/Regional_Graduate_Network_of_Oceanography_for_Southern_Africa.pdf)

some support for local expenses. The program has resulted in new exposure for SCOR in countries like Ghana, Morocco, and Thailand. Ittekkot showed a list of the 2013 Scholars, including the countries in which they are based, the host countries, and the purpose of the travel. Kurt Hanselmann was so enthusiastic after his first Visiting Scholar experience that he has gone back to Namibia for additional work. He was awarded support from Agouron Institute, administered by SCOR, to support a four-year plan of “research camps” at the University of Namibia (see [http://www.microeco.uzh.ch/rgno\\_namibia/RGNO\\_Namibia\\_14.html](http://www.microeco.uzh.ch/rgno_namibia/RGNO_Namibia_14.html)). Funding was approved for 2014 for the SCOR Visiting Scholars Program, so that three new Scholarships can be awarded.

Mike Lucas commented on the Visiting Scholars and the need to have more follow-up to the short-term visits. There is a vacuum when the Scholar leaves, so leaving a post-doc behind could be a positive development. Hal Batchelder added that the real goal is to leave new capacity in the region. This could be approached by asking host institutions to make commitments to provide a Masters-level student to work with the Scholar. Bob Duce noted that development in SCOR capacity building activities in the past 8 years has been impressive. But, who will fund the post-docs and Masters students? Lucas responded that the developing country Masters-level support should not be difficult to fund. Perhaps there could be joint funding for the post-doc between SCOR and the host institution. Venu noted that experience has shown that capacity building depends on commitment from host institutions. Institutions and countries to which SCOR is sending scholars need to make the commitment to take full advantage of the opportunities.

### **5.3 POGO-SCOR Visiting Fellowships for Oceanographic Observations**

Ed Urban noted that POGO and SCOR have co-funded this program since 2001 and have supported more than 120 participants so far. Both recipients and hosts have expressed that this has been a worthwhile program. There were 10 recipients of the fellowships in 2013, from Argentina, Brazil, China, Croatia, India, Nigeria and Tanzania. Host institutions were in Germany, France, UK, and the United States. SCOR approved continued funding for the program.

### **5.4 NSF Travel Support for Developing Country Scientists**

Ed Urban reported that the grant to SCOR from the U.S. National Science Foundation continues at a level of \$75,000 per year. The grants have been an important source of support for several SCOR-related meetings in the past year. The grant is in its final year; a renewal proposal will be submitted early next year. Requests for travel support were approved as presented.

There was discussion about the need to have younger scientists involved in SCOR, including on working groups. It was decided that a recommendation should be made about this to national SCOR committees. Ed Urban made a suggestion that national committees consider whether they can identify and pay for early-career scientists to be Associate Members of working groups that are approved. Perhaps SCOR should consider developing a program for Young Faculty and Early Career Scientists from Developing Countries and try to find seed money for this. The program could begin in a SCOR capacity-building priority region (e.g., southern Africa). It is important for SCOR to not only try to advance only *students* in developing countries but also

early-career faculty. SCOR could work with SCOR national committees to raise national, regional, or international funds for this activity.

Peter Burkill wondered whether there should be a separate line item for capacity building expenses in working group budgets. Burkill suggested that proposals should tell SCOR how the groups would use their funding (up to 10%) for capacity-building activities. Hal Batchelder suggested that SCOR could make funding for a group's final meeting dependent on successful capacity-building activities and outcomes. He noted that 10% is a rather small percentage. Withholding funding is the only way to make this happen. Corina Brussaard responded that she didn't think this is a good idea because SCOR's major focus is promoting new areas of science. Capacity-building activities should not be the restricting factor. It would be better to tell groups that they will get extra funding if they have adequate capacity building. Sun Song asked about how many Associate Members could be added to each group and what is a young scientist. Ed Urban responded that 4 or 5 additional Associate Members would be feasible to be funded by national SCOR committees. SCOR uses a definition of 5 years post-PhD as an early-career scientist. Mark Costello suggested 10 years post-Ph.D., as ICSU uses. Missy Feeley suggested requiring groups to report on their capacity building activities in their annual reports. Julie Hall agreed.

## **6.0 RELATIONS WITH INTERGOVERNMENTAL ORGANIZATIONS**

### **6.1 Intergovernmental Oceanographic Commission**

Peter Burkill and Ed Urban attended the IOC General Assembly in June 2013 to represent SCOR and ICSU. SCOR and IOC cooperate on several different activities, as discussed in other sections: the Global Ecology and Oceanography of Harmful Algal Blooms (GEOHAB) Program, the International Ocean Carbon Coordination Project, and the Symposium on the Ocean in a High-CO<sub>2</sub> World. IOC also partners with SCOR on capacity-building activities. IOC support for joint activities has been significantly curtailed because of drastic cuts in activity funding at IOC resulting from the United States and other nations withdrawing their funding to UNESCO. The newest area of cooperation between SCOR and IOC is related to the International Indian Ocean Expedition 2 (IIOE-2).

Nick D'Adamo made a presentation on behalf of IOC and then about the development of IIOE-2. He referred to the written report in the meeting background book that discusses the activities that IOC co-sponsors, including the GEOHAB project, the symposia on The Ocean in a High-CO<sub>2</sub> World, and capacity-building activities. D'Adamo offered to communicate any questions or comments in relation to these projects to the IOC Secretariat

D'Adamo continued by giving a chronology of development of IIOE-2 and steps forward. Various individuals and organizations, at national and international levels, have been discussing the IIOE-2 concept since early 2011. The idea has gained momentum, and IOC and SCOR have been involved in a variety of activities to promote the IIOE-2 idea.

A meeting was held in Hyderabad in May 2013 to form a "Reference Group" to discuss the IIOE-2 idea and to begin developing potential themes. D'Adamo presented a summary of the key

themes that emerged from the Hyderabad meeting and also the scientific questions:

- How do planetary waves impact the productivity, biogeochemistry, and ecology of the Indian Ocean?
- How will the biogeochemistry and ecology of the Indian Ocean change in response to warming?
- What are the biogeochemical and ecological impacts of intra-seasonal, inter-annual, and longer timescales on physical forcings and how might these change in the future?
- How does the Intertropical Convergence Zone influence the productivity, biogeochemistry, and ecology of the Indian Ocean?
- What is the role of the Indian Ocean in the global nitrogen cycle and how might this role change in response to global warming and what might be the higher trophic level impacts?
- What are the large-scale biogeochemical and ecological impacts of mesoscale eddies in the Indian Ocean?

The Reference Group resolved to meet again and to seek high-level governmental support, starting with the IOC Assembly. (The Indian Ocean Rim Association has endorsed IIOE-2). The IOC adopted the following decision:

Decides that it is appropriate for the IOC in collaboration with SCOR and IOGOOS, to further develop a proposal for the second international Indian Ocean Expedition in commemoration of the 50<sup>th</sup> anniversary of the IIOE-I.

Decides to add the International Indian Ocean Expedition 50<sup>th</sup> Anniversary Initiative to the agenda of the IOC Executive Council at its 47<sup>th</sup> Session in 2014 in order to formalize, through a Draft Resolution, IOC's involvement in an IIOE-2, implemented for the period 2015–2020;

Requests the IIOE-2 Reference Group and the IOC Executive Secretary to prepare the relevant documentation, timeline, organizational and financial implications for the IOC;

Urges interested Member States to support this planning effort to the best of their capacities

The IOC Executive Secretary, Wendy Watson-Wright, sent a circular letter inviting participation in the second reference group meeting, which was held in November 2013 at the First Institute of Oceanography, in Qingdao, China. Forty individuals attended, from Asia, Africa, Australia, Europe, and the United States. Meeting participants discussed ecological themes and societal drivers for the IIOE. Ongoing and planned activities in several nations were presented. Participants adopted an organization framework. The outcomes of the meeting will be reported in an *Eos* article. The activity would be managed by a steering committee chaired by IOC and SCOR. There will be a reference group and a symposium planning group. There should also be a cruise coordination subcommittee, a symposium subcommittee, capacity building subcommittee, data subcommittee, etc. National committees will form. Research projects will have their own

subcommittee. D'Adamo gave the example of upwelling as a unifying theme, with the East Indian Ocean Upwelling Research Initiative as the first component.

Mauritius has offered to host a Reference Group meeting for the western Indian Ocean in March 2014. In terms of other future activity, there is a workshop planned in Perth to gain Australian support.

Peter Burkill added information about SCOR's interest in IIOE-2. SCOR will sponsor both a celebration of 50 years of international research and a stepping-stone for future activities. He noted the Web site on IIOE history that Ed Urban put together (see [http://www.scor-int.org/IIOE\\_History.htm](http://www.scor-int.org/IIOE_History.htm)), including a compilation of cruise reports. In the UK, Burkill and Karen Heywood have been promoting the idea, and have received funding from the Royal Society to hold a workshop on the topic in March 2014. Colin Devey suggested for next year's SCOR meeting in Germany to invite Herman Bange or Martin Visbeck to give an update on German IIOE-2 activities. Karen Heywood asked to what extent the meteorology community will be engaged. D'Adamo replied that they are trying to engage that community, beyond CLIVAR. Robert Duce asked whether atmospheric inputs to the ocean should be considered. D'Adamo answered yes. Devey asked whether IODP should be engaged. The *JOIDES Resolution* will be going into the Indian Ocean in 2015. Mike Lucas asked about the *Meteor* cruises around southern Africa (Walvis Bay to Madagascar). Ed Urban asked for suggestions on individuals and topics for the IIOE-2 symposium and project.

## **6.2 International Council for Exploration of the Seas (ICES)**

Wolfgang Fennel noted that much ICES work focuses on climate change and impacts on ecosystems and fisheries. ICES has been involved in various SCOR activities in the past few years, including co-sponsoring a regional program of GLOBEC. New Strategic Initiatives are on Biodiversity Science and Advice, Spatial Planning and Area-based Management, and Stock Assessment Methods. Physical oceanography seems to be reducing in importance as a topic in ICES. ICES has a new science plan, with four pillars: (1) Building a Foundation of Science, (2) Producing the Information and Advice Decision-makers Need, (3) Underpinning Science and Advice Through Data and Information Services, and (4) Supporting the Organisation through the work of the Secretariat. ICES is going to develop methods for integrated ecosystem assessments and management.

## **6.3 Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP)**

Robert Duce presented information about GESAMP WG 38 (Atmospheric Input of Chemicals to the Ocean). GESAMP is an advisory group made up of 8 UN bodies. WG 38 was formed in 2008 and SCOR sponsored its first meeting. The group published three peer-reviewed papers in 2011 and 2012. GESAMP asked the WG to take on some new tasks in 2013 related to the impact of the atmospheric deposition of anthropogenic nitrogen to the ocean. The new tasks were as follows:

1. Update the geographical estimates of anthropogenic nitrogen deposition to the global ocean, utilizing newer and more geographically distributed data on anthropogenic atmospheric nitrogen concentrations and deposition over the global ocean as well as improved models of these processes and impacts.
2. Re-evaluate the impact of atmospheric nitrogen deposition on marine biogeochemistry, including re-estimating the amount of CO<sub>2</sub> that could be drawn down from the atmosphere into the ocean as a result of the increased productivity in the ocean derived from the additional anthropogenic nutrient nitrogen deposited.
3. Provide a more reliable estimate of the impact of atmospheric anthropogenic nitrogen deposition on the production of additional nitrous oxide in the ocean and its subsequent emission to the atmosphere.
4. Evaluate the extent to which anthropogenic nitrogen delivered to the coastal zone via rivers, atmospheric deposition, etc. is transported to the open ocean, in which regions this may happen, and what its impact is there.
5. Make a more detailed estimate of the input and impact of anthropogenic nitrogen in the area of the Northern Indian Ocean (Arabian Sea, Bay of Bengal) and the South China Sea - the areas that are expected to show the greatest increase of anthropogenic nitrogen deposition over the next few decades.

NSF provided support through SCOR for a workshop on The Atmospheric Deposition of Nitrogen and Its Impact on Marine Biogeochemistry to address these new tasks. The workshop was held at the University of East Anglia in Norwich, United Kingdom in February 2013. Up to nine scientific papers, covering the task areas above, have been (or will be) submitted to peer-reviewed journals. Duce described the contents of each paper and the timing and likely place where they would be submitted. Twenty-three scientists participated in this highly successful workshop.

#### **6.4 North Pacific Marine Science Organization (PICES)**

Satoru Taguchi introduced Hal Batchelder, who made the presentation about PICES. PICES' goals are to (1) advance scientific knowledge and capacity available for its member countries, including information on human activities affecting, and affected by, marine ecosystems, and (2) to provide a mechanism for collaboration among scientists in addressing timely and critical scientific questions. PICES conducts several activities that are relevant to SCOR interests and that implement SCOR activities in the North Pacific region and often supports members of SCOR working groups related to PICES activities. Batchelder is a member of the SCOR Committee on Capacity Building.

PICES has one integrated science program at a time, and the current one is called Forecasting and Understanding Trends, Uncertainty and Responses of North Pacific Marine Ecosystems (FUTURE). The FUTURE Open Science Meeting will be held in Hawaii in April 2014. This will be a mid-term meeting for the project.

Batchelder mentioned major meetings sponsored by PICES. He noted the HAB and Climate Change workshop co-sponsored by PICES, ICES, and GEOHAB. PICES holds parallel workshops before its annual meeting, often on topics relevant to SCOR.

PICES is very active in capacity building. A recent example is the 2013 PICES Summer School, for which SCOR provided travel support for developing country participants. The summer school lasted five days and included two days of cruises. PICES has co-funded IMBER and SOLAS meetings, and IMBER and SOLAS have co-sponsored PICES sessions. PICES provided support for the SOLAS Summer School in China from 23 August to 2 September 2013 and will provide support for the IMBER ClimEco4 summer school in Shanghai, China in August 2014.

PICES and SCOR could consider co-funding a working group, when it makes sense scientifically and organizationally. SCOR's groups are block funded and membership is determined ahead of time. In PICES, an idea for a working group is developed first and then PICES countries nominate members. It is not clear whether the SCOR and PICES approaches can be harmonized, but it is worth discussing. SCOR invited PICES to cooperate in the SCOR Visiting Scholars program. Batchelder mentioned the two requests for travel support from PICES. One of the two requests was approved, for the 2014 PICES Summer School on Ecological Modeling in Seoul, Korea.

## **7.0 RELATIONS WITH NON-GOVERNMENTAL ORGANIZATIONS**

### **7.1 International Council for Science**

Peter Burkill reported that he and Ed Urban met with Steven Wilson, the ICSU Executive Director, in June 2013 in conjunction with the IOC annual meeting in Paris. As part of its periodic review process, ICSU will review SCOR sometime in the next three years. ICSU awarded SCOR and SCAR a grant for 2013/2014 to fund an activity designed to identify and evaluate potential Ecosystem Essential Ocean Variables (eEOVs) that would be monitored through an enhanced Global Ocean Observing System, particularly as part of the Southern Ocean Observing System.

#### **7.1.1 International Geosphere-Biosphere Program (IGBP)**

Peter Burkill attended the 2013 IGBP Science Committee meeting in Bern, Switzerland to represent SCOR, and briefly provided comments from the IGBP written report. IGBP has initiated its final synthesis activities in preparation for the program completion at the end of 2015. SCOR and IGBP staff members have ongoing discussions in relation to co-sponsored projects. IGBP is co-funding WG 138 Modern Planktic Foraminifera and Ocean Changes, IMBER, SOLAS, and co-sponsored the last two symposia on The Ocean in a High-CO<sub>2</sub> World. SCOR co-sponsored two IGBP fast-track initiatives.

#### **7.1.2 World Climate Research Programme (WCRP)**

Wolfgang Fennel reported on WCRP and SCOR's links with this program. WCRP is focused on the climate aspects of different parts of the Earth system, including the ocean. WCRP is co-sponsoring the SOLAS project and has published an action plan for research activities on surface fluxes. It previously co-sponsored WG 136 on Climatic Importance of the Greater Agulhas System, and development of the Southern Ocean Observing System. SCOR projects (including IOCCP) are working well with CLIVAR, the part of WCRP most relevant to SCOR. Ed Urban



co-authored a paper in *Oceanography* magazine with Roberta Boscolo of WCRP on “Using scientific meetings to enhance the development of early career scientists.”<sup>16</sup> WCRP is contributing to the Future of Ocean Observations activity. They are looking at how physical oceanography can be linked to biology and ecology and are creating strong links with IMBER. Another area of WCRP focus is how dynamics of upwelling systems will affect ocean-atmosphere interactions. WCRP is developing plans for how the program can contribute to strategic initiatives, such as the Future Earth initiative.

### **7.1.3 Scientific Committee on Antarctic Research (SCAR)**

SCAR and SCOR are co-sponsoring the Southern Ocean Observing System (SOOS). The SOOS SSC met in May 2013 in Shanghai, China and held a workshop there to encourage Asian participation in SOOS. SCAR also is sponsoring an activity on ocean acidification in the Southern Ocean.

Corina Brussaard introduced Louise Newman, the SOOS Executive Officer, who made a presentation about SOOS. Newman noted that the Southern Ocean is central to function of the Earth System. However, the limited observations of the Southern Ocean show that it is changing. SOOS is needed to help develop sustained observations in this region. The SOOS mission is “to establish a multidisciplinary system to deliver the sustained observations of the Southern Ocean that are needed to address key challenges of scientific and societal relevance, including climate change, sea-level rise and the impacts of global change on marine ecosystems.”

The scientific co-sponsors of SOOS are SCOR and SCAR, and POGO, CLIVAR, and CLiC have endorsed SOOS. The SOOS International Project Office is hosted by the University of Tasmania and its Institute for Marine and Antarctic Studies. SOOS also is sponsored and supported financially by the Australian Antarctic Division, Antarctica New Zealand, and the New Zealand Antarctic Research Institute.

SOOS continues to implement its planned science, through the following activities:

- Held a [“Seeing Below the Ice” Workshop](#) in Oct. 2012
- Held the [1<sup>st</sup> SOOS Asian workshop](#) in May 2013.
- Held a joint workshop of SOOS and the Council of Managers of National Antarctic Programs (COMNAP) in July 2013, to discuss ways that SOOS and COMNAP could work together in implementation of SOOS. Some progress was made, but COMNAP has not yet agreed to any of the suggestions that emerged from the workshop
- An air-sea fluxes workshop is being planned, as this is a gap; a workshop prospectus is being drafted. The workshop will involve atmospheric and oceanographic data reanalysis. The objectives are to identify and bring the relevant communities together, identify existing observation requirements, and develop a strategy for enhancing existing observation efforts.
- SOOS is planning a two-hour POGO/SOOS workshop on 23 January 2014 at the annual POGO meeting, which will highlight identified priority observations and outline key

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<sup>16</sup>[http://www.tos.org/oceanography/archive/26-2\\_urban.html](http://www.tos.org/oceanography/archive/26-2_urban.html).

ways for POGO member institutions to support SOOS initiatives. The workshop will also advocate for continued/enhanced support of contributing programs (Argo, GO-SHIP, mammal tagging, etc.).

- SOOS is leading planning for a workshop in March 2014 on “Identification of Ecosystem Essential Ocean Variables (eEOVs) for the Global Ocean”. This workshop is being funded by a grant from ICSU to SCOR and SCAR. The workshop is based on the 2012 SCOR working group proposal that was not approved, but may result in a future working group proposal.
- A Priority Observations Task Group (PO-TAG) was formed by the SOOS SSC to identify the top priority observations across all disciplines. These will be “ranked” based on logistical demands, cost, and scientific value. The information is to be used as a foundation for research proposals, and as a way for nations/institutes/individuals to contribute to filling priority gaps in observations.
- SOOS is presently drafting a manuscript outlining the Priority Gaps in observations, as identified by the SSC at the recent SSC meeting. Gaps are based around the 6 Science Themes and the Theme Work plans are focused to help address these gaps. This activity is linked to PO-TAG.
- A Standardised Methodologies Task Group will be formed to compile all available information on internationally agreed standard methodologies and protocols in an effort to standardize the way that all observations are collected. This is important for quality control and comparability.
- Satellite Products, Validation and Coordination: First steps have been made towards development of an initiative that will identify existing and planned satellite products, communicate SOOS satellite data requirements to key communities (as requested by the Polar Space Task Group (PSTG) of the World Meteorological Organization's (WMO)), and seek to enhance satellite data validation efforts in the Southern Ocean. Initial discussions are taking place with the Climate and Cryosphere (CliC) to establish a working group on this, in alignment with the CliC Technical Committee on Sea Ice Observations, the European Space Agency’s Climate Change Initiative, and WMO PSTG.
- A key priority now is the development of the SOOS 10-year Detailed Implementation Plan, which will identify priority activities, products, and the mechanisms to achieve them (e.g., key active communities). Work plans are being developed for each of the 6 SOOS themes. Newman showed a potential structure for the implementation plan and project implementation.

Graham Hosie mentioned that there has been good cooperation between SCAR and SCOR in SOOS, which evolved from an Expert Group co-sponsored by the two organizations. The Implementation Plan needs considerable support. Julie Hall added that it is great to see how SOOS has developed. She asked about IMBER involvement in the eEOV meeting and SOLAS involvement in the air-sea flux workshop. Louise noted the importance of completion of the Implementation Plan and 10-year plan before more funding can be raised to implement SOOS. The chair of IMBER will be attending the eEOV meeting.

#### 7.1.4 Future Earth Initiative

Diana Greenslade made a presentation about the Future Earth initiative. This initiative grew out of the ICSU Global Environmental Change (GECs) programs. A review of the individual programs and the Earth System Science Partnership recommended more integration and interaction with policy. The Future Earth initiative was launched at Rio+20 in 2012. It is not intended to be a re-packaging of existing GECs, but will be a global platform for international scientific collaboration. An interim Future Earth governing body has been announced and a permanent secretariat will be established by the end of 2014. More information is available at <http://www.icsu.org/future-earth/>. The key principles include the following:

- Scientific Excellence
- Scientific Scope: Integrated Earth systems and global sustainability research; seeks to solve the global environmental change-related challenges facing humanity.
- International: Global in scope but regionally and locally relevant.
- Interdisciplinary: Integrates natural science and social science, economics, engineering, arts and the humanities.
- Bottom-up driven: Emphasizes the importance of “bottom-up” ideas from the research community.
- Co-designed and co-produced: The research agenda will be co-designed and co-produced by researchers in collaboration with stakeholders in governments, industry, civil society, etc.

Future Earth will include three research themes:

1. **Dynamic Planet:** Understanding how Earth is changing due to natural phenomena and human activities. The emphasis is on observing, explaining, understanding, and projecting Earth environmental and societal trends, drivers, and processes and their interactions.
2. **Global Development:** Providing the knowledge for addressing the most pressing needs of humanity including sustainable, secure and fair stewardship of food, water, biodiversity, energy, and materials.
3. **Transformations towards Sustainability:** Providing the knowledge for transformations toward a sustainable future: understanding transformation processes and options, assessing how these relate to human values and behavior, emerging technologies, and economic development pathways.

The Future Earth initiative is an activity of the Science and Technology Alliance for Global Sustainability. This Alliance is a consortium of ICSU, the International Social Science Council, the UN Environment Programme, the International Group of Funding Agencies for Global Change Research, UNESCO, the United Nations University, and the Belmont Forum. The Alliance will set up a Governing Council that will have two committees reporting to it: (1) an Engagement Committee and (2) a Science Committee. The Science Committee has been established and an interim Engagement Committee has been established. Bids have been requested for hosting a Future Earth Secretariat. An interim secretariat is being hosted by ICSU in Paris. In the short term, Future Earth is considering funding Fast-Track Initiatives, similar to IGBP’s Fast-Track Initiatives and SCOR working groups. These would be focused on integrative

workshops on emerging issues and would be two- to three-year activities with specific outcomes. Future Earth may also encourage clusters of existing GEC projects to join together to respond to interdisciplinary priority topics. These clusters could play a role in re-shaping existing project structures. Future Earth is developing a memorandum of understanding that describes the general framework under which an existing GEC project can join Future Earth, including benefits for projects, commitments from Future Earth, and commitments from projects, in terms of governance (e.g., SSCs), noting co-sponsorship arrangements; science plans (10 years); and expected contributions to integrative activities. Future Earth will also establish Memoranda of Understanding or exchange of letters with co-sponsors, such as SCOR.

In 2014, a core projects meeting will be held in January 2014, in Washington D.C. Future Earth will complete the process for establishment of a permanent secretariat. It will establish a full Engagement Committee. It will develop a Strategic Research Agenda and will establish communications activities. The interim period ends in December 2014.

John Volkman asked about the funding model. Will it just be rolling together all the money currently used by the GECs? Greenslade answered that they anticipate the funding to be streamlined through approaching the same sources in the same countries that are funding the GECs. Corina Brussaard asked about the justification for the creation of Future Earth. Greenslade answered that there was a desire for better integration. Batchelder asked about tapping industry and foundations for funding. Greenslade answered that this would be a role for the Engagement Committee.

## **7.2 Affiliated Organizations**

### **7.2.1 International Association for Biological Oceanography (IABO)**

IABO is an association of the ICSU International Union of Biological Sciences. Mark Costello, the IABO President, made a presentation about the organization. A major activity of IABO in the coming year will be the Third World Conference on Marine Biodiversity, to be held in October 2014 in Qingdao, China. This is the premier international conference in marine biology and oceanography and 700-1,000 participants are expected to attend. The IABO General Assembly will be held in conjunction with this event. SCOR working groups and programs are welcome to suggest special sessions. Sun Song added that they are using “Life in a Changing Ocean” as the title for the assembly. Organizers are seeking funding to support young scientists from developing countries to attend and Costello thanked SCOR for its contribution of such support.

Costello noted that the number of new marine species discovered and described each year has never been greater. However, although authors per year is increasing, the new species described per author is decreasing. An important activity related to IABO is the World Register of Marine Species (WoRMS). This activity is supported by more than 200 experts who serve as editors for the online open-access database of all marine species. WoRMS is heavily used and cited (by more than 840 publications). More than 16 research papers have been published based on WoRMS (in *Current Biology*, *PLoS Biology*, *PLoS ONE* and other journals). WoRMS includes about 98% of described marine species.

The Ocean Biogeographic Information System (OBIS) is also related to IABO. It is a legacy of the Census of Marine Life and is hosted at IOC's International Oceanographic Data and Information Exchange (IODE) in Oostende, Belgium. OBIS presents species distribution data in space and time for 150,000 species, 37 million location records, and 1,300 datasets integrated into a single database.

Peter Burkill noted that IABO is on the ascendancy. Costello had suggested that SCOR be proactive about seeking new affiliated organizations, such as the Deep-Sea Society, WoRMs, etc. might want to affiliate.

### **7.2.2 International Association for Meteorology and Atmospheric Sciences (IAMAS)**

Athena Coustenis reminded participants that IAMAS has been (for 90 years) one of the eight associations dealing with the Earth system and its environs that make up the ICSU International Union of Geodesy and Geophysics (IUGG). The scope of IAMAS includes the study of the atmospheres of the Earth and other planets. IAMAS is a parent of the international Commission on Atmospheric Chemistry and Global Pollution (iCACGP), which is a co-sponsor of SOLAS. iCACGP supports atmospheric chemistry research that contributes to solving the basic societal issues of water supply, food production and human/ecosystem health. This is done through an enhanced understanding of the fundamental mechanisms that control atmospheric composition and development of improved predictive capabilities. IAMAS includes 10 international commissions and one committee. This set of commissions provides an important supplement and extension to the leadership and research role of the World Meteorological Organization (WMO). The main event recently was the 2013 General Assembly with the International Association for Cryospheric Science. More than 1,000 people attended this assembly. The first IAMAS early-career scientist medal was awarded. IAMAS approved a resolution to the Future Earth initiative expressing concern that new program does not sufficiently support important atmospheric networks established by previous ICSU programs (e.g., IGBP). They also issued a statement on radiation management climate engineering stating that "climate engineering cannot be considered a viable alternative or substitute for aggressive emissions reductions. IAMAS supports conducting research to improve the basic understanding and to explore the possibility that climate engineering may eventually be part of a broad risk management strategy aimed at temporarily reducing some of the dangerous impacts of climate change until emissions reductions are sufficient."

### **7.2.3 International Association for the Physical Sciences of the Oceans (IAPSO)**

Eugene Morozov reported that IAPSO is also an association of the ICSU International Union of Geodesy and Geophysics. SCOR and IAPSO recently co-sponsored WG 136 on Climatic Importance of the Greater Agulhas System (with WCRP) and are co-sponsoring the new IAPWS/SCOR/IAPSO Joint Committee on Seawater. SCOR and IAPSO (and its predecessors) have co-sponsored working groups for more than 50 years.

The main activity of IAPSO in 2013 was its General Assembly in Gothenburg, Sweden. The assembly attracted 1,087 participants from 66 countries. Nine symposia were convened by IAPSO on its own, among 48 total symposia. IAPSO is preparing for its next assembly in Prague in 2015, with IUGG. They are preparing symposia and looking for conveners. This could be an opportunity for the group that submitted the proposal for the working group on surface waves.

IAPSO will invite people from this group to organize a symposium. IAPSO will plan three chemistry-related symposia and will invite appropriate people from SCOR working groups and others related to groups that weren't approved. IAPSO will hold a joint assembly in Cape Town in 2017.

Many former SCOR-IAPSO working groups continue holding sessions under IAPSO during assemblies, such as the ocean mixing group (WG 121) and the equation of state of seawater group (WG 127). This latter work is important because absolute salinity is almost one unit of salinity greater than salinity determined by conductivity, due to salinity-affecting substances that are not detected by conductivity measurements. The IAPSO Commission on Tsunamis is working with the Commission on Seismology. Another IAPSO Commission is on Sea-level Rise. IAPSO oversees the production of standard seawater. Another activity is choosing medalists. The Prince Albert I medal is awarded once every two years to an outstanding oceanographer. A second medal is the Eugene La Fond Medal, awarded to a developing country scientist who contributes during IAPSO assemblies. Awarding of this medal can help a developing country scientist's career. Peter Burkill asked how medalists are selected. Morozov responded that for the La Fond Medal they first analyze abstracts, then members of IAPSO Assembly decide on medal recipients.

### **7.3 Affiliated Programs**

The benefit of continued affiliation to SCOR is evaluated at each General Meeting, but annual reports are requested from the programs for information.

#### **7.3.1 InterRidge - International, Interdisciplinary Ridge Studies**

Missy Feeley reported that InterRidge has an active program of working groups and scientific meetings, as well as significant education and outreach activities. There are currently seven active InterRidge Working Groups, including the SCOR/InterRidge WG 135 on Hydrothermal Energy Transfer and its Impact on the Ocean Carbon Cycles. The InterRidge program office moved to Peking University at the beginning of 2013. The new chair is John Chen (School of Earth and Space Sciences, Peking University, Beijing) and Jiabiao Li (Second Institute of Oceanography, Hangzhou) is co-chair. InterRidge worked on its Third Decadal Plan throughout 2012.

#### **7.3.2 International Ocean Colour Coordinating Group (IOCCG)**

John Volkman made a presentation provided by Venetia Stuart, the IOCCG Project Scientist. IOCCG was established in 1996 to promote the use of ocean-color data, and to develop consensus at the global scale regarding how to advance the collection and use of such data. IOCCG has been an Affiliated Program of SCOR since 1997. It is an Associate Member of the Committee on Earth Observation Satellites (CEOS) and is supported by national space agencies. The IOCCG Project Office is located at the Bedford Institute of Oceanography, in Nova Scotia, Canada. The governing committee of IOCCG consists of space agency representatives (who contribute financially and carry out the decisions endorsed by the group), and research scientists (who address current research issues and make recommendations).

The IOCCG mandate includes the following:

- To provide a common voice for the user community
- To liaise with space agencies
- To hold advanced training courses to foster expertise in using ocean-color data
- To facilitate free and open access to ocean-color data from all agencies
- To ensure continuity and quality of the ocean-color data stream
- To advocate the importance of ocean-color data to the global community (informative Web site, newsletters, brochures, IOCCG reports...)

IOCCG working groups have produced 13 Scientific Working Group Reports. The current working groups include the following:

- Calibration of Ocean-Colour Sensors – to be published early 2014
- Harmful Algal Blooms (combined IOCCG/GEOHAB working group). Will publish an IOCCG Report plus a special issue of a peer-reviewed journal.
- Phytoplankton Functional Types
- Ocean Colour Remote Sensing in Polar Seas
- Uncertainties in Ocean Colour Radiometry
- Retrieval Algorithms for Coastal Waters
- Atmospheric Correction in Turbid Waters

Proposals for new working groups include (1) Ocean Colour Applications for Coral Reefs and (2) Earth Observations in Support of Global Water Quality Monitoring.

More than 500 students from about 90 different countries have received training in 25 different IOCCG training initiatives (see [www.ioccg.org/training/past.html](http://www.ioccg.org/training/past.html)), including introductory courses (processing data/applications) and high-level training courses (scientific research). SCOR has provided LDC travel support for several IOCCG training activities. A new activity is the IOCCG Summer Lecture Series. The first installment took place at the Laboratoire d'Océanographie de Villefranche (LOV), France in July 2012 and was very successful. This was an advanced training course dedicated to high-level training in the fundamentals of ocean optics, bio-optics, and ocean color remote sensing delivered by prominent research scientists. IOCCG plans to hold the second Summer Lecture Series from 21 July to 2 August 2014 and SCOR has committed to provide support to two students from developing countries to attend the course.

Another new IOCCG activity is the International Ocean Colour Science (IOCS) Meeting. The 1<sup>st</sup> IOCS meeting was held Darmstadt, Germany, on 6-8 May 2013, sponsored by NASA, EUMETSAT, ESA, and CNES. It was a very successful event, with about 240 participants from around the world (scientists plus space agency representatives). The rationale of the meetings is that it is important to maintain consultation and interaction with the broader ocean color user community. SCOR played a major role in helping to secure funding from NASA for this meeting. Recommendations arising from the meeting included proposals from various splinter sessions for follow-up workshops (to be sponsored by IOCCG):

1. Workshop on Ocean Colour System Vicarious Calibration for Science and Operational Missions – to take place at ESA/ESRIN, Italy, December 2013 (chaired by Ewa Kwiatkowska, EUMETSAT)
2. Workshop on Protocols for In Situ Observations - to take place after the Ocean Optics conference, Portland, USA, Oct 2014 (chaired by Steve Ackleson, USA).
3. Workshop on Phytoplankton Composition from Space: towards operational processing and usage for climate change studies and services - to take place after the Ocean Optics conference, Portland, USA, Oct 2014 (chaired by Astrid Bracher, Germany).

The Second IOCS meeting is scheduled to take place in the United States, in May 2015.

The presentation finished with some thoughts about benefits of affiliation to SCOR. IOCCG has had a very favorable and positive relationship with SCOR since its affiliation in 1997. SCOR has helped IOCCG consolidate its credibility as a scientific force by having visible links with one of the major international oceanographic organizations. Affiliation with SCOR ensures an efficient mechanism for coordination with other international organizations (e.g., GEOHAB). NASA funding is vital to support IOCCG activities, and is obtained through SCOR. IOCCG respects and appreciates SCOR's procedures, including regular rotation of scientific committee members.

### **7.3.3 Global Alliance of CPR Surveys (GACS)**

GACS was formed in September 2011 to foster global cooperation and coordination of the Continuous Plankton Recorder (CPR) surveys carried out in several different parts of the world. GACS became affiliated to SCOR in 2012.

Graham Hosie made a presentation about GACS, as the chair of the project. He thanked SCOR for its support. The goal of GACS is to understand (characterize, analyze and interpret) changes in plankton biodiversity at ocean-basin scales through a global alliance of CPR surveys. The key objectives are to develop and agree to common standards, develop a global database, pursue capacity building and secondments, maintain a Web site, produce an Annual Global Marine Ecological Status Report, and act as interface to other global observation programs.

The Ecological Status Reports include reports from regional surveys, global Phytoplankton Color Index scores, global zooplankton abundance trends, global trends in Average Copepod Community Size (ACCS), biogeographic shifts, phenological change, changes in biodiversity and invasive species, eutrophication and HABs, microplastics, and ocean acidification. These reports helped identify the regime shift in North Sea in the mid-1980s.

GACS is attempting to engage with as many different organizations that operate CPR surveys as possible to ensure that GACS can deliver data and know the data needs of each organization. CPR is 1931 technology that still works. Using the same technology worldwide allows global comparisons. GACS brings together 50 plankton experts (technicians and scientists) from 14 laboratories involved in 10 regional surveys using about 50 vessels (merchant, research, military) from nearly 40 shipping companies/agencies. India, Cyprus, and South Korea will probably join GACS in the near future. Some areas are well covered, but large areas have no consistent and standardized monitoring survey. There are numerous smaller monitoring programs, such as CALCOFI off the California coast, but they use different methodology, and often for a specific



species. Most CPR effort has been done in the Northern Hemisphere so far, but efforts are expanding in both the Southern and Northern hemispheres. To conduct CPR surveys and understand the results requires expertise in maintenance and use of the CPR, plankton taxonomy, plankton ecology, genetic and molecular analysis, quantitative numerical analyses, ecological and predictive modelling, and data management.

Hosie concluded by noting that the benefits to SCOR of affiliation with GACS is that GACS can provide data to established programs (e.g., SOOS, IMBER), provide data to established and future SCOR working groups, and provide advice on plankton diversity. The benefits to GACS of affiliation to SCOR include advice from SCOR on enhancing integration with research projects and working groups, support from SCOR for travel of developing country scientists, and SCOR's assistance in expanding the CPR network to fill the gaps.

Julie Hall added that the strength of GACS has been key for funding in New Zealand. Links with industry have been important, particularly with the fishing industry. Sun Song noted that it has been good for Peter Burkill to take such an important role in helping develop GACS. Sun Song also noted that it is hard to use CPR in the western Pacific, although there is a Shanghai-to-Antarctic CPR line each year with high-speed sampling. Mike Lucas asked about putting other sensors on CPRs. Graham answered that the sensors being used on organisms (e.g., marine mammals) could be deployed on CPRs.

## **7.4 Other Organizations**

### **7.4.1 Partnership for Observation of the Global Oceans (POGO)**

Missy Feeley noted that POGO and SCOR have had a long association. POGO is a non-profit consortium of oceanographic institutions from around the world. POGO promotes global oceanography, particularly the implementation of international and integrated global ocean observing systems. POGO has focused much of its attention in recent years on interactions with the Group on Earth Observations (GEO) to represent ocean observation issues. A new Task on "Oceans and Society: the Blue Planet" is included in the GEO Workplan, and this task draws together POGO and many of the other organizations and projects involved in ocean observations. POGO convened a kick-off symposium for the task, held in Brazil on 19-21 November 2012. POGO and SCOR are cooperating on development of the International Quiet Ocean Experiment (IQOE) and co-fund the POGO-SCOR Visiting Fellowships for Oceanographic Observations. John Volkman will represent SCOR at the POGO meeting in Hobart in January.

### **7.4.2 International Arctic Science Committee Marine Working Group**

Wolfgang Fennel noted that the Marine Working Group (MWG) of the International Arctic Science Committee (IASC) is a non-governmental body that includes members and participants from research and governmental institutions in all 19 IASC countries. Its predecessor, the Arctic Ocean Science Board, was established in May 1984 to fill a recognized need to coordinate the priorities and programs of countries and institutions engaged in research in the Arctic Ocean. The MWG has identified the following priority themes for 2011-2015:

- Arctic Ocean System: predicting and understanding rapid changes in the Arctic;
- sea ice structure dynamics and the Arctic system;
- ecosystem responses to changing physical parameters in the Arctic;
- understanding geochemical process in the Arctic Ocean and Sub-Arctic Seas; and
- improving access to the geological record of the Arctic Ocean.

There may be potential interactions between some of these groups and SCOR WG 140 on Biogeochemical Exchange Processes at the Sea-Ice Interfaces. Fennel added that the MWG is trying to facilitate deep-sea drilling in Arctic Ocean. They have some cross-cutting activities defined. Ed Urban suggested that maybe we should have a presentation at next year's SCOR meeting from this group.

## 8.0 ORGANIZATION AND FINANCE

### 8.1 Membership

#### 8.1.1 National Committees

The following changes were made in national SCOR committee memberships since the 2012 SCOR meeting:

- CHILE: Miguel Vasquez was replaced by Carlos A. Zuniga
- CHINA-TAIPEI: Shu-Kun Hsu is the new chairman and Ben Chao and C.-F. Dai are the other two new Nominated Members
- FRANCE: Catherine Beltran replaced Laurent Labeyrie
- PAKISTAN: Mohammad Moazaam Rabbani and Tariq-ur-Rehman were replaced by Ali Rashid Tabrez and Asif Inam
- SWEDEN: Lena Kautsky was replaced by Agneta Andersson
- USA: Robert Duce and Dawn Wright replaced Jay Pearlman and Jorge Corredor

Ed Urban and Peter Burkill met with the French SCOR Committee in June 2013 and met with the UK SCOR Committee in July 2013. Ed Urban made a presentation to the U.S. SCOR Committee in August 2013.

### 8.2 Publications Arising from SCOR Activities

SCOR-sponsored research projects have produced many peer-reviewed publications, as listed on their Web sites. One SCOR working group completed a special issue from its work in the past year, and several other groups published articles about their work in *Eos* and other publications.

2012 *SCOR Proceedings*—The *Proceedings* was distributed in electronic form only.

SCOR Web site—The SCOR Web site is updated and checked for dead links regularly. Many historical documents from the SCOR files have been scanned and are available on the SCOR History page (<http://www.scor-int.org/history.htm>). The papers of Robert Snider (first

coordinator of the International Indian Ocean Expedition) were scanned and are available on a specific page for the IIOE ([http://www.scor-int.org/IIOE\\_History.htm](http://www.scor-int.org/IIOE_History.htm)).

*SCOR Newsletter*—The SCOR Newsletter was started late in 2004, to provide more frequent updates about SCOR activities between annual meetings. Twenty-five issues have been distributed so far. (All are available on the SCOR Web site.) The Newsletter is printed in hard copy occasionally for limited distribution. A graphic designer was employed to format issue #25 and will be involved in formatting future issues of the newsletter.

### **8.3 Finances**

The ad hoc Finance Committee was composed of Colin Devey (Germany), Karen Heywood (UK), and Motoyoshi Ikeda (Japan). Devey reported on the work and recommendations of the committee. The tasks of the committee were to (1) Do a retrospective check of 2012 finances, including the audit; (2) check the current 2013 budget and suggested revisions; and (3) check projected budgets for 2014 and 2015 for affordability and realism.

#### Summary of 2012 Finances (Auditors)

- The total 2012 income for SCOR was US\$1,529,211 (\$1,081,671 in 2011) and the total expenses were US\$1,509,976 (\$1,099,247 in 2011). This resulted in a 2012 surplus of US\$19,235 (\$17,577 deficit in 2011) in accordance with 2012 audit.
- The total assets at the end of 2012 were US\$349,209 (this includes some money promised but not yet received (e.g., \$29,777 unpaid dues from Brazil, Chile, Ecuador, France, India, Spain, Peru).
- The cash balance at the end of 2012 was US\$171,422 (up from US\$152,187 at the end of 2011).
- Auditor's report: The Finance Committee reviewed the auditor's report of 2012 finances. The auditor found no accounting discrepancies (and found SCOR a low-risk auditee). The Finance Committee found the Auditor's report in accordance with the SCOR financial report, and there are no special remarks in the Audit to consider.

The Finance Committee recommended that SCOR accept the 2012 financial report and auditor's report and these were accepted by meeting participants.

#### Summary of 2013 Budget

- The income for SCOR discretionary activities was budgeted to US\$430,709. The proposed revised budget is US\$402,713. The difference resulted from a reduction in funds called-up from the Science grant from NSF to SCOR, particularly for working groups. The funds can be used in 2014.
- The discretionary expenses were budgeted to US\$437,532. In the revised budget expenses are US\$350,019 (as last year, working group expenses are lower than expected).
- The cash balance at the end of 2013 was originally budgeted to US\$163,934. The revised budget's ending cash balance is US\$224,116.

The Finance Committee recommended that SCOR approve this revised budget, but noted that working groups are underspending by US\$70,000. There has been a trend over the past few years that working groups underspend their budgeted amounts, because they meet in conjunction with other meetings, more members are self-funding, and/or groups postpone their meetings. The revised budget was approved by meeting participants.

#### 2014 Draft Budget

- The cash balance is estimated to come down at the end of 2014 from projected \$224,115 to US\$194,809. This is above the set minimum cash balance of US\$100,000. The Finance Committee believed it is unrealistic to expect this decrease.

The Finance Committee recommended acceptance of the proposed budget for 2014, but recommended that the SCOR Executive Committee use more of SCOR funds to stimulate scientific research on the ocean, either via working groups or new instruments. The Finance Committee estimated that about US\$70,000 will be available for this purpose in 2014. Meeting participants approved the 2014 draft budget.

In summary, the Finance Committee noted that the cash situation for 2013 allows the planned establishment of two new working groups in 2013 (and we can expect to be able to fund at least two additional groups in 2014). The trend in working group underspending is expected to continue; this is an opportunity for SCOR to expand its portfolio of science-stimulating activities. In view of this opportunity, the Finance Committee saw no need in 2014 to diverge from the incremental 3% dues increase practiced in recent years.

In discussion following the report of the Finance Committee, it was recommended to determine how many working group members are attending each meeting. Bjørn Sundby suggested that the chairs of working groups be involved in the dialog and ask whether they will use all their funds in any given year. It seems that groups are trying to limit their time and carbon footprints by holding meetings in conjunction with major meetings. Mark Costello suggested spending more on capacity building for working groups and Karen Heywood suggested that SCOR could directly offer funds to working groups for their capacity-building activities. Another idea was to use some of the surplus funds to help working groups develop Web sites. Ed Urban will contact the chairs of working groups to ask for their forward projections, and that SCOR will consider spending more on capacity building as a first priority, but will also consider one-off expenditures. Sundby added that we should make clear that we admire the working group chairs for their frugality.

## **9.0 SCOR-RELATED MEETINGS**

### **9.1 SCOR Annual Meetings**

#### **9.1.1 2013 Executive Committee Meeting – New Zealand**

Peter Burkill thanked the New Zealand SCOR Committee for hosting the meeting, on behalf of the SCOR Executive Committee and staff. Special thanks were expressed to the local host, Julie Hall, for hosting the Executive Committee meeting and for arranging for SCOR meeting

participants to learn about marine research being conducted in New Zealand. A gift was presented from SCOR to Julie Hall in appreciation for her efforts.

### **9.1.2 2014 General Meeting – Bremen, Germany**

SCOR hold its 2014 General Meeting in Bremen, Germany on 15-17 September, with special presentations on Sept. 18 on ocean science in Germany. Wolfgang Fennel made a short presentation showing meeting locations and giving a timetable of events:

- 15 September: start of the SCOR meeting, followed by a reception with finger food, invitation of local scientist to meet the SCOR members at the reception
- 16 September: SCOR meeting, followed by dinner at the Ratskeller (town hall and in the "Hauff Saal") at 8 p.m.
- 17 September: SCOR meeting
- 18 September: Symposium with emphasis on marine research in Germany (9am - 3pm), poster presentations of students, optional lab visit

### **9.1.3 2015 Executive Committee Meeting – Goa, India**

Peter Burkill reminded meeting participants that the SCOR Executive Committee has accepted an invitation to hold the 2015 Executive Committee meeting in Goa, India. The SCOR meeting will be held before or after the symposium celebrating the Silver Jubilee of the National Institute of Oceanography and the 50<sup>th</sup> anniversary of the completion of the International Indian Ocean Expedition.

### **9.1.4 2016 General Meeting – Sopot, Poland**

Peter Burkill noted that the SCOR Executive Committee has accepted an invitation to hold the 2016 General Meeting in Sopot, Poland.

Peter Burkill closed the 41<sup>st</sup> SCOR Executive Committee Meeting at 3:50 p.m. on 27 November 2014.

## Appendix 1 - Agenda

### 1.0 OPENING

- |     |   |                             |
|-----|---|-----------------------------|
| 1.1 | Opening Remarks and Administrative Arrangements   | <i>Hall, Burkill, Urban</i> |
| 1.2 | Approval of the Agenda                            | <i>Burkill</i>              |
| 1.3 | Report of the President of SCOR                   | <i>Burkill</i>              |
| 1.4 | Report of SCOR Executive Director                 | <i>Urban</i>                |
| 1.5 | Appointment of an <i>ad hoc</i> Finance Committee | <i>Burkill</i>              |
| 1.6 | 2014 Elections for SCOR Officers                  | <i>Fennel</i>               |

### 2.0 WORKING GROUPS

- |       |   |                  |
|-------|---|------------------|
| 2.1   | Disbanded Working Groups  |                  |
| 2.1.1 | SCOR WG 131 on The Legacy of in situ Iron Enrichment: Data Compilation and Modeling   | <i>Urban</i>     |
| 2.1.2 | SCOR/LOICZ WG 132 on Land-based Nutrient Pollution and the Relationship to Harmful Algal Blooms in Coastal Marine Systems   | <i>Taguchi</i>   |
| 2.1.3 | SCOR/WCRP/IAPSO Working Group 136 on the Climatic Importance of the Greater Agulhas System  | <i>Urban</i>     |
| 2.2   | Current Working Groups  |                  |
| 2.2.1 | SCOR WG 134 on The Microbial Carbon Pump in the Ocean   | <i>Urban</i>     |
| 2.2.2 | SCOR/InterRidge WG 135 on Hydrothermal energy transfer and its impact on the ocean carbon cycles  | <i>Coustenis</i> |
| 2.2.3 | WG 137 on Patterns of Phytoplankton Dynamics in Coastal Ecosystems: Comparative Analysis of Time Series Observation   | <i>Volkman</i>   |
| 2.2.4 | SCOR/IGBP WG 138 on Modern Planktic Foraminifera and Ocean Changes  | <i>Feeley</i>    |
| 2.2.5 | WG 139 on Organic Ligands – A Key Control on Trace Metal Biogeochemistry in the Ocean   | <i>Urban</i>     |
| 2.2.6 | WG 140 on Biogeochemical Exchange Processes at the Sea-Ice Interfaces   | <i>Volkman</i>   |
| 2.2.7 | WG 141 on Sea-Surface Microlayers   | <i>Volkman</i>   |
| 2.2.8 | WG 142 on Quality Control Procedures for Oxygen and Other Biogeochemical Sensors on Floats and Gliders  | <i>Feeley</i>    |
| 2.3   | New Working Group Proposals   |                  |
| 2.3.1 | SCOR Working Group on Zooplankton Production Measurement Methodologies and Their Application  | <i>Burkill</i>   |
| 2.3.2 | SCOR Working Group on Response of marine biota to complex global environmental change: co-ordination and harmonization of experimental approaches   | <i>Brussaard</i> |
| 2.3.3 | SCOR Working Group on Dissolved N <sub>2</sub> O and CH <sub>4</sub> measurements: Working towards a global network of ocean time series measurements of N <sub>2</sub> O and CH <sub>4</sub> | <i>Volkman</i>   |
| 2.3.4 | SCOR Working Group on Climate and tsunami science with green repeaters on submarine cable systems   | <i>Feeley</i>    |
| 2.3.5 | SCOR Working Group Towards harmonization of global oceanic nutrient data  | <i>Duce</i>      |
| 2.3.6 | SCOR Working Group on Development of new methodologies for chemical and other branches of oceanography  | <i>Volkman</i>   |
| 2.3.7 | SCOR Working Group on Microbial Community Responses to Ocean Deoxygenation  | <i>Brussaard</i> |

- |        |  |                 |
|--------|--|-----------------|
| 2.3.8  | SCOR Working Group on Surface Waves in Ocean Circulation and Climate System                              | <i>Cousten</i>  |
| 2.3.9  | SCOR Working Group on Standard protocols for the development of an atlas of marine plankton biogeography | <i>Costello</i> |
| 2.3.10 | SCOR Working Group on Studying Ocean Acidification Effects on Continental Margin Ecosystems              | <i>Taguchi</i>  |
| 2.3.11 | SCOR Working Group on Science and Technology Imperatives Created by Deep-Ocean Industrialization         | <i>Fennel</i>   |

### 3.0 LARGE-SCALE SCIENTIFIC PROGRAMS

- |     |  |                        |
|-----|--|------------------------|
| 3.1 | SCOR/IOC Global Ecology and Oceanography of Harmful Algal Blooms (GEOHAB) Program  | <i>Kudela, Taguchi</i> |
| 3.2 | SCOR/IGBP Integrated Marine Biogeochemistry and Ecosystem Research (IMBER) Project | <i>Hall, Burkill</i>   |
| 3.3 | GEOTRACES Project  | <i>Volkman</i>         |
| 3.3 | SCOR/IGBP/WCRP/iCACGP Surface Ocean-Lower Atmosphere Study                         | <i>Law, Coustenis</i>  |

### 4.0 OCEAN CARBON AND OTHER ACTIVITIES

- |       |  |                      |
|-------|--|----------------------|
| 4.1   | IOC/SCOR International Ocean Carbon Coordination Project (IOCCP) | <i>Fennel, Urban</i> |
| 4.2   | Symposia on The Ocean in a High-CO <sub>2</sub> World            | <i>Volkman</i>       |
| 4.3   | Other Activities   |                      |
| 4.3.1 | Data Publication Activity  | <i>Costello</i>      |
| 4.3.2 | SCOR/POGO International Quiet Ocean Experiment                   | <i>Feeley</i>        |
| 4.3.3 | Joint Committee on Seawater (SCOR/IAPWS/IAPSO)                   | <i>Morozov</i>       |

### 5.0 CAPACITY-BUILDING ACTIVITIES

- |     |   |                 |
|-----|---|-----------------|
| 5.1 | SCOR Committee on Capacity Building                           | <i>Ittekkot</i> |
| 5.2 | SCOR Visiting Scholars  | <i>Ittekkot</i> |
| 5.3 | POGO-SCOR Visiting Fellowships for Oceanographic Observations | <i>Urban</i>    |
| 5.4 | NSF Travel Support for Developing Country Scientists          | <i>Urban</i>    |

### 6.0 RELATIONS WITH INTERGOVERNMENTAL ORGANIZATIONS

- |     |  |                            |
|-----|--|----------------------------|
| 6.1 | Intergovernmental Oceanographic Commission   | <i>D'Adamo, Burkill</i>    |
| 6.2 | International Council for Exploration of the Seas  | <i>Fennel</i>              |
| 6.3 | Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP) | <i>Duce</i>                |
| 6.4 | North Pacific Marine Science Organization (PICES)  | <i>Batchelder, Taguchi</i> |

## 7.0 RELATIONS WITH NON-GOVERNMENTAL ORGANIZATIONS

- |       |  |                   |
|-------|--|-------------------|
| 7.1   | International Council for Science  | <i>Burkill</i>    |
| 7.1.1 | International Geosphere-Biosphere Programme (IGBP)                         | <i>Burkill</i>    |
| 7.1.2 | World Climate Research Programme (WCRP)                                    | <i>Fennel</i>     |
| 7.1.3 | Scientific Committee on Antarctic Research (SCAR)                          | <i>Brussaard</i>  |
| 7.1.4 | Future Earth Initiative  | <i>Greenslade</i> |
| 7.2   | Affiliated Organizations   |                   |
| 7.2.1 | International Association for Biological Oceanography (IABO)               | <i>Costello</i>   |
| 7.2.2 | International Association for Meteorology and Atmospheric Sciences (IAMAS) | <i>Coustenis</i>  |
| 7.2.3 | International Association for the Physical Sciences of the Oceans (IAPSO)  | <i>Morozov</i>    |
| 7.3   | Affiliated Programs  |                   |
| 7.3.1 | InterRidge - International, Interdisciplinary Ridge Studies                | <i>Feeley</i>     |
| 7.3.2 | International Ocean Colour Coordinating Group (IOCCG)                      | <i>Volkman</i>    |
| 7.3.3 | Global Alliance of CPR Surveys (GACS)                                      | <i>Hosie</i>      |
| 7.4   | Other Organizations  |                   |
| 7.4.1 | Partnership for Observation of the Global Oceans (POGO)                    | <i>Feeley</i>     |
| 7.4.2 | IASC Marine Working Group  | <i>Fennel</i>     |

## 8.0 ORGANIZATION AND FINANCE

- |       |   |                                 |
|-------|---|---------------------------------|
| 8.1   | Membership                                |                                 |
| 8.1.1 | National Committees                       | <i>Urban</i>                    |
| 8.2   | Publications Arising from SCOR Activities | <i>Urban</i>                    |
| 8.3   | Finances                                  | <i>Finance Committee, Urban</i> |

## 9.0 SCOR-RELATED MEETINGS

- |       |  |                |
|-------|--|----------------|
| 9.1   | SCOR Annual Meetings   |                |
| 9.1.1 | 2013 Executive Committee Meeting – New Zealand                                       | <i>Burkill</i> |
| 9.1.2 | 2014 General Meeting – Bremen, Germany   | <i>Fennel</i>  |
| 9.1.3 | 2015 Executive Committee Meeting – Goa, India  | <i>Burkill</i> |
| 9.1.4 | 2016 General Meeting – Sopot, Poland   | <i>Burkill</i> |
| 9.2   | Locations of Past SCOR Annual Meetings   |                |
| 9.3   | SCOR-Related Meetings Since the 2012 SCOR General Meeting and Planned for the Future |                |



## Appendix 2

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## Appendix 3

### Proposal for a Working Group on Dissolved N<sub>2</sub>O and CH<sub>4</sub> measurements: Working towards a global network of ocean time series measurements of N<sub>2</sub>O and CH<sub>4</sub>

#### Overview

This proposal aims to (i) improve and consolidate measurements of the greenhouse gases nitrous oxide (N<sub>2</sub>O) and methane (CH<sub>4</sub>) dissolved in seawater by conducting an international intercalibration exercise and (ii) to establish a framework for a global network of times series measurements of N<sub>2</sub>O and CH<sub>4</sub>.

**(i) Improve and consolidate measurements by conducting an international intercalibration exercise.** N<sub>2</sub>O and CH<sub>4</sub> are routinely measured in diverse parts of the world's oceans either as discrete measurements or continually sampling from ship's underway systems. The vast majority of dissolved N<sub>2</sub>O and CH<sub>4</sub> measurements during the past 30 years has relied on the collection, preservation, and subsequent analysis of seawater samples using widely available gas chromatography (GC) techniques (e.g., Elkins 1980, Weiss 1981). In recent years, the increasing availability of novel cavity ringdown analyzers has opened the door for precise measurements of dissolved N<sub>2</sub>O and CH<sub>4</sub> with unprecedented time resolution (Gülzow et al. 2011). We propose to evaluate the currently operational analytical procedures by conducting a detailed intercalibration exercise organized by the full members of the Working Group (WG).

We feel that it is particularly timely to establish a SCOR working group to address the issues of intercalibration and reporting protocols for N<sub>2</sub>O and CH<sub>4</sub>. The current lack of comparative N<sub>2</sub>O and CH<sub>4</sub> measurements between international laboratories contrasts with other oceanographic greenhouse gas measurements, such as CO<sub>2</sub> which can be considered a hypothetical 'gold standard' of intercalibration exercises. Dissolved CO<sub>2</sub> analysis is routinely conducted by commercially available analytical systems (e.g., SOMMA, VINDTA) and the measurements are aided by reference seawater (Dickson et al. 2003) and reference manuals (Dickson et al. 2007). Improvements to the CO<sub>2</sub> analytical system and implementing best practices represent several decades of coordinated effort, however the successes are apparent with the accurate reporting of CO<sub>2</sub> increase in seawater (Dore et al. 2009; Keeling et al. 2004; Winn et al. 1998) and the concomitant decrease in seawater pH (Dore et al. 2009). It is imperative to set the N<sub>2</sub>O and CH<sub>4</sub> on the correct path if we are to accurately determine the role of the oceans in climate change as detailed in the 'Scientific Background'.

**(ii) Network of time series measurements of N<sub>2</sub>O and CH<sub>4</sub>.** Time series measurements of dissolved trace gases are a critical element of marine sciences. They are crucial to decipher the feedbacks between formation and emissions of climate relevant trace gas and short- and long-term environmental repercussions such as climate change, eutrophication, ocean deoxygenation and acidification. Unfortunately, dissolved trace gases such as N<sub>2</sub>O and CH<sub>4</sub> are regularly measured only at a few time series sites such as Stn. ALOHA (Hawaii), CaTS (off Goa, India), Line P (North Pacific), Boknis Eck (SW Baltic Sea) and off Chile. With a common measurement protocol (developed under (i)) we will establish the basis for a worldwide network of compatible measurements of oceanic N<sub>2</sub>O and CH<sub>4</sub>. The SCOR working group will compile and review the existing time series measurements of N<sub>2</sub>O and CH<sub>4</sub> and will provide a framework for (a) linking and bringing together existing measurements (e.g. in a joint internet platform which provides access to the data from all sites) and (b) recommend sites for new N<sub>2</sub>O/CH<sub>4</sub> time series measurements by identifying areas important for oceanic N<sub>2</sub>O/CH<sub>4</sub> which are undersampled up to now.

We recognize that improving the analysis and reporting protocols of N<sub>2</sub>O and CH<sub>4</sub> dissolved in seawater is a broad and long-term goal. Therefore to help achieve the 'Terms of Reference' within a 4-year time period, we intend to focus on N<sub>2</sub>O and CH<sub>4</sub> measurements conducted at globally-renowned oceanographic time-series sites. These time-series sites are listed under 'Working Group composition' and provide the oceanographic counterpart to atmospheric monitoring stations which have documented the increase in greenhouse gas concentrations over recent decades. Furthermore, the annual increase in atmospheric N<sub>2</sub>O and CH<sub>4</sub> concentrations of 0.25% and 0.4% respectively (IPCC, 2007), represent suitable goals for the analytical accuracy and precision of N<sub>2</sub>O and CH<sub>4</sub> measurements dissolved in seawater. This would permit more rapid prediction of variations of dissolved N<sub>2</sub>O and CH<sub>4</sub> to their overlying atmosphere.

Finally, we believe, the intercalibration exercise is highly suited to be conducted under the SCOR auspices due to the international composition of the Working Group. In addition, SCOR has a successful track record of conducting international intercalibration exercises as demonstrated by WG2 ‘Carbon Dioxide in the Ocean’, WG109 ‘Biogeochemistry of Iron in Seawater’ and WG16 ‘General Problems of Intercalibration and Standardization’. We seek to learn from these previous examples and have included experts in this field as associate members of the Working Group.

### **Scientific Background**

#### *Why measure N<sub>2</sub>O and CH<sub>4</sub> in the marine environment?*

In the Earth’s atmosphere, N<sub>2</sub>O and CH<sub>4</sub> account for 24% of the total radiative forcing associated with greenhouse gases. Whilst CO<sub>2</sub> is the most abundant greenhouse gas, N<sub>2</sub>O and CH<sub>4</sub> are more virulent, respectively exerting ~300 and 25 times more radiative forcing than CO<sub>2</sub> over a period of 100 years (IPCC, 2007). Because of its comparatively long atmospheric lifetime N<sub>2</sub>O reaches the stratosphere where it is the precursor of nitric oxide radicals which are involved in one of the most efficient catalytic reaction cycles leading to pronounced stratospheric ozone depletion. The atmospheric burden of CH<sub>4</sub>, and N<sub>2</sub>O are increasing with an annual increase of 0.4 % for CH<sub>4</sub>, and 0.25 % for N<sub>2</sub>O. Because of the ongoing decline of chlorofluorocarbons and the continuous increase of N<sub>2</sub>O and CH<sub>4</sub> in the atmosphere, the contributions of N<sub>2</sub>O and CH<sub>4</sub> to the greenhouse effect and ozone depletion will be even more pronounced in the 21st Century (IPCC 2007; Ravishankara et al. 2009). This, in turn, has resulted in the need to better constrain and understand the sources and sinks of both gases at the Earth’s surface (Keeling 2008). The global oceans represent a source of both N<sub>2</sub>O and CH<sub>4</sub> to the overlying atmosphere. The IPCC (2007) estimates oceanic CH<sub>4</sub> emissions range from 4-15 Tg CH<sub>4</sub> yr<sup>-1</sup> and the rate of oceanic N<sub>2</sub>O emissions to range from 1.8-5.8 Tg N yr<sup>-1</sup>, although it should be noted that this is considered to be an underestimation by at least a factor of 2 (Bange 2006; Naqvi et al. 2000).

#### *Why conduct an intercalibration exercise for N<sub>2</sub>O and CH<sub>4</sub> measurements?*

A number of laboratories throughout the world have developed analytical systems for measuring dissolved N<sub>2</sub>O and CH<sub>4</sub> in seawater and undoubtedly new groups will make these measurements in the future. To maximize the scientific value of these studies, it is important to insure that the measurements made by all groups are intercomparable and of the highest possible accuracy and precision. We adopt the definition of intercalibration as “The process, procedures, and activities used to ensure that the several laboratories engaged in a monitoring program can produce compatible data. When compatible data outputs are achieved and this situation is maintained, the laboratories can be said to be intercalibrated (Taylor, 1987).”

#### *Learning from previous intercalibrations.*

To establish the reliability and compatibility of the N<sub>2</sub>O and CH<sub>4</sub> datasets, we will conduct inter-laboratory collaborative exercises and trial the use of reference seawater material for dissolved N<sub>2</sub>O and CH<sub>4</sub> analysis. Similar exercises have been conducted for other oceanographic analyses including DIC (Dickson 2010), dissolved organic carbon (Sharp et al. 2002), sulfur hexafluoride and chlorofluorocarbons (Bullister and Tanhua 2010), halocarbons (Jones et al. 2011), and trace elements (Cutter et al. 2010). Therefore we will work with members of the scientific community actively involved in inter-laboratory collaborative exercises, for example, Andrew Dickson at Scripps Institution of Oceanography (SIO), to learn from their experience. The outcomes from these exercises including key recommendations and reporting procedures will be published in refereed scientific journals.

### **Working Group Composition**

The Full Members of the Working Group represents a balance between scientists actively engaged in measuring N<sub>2</sub>O and CH<sub>4</sub> as part of time-series programs and having a global distribution of scientists with both senior and early career personnel. Associate members are represented by analytical experts in either trace gas chemistry and/or previously involved in intercalibration exercises.

### **Terms of Reference**

We outline six Terms of Reference and describe how these will be achieved together within a 4 year timescale. The pending outcome is highlighted at the end of each description for the Terms of Reference:

1. Establish the analytical reporting procedures to be used for N<sub>2</sub>O and CH<sub>4</sub>
2. Adopt an appropriate standard to be used by the scientific community

3. Conduct an intercalibration exercise between the time series programs
4. Host at least two international meetings
5. Establish framework for an N<sub>2</sub>O/CH<sub>4</sub> ocean time series network
6. Write a global oceanic N<sub>2</sub>O/CH<sub>4</sub> summary paper for publication in Annual Review of Marine Science or an equivalent journal.

#### *1. Establish N<sub>2</sub>O and CH<sub>4</sub> reporting procedures*

Detailed documentation should be provided with each N<sub>2</sub>O and CH<sub>4</sub> data set and stored at publicly available national and international data centers. The information to be included in the reporting procedures will be agreed upon by the working group. Publication of the intercalibration exercise (Terms of Reference #3) will provide an opportunity to highlight these reporting procedures to the wider oceanographic scientific community.

**All members of the Working Group will submit N<sub>2</sub>O and CH<sub>4</sub> datasets using the agreed N<sub>2</sub>O and CH<sub>4</sub> reporting procedures to a publicly available data center (MEMENTO; Bange et al., 2009) by December 2014.**

#### *2. Instigate the use of primary N<sub>2</sub>O and CH<sub>4</sub> standards and investigate the use of certified reference material.*

- Laboratory gas standards

To assist the compatibility of the measurements, at least one of the standard gas mixtures used by the separate laboratories should be derived from NOAA ESRL GMD which is the central calibration laboratory for the World Meteorological Organization (WMO), Global Atmosphere Watch (GAW). The concentration values of the laboratory reference standards will be close to that of modern air, that is, 0.36 ppm for N<sub>2</sub>O and 2 ppm for CH<sub>4</sub>. These gas standards have an accuracy of  $\pm 1$  ppb (IMBER/SOLAS Implementation Plan 2006). The approximate cost for a cylinder containing 150 cubic feet of either N<sub>2</sub>O or CH<sub>4</sub> standard gas mixture is \$1000.

- Certified reference material

Certified Reference Materials (CRMs) are ‘control measurements’ used to relate the concentration of dissolved N<sub>2</sub>O or CH<sub>4</sub> to a reference database for calibration. We will assess the suitability of having certified reference materials for N<sub>2</sub>O or CH<sub>4</sub> during Year 2 of the project, by bottle multiple essentially identical seawater samples and evaluating whether (a) the container is well-suited to holding the samples, (b) long-term stability of the reference material and (c) the effect of transportation

**Ensure all Working Group members have access to primary standards by May 2014 and establish the feasibility of a certified reference material by May 2015 (see timeline below).**

#### *3. Conduct an intercalibration exercise between the time series programs.*

The first intercalibration exercise will occur in Year 1 of the project and its purpose is to fully evaluate the analytical procedures for quantifying N<sub>2</sub>O and CH<sub>4</sub> dissolved in seawater. A second intercalibration exercise has also been included in the timetable scheduled to occur in Year 2 of the project to resolve long-term issues associated with the analysis *e.g.* preservation and storage of samples. Overall, the intercalibration exercise has multiple objectives:

- Instrument set-up: Calibration procedures, sample blanks, the stripping efficiency, and instrument drift over a 1 year period.
- Transportation and preservation of samples. This will also help determine the possibility of reference material.
- Exchange seawater samples in order to determine any offset between the N<sub>2</sub>O and CH<sub>4</sub> datasets.

Ultimately, the intercalibration exercise will help improve the analytical systems used by the different laboratories. It will also help recommend the ideal analytical system (to be defined as one providing <1% precision) for future laboratories establishing reduced gas analysis.

**The outcome and conclusions of the intercalibration exercise will be published in a refereed scientific journal, alongside the reporting procedures outline in Terms of Reference #1.**

#### *4. Host at least two international meetings on this topic.*

We will host the first working group meeting at the University of Hawaii, February 2014. This date is 1 week prior to the ASLO Ocean Sciences meeting to be held in Honolulu, Hawaii which will allow cost-sharing with other funding sources. The primary objective of the meeting will be to introduce the objectives of the intercalibration exercise and to host a practical demonstration of an analytical system capable of delivering high-precision measurements of N<sub>2</sub>O and CH<sub>4</sub>.

A second opportunity for a WG meeting is the SOLAS Open Science Conference which will be held in Kiel, Germany, in September 2015. The meeting will present the results from the first calibration exercise to the SOLAS conference.

**The timeline provided below shows how the workshop fits in with the overall timeline.**

#### 5. Establish a framework for an N<sub>2</sub>O/CH<sub>4</sub> ocean time series network

The SCOR WG will compile available N<sub>2</sub>O and CH<sub>4</sub> data from the global ocean (both open and coastal), sourcing both peer reviewed publications, unpublished reports and data archives such as MEMENTO. These data will be reviewed and checked for data consistency. Maps of the global N<sub>2</sub>O/CH<sub>4</sub> distribution in the ocean will be produced (if possible with a monthly resolution). Based on these data, locations for new time series measurements (sites and lines for VOS, volunteer observing ships) will be identified. Additionally, recommendations will be published on how to link the existing time series data and how to make them available to the public in order to facilitate the use of data by modellers, stakeholders, and policy makers.

**The recommendations for a network of N<sub>2</sub>O/CH<sub>4</sub> ocean time series measurements will be published in a refereed scientific journal.**

#### Timeline

- 2013 May: Submission of proposal  
November: Decision by SCOR on the suitability of the Working Group for funding
- 2014 February: Working Group meeting followed by ASLO Ocean Sciences in Honolulu, Hawaii  
May: All working groups to have received their primary standards  
June-December: First intercalibration exercise
- 2015 February: 1 year review, summary of first calibration exercise  
June-December: Second intercalibration exercise  
September: WG meeting and presentation of results at the International SOLAS Open Science Conference (15-18 Sept. 2015) in Kiel, Germany
- 2016 February: 2 year review,  
April-Dec: Summarizing results and publication of Best Practice Guide
- 2017 February: 3 year review and Working Group meeting followed by Ocean Sciences  
November: Publication of recommendation for N<sub>2</sub>O/CH<sub>4</sub> Time Series Station Network

#### Capacity Building

To help achieve the objectives of this proposal and build the capacity to improve and sustain accurate N<sub>2</sub>O and CH<sub>4</sub> measurements we will encourage all the Working Group core members to involve an early career scientist in the intercalibration exercise. This working group proposal engages oceanographers across the world and we will insure full participation in the international meetings to be held in 2014 and 2015 by core members of the Working Group and make the resulting publications are freely available. We do not believe the financial costs of participating in the intercalibration exercise to be prohibitive as all participating laboratories currently conduct the measurements. The main costs will be shipping, travel, and the certified gas standards.

#### References

- Bange, H.W. (2006) New Directions: The importance of the oceanic nitrous oxide emissions. *Atmos Environ* 40:198-199.
- Bange, H.W., Bell, T.G., Cornejo, M., Freing, A., Uher, G., Upstill-Goddard, R.C., and Zhang, G. (2009) MEMENTO: a proposal to develop a database of marine nitrous oxide and methane measurements. *Environ Chem* 6:195-197.
- Bullister, J.L. and Tanhua, T. (2010) Sampling and measurement of chlorofluorocarbons and sulfur hexafluoride in seawater. IOCCP Report No. 14 ICPO Publication Series No. 134, Version 1.
- Cutter, G., Andersson, P., Codispoti, L., Croot, P., Francois, R., Lohan, M., Obata, H. And van der Loedd, M.R. (2010) Sampling and sample-handling protocols for GEOTRACES cruises. Version 1.0
- Dickson, A.G., Afghan, J.D. and Anderson, G.C. (2003) Reference materials for oceanic CO<sub>2</sub> analysis: A method for the certification of total alkalinity. *Mar Chem* 80:185-197.
- Dickson, A.G., Sabine, C.L. and Christian, J.R. (eds.) (2007) Guide to best practices for ocean CO<sub>2</sub> measurements. PICES Special Publication 3.
- Dickson, A.G. (2010) Standards for ocean measurements. *Oceanography* 23:34-47.
- Dore, J.E., Lukas, R., Sadler, D.W., Church, M.J. and Karl, D.M. (2009) Physical and biogeochemical modulation of ocean acidification in the central North Pacific. *Proc Natl Acad Sci USA* 106:12235-12240.
- Elkins, J.W. (1980) Determination of dissolved nitrous oxide in aquatic systems by gas chromatography using electron-capture detection and multiple phase equilibration. *Anal Chem* 52:263-267.
- Gülzow, W., Rehder, G., Schneider, B., Schneider v. Deimling, J. and Sadkowiak B. (2011) A new method for

- continuous measurement of methane and carbon dioxide in surface waters using off-axis integrated cavity output spectroscopy (ICOS): An example from the Baltic Sea. *Limnol Oceanogr* 9:176-184.
- IMBER/SOLAS Report (2006) Joint SOLAS-IMBER Ocean Carbon Research. Implementation Plan
- IPCC (2007) Climate Change 2007: The physical science basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. S. Solomon, D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor, and H.L. Miller (eds) Cambridge, U.K. and New York, U.S.A., Cambridge University Press
- Jones, C.E, Andrews, S.J., Carpenter, L.J., Hogan, C., Hopkins, F.E., Laube, J.C. Robinson, A.D., Spain, T.G., Archer, S.D. et al. (2011) Results from the first national UK inter-laboratory calibration for very short-lived halocarbons. *Atmos Meas Tech* 4:865-874.
- Keeling, C.D., Brix, H. and Gruber, N. (2004) Seasonal and long-term dynamics of the upper ocean carbon cycle at Station ALOHA near Hawaii. *Global Biogeochem Cycles* 18:10.1029/2004GB002227.
- Keeling, R.F. (2008) Recording Earth's vital signs. *Science* 319:1771-1772.
- Naqvi, S.W.A., Jayakumar, D.A., Narvekar, P.V., Naik, H., Sarma, V.V.S.S., D'Souza, W., Joseph, S. and George, M.D. (2000) Increased marine production of N<sub>2</sub>O due to intensifying anoxia on the Indian continental shelf. *Nature* 408:346-349.
- Ravishankara, A.R., Daniel, J.S., and Portmann, R.W. (2009) Nitrous oxide (N<sub>2</sub>O): The dominant ozone-depleting substance emitted in the 21st Century. *Science* 236:123-125.
- Sharp, J.H., Carlson, D.A., Peltzer, E.T., Castle-Ward, D.M., Savidge, K.B. and Rinker, K.R. (2002) Final dissolved organic carbon broad community intercalibration and preliminary use of DOC reference materials. *Mar Chem* 77:239-253.
- Taylor, J.K. (1987) Quality Assurance of Chemical Measurements. Lewis Publishers, Michigan, 328 pp.
- Weiss, R.F. (1981) Determinations of carbon dioxide and methane by dual catalyst flame ionization chromatography and nitrous oxide by electron capture chromatography. *J Chromatogr* 19:611-616.
- Winn, C.D., Li, Y.-H., Mackenzie, F.T. and Karl, D.M. (1998) Rising surface ocean dissolved inorganic carbon at the Hawaii Ocean Time-series site. *Mar Chem* 60:33-47.



## Appendix 4

### Proposal on Microbial Community Responses to Ocean Deoxygenation

**Summary:** Water column oxygen (O<sub>2</sub>) deficiency shapes food web structure by progressively directing nutrients and energy away from higher trophic levels and into microbial community metabolism. There is increasing evidence that ocean warming trends will decrease dissolved O<sub>2</sub> concentrations within the coastal and interior regions of the ocean, resulting in oxygen minimum zone (OMZ) expansion. These processes will directly impact coastal benthic ecosystems and fisheries productivity due to habitat compression and changes in nutrient cycles with currently unconstrained feedbacks on the global ocean. Our SCOR working group will catalyze knowledge creation at the forefront of research on microbial community responses to changing levels of water column O<sub>2</sub>-deficiency. We will unite oceanographers, microbial ecologists and biogeochemists to define model ecosystems, new standards of practice, and economies of scale needed for effective comparative analyses and enhanced forecasts of ocean deoxygenation. Our deliverables will include one field experience, two program meetings, a white paper on best practices, and a peer-reviewed monograph.

**Objectives and timeliness:** Direct quantitative comparisons of microbial community structure and function in O<sub>2</sub>-deficient marine waters are currently stymied by a lack of standards for process rate and molecular data collection. This deficiency prevents cross-scale analysis linking the genotypic properties of microbial communities to higher order biogeochemical cycles and impedes synergistic scientific collaborations. Moreover, we need to formally define model ecosystems and concerted community initiatives to address fundamental questions and take advantage of appropriate economies of scale for transformative knowledge creation and translation. Our working group proposal was inspired by a recent exploratory workshop sponsored by the Moore Foundation and the Agouron Institute in Santa Cruz, Chile, which focused on identifying opportunities and bottlenecks for collaborative research in O<sub>2</sub>-deficient marine waters. This workshop identified cross-scale comparisons and standardized measurements as a key bottleneck and an urgent opportunity for transformative science. Here we propose the establishment of a working group that networks the intellectual power of oceanographers, microbial ecologists and biogeochemists to build on the momentum of the Chilean workshop based on the following program objectives:

1. Identify model ecosystems manifesting ecological and biogeochemical phenotypes across a range of water column O<sub>2</sub>-deficiency states
2. Develop community standards of data collection for both process rate and molecular measurements enabling cross-scale comparisons
3. Establish core metrics for modeling microbial community responses to changing levels of O<sub>2</sub>-deficiency.
4. Disseminate standards, data sets and comparative analysis to the wider oceanographic and Earth system science communities and the public.

**Terms of Reference:** Our working group will catalyze research network formation and collaborative scientific practices over a four-year time frame that progressively transforms participants into a more focused and effective research community.

1. In year 1 of the working group we will convene a practical workshop in Saanich Inlet, a seasonally anoxic fjord off the coast of Vancouver Island British Columbia, Canada, to ground-truth common standards for process rate and molecular measurements and identify model ecosystems for future cross-scale comparative analyses.
2. In year 2, we will convene a meeting at the Leibniz Institute for Baltic Sea Research in Warnemünde, Germany to codify standards of best practice, identify leveraged funding opportunities and economies of scale, and compose a white paper describing said standards and opportunities.
3. In year 3, we will sponsor a topical session at an international conference such as ASLO, ISME, or ASM to highlight research findings informed by the best practices described in the white paper.
4. In year 4, we will convene a meeting at the National Institute of Oceanography in Goa,

India to compile a peer-reviewed monograph, which we tentatively plan to publish as an electronic book in the Frontiers or PLoS open access journals to ensure both visibility and long-term access.

**Scientific background and rationale:** Ocean deoxygenation directly impacts marine ecosystem functions and services through changes in food web structure and biodiversity<sup>1</sup>. Climate change induced water column stratification and anthropogenic discharges are enhancing deoxygenation throughout the modern ocean<sup>2,3,4,5,6</sup>. As oxygen levels decline, energy is increasingly diverted away from higher trophic levels into microbial community metabolism resulting in significant environmental changes including fixed nitrogen loss, possible accumulation of hydrogen sulfide, and the production of climate active trace gases. Current research efforts are defining the interaction networks underlying microbial community metabolism in O<sub>2</sub>-deficient waters and are rapidly generating new insights into coupled biogeochemical processes in the ocean<sup>7,8</sup>. However, many open questions remain regarding the commonalities and differences among and between locales, sensitivities to climate forcing, underlying regulatory mechanisms, and biotic interactions that modulate microbial community metabolism including grazing and viral infection. Moreover, we are presently unable to accurately forecast biogeochemical dynamics associated with changing levels of water column O<sub>2</sub>-deficiency due, in part, to the limited integration of process rate and microbial community structure and function information between locales. Thus, the inevitable impacts of deoxygenation on ocean ecosystems, climate and human society remain uncertain. Technological innovations from high throughput sequencing to in situ monitoring and paired isotope labeling methods have increased our analytical capacity to probe the mechanisms underlying microbial community responses to ocean deoxygenation<sup>8,9,10,11,12,13,14</sup>. These technical innovations have yet to be standardized and applied in a cross-scale collaborative scientific endeavor to integrate process rate and microbial community structure and function information. A SCOR working group is needed to overcome existing activation barriers and achieve such cross-scale syntheses.

**Why a SCOR Working Group?:** Contemporary international collaborations can be effective in charting the microbial ecology and biogeochemistry of O<sub>2</sub>-deficient waters. However these collaborations are almost exclusively compartmentalized into groups focused on specific biogeochemical processes in disparate oceanic locales. A SCOR working group would provide the opportunity to fuse these disparate efforts into a *bona fide* scientific network enabling synergistic cross-scale studies between locales that address long-term goals. Our working group focused on microbial controls on biogeochemical transformation and ecosystem stability in O<sub>2</sub>-deficient marine waters is both timely and pressing as it directly addresses the ecological implications associated with current global warming trends and OMZ expansion. Our working group will promote idea exchange, community engagement and transformative collaborative research projects on a global-scale by uniting oceanographers, microbial ecologists and biogeochemists across geopolitical and traditional disciplinary boundaries. The resulting network will build capacity in developing nations (India, Chile) and promote best practices at the epicenter of a pivotal issue in marine and climate science. We expect that our working group will inspire national agencies and international organizations to support operational components of our combined research programs, promote economies of scale that leverage matching funds between stakeholders including national and regional funding agencies and the private sector.

**Relevance to other SCOR activities:** Our proposed working group synergies with existing SCOR working groups including WG5 “The International Indian Ocean Expedition”, WG128 “Natural and Human-Induced Hypoxia and Consequences for Coastal Areas”, WG134 “Microbial Carbon pump in the Ocean” and WG137 “Patterns of Phytoplankton Dynamics in Coastal Systems”. SCOR has a record of sustained interest in water column O<sub>2</sub>-deficiency with a regional focus. Here we seek to develop an integrated science program that builds on previous working group successes on a global scale. Indeed a number of our members have participated in prior working groups bringing continuity and historical perspective to our new initiative. For example, between 2006-2010 associate members Daniel Conley, Nancy Rabalais, and SWA Naqvi participated in Working Group 128 focused on spatio-temporal variability, anthropogenic causes, ecological and biogeochemical impacts and ecosystem responses to coastal O<sub>2</sub>-deficiency at a time when molecular methods for charting microbial community structure and function were still emerging. Our working group is differentiated from WG128 in its emphasis on cross-scale comparative analyses and standardization of process rate and molecular measurements. Our initiative is a direct and pressing response to recent scientific discoveries including the discovery of a cryptic sulfur cycle in the Eastern Tropical South Pacific OMZ<sup>8</sup> and the recent expansion of high throughput sequencing technologies opening a functional genomic window into microbial community metabolic potential and phenotypic expression. The

monograph that we produce will integrate new data collected with best practices in working group defined model ecosystems to provide direct insight into the paradoxical role of microbial communities in biogeochemical transformation and ecosystem stability in O<sub>2</sub>-deficient marine waters.

**Composition of the group:** Our working group management structure will be dynamic with leadership rotating between chairs each year. Bess Ward will serve as the leadership coordinator, working closely with the rotating chairs to ensure that working group objectives are met in accordance with the terms of reference. Sean Crowe and Steven Hallam will co-chair the field experience in year 1, Klaus Jurgens will chair the standards meeting in year 2, Virginia Edgcomb and Veronique Garcon will co-chair the session searches in year 3 and Nagappa Ramaiah will chair the synthesis meeting in year 4. All full members are committed to participating in working group activities and will engage associate members in collaborative scientific endeavors. Sean Crowe and Steven Hallam will edit the monograph. Associate members augment the experience and expertise of the working group and in several cases provide an intellectual bridge to prior SCOR working groups.

## References

1. Vaquer-Sunyer, R. & Duarte, C.M. Thresholds of hypoxia for marine biodiversity. *P Natl Acad Sci USA* **105**, 15452-15457, doi:10.1073/Pnas.0803833105 (2008).
2. Diaz, R.J. & Rosenberg, R. Spreading dead zones and consequences for marine ecosystems. *Science* **321**, 926-929, doi:10.1126/Science.1156401 (2008).
3. Whitney, F.A., Freeland, H.J. & Robert, M. Persistently declining oxygen levels in the interior waters of the eastern subarctic Pacific. *Prog Oceanogr* **75**, 179-199, doi:10.1016/J.Pocean.2007.08.007 (2007).
4. Stramma, L., Johnson, G.C., Sprintall, J. & Mohrholz, V. Expanding oxygen-minimum zones in the tropical oceans. *Science* **320**, 55-658, doi:10.1126/Science.1153847 (2008).
5. Emerson, S., Watanabe, Y.W., Ono, T. & Mecking, S. Temporal trends in apparent oxygen utilization in the upper pycnocline of the North Pacific: 1980-2000. *J Oceanogr* **60**, 139-147, doi: 10.1023/B:Joce.0000038323.62130.A0 (2004).
6. Conley, D.J. *et al.* Hypoxia Is Increasing in the Coastal Zone of the Baltic Sea. *Environ Sci Technol* **45**, 6777-6783, doi:10.1021/Es201212r (2011).
7. Wright, J. J., Konwar, K. M. & Hallam, S. J. Microbial ecology of expanding oxygen minimum zones. *Nat Rev Microbiol* **10**, 381-394, doi:10.1038/Nrmicro2778 (2012).
8. Canfield, D.E. *et al.* A Cryptic Sulfur Cycle in Oxygen-Minimum-Zone Waters off the Chilean Coast. *Science* **330**, 1375-1378, doi:10.1126/Science.1196889 (2010).
9. Walsh, D.A. *et al.* Metagenome of a Versatile Chemolithoautotroph from Expanding Oceanic Dead Zones. *Science* **326**, 578-582, doi:10.1126/Science.1175309 (2009).
10. Stewart, F.J. *et al.* Experimental Incubations Elicit Profound Changes in Community Transcription in OMZ Bacterioplankton. *Plos One* **7**, doi:ARTN e37118 DOI 10.1371/journal.pone.0037118 (2012).
11. Dalsgaard, T., De Brabandere, L. & Hall, P.O.J. Denitrification in the water column of the central Baltic Sea. *Geochim Cosmochim Acta* **106**, 247-260, doi:10.1016/J.Gca.2012.12.038 (2013).
12. Thamdrup, B., Dalsgaard, T. & Revsbech, N.P. Widespread functional anoxia in the oxygen minimum zone of the Eastern South Pacific. *Deep-Sea Res Pt I* **65**, 36-45, doi:10.1016/J.Dsr.2012.03.001 (2012).
13. Kalvelage, T. *et al.* Oxygen Sensitivity of Anammox and Coupled N-Cycle Processes in Oxygen Minimum Zones. *Plos One* **6**, doi:ARTN e29299 DOI 10.1371/journal.pone.0029299 (2011).
14. Revsbech, N. P. *et al.* Determination of ultra-low oxygen concentrations in oxygen minimum zones by the STOX sensor. *Limnol Oceanogr-Meth* **7**, 371-381 (2009).

## Appendix 5

### SCOR-IOC

#### Global Ecology and Oceanography of Harmful Algal Blooms (GEOHAB) Program Activities, 2012-2013

The GEOHAB project is preparing synthesis for completion of its first phase, at the end of 2013. GEOHAB-related activities will be continued after the end of 2013, under a different format, as described at the end of this report.

##### **1. IPHAB-XI Meeting: Paris, France, April 2013**

GEOHAB was represented by the SSC Chair (Raphe Kudela) at the Tenth Intergovernmental Panel on Harmful Algal Blooms (IPHAB-XI) meeting. An update on GEOHAB activities during the past two years was presented, and a resolution was passed (see attached) recommending support from IOC for a new international research project called GlobalHAB, with an invitation to SCOR to co-sponsor the project.

##### **2. Implementation of Core Research Projects**

The GEOHAB *Implementation Plan*<sup>1</sup>, published in November 2003, specified the formation of Core Research Projects (CRPs) related to four ecosystem types—upwelling systems, fjords and coastal embayments, eutrophic systems, and stratified systems. Since then, initiation and implementation of these CRPs has been the primary GEOHAB objective through OSMs and other activities. All four of the CRP research plans have now been published and some implementation has been accomplished. A fifth CRP plan was published in late 2012 (see below).

##### **A. Core Research Project: HABs in Upwelling Systems**

This sub-group is chaired by Grant Pitcher (South Africa). The group is developing plans with other organizations for a meeting on climate change effects on HABs, in upwelling systems and beyond. This activity has been endorsed by the Intergovernmental Panel on Harmful Algal Blooms (IPHAB), ICES, and PICES. A preliminary workshop was held in 2013 at Friday Harbor, Washington (USA). Reports from the workshop were submitted to the sponsoring agencies, and an overview article was submitted to *Harmful Algae News*, attached to this report as an Appendix.

##### **B. Core Research Project: HABs in Fjords and Coastal Embayments**

This sub-group is chaired by Suzanne Roy (Canada). It held a workshop in May 2012 in Victoria, Canada, on Life Cycles of HABs, focusing particularly on benthic resting stages of harmful algal species (see [http://www.geohab.info/index.php?option=com\\_content&view=article&id=113:geohab-special-issue-of-harmful-algae&catid=40](http://www.geohab.info/index.php?option=com_content&view=article&id=113:geohab-special-issue-of-harmful-algae&catid=40)). The outcomes of this OSM include the following: (1) a GEOHAB Meeting Report with synthesis, conclusions, and future research perspectives (see [http://hab.ioc-unesco.org/index.php?option=com\\_oa&task=viewDocumentRecord&docID=10400](http://hab.ioc-unesco.org/index.php?option=com_oa&task=viewDocumentRecord&docID=10400)); (2) the production of several mini-reviews to be incorporated in a special issue of an international journal, along with papers from the CRP on Stratified Systems.

##### **C. Core Research Project: HABs and Eutrophication**

The sub-group on HABs and Eutrophication is chaired by Patricia Glibert (USA). The work of the group is complementary and somewhat combined with the SCOR/LOICZ Working Group 132 on Land-based Nutrient Pollution and the Relationship to Harmful Algal Blooms in Coastal Marine Systems, which has been disbanded after completing several publications, but continues to complete additional papers (see Tab 2).

##### **D. Core Research Project: HABs and Stratification**

The sub-group on HABs and Stratification is chaired by Robin Raine (Ireland). The group conducted a workshop on “Advances and challenges for understanding physical-biological interactions in HABs in Stratified Environments” at the Monterey Bay Aquarium Research Institution, Moss Landing, California, USA on 21-23 August 2012. The workshop reviewed the major discoveries relating to the physics, biology, ecology, and/or chemistry of HABs in stratified systems. Through presentations and group discussion, the participants identified critical remaining questions, and new technologies that may be needed to fulfill sampling protocols necessary to answer them. A goal of the meeting was to produce a conceptual model or ‘roadmap’ of the direction in which biological, physical, and

chemical measurements of harmful algal blooms in stratified systems should be headed during the next 10 years, as well as a manuscript synthesizing the findings of this meeting. Another goal was to produce collaborative proposals to conduct a multidisciplinary field experiment addressing this subject. The outcomes of the meeting will be published in a GEOHAB Report. The report is drafted, and has been circulated to the OSM participants for final comments, and is currently being prepared for printing.

This CRP is also producing a special issue in *Deep-Sea Research II*. Guest editors include R. Raine, E. Berdalet, M. McManus, and H. Yamazaki. The special issue has recently (September 2013) been finalized and will be published imminently. It includes 21 peer-reviewed manuscripts and a preface.

#### **E. Core Research Project: HABs in Benthic Systems (BHABs)**

GEOHAB sponsored an OSM on HABs in Benthic Systems in Honolulu, Hawaii in June 2010, with Paul Bienfang as the convener. The OSM organizing committee has completed the science plan from the meeting, a report edited by E. Berdalet, P. Tester and A. Zingone, and printed in late 2012 (see [http://hab.ioc-unesco.org/index.php?option=com\\_oa&task=viewDocumentRecord&docID=9693](http://hab.ioc-unesco.org/index.php?option=com_oa&task=viewDocumentRecord&docID=9693)). The report contains the state of the art regarding research on benthic HABs and the main open questions for the coming years, in order to initiate and implement the CRP. Three follow-on activities have been proposed and are being actively pursued:

- Sampling/ID workshop focusing on BHAB organisms, proposed by Wayne Litaker and Patricia Tester (USA). Gires Usup (Malaysia) secured local funding for this activity, and the BHAB working group organized a workshop.
- YEOSU International Organization Collaboration Project (GEOHAB Asia & BHAB) proposal was submitted and successfully funded in 2011.
- The BHAB program was presented at the “International Conference on *Ostreopsis* Development (ICOD)” and was recently published (Zingone et al. 2012, *Cryptogamie Algologie* 33(2): 225-230).

### **3. 2013 GEOHAB Open Science Meeting**

The SSC convened the final GEOHAB Open Science Meeting at IOC Headquarters in Paris, France in April 2012. The purpose of the meeting was to review the scientific advances accomplished under GEOHAB since its inception and to identify a near-future roadmap of GEOHAB-like activities to be pursued beyond 2013. To achieve these objectives, the meeting was structured with the following components:

- Invited presentations that reviewed GEOHAB’s past and present through its 5 Core Research Projects, Regional Programs and Targeted Activities, and topics that provided a general framework for future research on HABs.
- Concept papers (i.e., proposals for specific activities, such as research projects, training sessions, or comparisons among ecosystems) that could be implemented between 2014 and 2018. It was requested that the papers be based on GEOHAB planning documents, such as the GEOHAB Science and Implementation Plans, and the Core Research Project reports ([www.geohab.info](http://www.geohab.info)). The concept papers contributed to development of the GlobalHAB project concept and some may be implemented as activities beyond 2013.
- Poster sessions that broadened the number of topics that could be considered during the meeting and encouraged the widest possible scientific participation.
- Breakout discussion sessions among the participants based on both the invited presentations and the concept papers. Three breakout sessions were held:
  1. What has GEOHAB accomplished and how was it done? What did and didn't work and why?
  2. Which scientific objectives can effectively be implemented in the coming years and what are the best mechanisms to accomplish them, based on the Concept Papers that were submitted?
  3. Based on the previous session’s outcomes, how should GEOHAB be structured to most effectively move forward in the future?

### **4. IOCCG/GEOHAB Working Group**

The International Ocean Colour Coordination Group and GEOHAB are co-funding a working group on HABs and Ocean Colour. The group will

- Summarize the relevance of ocean color-based harmful algal bloom observation systems.
- Summarize the wide variety of harmful algal bloom types with regard to ecosystem function, consistent with GEOHAB Core Research structures.
- Summarize the principal methodological difficulties for ocean color in coastal and inland waters, with reference to previous IOCCG Working Groups and other ongoing initiatives, e.g. GEO Tasks, CoastColour, etc.
- Summarize our current understanding of the physics of phytoplankton community composition from a bio-optical and ocean colour perspective.
- Review the relevance of Phytoplankton Functional Type (PFT) approaches (with reference to the IOCCG PFT Working Group) for harmful algal bloom observations across a variety of coastal and inland ecosystems.
- Review and summarize current and emerging harmful algal bloom-related ocean colour techniques, from reflectance-based community composition algorithms to ecosystem-specific change-detection algorithms, that is, research and operational applications.
- Compare the results of a variety of algorithms on selected bloom case studies, representative of the GEOHAB core research ecosystems with the specific addition of inland waters, and use these studies to provide a clear guide to ocean color algorithm performance diagnostics, and optimal ocean colour-based approaches for various bloom and ecosystem types.
- Examine the utility of ocean color observations beyond the event scale: multisensory and temporal analyses of ecological drivers and response for example systems, analyzing and demonstrating the value of routine synoptic data and integration with other observations and models.
- Recommend future studies, measurements, protocols, etc. to develop, improve and better understand application limitations for harmful algal bloom-focused ocean colour algorithms
- Summarize, recommend, and present a future outlook for the development of new ocean color observation systems, incorporating future sensors/systems.
- Prepare a monograph to be published within the IOCCG or GEOHAB series.
- Prepare a special issue in a peer-reviewed journal incorporating suitable review and case study chapters as papers.

The group has met twice and is working on a monograph for the *IOCCG Report* series and potentially a special issue of a peer-reviewed journal. This group anticipates finalizing the report before the end of 2013.

## 5. GEOHAB Modelling

Based in part on the successful collaboration between GEOHAB and IOCCG, GEOHAB participated in the GEO Blue Planet Symposium in Brazil 19-21 November 2012 ([http://www.faro-project.org/blue\\_planet/announcement.html](http://www.faro-project.org/blue_planet/announcement.html)). Stewart Bernard (SSC member; South Africa) and Lourdes Veloso-Suarez (Spain) represented GEOHAB, addressing the HAB observations and modelling needs within the GEO framework. Travel support was provided by IOCCG through the Fisheries Applications from Remotely-Sensed Ocean Colour (FARO) effort. A contributed chapter was written to be included in the “Oceans & Society: Blue Planet” book, anticipated to be published in 2014.

## 6. Publications and Endorsed Projects

A full list of GEOHAB reports, publications, and endorsed activities are available on the GEOHAB Web site. GEOHAB generated considerable interest from the community during this interval, and GEOHAB-endorsed work has been conducted in Australia, Canada, Chile, France, Philippines, Spain, South Africa, United Kingdom, and the United States. We continue to receive requests annually for project endorsements and are reaching out to the prior endorsed projects for inclusion in the GEOHAB synthesis activities.

## 7. GEOHAB Synthesis

At the end of 2013, the GEOHAB program will complete 10 years from the publication of its Implementation Plan. The SCOR Executive Committee has requested that GEOHAB conduct synthesis activities and complete its current phase of activity. Information from the Open Science Meeting will contribute to the synthesis documents, which will be a major focus of the final GEOHAB meeting in December 2013.

#### **A. GEOHAB Summary Outcomes**

Tentatively planned synthesis documents include the following:

1. Special issue from the meeting, with guest editors and the journal to be determined. The SSC is in favor of selecting an open-access journal, if possible. The SSC is currently also looking into possible publication of a monograph, rather than a special issue.
2. GEOHAB Science Summary—As part of our synthesis report to both IOC and SCOR, GEOHAB will revisit the Science Plan and CRP plans to review what has been accomplished and what remains to be achieved.
3. A summary/overview article was originally envisioned to be submitted to *Oceanography* in late 2013. All SSC members would be authors. This builds on the past *Oceanography* publications highlighting the mid-stream goals and accomplishments of the GEOHAB effort, and would be suitable for the scientifically literate public, policy makers, and program managers. Depending on task 1, this may be revised to represent an overview paper for the special issue.
4. Summary for Policy Makers. The SSC is strongly in favor of developing a *Summary* similar to previous efforts such as the *Ocean Fertilization* summary document (<http://unesdoc.unesco.org/images/0019/001906/190674e.pdf>). GEOHAB is working with IOC, SCOR, and NOAA to implement this effort.

#### **8. Final GEOHAB SSC Meeting**

The final GEOHAB SSC Meeting will be held in Barcelona, Spain on 3-5 December 2013, with many of the SSC members agreeing to an informal extension (December 6-8) to implement the GEOHAB Summary Outcomes. The meeting will discuss several topics: completion of GEOHAB synthesis products, implementation of concept papers from the Open Science Meeting, and plans for GlobalHAB.



## Appendix 6

### Integrated Marine Biogeochemistry and Ecosystem Research (IMBER) Project

#### A. Introduction

IMBER ([www.imber.info](http://www.imber.info)) is an international global environmental change research project with the goal to develop a comprehensive understanding of, and accurate predictive capacity for, ocean responses to accelerating global change and the consequent effects on the Earth System and human society. The challenge of the scientific community is to understand inter-relationships between biogeochemical cycles and ecosystems, and to quantify and predict responses of the marine system to natural and anthropogenic perturbations, on time scales ranging from years to decade, with local, regional and global focus.

IMBER research activities are organised around four themes that focus on interactions between biogeochemical cycles and marine food webs, the sensitivity to global change, feedbacks to the Earth System, and responses of society. IMBER research is supported by a network of 35+ national contributions, and by four regional research programmes, seven topical working groups, more than 35 endorsed projects, and a range of approaches to facilitate synthesis and integration, and strategic collaboration with other international research projects, programmes and initiatives.

Since its initiation in 2005, IMBER has placed a priority on coordination and networking activities that bring together diverse research communities to address IMBER research goals. IMBER has accomplished much during its first eight years, as evidenced by the many special issues of peer-reviewed journals and books that have been produced by the working groups and regional programmes ([www.imber.info/index.php/Products/Publications](http://www.imber.info/index.php/Products/Publications)).

IMBER is now entering the last two years of its initial 10-year science plan. At the same time, the global environmental change (GEC) research landscape is evolving. The Future Earth initiative, which is focused around three themes (*Dynamic Planet*; *Global Development*; and *Transformations toward Sustainability*), is developing, and the International Geosphere-Biosphere Programme (IGBP), IMBER's other sponsor, will end in December 2015. The transition towards Future Earth is potentially important for all GEC projects such as IMBER. IMBER has a history of undertaking activities that interconnect natural and social marine sciences and promoting integration across disciplines. As a result, the IMBER community is well placed to take the lead on developing the marine-focused efforts under Future Earth and proposing new research directions.

The IMBER Open Science Conference, which will take place in June 2014 in Bergen, Norway ([www.imber.info/index.php/Meetings/IMBER-OSC-2014](http://www.imber.info/index.php/Meetings/IMBER-OSC-2014)), will be important in developing directions for marine research at the international level for the next 5-10 years. The outputs from the Open Science Conference will provide a basis for a request to SCOR for a five-year project extension in the fall of next year.

#### A. Selection of IMBER Science Highlights, 2012-2013

**Salihoğlu, B., S. Neuer, S. Painting, R. Murtugudde, E.E. Hofmann, J.H. Steele, R.R. Hood, L. Legendre, M.W. Lomas, J.D. Wiggert, S. Ito, Z. Lachkar, G.L. Hunt Jr., K.F. Drinkwater, and C.L. Sabine. 2013. Bridging marine ecosystem and biogeochemistry research: Lessons and recommendations from comparative studies. *Journal of Marine Systems*, 109-110 161-175.**

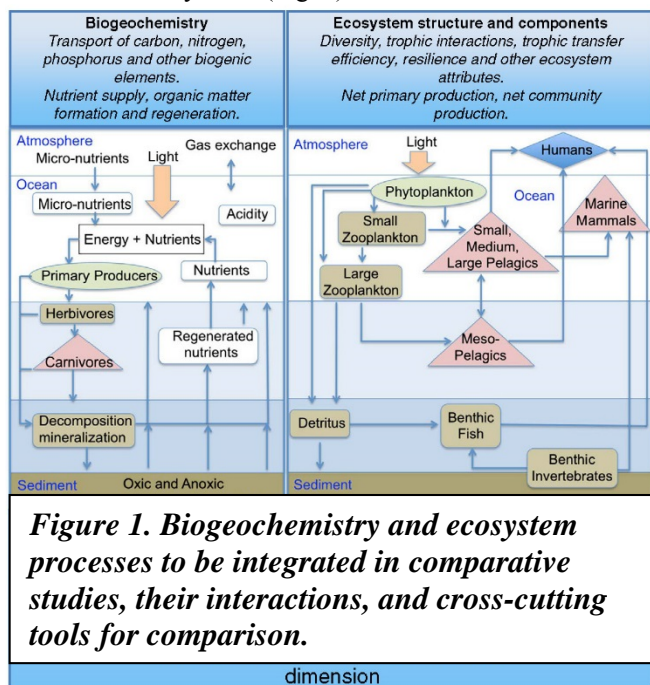
*Linked to IMBER IMBIZO II Workshop on regional comparative studies*

Oceanic and coastal systems are integrated across space and time scales that span several orders of magnitude and include complex interactions among and within diverse and interlinked communities with implications for biogeochemical cycling. To understand and predict the effects of anthropogenic global change (e.g., warming temperatures, increasing acidification, harvesting resources) on the marine ecosystem, and its responses, there is growing interest in combining information on oceanographic and biogeochemical processes and on organisms and communities, ranging from microbes to higher trophic levels. Comparative studies of similar marine and coastal biomes offer a means to improve our understanding of the sensitivity of the key features of an ecosystem (e.g., habitat quality, food web components, and biogeochemical cycles) to planned and unplanned perturbations at different time and space scales, by bringing attention to the critical processes that differentiate one system from



another and result in differences in ecosystem response to a changing ocean system.

Comparative studies based on long-term observations at fixed time-series stations make it also possible to evaluate long-term changes in the physical and biological environment, such as those driven by climate patterns. Moreover, based on a minimalistic observational framework grounded within a conceptual model, comparative studies could sometimes be a suitable alternative to costly and complex research endeavours designed to provide detailed end-to-end assessment of marine ecosystem status. The understanding gained from these comparative studies allows development of models for investigating of potential future states and predicting responses of present-day marine and coastal ecosystems (Fig. 1).



Recently, for improved ecosystem-based management, end-to-end models that combine bottom-up and top-down components have been developed (Table 1). These large, complex models are intended for “strategic management evaluations” of particular ecosystems, rather than comparisons across several systems. An alternative is to combine aggregated versions of existing food-web models of the upper trophic levels, with NPZD formulations of the microbial web, and with simplified representations of the main physical forcing. Cross-ecosystem, multi-model comparisons are difficult to conduct, but essential to evaluate the robustness of the ecosystem responses to climate change and/or anthropogenic forcing. To conduct these kinds of studies, support by international activities such as IMBER is needed. The focus of the IMBER project on interactions and feedbacks between food webs and biogeochemical cycling brings together two areas of marine science that have typically proceeded in parallel, with little cross integration.

The observational and modelling activities now underway through IMBER have a focus on end-to-end ecosystem studies, which is already influencing the structure of models and the types of observations. Within the IMBER regional programmes, comparative studies are underway which are providing synthesis and integration of historical and diverse data sets, the results of which provide a basis for across-region comparative studies. The IMBER focus on comparative studies from the outset will help ensure that the datasets and models are appropriate to undertake these studies. One challenge to the science community is to extend the comparative studies of the natural system to include human, social, economic and cultural effects. The global vision for clean, safe, biologically diverse and productive oceans and seas is the basis for managing sustainable human utilization of the goods and services provided by the seas.

This challenge requires the development of methods/metrics to describe the state of an ecosystem and mechanisms to minimize the impacts of human activities to avoid undesirable disturbances and tipping points. Ecosystem studies typically focus on key linkages between hydrography, pelagic food webs, benthic food webs and higher trophic levels such as fish.

Model	Description
NPZD (Nutrients, Phytoplankton, Zooplankton and Detritus)-type models	Represent lower trophic levels and biogeochemical cycles in marine ecosystems as Eulerian state variables with mathematically specified flows between each compartment.
Ecosim with Ecopath (EwE)	Defines the food web in the form of functional groups representing species and/or groups of species linked by trophic interactions.
ERSEM and ERSEM II	Among the first examples of end-to-end models, fish and seabirds were inclusions in the original models.
NEMURO.FISH	Formed by addition of a fish model to the detailed NPZD (nutrient, phytoplankton, zooplankton, detritus) model NEMURO.
SEAPODYM	A complex example of the coupled approach, which includes a biogeochemical model, vertically structured mesopelagic fish and an age-structured fish population.

Integrated studies of biogeochemistry and food webs need to be underpinned by one or more conceptual models of key ecosystem processes relevant to the study, and identification of the key high level (e.g., policy or societal) and scientific questions to be addressed. Together these can be used to inform field measurements required and the appropriate selection of models and other investigative tools.

New research endeavours should ensure that the results obtained are relevant for regional comparative works, especially as responses of marine ecosystems to global change are expected to differ among biogeographical or biogeochemical provinces. Understanding and defining what these responses might be is critical to the development of mitigation strategies and management policies. Well-designed comparative analyses, based on observations, models or both should be applied within and across ecosystems. As such, they provide an approach for identifying key processes and constraining the range of potential ecosystem responses.

**Table 1. Examples of models combining (green-shaded) lower (light blue, top) and higher (light blue, bottom) trophic levels suitable for comparative studies.**

ATLANTIS	<p>focusing on top predators.</p> <p>Involves the explicit inclusion of physical and biogeochemical system components to higher trophic levels and incorporates the potential to consider human dynamics in some detail.</p>
OSMOSE	A multispecies and Individual-based model (IBM) which focuses on fish species.
Multispecies Virtual Population Analysis (MSVPA) model	A trophic dynamics model focusing on interactions between fish species within exploited communities

**Bakker, D.C.E., B. Pfeil, K. Smith et al. 2013. An update to the Surface Ocean CO<sub>2</sub> Atlas (SOCAT version 2). *Earth System Science Data Discussion*, 6, 465-512.**

[DOI:10.5194/essdd-6-465-2013](https://doi.org/10.5194/essdd-6-465-2013)

*Linked to the SOLAS-IMBER Carbon – ‘Surface Ocean System’ and ‘Interior Ocean Carbon’ Groups*

As a result of a large, international, collaborative effort of the marine carbon research community, the Surface Ocean CO<sub>2</sub> Atlas (SOCAT, [www.socat.info](http://www.socat.info)) project was initiated in 2007 with the aim of providing a comprehensive, publicly available, regularly updated, quality-controlled, global data set of marine surface carbon dioxide measurements for the global oceans and coastal seas, following internationally agreed procedures and regional review. In addition, SOCAT gives open access to a 1° latitude by 1° longitude gridded product of mean monthly surface water *f*CO<sub>2</sub> (fugacity of carbon dioxide) data with minimal temporal or spatial interpolation and with a higher 0.25° latitude by 0.25° longitude resolution for the coastal seas.

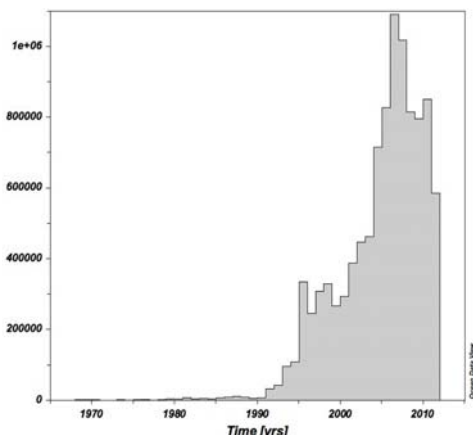
The culmination of much hard work in data collection, data assembly and quality control by many seagoing marine carbon scientists around the world, SOCAT version 2, with 10.1 million surface water *f*CO<sub>2</sub> values from 2,660 cruises spanning more than four decades (Nov. 1968 – Dec. 2011), was presented publicly in June 2013 at the 9<sup>th</sup> International Carbon Dioxide Conference (ICDC-9) in Beijing, China (Figs. 2, 3).

The SOCAT products highlight the response of surface water *f*CO<sub>2</sub> and the oceanic CO<sub>2</sub> sink to increasing levels of atmospheric CO<sub>2</sub> in a changing climate, and are used in process studies of spatial and temporal (seasonal, inter-annual and decadal) variability and trends in surface water *f*CO<sub>2</sub>, for example, in the North Atlantic, in the Pacific

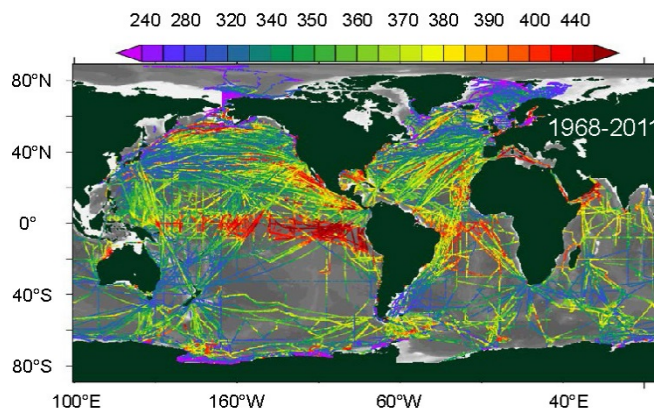
Ocean, in coastal seas, in the Arctic Ocean, in seasonally ice-covered Southern Ocean regions, near remote islands and oceanographic fronts.

The international importance of SOCAT is evident from the many recent scientific articles using SOCAT data products for quantification of the ocean carbon sink, process studies and ocean carbon modelling. Applications of SOCAT include process studies, quantification of the ocean carbon sink and its spatial, seasonal, year-to-year and longer-term variation, as well as initialisation or validation of ocean carbon models and coupled-climate carbon models.

Regular updates to SOCAT will extend its data record, improve its quality control, and will become a crucial tool in quantification and modelling of changes in oceanic CO<sub>2</sub> uptake and in global climate change research and assessments. Regular future SOCAT releases will require sustained funding for key players.



**Figure 2.** Number of annual data points for the 1968-2011 period included in SOCAT v.2



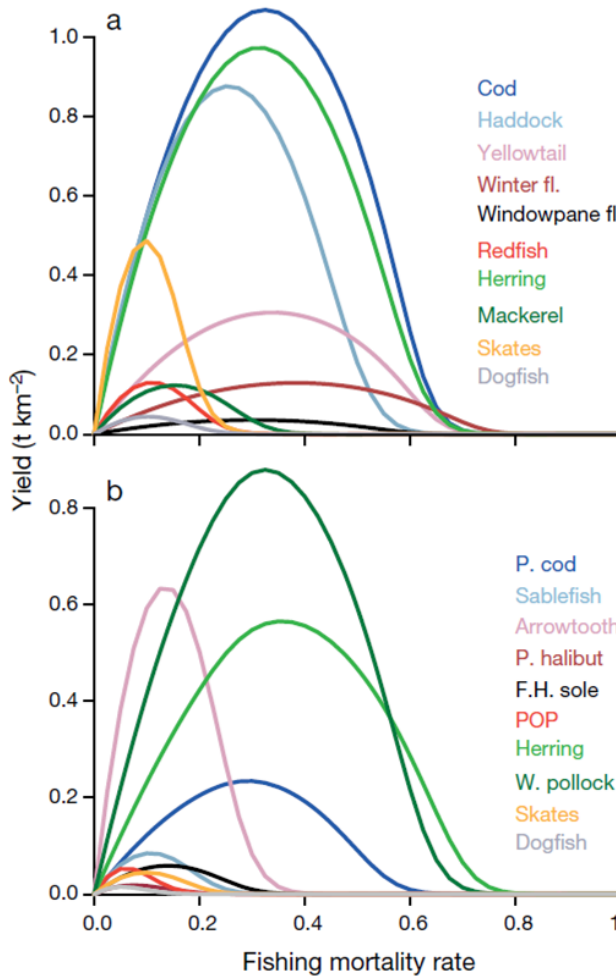
**Figure 3.** The global distribution of surface water fCO<sub>2</sub> values in SOCAT v.2 for 1968 to 2011  
(from Bakker et al. (2013), ESSDD, 6, 465–512)

**Gaichas, D., R. Gamble, M. Fogarty, H. Benoît, T. Essington, C. Fu, M. Koen-Alonso, and J. Link. 2012. Assembly rules for aggregate-species production models: simulations in support of management strategy evaluation. *Marine Ecology Progress Series*, 459, 275-292.**

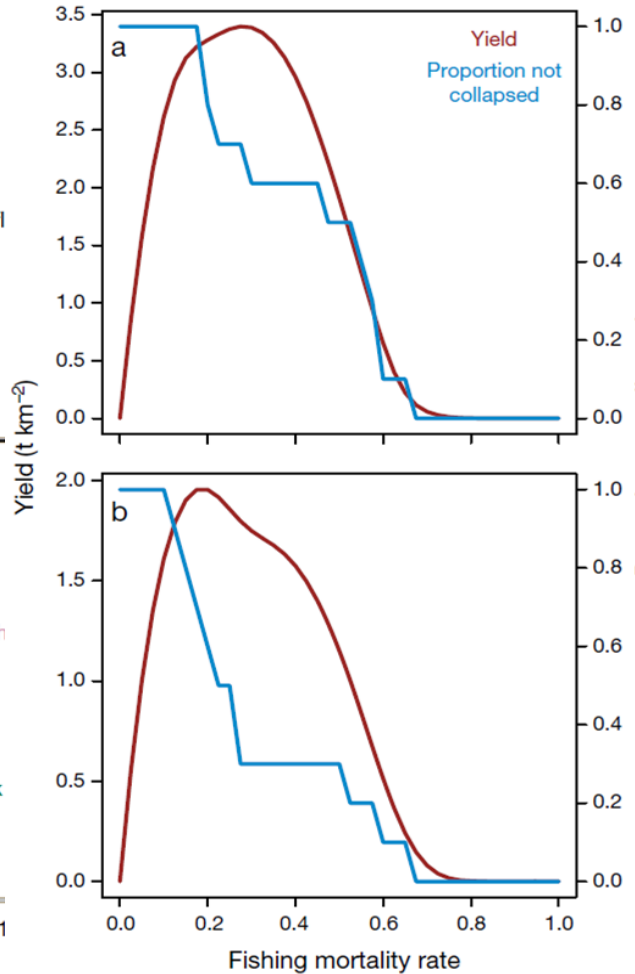
*Linked to the IMBER ESSAS regional programme*

The concept of biological production has long served as a cornerstone in the development of the theory of resource management. An early focus on this issue in fisheries management research distinguished it from other approaches in population biology in the emerging field of ecosystem-based fisheries management (EBFM) that emphasizes sustainability at multiple levels of organization beyond single target species. Biological reference points (BRPs) for aggregated specific groups are then required, that help optimize yields while preventing overexploitation of individual species. The tradeoffs between yield and biodiversity objectives must be evaluated for a wide range of aggregation strategies using multi-species surplus production models and comparing several simulated fish communities.

Fish production parameters and BRPs (e.g., maximum sustainable yield, MSY) were estimated using a simple assessment model applied to each aggregated time series. Multi-species precautionary reference points could be defined that meet both yield and biodiversity objectives across full system, taxonomic, habitat, feeding, and size-based aggregations. Aggregation strategies were best able to meet both objectives when species with broadly similar productivity, life history, environmental sensitivity, and species interactions were aggregated. Implementation of EBFM requires a better understanding of the consequences of stock-aggregate management in achieving the maximization of sustainable fishery yields and biodiversity, that is, the prevention of collapse or extinction. The simulation modelling of hypothetical fish communities make it possible to explore how the estimation of BRPs at different levels of species aggregation affects the simultaneous achievement of the objectives of yield and of biodiversity, that is, maintaining ecosystem structure (Figs. 4, 5).



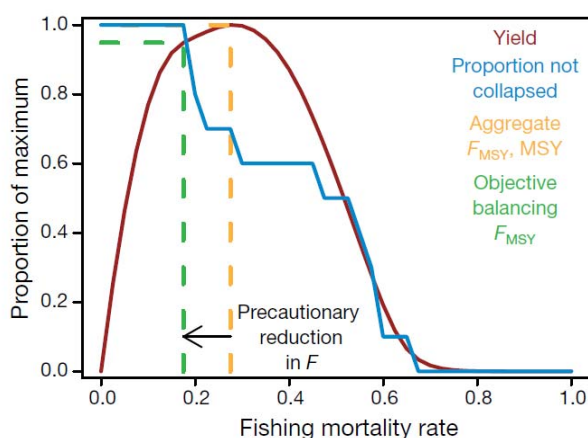
**Figure 4.** Yield curves for simulated 10-species interacting fish communities: (a) Georges Bank; (b) Gulf of Alaska; comparable species have similar colours. fl.: flounder; P.: Pacific; F.H.: flathead; W.: Walleye



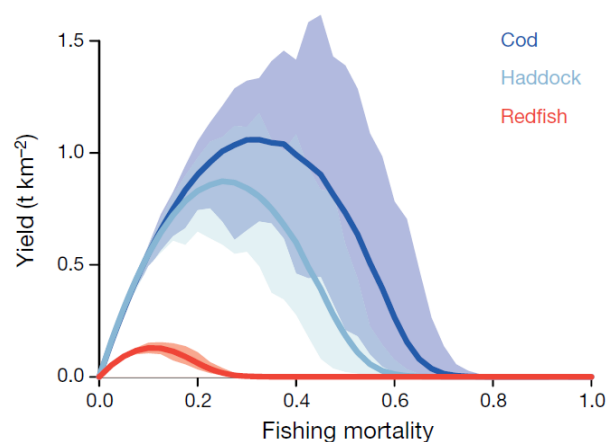
**Figure 5.** Full 10-species system aggregate yield and collapse curves (where collapse is defined as biomass <10% of unfished biomass) for (a) Georges Bank; (b) Gulf of Alaska

Management considerations based on simple extensions of traditional single-species production models provide one avenue for recasting the harvesting problem in a context that is familiar to fishery managers while accommodating a broader multi-species perspective, particularly for those stocks that are caught together in multi-species fisheries, interact highly, or have similar production characteristics. It is possible to achieve multiple EBFM objectives by managing aggregate species groups. And our simple assessment method estimated BRPs reasonably well for many species and aggregates without explicitly including species interactions, but showed some bias even with the high-quality simulated ‘data’ we used. However, poor aggregations sacrifice biodiversity for yield, leading to severely depleted (or extinct) stocks within the aggregate, as well as more subtle effects such as loss of genetic diversity. In managing species complexes, it appears that modest reductions from aggregate fishing mortality rate at MSY have the dual benefits of maintaining biodiversity and buffering against environmental uncertainty (Figs. 6, 7).





**Figure 6.** In multispecies complexes, fishing mortality rate  $F$  can be reduced from aggregate  $F_{MSY}$  ( $MSY$ , maximum sustainable yield) to prevent collapses. For the full 10-species Georges Bank model, nearly 95% of  $MSY$  can be achieved with no species dropping below 10% of unfished biomass



**Figure 7.** Average yield curves (lines) with ranges (shading) from 1000 stochastic runs for the Georges Bank groundfish complex

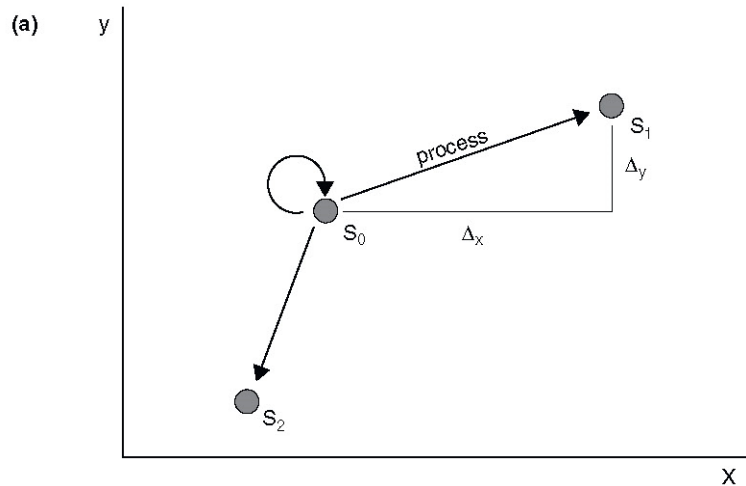
Glaser, M., P. Christie, K. Diele, L. Dsikowitzky, S. Ferse, I. Nordhaus, A. Schlüter, K. Schwerdtner Mañez, and C. Wild. 2012. Measuring and understanding sustainability-enhancing processes in tropical coastal and marine social-ecological systems. *Current Opinion in Environmental Sustainability*, 4, 300-308.

Linked to IMBER HDWG and CMWG activities

Tropical coastal and marine social-ecological systems (CM-SES) are diverse, complex and dynamic, facing special challenges as hotspots of biodiversity and centres of population growth, with high rates of direct human dependence on natural resources and a great diversity of stakeholders, institutions and scales of processes. CM-SES are also frequently beset by poverty, conflict, human security and well-being problems, weak social policy regimes and globalization-related economic and cultural pressures. Bio-geophysical and social vulnerabilities reinforce each other. In a collaborative effort between natural and social scientists, a number of processes have been identified that drive desirable social-ecological dynamics, link the debates on ecosystem services and social-ecological systems analysis and offer a framework for identifying key social-ecological processes. The social-ecological systems (SES) framework highlights the complex feedbacks between humanity and nature which can create unsustainable dynamics such as over- and destructive fishing, coastal erosion and pollution and undesirable outcomes such as degraded ecosystems and impoverished ecosystem users (Fig. 8).

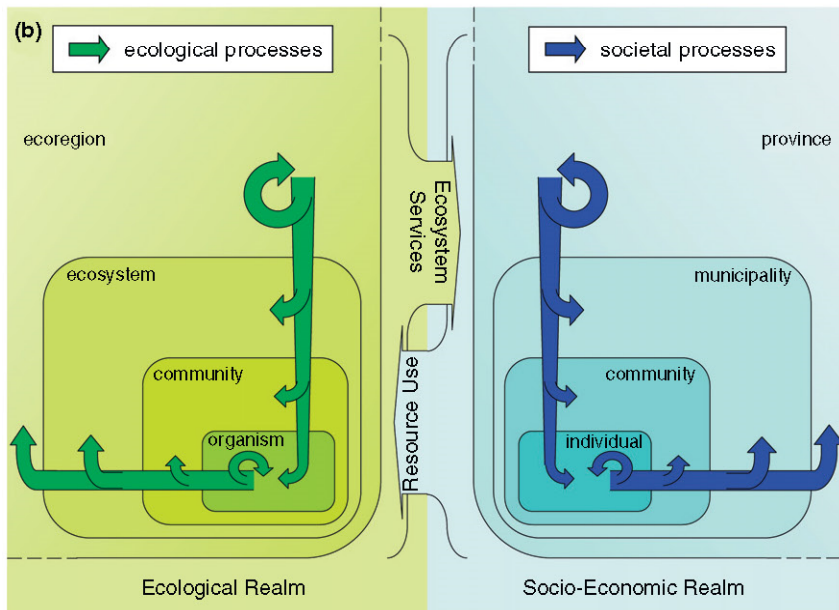
Indicators are required to help identify the processes in a system, its state evolution and its management needs. Single measurements of state indicators show a system's position along multiple axes, while process indicators assess and explain its trajectory and speed of change. Sustainability science focuses on the state of such systems and mostly analyses undesirable social-ecological outcomes. Sustainability objectives need to be negotiated between disciplines and stakeholders and effective monitoring needs to create transparency on processes and outcomes. Social-ecological sustainability in CM-SES is closely linked to system resilience and capacity to transform, but identification of the conditions under which sustainable human-nature feedbacks occur requires greater attention. Undesirable processes such as ocean acidification, over-fishing, biodiversity loss, and nutrient and chemical pollution drive oceanic and coastal systems to and beyond sustainability thresholds and must therefore also be a focus of scientific attention. Indicators on key, and often context-specific, ecological, socio-economic, and social-ecological processes are needed to provide meaning to regular measurements of system state by allowing for an understanding of the underlying causes of identified system changes.

More comparative research on sustainability policy is required, including the linkages between research, policy making, and stakeholder decision-making. As social-ecological analyses become more complex and increasingly global, stakeholder engagement in analysis and decision-making needs to expand, and research and policy-making need to diversify ways of actively engaging stakeholders at multiple levels.



**Figure 8**

*(a) System status ( $S_0$ ,  $S_1$ ,  $S_2$ ) and processes of change. Only two axes are presented but  $n$  dimensions are theoretically possible in the coordinate system. Processes (defined as change over time) are indicated by deltas / arrows. A process can maintain or alter the system state.*



*(b) Realms of a social-ecological system contain multiple levels, and the processes connecting them. Shown system levels are exemplary and extendable to include further lower or higher levels. Social-ecological systems analysis needs to identify the important components and processes of the system under study by applying indicators.*

## B. IMBER Regional Programmes

### Ecosystem Studies of Sub-Arctic Seas (ESSAS) Regional Programme

The ESSAS programme ([www.imr.no/essas](http://www.imr.no/essas)) focuses on the impacts of climate change on sub-Arctic marine ecosystems and their sustainability. The ESSAS Annual Science Meeting (January 2013, Hakodate, Japan) entitled, 'Spatial Dynamics of Subarctic Marine Ecosystems' focused on bioenergetics of sub-polar fish species; Arctic-Subarctic interactions; human dimensions of Subarctic seas exploring fisheries and fishing communities; and future directions and activities of ESSAS.

At the annual ESSAS SSC meeting, also held in January 2013, Dr. Sei-Ichi Saitoh (Hokkaido University, Japan) was appointed as the third SSC co-chair, the 'Working Group on Bioenergetics of sub-Arctic fishes' was launched, and three new Working Groups (*Human Dimension*, *Comparative Paleo-Ecology in Sub-Arctic Seas* and *Arctic-Subarctic Interactions*) were accepted for further development.

ESSAS held a joint workshop with the IMBER ICED programme in May 2012, in Yeosu, Korea during the 2<sup>nd</sup> ICES/PICES/IOC International Symposium on, *Effects of Climate Change on the World's Oceans*. This workshop, *'Effects of climate change on advective fluxes in high latitude regions'*, reviewed the role of advection on the ecology of these high-latitude regions, including heat and nutrient fluxes as well as the advection of flora and fauna, and developed likely scenarios of these advective fluxes under climate change, and comparative studies of the responses in the Arctic and Antarctic regions.

ESSAS also organised sessions on, *'Subarctic-Arctic Interactions: Ecological Consequences'*, at the ICES Annual Science Conference (September 2012, Bergen, Norway) and the PICES Annual Meeting (October 2012, Hiroshima, Japan). These examined the influence of water exchange between the Arctic basin and surrounding shelves, and the warmer sub-Arctic basin on the physical and biological/ecological conditions in the two regions.

[www.ices.dk/iceswork/asc/2012/themesessions/Abstracts%20Session%20M\\_ED.pdf](http://www.ices.dk/iceswork/asc/2012/themesessions/Abstracts%20Session%20M_ED.pdf) and  
[www.pices.int/meetings/annual/PICES-2012/2012-background.aspx](http://www.pices.int/meetings/annual/PICES-2012/2012-background.aspx)

The 28<sup>th</sup> Lowell Wakefield Fisheries Symposium, *Responses of Arctic Marine Ecosystems to Climate Change* (March 2013, Anchorage, Alaska), organized by Franz Mueter (ESSAS co-chair) focused on present and future responses of Arctic marine ecosystems to climate change at all trophic levels, from plankton to marine mammals to humans.

ESSAS-related publications include several papers, special issues, and special sections in the *ICES Journal of Marine Science*, *Marine Ecology Progress Series*, *Deep Sea Research Part II: Topical Studies in Oceanography* and *Progress in Oceanography*; derived from the ESSAS-related projects (ISE, BEST/BESIRP, TROPHARCT, NORCAN, MENUUI, CAMEO and CANUSE) and from the May 2011 ESSAS OSM; and focusing on topics such as subarctic fish and crustacean populations - climate effects and trophic dynamics; comparative analysis of marine fisheries production; understanding ecosystem processes in the eastern Bering Sea; and harvested fish stocks in a changing environment. A special volume of *Progress in Oceanography* dedicated to former ESSAS SSC member, Bernard Megrey, is in preparation on the theme "Modeling and observational approaches to understanding marine ecosystem dynamics".

#### Future ESSAS activities:

- The ESSAS ASM and SSC meeting will be held in April 2014 in Copenhagen, Denmark.
- ESSAS will convene a session on "*Changing ecosystems in sub-Arctic and Arctic regions*" at the **IMBER OSC** in June 2014, Bergen, Norway.

### **Integrating Climate and Ecosystem Dynamics in the Southern Ocean (ICED) Regional Programme**

The ICED programme aims at a better understanding of the climate interactions in the Southern Ocean, the implications for ecosystem dynamics, the impacts on biogeochemical cycles, and the development of sustainable management procedures. See [www.iced.ac.uk/index.htm](http://www.iced.ac.uk/index.htm)

During the IPY 2012 Conference (April 2012, Montreal, Canada), ICED scientists co-convened a session on *'Polar marine ecosystems: status and change'*, that focused on advances in research in polar marine ecosystems, particularly those relating to IPY. ICED scientists were also prominent at the Polar Educators workshop, APECS workshop and at discussion panels.

As mentioned above, an ESSAS-ICED workshop at the 2<sup>nd</sup> ICES/PICES/IOC International Symposium (May 2012, Yeosu, Korea) compared the Arctic and sub-Arctic sectors for the Atlantic and Pacific and the Antarctic regions, with particular emphasis on the role of advection.

ICED sponsored the *'Southern Ocean Sentinel'* Workshop (May 2012, Hobart, Australia), to help develop the *'Southern Ocean Sentinel Monitoring'* programme entitled *'Southern Ocean Ecosystem Change and Future Projections'*. It focused on the state of Southern Ocean food webs, how these might change in the future, and how to measure the specific impacts of climate change and ocean acidification.

During the XXXII SCAR Open Science Conference, July 2012, Portland, USA, a multidisciplinary ICED session was organised on *'Understanding the response of Southern Ocean ecosystems to climate change and exploitation'*.

In the framework of the EUR-OCEANS flagship programme on *'Polar Ecosystem Change and Synthesis'* (PECS),

the European branch of ICED held two workshops on “*Identifying key links between biogeochemical processes and food web structure*”, in November 2012, Bremerhaven, Germany and in May 2013, Brussels, Belgium, to further discuss the coordination, integration and leadership of polar marine ecosystem science within Europe, and to develop a strategic briefing entitled “Polar Marine Ecosystems Research: Strategic directions for the EU Research Area”. This document highlights why research on polar marine ecosystems should be an essential component of the EU Research Area through the Horizon 2020 Work Programmes, and promotes collaborative research within Europe and internationally. [www.eur-oceans.eu/sites/default/files/activities/2011/25935/Strategy%20EU%20Polar%20MER.pdf](http://www.eur-oceans.eu/sites/default/files/activities/2011/25935/Strategy%20EU%20Polar%20MER.pdf)

ICED-related Publications include several papers, special issues, and special sections in *Nature Geoscience*; *Global Change Biology*; *Annual Review of Ecology, Evolution, and Systematics*; *Deep Sea Research Part II: Topical Studies in Oceanography*; *Marine Ecology Progress Series*; *Journal of Marine Systems*; *Progress in Oceanography*; *Current Opinion in Environmental Sustainability* and *Deep Sea Research Part I: Oceanographic Research Papers*; along with several contributions to the 2012 book entitled “*Antarctic Ecosystems: An Extreme Environment in a Changing World*” (DOI:10.1002/9781444347241).

#### Future ICED activities:

- An ICED workshop on “*Circumpolar food webs and scenarios of change*” will be held in Cambridge, UK, November 2013.
- ICED will convene a session on “*Detecting, projecting and managing the impacts of change in Southern Ocean ecosystems*” at the **IMBER OSC** in June 2014, Bergen, Norway.
- The re-development of the online fieldwork map tool is underway, and a Southern Ocean wiki is under development, led by the ‘Sentinel’ programme.

#### **CLimate Impacts on Oceanic TOP Predators (CLIOTOP) Regional Programme**

The CLIOTOP programme aims to use a worldwide comparative approach to identify the impact of both climate variability and fishing on the structure and function of open ocean pelagic ecosystems and their top-predator species. See [www.imber.info/CLIOTOP.html](http://www.imber.info/CLIOTOP.html)

The 2012 CLIOTOP SSC meeting held in September 2012 in Hobart, Australia, reviewed the progress of the CLIOTOP working groups, including synthesis publications, database development, analytical tools, dedicated workshops, and conference sessions and presentations. Olivier Maury stepped down as CLIOTOP SSC co-chair but remains as an SSC member, and has been replaced as CLIOTOP co-chair by Kevin Weng, University of Hawaii, USA, from January 2013.

The 2013 CLIOTOP SSC meeting and the 2<sup>nd</sup> CLIOTOP Symposium focusing on ‘*Certainty of change in pelagic systems – detection, attribution, and prediction*’ were held in February 2013, Nouméa, New Caledonia. The symposium brought together experts with different physical, biological, social perspectives to discuss cross-cutting themes such as ‘*Blue economy – what role for pelagic species and ecosystems?*’; ‘*Pelagic conservation-fisheries management conflicts – maximising dual objectives*’; ‘*Pelagic-coastal linkages – food and conservation*’ ([www.imber.info/index.php/News/Newsletters/Issue-n-23-April-2013](http://www.imber.info/index.php/News/Newsletters/Issue-n-23-April-2013)).

In an attempt to align CLIOTOP’s overall plan and working group objectives with the goals of IMBER as earlier requested by the IMBER SSC, the CLIOTOP SSC is taking a more applied outcome-oriented approach that should also be more compatible with national funding initiatives. Indeed, national programmes remain the dominant source of funding, which have limited several of the global comparative approaches proposed by CLIOTOP. In some countries, the focus of global change research is shifting from understanding the impacts of climate change to developing adaptation options. Consequently, developing adaptation options for open ocean and fisheries management bodies are likely to become a major focus beyond the current phase of CLIOTOP research. The CLIOTOP SSC also recognized that the connections with the activities of the other IMBER regional programmes relevant to research on top predators should be improved.

A CLIOTOP-associated session on ‘*Interdisciplinary Approaches to Cephalopod Biology*’ was organised at the ‘Cephalopod International Advisory Council’ Symposium, in October 2012, Florianópolis, Brazil.

CLIOTOP-related publications include several papers, special issues, and special sections in *Climatic Change*; *Deep Sea Research Part II: Topical Studies in Oceanography*; *Journal of Marine Systems*; *Reviews in Fish Biology* and



*Fisheries; Aquaculture Environment Interactions; and Fish and Fisheries*, and focusing on topics such as: Climate and oceanic fisheries; Squids and top predators.

Future CLIOTOP activities:

- A special issue of *Deep Sea Research Part II: Topical Studies in Oceanography* is in preparation following the 2<sup>nd</sup> CLIOTOP Symposium.
- CLIOTOP will convene a workshop entitled “*Beyond ‘Z’: what modelers need and empiricists have to offer to better incorporate higher trophic levels and humans in end-to-end models*” and a session on “*The pivotal role of the mesopelagic functional groups in biogeochemical cycles*” at the IMBER OSC in June 2014, Bergen, Norway.
- The 3<sup>rd</sup> CLIOTOP Symposium is scheduled for June 2015.

**Sustained Indian Ocean Biogeochemistry and Ecosystem Research (SIBER) Regional Programme**

SIBER (co-sponsored by the Indian Ocean Global Ocean Observing System, IOGOOS), is the newest IMBER regional programme, and focuses on understanding climate change and anthropogenic forcing on biogeochemical cycles and ecosystems in the Indian Ocean ([www.imber.info/index.php/Science/Regional-Programmes/SIBER](http://www.imber.info/index.php/Science/Regional-Programmes/SIBER) and [www.incois.gov.in/Incois/siber](http://www.incois.gov.in/Incois/siber)).

The 3<sup>rd</sup> SIBER SSC meeting took place in October 2012 in Cape Town, South Africa, in conjunction with the Chapman Conference on the Agulhas Current System, in close liaison with CLIVAR Indian Ocean Panel (IOP), IOGOOS and the IndOOS Resource Forum (IRF), and to help reaching out to the relevant South African research community. The 4<sup>th</sup> SIBER SSC meeting took place in July 2013, Lijiang, China, again in close liaison with the CLIVAR IOP.

SIBER organised a session on ‘*Physical and biogeochemical processes in the Indian Ocean: Recent progress and toward future collaborations*’ during the Asia Oceania Geosciences Society (AOGS) – AGU Western Pacific Geophysics Meeting (WPGM) Joint Assembly meeting in August 2012, Singapore.

The SIBER mid-term symposium will be held in 2015, in conjunction with the 50<sup>th</sup> anniversary celebration of the International Indian Ocean Expedition (IIOE-2) ([www.incois.gov.in/Incois/iioe/index.jsp](http://www.incois.gov.in/Incois/iioe/index.jsp) and [http://hab.ioc-unesco.org/index.php?option=com\\_oe&task=viewDocumentRecord&docID=11117](http://hab.ioc-unesco.org/index.php?option=com_oe&task=viewDocumentRecord&docID=11117)).

SIBER researchers are making substantial contributions to the design and deployment of the Indian Ocean Observing System (IndOOS) / Research moored Array for African-Asian-Australian Monsoon Analysis and prediction (RAMA) for physical and biogeochemical observatories. Biogeochemical sensors deployed at a few sites have already provided data that was presented at the AOGS 2012 meeting, and in late 2013, additional biogeochemical sensors will be deployed at two other reference sites, provided by the Bay of Bengal Large Marine Ecosystem (BOBLME) project and by NOAA/RAMA. Under the IOGOOS framework, relevant activities also focus on issues of local or global importance, such as monsoons and ENSO, and also include capacity building, modelling and forecasting.

Efforts are proceeding to establish and support a SIBER Regional Office in Australia, sponsored by the Australia’s Integrated Marine Observing System (IMOS) and the IOC Perth Office.

Overall, SIBER has strong collaboration with various regional actors (e.g., Indian Ocean Panel of the Variability and predictability of the ocean-atmosphere system project CLIVAR, and IOGOOS) and in this respect has developed a useful model for CLIVAR-IMBER collaboration.

Future SIBER activities:

- A SIBER special issue of *Biogeosciences* is in preparation on *Current biogeochemical and ecosystem research in the Northern Indian Ocean*. This will highlight results of benthic and pelagic process studies in the Arabian Sea, and more recently the Bay of Bengal and Andaman Sea, coastal studies in the Northern Indian Ocean, and numerous physical and biogeochemical modelling studies relevant to the wider Indian Ocean.
- SIBER will convene a workshop entitled, ‘*Eastern Indian Ocean upwelling research initiative planning Workshop Phase 3: physical dynamics and ecosystem responses*’, and a session on ‘*Biogeochemical and ecological impacts of boundary currents in the Indian Ocean*’ at the IMBER OSC in June 2014, Bergen, Norway.

## C. IMBER Working Groups and Task Teams

### SOLAS-IMBER Carbon (SIC!) Working Group

To oversee the marine carbon process studies, there are currently three joint SOLAS-IMBER carbon (SIC!) groups dealing with carbon in the surface ocean systems (SOS), carbon in the interior ocean (IOC) and ocean acidification (SIOA). A proposal submitted by the SCOR Working Group 134 on 'The Microbial Carbon Pump in the Ocean', to develop a new SIC! activity focusing on dissolved organic carbon production, transformation and storage was not accepted by the IMBER SSC. However, it was suggested that the remit of the existing SIC! Working Groups could be revisited to incorporate this topic, its possible interactions with the existing SIC! WGs, and potentially improve the studies of the various forms, sources, sinks and interactions of all pools of organic matter. It was also agreed that this should be done in collaboration with SOLAS and GEOTRACES.

#### Surface Ocean Systems (SIC!-SOS)

This working group focuses on data synthesis for the carbon in the surface ocean systems (SOS), and on instrumentation and technology development, Voluntary Observing Ships (VOS) and mixed layer sampling strategy.

The Surface Ocean CO<sub>2</sub> Atlas (SOCAT, [www.socat.info](http://www.socat.info)) was first presented at the 'Ocean Carbon Cycle at a Time of Change: Synthesis and Vulnerabilities' meeting, convened by SIC!-SOS, SIC!-IOC and IOCCP in 2011. The updated SOCAT v.2 was released at the 9<sup>th</sup> International CO<sub>2</sub> Conference (ICDC-9) in June 2013, Beijing, China. (see also the science highlight above). This atlas is a publicly available, high-quality dataset that can be used for: (i) process studies, (ii) quantifying ocean carbon sinks and its seasonal, year-to-year, decadal variation; and (iii) initialization and validation of ocean carbon cycle models. Regular updates are planned, and work has already commenced on SOCAT v.3. This will become a keystone dataset for carbon cycle science and is worthy of support.

A new activity supported by the SIC!-SOS is now underway which focuses on the comparison of different techniques for mapping pCO<sub>2</sub> in the global ocean. This effort also builds on the Regional Carbon Cycle and Process (RECCAP, [www.globalcarbonproject.org/reccap](http://www.globalcarbonproject.org/reccap)) project which is now finalising a special issue of *Biogeosciences* ([www.biogeosciences-discuss.net/special\\_issue83.html](http://www.biogeosciences-discuss.net/special_issue83.html)).

#### Future SIC!-SOS activities:

- A meeting with members of the Southern Ocean Observing System (SOOS, [www.soos.aq](http://www.soos.aq)) on the science of detecting change in the high-latitude ocean is being considered.
- SIC!-SOS members will co-convene, with SIC!-IOC and IOCCP, a session on 'The ocean carbon cycle at a time of change: Data syntheses, analyses and modelling' at the IMBER OSC in June 2014, Bergen, Norway. It aims to focus on surface-to-interior connections.

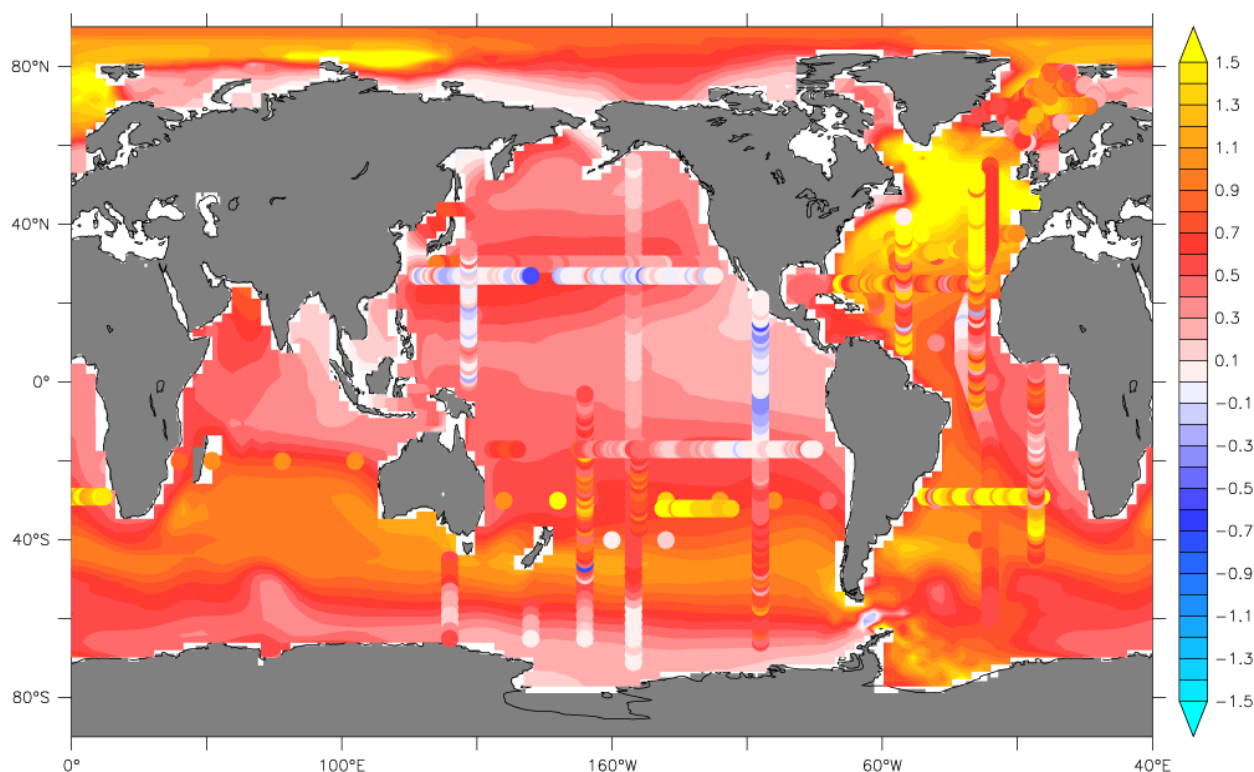
### Interior Ocean Carbon (SIC!-IOC)

This working group co-ordinates international research on interior ocean changes in carbon and biogeochemistry, undertakes synthesis activities, and aims to develop sustainable observing systems, including the addition of oxygen sensors to the international ARGO float programme (ARGO-O<sub>2</sub>).

A new SCOR Working Group 'Quality Control Procedures for Oxygen and Other Biogeochemical Sensors On Floats and Gliders' ([http://scor-int.org/Working\\_Groups/wg142.htm](http://scor-int.org/Working_Groups/wg142.htm)), proposed by members of SIC!-IOC, was launched this year. Measuring dissolved oxygen from profiling floats adds greatly to our understanding of both physical and biogeochemical process. To date, almost 300 floats carrying dissolved oxygen sensors have been deployed, in the Pacific, the Southern Ocean and the tropical and subpolar Atlantic. The development and deployment of other biological sensors are also on-going for a "full Bio-Argo" network.

Several SIC!-IOC-related sessions were organised at the 9<sup>th</sup> International CO<sub>2</sub> Conference (ICDC-9) in June 2013, Beijing, China.

Currently, the focus of SIC!-IOC is to move forward with the inter-comparison study of the different methods to determine the changes in carbon in the ocean's interior (Fig. 9), and especially the global-scale oceanic accumulation of anthropogenic CO<sub>2</sub> since the 1990s. In this respect, the global synthesis of repeat hydrography, mainly based on work from the CARINA and PACIFICA projects, is on-going. Progress has been slower than anticipated, due to data quality control issues, but the aim is to complete it in 2014.



**Figure 9 Interior trends of anthropogenic CO<sub>2</sub>: It appears that an Atlantic-versus-Pacific pattern emerges clearly, but substantial differences exist between different methods. after Gruber et al. (unpublished, 2012), in mol m<sup>-2</sup> yr<sup>-1</sup>**

#### Future SIC!-IOC activities:

- The 3<sup>rd</sup> SIC!-IOC WG meeting will be held in conjunction with the ASLO/TOS/AGU 2014 Ocean Sciences Meeting in February 2014, Honolulu, Hawaii, USA.
- SIC!-IOC will convene, in partnership with SIC!-SOS and IOCCP, a session on “*The ocean carbon cycle at a time of change: Data syntheses, analyses and modelling*” at the IMBER OSC in June 2014, Bergen, Norway.

#### Ocean Acidification (SIOA)

This working group co-ordinates international research efforts and synthesis activities in ocean acidification. Within a single decade, ocean acidification has grown from involving only a few scientists to a research topic that has recently been considered the #1 research front in ecology and environmental sciences. While exciting, this rapid expansion has not been without its problems. For example, it has not been easy for experts to share information and train newcomers from different countries, which is essential to avoiding unnecessary duplication.

The SIOA was instrumental in the establishment of the *Ocean Acidification - International Coordination Centre (OA-ICC)* in summer 2012, IAEA's Environment Labs, Monaco, in coordination with the Ocean Acidification Reference Users Group (OA-RUG). Its goals are to foster international scientific collaboration, promote best practices, improve observational capacities and databases, and facilitate communication, outreach and synthesis (see [www.iaea.org/nael/OA-ICC](http://www.iaea.org/nael/OA-ICC) and <http://news-oceanacidification-icc.org>).

The first OA-ICC Advisory Board meeting, chaired by SIOA member Carol Turley, included all SIOA members and other representatives (including the IMBER Chair, Eileen Hofmann), and was held in May 2013 in Monaco, following the SIOA meeting. The focus of the meeting was to discuss and organise future activities. The scientific credibility of the OA-ICC relies almost entirely on the SIOA. Through the recent interactions between OA-ICC staff and the SIOA Chair, Jim Orr, also OA-ICC Scientific Coordinator, the SIOA set the priorities and what should be done, also taking into account the context of the IAEA, host institution of the OA-ICC. To be cost effective, the current SIOA membership will most likely be maintained without changes until December 2015.

#### Future SIOA and OA-ICC activities:

- SIOA members will convene a session on “*Regional responses to climatic and non-climatic drivers in a high-CO<sub>2</sub> ocean*” at the IMBER OSC in June 2014, Bergen, Norway.
- OA-ICC has already begun to promote a series overarching international activities to serve not only the scientific community but also science users, including policy makers, media, and the general public. Recent and ongoing OA-ICC activities include: (1) helping to run an international exhibition stand that highlighted ocean acidification at the UNFCCC COP18 Climate Change Conference, in November 2012, Doha, Qatar; (2) running a comparison exercise for 7 publicly available packages that compute marine carbonate chemistry, in collaboration with IOCCP, and (3) supporting the 2<sup>nd</sup> International Workshop of the Global Ocean Acidification Observing Network (GOA-ON) held in July 2013, St. Andrews, UK, [www.pmel.noaa.gov/co2/GOA\\_ON/2013](http://www.pmel.noaa.gov/co2/GOA_ON/2013); and the 6<sup>th</sup> SOLAS summer school to be held in Aug.-Sept. 2013, Xiamen, China, <http://mel.xmu.edu.cn/solassummerschool/>.
- During the next year, OA-ICC will also organize or help organize several workshops, including a GOA-ON observational workshop, a natural-social science connection workshop, an OA data curators' workshop, a OA-related capacity building workshop in South America), and further promote international collaboration and sharing of international ocean acidification research platforms and facilitating exchanges of early-career researchers.

#### **Continental Margins Working Group (CMWG)**

The joint IMBER-LOICZ CMWG held its first meeting in June 2012, Halifax, Canada. It was decided to rename the group the Continental Margins Working Group because, unlike its predecessor, the Continental Margins Task Team (CMTT), which was tasked only with drafting the Continental Margins Implementation Plan, the group has multiple responsibilities. These include convening the ‘*Biogeochemistry-ecosystem interactions on changing continental margins*’ workshop at IMBIZO III and revising the Science Plan and Implementation Plan (SPIS) drafted by the CMTT in order to develop a new strategy for continental margins research in light of the Grand Challenges in earth system science research for global sustainability.

The 2<sup>nd</sup> CMWG meeting was held in January 2013 in Goa, India. A strategic paper “*Living on the Margin in the Anthropocene: from Frontier to Engagement Arenas for Global Sustainability*” is in preparation for submission to a peer-review journal (see Fig. 10).

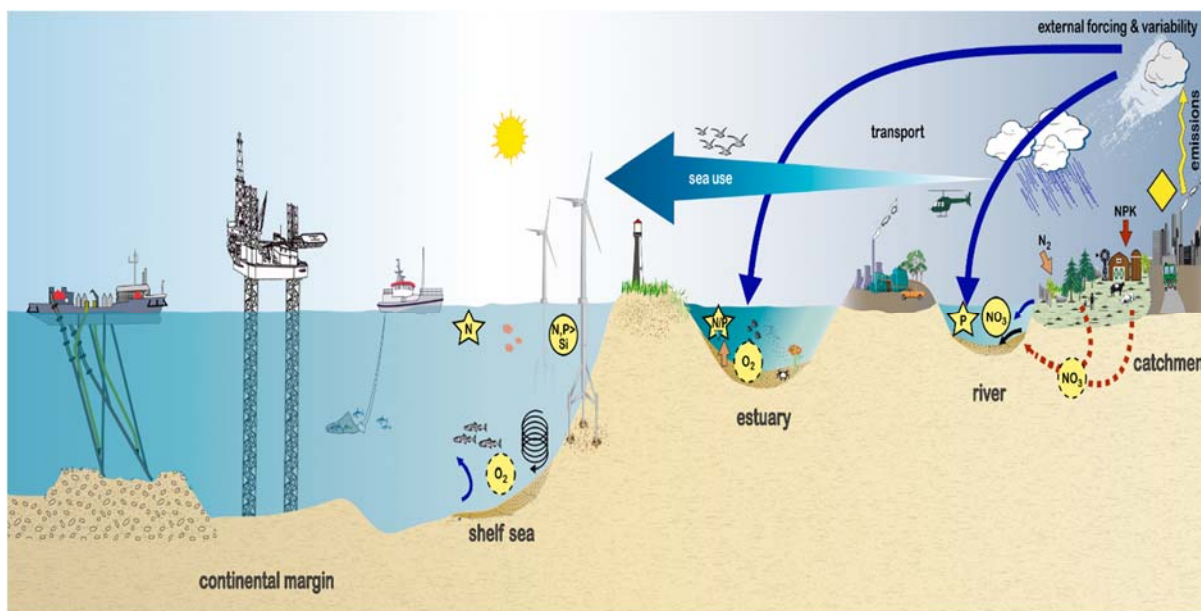
The SPIS for CM research will be structured according to this paper, to fit the requirements of the Future Earth Initiative and to facilitate the transition of on-going CM projects into this transdisciplinary research phase. Material from the original draft may be repackaged into the new structure, but new material is also needed, especially, on the human dimensions.

During the IMBIZO III continental margins workshop it was recognized that specifically developed models would provide guidance to effective governance of social-ecological systems on CMs, which in turn would rely on communication and mutual understanding of the issues and capabilities of social and natural scientists.

#### Future CMWG activities:

- CMWG members and colleagues will convene two sessions on “*Impacts of anthropogenic stressors and climate change on biogeochemistry-ecosystem in continental margins and feedbacks to earth system and society: Challenges and solutions*” and “*Environmental changes in Eastern Boundary Upwelling Systems: drivers, mechanisms and implications for the ecosystems*” at the IMBER OSC in June 2014, Bergen, Norway.
- A special issue derived from the IMBIZO III continental margins workshop and entitled “*Biogeochemistry-ecosystems interaction in changing continental margins in the Anthropocene*” has been accepted for the *Journal of Marine Systems*.





**Figure 10: The Margin, comprising the coastal zone, continental slope and shelf**  
(after K. Emeis, pers. comm.)

### Data Management Committee (DMC)

The DMC promotes a cooperative data management approach - involving experienced data management specialists, from the start of a project, and training young scientists in good data management procedures.

As with previous IMBIZOs, the DMC organised an IMBER *Data management training course and workshop* the day before the start of IMBIZO III in Goa, India. About fifty IMBIZO III participants and local NIO researchers and students attended. Overall, the presentations and discussions provided useful information on how their science will benefit from improved data management practices and this will facilitate data sharing. The presentations are available at [www.imber.info/index.php/Meetings/IMBIZO/IMBIZO-III/Data-Management-Workshop](http://www.imber.info/index.php/Meetings/IMBIZO/IMBIZO-III/Data-Management-Workshop).

In addition to its usual capacity building goal, this event made it possible for IMBER researchers to further identify data management needs of IMBER research projects, to start addressing the emerging challenges of the social and natural marine science integration and especially the marine social science data management, and start elaborating new recommendations specific to the management of new types of marine data. A revision/addendum is now under consideration for the IMBER Data Management Cookbook (2011), to consider such new marine data, related to – omics research (e.g., genomics, proteomics) that delivers huge amount of new data, and social science research where data and information are often not geo-referenced and have confidentiality-related access restrictions.

The IMBER metadata portal (<http://gcmd.nasa.gov/portals/imber>) within the NASA's Global Change Master Directory (GCMD) is actively populated and currently contains description of 32 endorsed projects and related activities.

The IMBER poster entitled, '*Contributions from the IMBER Data Management Committee to the scientific challenges of the changing marine ecosystems*', was presented at several events, including the 3<sup>rd</sup> *International Symposium on the Ocean in a High CO<sub>2</sub> World*, September 2012, Monterey, CA, USA; the 2012 *ICES Annual Science Conference*, September 2012, Bergen, Norway; the *CLIVAR international workshop on interdecadal variability of the global monsoons*, September 2012, Nanjing, China; and the *PICES 2012 Annual Meeting*, October 2012, Hiroshima, Japan.

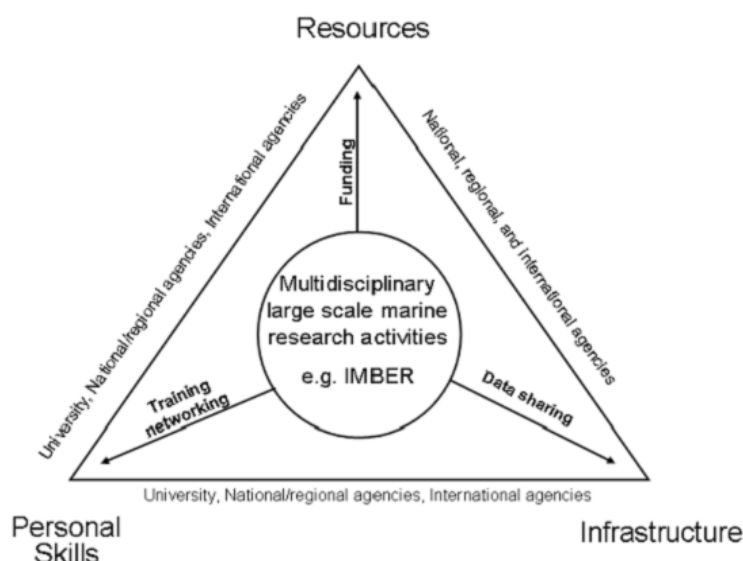
### Future DMC activities:

- DMC will convene a workshop entitled “*Data Management for IMBER*” at the **IMBER OSC** in June 2014, Bergen, Norway.

### Capacity Building Task Team (CBTT)

The CBTT objectives are to enhance marine research capabilities in less developed countries, enhance research capabilities globally in relevant IMBER activities, and strengthen graduate education in ocean sciences.

The CBTT organised a workshop on the “*Needs assessment for capacity development for integrated marine biogeochemistry and ecosystem research in the Asia-Pacific*” in July-August 2012, Shanghai, China. There were about twenty participants from 14 countries, including scientists, capacity building (CB) experts and representatives from IMBER, SCOR, the Asia-Pacific Network for Global Change Research (APN), the IOC Sub-commission for the Western Pacific (IOC-WESTPAC), and the Partnership for Observation of the Global Oceans (POGO). Included were presentations about CB experiences and case studies, and assessment of CB needs. Consideration was also given to potential collaborative activities for capacity development regionally and globally to help IMBER deliver its objectives. The capacity development needs for IMBER-related research in the Asia-Pacific region were identified using an information matrix developed from the capacity building efforts and challenges reported by the workshop participants.



**Figure 11. Three key components involved in capacity building, while national/regional agencies focus more on resources and infrastructure building, and universities provide more opportunity on personal skills development. Multidisciplinary large-scale marine research activities, such as IMBER, contribute to the three components through training, networking, financial support, data sharing, etc. (from “Developing Human Capital for Successful Implementation of International Marine Scientific Research Projects”. R.J. Morrison et al., subm.)**

A meeting report titled, ‘*Capacity Building for Sustainable Marine Research in the Asia-Pacific Region*’, was also published in *EOS*, January 2013, and the main workshop report is available at [www.apn-gcr.org/resources/items/show/1766](http://www.apn-gcr.org/resources/items/show/1766). A small writing meeting held in March 2013, in Shanghai, China made it possible to further develop a strategic paper, ‘*Developing Human Capital for Successful Implementation of International Marine Scientific Research Projects*’, which was recently published on-line in *Marine Pollution Bulletin* (see <http://www.sciencedirect.com/science/article/pii/S0025326X13005377>).

#### Future CBTT activities:

- CBTT will convene a workshop entitled “*Capacity Development for IMBER*” at the **IMBER OSC** in June 2014, Bergen, Norway.
- CBTT is also encouraging the development of the next IMBER summer school, ClimEco4 in August 2014, Shanghai, China (see below).

### Human Dimensions Working Group (HDWG)

The HDWG focuses on the interactions between human and ocean systems, and aims to create an integrated and interactive natural-social science marine research community within IMBER. Marie-Caroline Badjeck stepped down as HDWG Co-Chair at the end of 2012, but remains as an associate member.

HDWG members and colleagues convened the IMBIZO III workshop on ‘*Understanding and forecasting human-ocean-human interactions, drivers and pressures, with respect to global change*’ in January 2013 in Goa, India. Presentations analyzed the vulnerability and adaptation of marine-dependent communities to global change and

governance response and methodological approaches to assess and mitigate the impacts of global change. A range of locations, issues and scales were covered, but several common themes and issues emerged: informal social networks are important for adaptation; responses can and should occur at several levels; lessons can be learned from comparative analyses; local issues are affected by local, regional and global drivers; greater interdisciplinarity is required to address these issues; there are several major disconnects between natural and social sciences; between science and policy; and between the public perception and the “reality” of global change.

The HDWG held its third meeting in conjunction with IMBIZO III, to further develop the HDWG work plan for the next five years and also the ‘*Assessment from Description, Appraisal and Typology*’ (ADApT) conceptual framework and template for case studies. IMBER-ADApT is an integrated decision support tool to enable decision makers and resource managers to identify options to improve their response to global change for the coastal and marine environment and related, vulnerable communities. IMBER-ADApT is based on a broad suite of case studies, focusing on fisheries and aquaculture, from a diversity of social, natural and governance systems, of activity sectors, including those related to fisheries and aquaculture, and of factors that can affect these, such as poverty and social justice.

#### Future HDWG activities:

- The IMBER-ADApT template will be soon widely distributed to solicit about 100 case studies
- A “Ghoti” paper on IMBER-ADApT will to be soon submitted to *Fish and Fisheries*
- A special issue of *Regional Environmental Change* on the contributions from the IMBIZO III HDWG-related workshop is in preparation.
- HDWG Meeting in March 2014, Halifax, Canada
- Analysis of case studies and development of the ADApT typology
- HDWG members and colleagues will convene three sessions entitled “*Not so simple: developing robust approaches to the use of indicators for ecosystem based fisheries management*”, “*Responses of society to marine and global changes as a core mandate for IMBER: ways forward*” and “*Future Oceans’ stewardship: roles, responsibilities and opportunities in small-scale fisheries*” at the **IMBER OSC** in June 2014, Bergen, Norway.

### **D. IMBER Project-wide Activities**

#### **IMBIZO III**

*IMBIZO* is a Zulu word for a ‘gathering’. IMBER organised IMBIZO III in January 2013 in Goa, India, focusing on ‘*The future of marine biogeochemistry, ecosystems and societies - Multi-dimensional approaches to the challenges of global change in continental margins and open ocean systems*’. The aim was to explore the linkages and interactions between humans and marine systems and deepen our understanding of future ecological and biogeochemical systems in the continental margins and open ocean and their societal implications. IMBIZO III was co-sponsored by EUR-OCEANS Consortium (EU), IMR (NO), RCN (NO), NASA (US), OCB (US), PICES (INT), SCOR (INT), ECNU (CN) and SKLEC (CN). IMBIZO III brought together about 120 researchers, from the natural and social research fields, who represented 29 countries.

Following the proven IMBIZO format, three concurrent, but interacting, workshops dealt with (1) *Biogeochemistry-ecosystem interactions on changing continental margins*, (2) *Impacts of anthropogenic perturbations on the biological and microbial carbon pumps in the ocean*, and (3) *Understanding and forecasting human-ocean-human interactions, drivers and pressures, with respect to global change*. Joint daily plenary and poster sessions provided the opportunity for interdisciplinary discussion among participants from the three workshops. The meeting presentations are available online at [www.imber.info/index.php/Meetings/IMBIZO/IMBIZO-III](http://www.imber.info/index.php/Meetings/IMBIZO/IMBIZO-III).

A mentoring programme was activated prior to IMBIZO III and matched about fifteen students and early-career researchers with experienced scientists. Advice and assistance was given on poster or presentation preparation, and on career development. A “lunch with scientists” was also held. At the end of IMBIZO III, a 3-hour tutorial session on ‘*Scientific Writing and Publishing*’ was attended by about 35 participants.

As mentioned above, a “*Data management training course and workshop*” was organised by the DMC the day before the start of IMBIZO III.

A meeting report, *'The Future of Marine Biogeochemistry, Ecosystems, and Societies'*, was published in *EOS*, May 2013, and the IMBER Update Newsletter issue n°24 focused on science highlights from IMBIZO III (see below).

#### Future IMBIZO III-related activities:

- A synthesis of the outcomes of IMBIZO III *'The Future of Marine Biogeochemistry, Ecosystems, and Societies'* is in preparation as an article in the "Breaking Waves" section of *Oceanography*.
- Syntheses of the ideas and concepts presented and new scientific discoveries reported at IMBIZO III will be published in special issues of *Journal of Marine Systems* (Continental Margins Workshop), *Biogeosciences* (Open Ocean Workshop) and *Regional Environmental Change* (Human-Ocean Interactions Workshop).

#### **ClimEco Summer Schools**

IMBER ClimEco Summer Schools are held every two years and have proved to be a successful capacity building mechanism for students and early-career scientists. The first edition (2008) was co-organised by IMBER, GLOBEC and CLIVAR.

IMBER organised ClimEco3, in July 2012, Ankara, Turkey, focusing on *'A view towards integrated Earth System models. Human-nature interactions in the marine world'*. There were 10 lecturers and about 60 students from 26 countries with an array of social and natural science backgrounds. The participants were selected from the 168 applicants to facilitate hands-on training. The summer school was designed to provide participants with an overview of methods, models and approaches for analyzing the impact of climate change on marine ecosystems and the consequences for society. All the lectures were webcast live and were followed by several people from around the world. Recordings of the broadcasts are available at [www.imber.info/index.php/Science/Working-Groups/Capacity-Building/Summer-Schools/ClimECO3-July-2012-Ankara-Turkey](http://www.imber.info/index.php/Science/Working-Groups/Capacity-Building/Summer-Schools/ClimECO3-July-2012-Ankara-Turkey). Sponsors included IMBER, METU (TR), PICES (INT), CLIVAR (INT), SCOR (INT), EUR-BASIN (EU), OCB (US), KORDI (KR, now: KIOST).

#### Future ClimEco activities:

- ClimEco4 entitled, *'Delineating the issues of climate change and impacts to marine ecosystems: Bridging the gap between research, assessment, policy and management'*, will be held in early August 2014, Shanghai, China. It should focus on indices for evaluating marine ecosystems - what they are, how to construct them (for process/observation scientists), how to use them (for modellers from natural to social sciences), and how to combine them so that they can be used to inform policy and decision-making.

Funding from SCOR has been kindly requested to support participants from developing and emerging economies to attend the ClimEco4 summer school.

#### **Open Science Conference (OSC) 2014**

IMBER has been underway for eight years and it is now appropriate to begin elaborating a broad synthesis of its achievements and developing a strategic plan for the next phase of marine biogeochemical and ecosystem research.

The IMBER Open Science Conference, *'Future Oceans – Research for marine sustainability: multiple stressors, drivers, challenges and solutions'*, to be held from 23 to 27 June 2014 in Bergen, Norway, is a key step in this process and is intended to provide a venue to the larger marine science community for presenting key findings of IMBER-relevant research, for promoting integrated syntheses of IMBER research, and for developing a new research agenda to guide future marine biogeochemistry and ecosystem research. We expect about 300 to 400 participants to attend.

Innovative discussion formats will be promoted, such as world cafés, panel discussions, breakout groups, poster sessions and exhibition booths. Facilitated scenario-testing/strategic sessions are also being considered for discussing future research needs, particularly those relevant to societal issues, such as marine food security, or vulnerability assessments of marine systems under global change.

The OSC will feature:

- keynote plenary presentations;
- multiple contributed parallel sessions focusing on IMBER achievements, ambitions and strategy development;



- several one-day topical workshops focusing on integration across the IMBER research themes, results from IMBER regional programmes and working groups, and IMBER-relevant research at the interface of natural and human sciences;
- targeted breakout groups focused on defining a new research agenda and implementation strategy for the next phase of marine research;
- a mentoring programme for students and early-career researchers; and
- poster sessions.

The list of accepted sessions and workshops is available at [www.imber.info/index.php/Meetings/IMBER-OSC-2014/Sessions-Workshops](http://www.imber.info/index.php/Meetings/IMBER-OSC-2014/Sessions-Workshops).

Several scientific side-events and additional IMBER-related activities will be held in conjunction with the IMBER OSC 2014, including pre-conference events such as workshops for early-career researchers on new research challenges, capacity building, and data management, and the IMBER SSC meeting to be held on 27-28 June 2014 in Bergen, Norway. Several social events, such as an ice-breaker, conference reception and conference dinner, will also be organized. These are funded by sponsorship raised locally or provided by local organizations. This is especially important for the OSC because it is an attempt to bring together and facilitate interactions and collaborations between the natural and social science marine research communities, both globally and locally. Current environmental issues facing society are at the interface between natural and social science, and it is imperative to support the development of an interdisciplinary community of researchers who understand and have the skills to address complex issues at this interface.

The OSC will help disseminate IMBER science results to a broader community, with both natural and social science representation. The keynote presentations will be broadcast live and subsequently posted on the IMBER website. Social media outlets will facilitate the involvement of a wider audience of marine researchers and research end-users, allowing a broader engagement in the strategic discussions. Results from the OSC will be published as peer-reviewed synthesis publications and special issues with contributed and solicited papers.

To facilitate future planning, the IMBER Scientific Steering Committee (SSC) is developing a strategic document to stimulate discussions that help define and implement the next phase of research in biogeochemical cycling-ecosystem interactions and human-ocean-human interactions. The general outline of this strategic document should include the following: a self-evaluation report; some highlights of success; new questions and new challenges; an overview of the new research landscape; some proposed new themes, issues, priority questions; some proposal for a new research agenda; a draft science plan and implementation strategy; and timeline. This document will be made available to participants in advance of the OSC. It will also be posted on the IMBER website for comment from individual researchers, research partners and marine organisations. Following this open consultation period, the document will be revised and updated by the IMBER SSC to reflect the inputs and suggestions of the community and to take into account the status of the IMBER dialogue with its current sponsors (SCOR and IGBP) and the 'Future Earth' initiative. It will then be sent to SCOR during late summer 2014, along with a request for a potential five-year project extension.

SCOR has agreed to support the participation of several researchers from developing and emerging economies in the OSC. Other confirmed sponsors are the North Pacific Marine Sciences Organization (PICES); Research Council of Norway (RCN); Institute of Marine Research (IMR), Bergen, Norway; University of Bergen, Norway; Norwegian Research School in Climate Dynamics (ResClim); and City of Bergen, Norway. Additional financial support has been requested from the International Council for the Exploration of the Sea (ICES), U.S. National Aeronautics and Space Administration (NASA), U.S. Ocean Carbon and Biogeochemistry (OCB) Program, Korea Institute of Ocean Science and Technology (KIOST). Additional funding proposals are being prepared for the Inter-American Institute for Global Change Research (IAI), Partnership for Observation of the Global Oceans (POGO), Japan Society for the Promotion of Science (JSPS), and several national research funding agencies and private philanthropic foundations.

The funding provided by external sponsors will especially facilitate participation of early-career researchers at an international science conference, thereby providing these individuals the opportunity to experience international science and to learn about advances in marine science that are being made as part of IMBER activities. They are potentially the next generation of leaders in marine science and entraining them in international science at an early stage will benefit them and the larger marine research community, and ensure that all regional communities are an integral part of planning the future directions of a marine global environmental change research agenda.

### **China-Japan-Korea (CJK) IMBER Symposia**

The 6<sup>th</sup> China-Japan-Korea (CJK) IMBER Symposium focusing on “*Ocean Ecosystem Dynamics and Integrated Marine Biogeochemistry and Ecosystem Research*” will be held in October 2013 in Tokyo, Japan.

### **Continuation of the IMBER Regional Project Office**

The IMBER Regional Project Office (RPO), established under a MoU with the East China Normal University in 2010 for an initial three-year period, has been renewed for another three years (2013-2016). The RPO is an essential facilitator in the IMBER efforts to reach out to the related research community in the Asia-Pacific region, and a very active partner of the International Project Office in many of its activities.

## **E. IMBER SSC membership**

There are currently 15 IMBER SSC members. At the end of 2012, Dr. Mike Roman (Vice Chair) completed his second term of office on the SSC. The IMBER SSC nominated Dr. Tatiana Rynearson to fill this vacancy, and her nomination (2013-2015) was endorsed by IMBER’s sponsors (SCOR and IGBP). Dr. Alida Bundy replaced Dr. Roman as Vice Chair of the IMBER SSC.

At the end of 2013, Prof. Javier Aristegui (Vice Chair), Dr. Carol Robinson (Vice Chair), Dr. Jean-Pierre Gattuso and Prof. Nicolas Gruber will complete their second terms of office on the SSC. In February 2013, IMBER solicited the research community for nominations for their replacements with the following expertise, identified by the IMBER Executive Committee: human-ocean-human interactions, marine anthropology; marine/environmental economics; microbial ecology and biogeochemistry, meso-pelagic processes; carbon fluxes and budgets; biogeochemical modelling, carbon-climate interactions and ocean acidification. Fifty-seven submissions were reviewed extensively and a short list of nominees is now presented to SCOR and IGBP for their approval.

## **F. IMBER Cooperation**

### **Cooperation with the ‘Variability and predictability of the ocean-atmosphere system’ project (CLIVAR)**

CLIVAR ([www.clivar.org](http://www.clivar.org)), a core project of the World Climate Research Programme (WCRP), focuses on the role of the oceans in climate variability and change. Following several earlier, informal interactions, and thanks to the help of Ken Drinkwater, member of both IMBER and CLIVAR SSCs, the collaboration between the two projects have been increased: A joint meeting of the Scientific Steering Committees of IMBER and CLIVAR was held in June 2012 in La Paz, Mexico, to explore possible topics and ways for active CLIVAR-IMBER collaboration. The presentations from this meeting are available at [www.clivar.org/node/2509](http://www.clivar.org/node/2509). There is already interaction between the CLIVAR ‘Pacific Implementation Panel’, ‘Asian-Australian Monsoon Panel’ and ‘Indian Ocean Panel’ and the IMBER regional programmes. CLIVAR is also a co-sponsor of the IMBER ClimEco summer schools.

There has been discussion on the possibility of establishing a joint IMBER-CLIVAR working group to establish stronger links with the climate research community, on specific topics, such as upwelling regions; natural decadal/multi-decadal variability; bio-physical feedbacks; oxygen minimum zones; impact of ocean acidification on marine ecosystems; and ocean carbon uptake. Consideration is also being given to how both projects could evolve partly together also in the context of the ‘Future Earth’ initiative (with which WCRP will partner). Joint studies on marine biophysical interactions and the dynamics of upwelling systems, which are productive fisheries areas, were suggested as starting points. Eastern boundary upwelling systems, upwelling systems associated to western boundary currents and equatorial upwelling systems should be considered, in their geophysical and ecological variability and the anthropogenic changes (e.g., global warming, extreme events, ocean acidification) affecting them, that could be observed or forecasted therein. There is already a research effort underway by the IMBER regional programme, SIBER, and the CLIVAR Indian Ocean Panel on upwelling in the Eastern Indian Ocean. An informal IMBER-CLIVAR working team was assembled in early 2013 to consider possible research questions that an upwelling research initiative should address. Representatives from the IOC and the former GLOBEC regional programme on small pelagics (SPACC) were also included.

#### Future IMBER-CLIVAR-related activities:

- A workshop entitled “*Eastern Indian Ocean Upwelling Research Initiative Planning Workshop Phase 3 – Physical Dynamics and Ecosystem Responses*”, and two sessions on “*Environmental changes in Eastern Boundary Upwelling Systems: drivers, mechanisms and implications for the ecosystems*” and “*Climate-biogeochemistry interactions associated with open-ocean oxygen minimum zones*” will be co-convened by IMBER and CLIVAR researchers at the **IMBER OSC** in June 2014, Bergen, Norway.

#### **Partnership with Too Big To Ignore (TBTI)**

IMBER has partnered with the *Too Big To Ignore* initiative (<http://toobigtoignore.net>), a research network that aims to promote and revitalize small-scale fisheries around the world. Its main goal is to improve understanding of the real contribution of small-scale fisheries to food security, nutrition, sustaining livelihoods, poverty alleviation, wealth generation and trade, as well as the impacts and implications of global change processes such as urbanization, globalization, migration, climate change, aquaculture, and communication technology on small-scale fisheries. Many of the objectives of the IMBER HDWG coincide with those of the initiative, which is led by IMBER SSC member Ratana Chuenpagdee. The TBTI inaugural meeting was held in September 2012 in St. Johns, Canada and focused on working principles guiding the partnership, on workgroups and regional activities, and on partners’ and individual members’ contributions to TBTI network. Among other activities, TBTI is currently running two surveys on *who’s who in small-scale fisheries research* and on the *research priorities for small-scale fisheries*. Key publication of TBTI interest: Bavinck, M., Chuenpagdee, R., Jentoft, S. and Kooiman, J. (Eds.) (2013). *Governability of Fisheries and Aquaculture: Theory and Applications*. Springer. [ISBN 978-94-007-6107-0](#).

#### **Contributions to international assessments**

- Many SIC!-related research projects have contributed to a series of synthesis chapters for the Regional Carbon Cycle Assessment and Processes (RECCAP) effort ([www.globalcarbonproject.org/reccap/](http://www.globalcarbonproject.org/reccap/)). Several ocean-related papers are being published in *Biogeosciences* (see [www.biogeosciences-discuss.net/special\\_issue83.html](http://www.biogeosciences-discuss.net/special_issue83.html)).
- Many of these syntheses and other contributions from the IMBER-related research projects and IMBER regional programmes are included in the *fifth Intergovernmental Panel on Climate Change Assessment Report* (AR5) of the Intergovernmental Panel on Climate Change’ (IPCC, [www.ipcc.ch](http://www.ipcc.ch)). Richard Feely; Eileen Hofmann; Yukihiro Nojiri and James Overland are involved in Working Group I (*The Physical Science Basis*), and Kenneth Drinkwater; Jean-Pierre Gattuso; Yukihiro Nojiri and Carol Turley in Working Group II (*Impacts, Adaptation and Vulnerability*).
- IMBER researchers are involved in the United Nations ‘*Regular process for global reporting and assessment of the state of the marine environment, including socio-economic aspects*’, aka, UN World Ocean Assessment (UN-WOA; [www.worldoceanassessment.org](http://www.worldoceanassessment.org)).
- IMBER has provided comments on the European Space Agency (ESA) science strategy (2006), as inputs to the *ESA Living Planet Symposium* ([www.livingplanet2013.org](http://www.livingplanet2013.org)), taking place in September 2013, Edinburgh, UK.
- IMBER is now considering how best to contribute to the activities of the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES, [www.ipbes.net](http://www.ipbes.net)).

### **G. Communication, Publications**

#### **Communication and Outreach**

The IMBER Website, [www.imber.info](http://www.imber.info), remains our main communication tool, with about 250 unique visitors/days and about 14 clicks per visit.

The *IMBER Update Newsletter*, [www.imber.info/index.php/News/Newsletters](http://www.imber.info/index.php/News/Newsletters), is emailed to ~1,600 scientists three times a year, and re-directed through multiple channels to about 10,000 researchers:

- **Issue n°24** - August 2013, included articles about Science highlights from IMBIZO III, new endorsed project and the endorsed project POMAL
- **Issue n°23** - April 2013, included articles about Science Highlights from CLIOTOP, new National Contacts and the endorsed projects GENUS and AMT, and IMBER-related future events
- **Issue n°22** – Dec. 2012, included articles about research in the China Seas and Southern Ocean, the MEcoPAM endorsed project and the ICED regional programme.

- **Issue n°21** – Sept. 2012, included articles about the IMBER ClimECO3 summer school, the workshop organised by the IMBER Capacity Building Task Team, and Norwegian IMBER-related research.

The IMBER eNews Bulletin is published electronically every month, providing information about IMBER and IMBER-relevant activities and events. Calls for funding proposals, job opportunities, workshop and conference announcements are also included.

The IMBER contact database is continuously improved with about 3,600 contacts and detailed information for about 1,600 marine researchers.

The IMBER IPO YouTube channel was opened in October 2012 to disseminate the ClimEco3 *e*-lectures, [www.youtube.com/channel/UCinzjRz7\\_TKHEsn6uggCKlw](http://www.youtube.com/channel/UCinzjRz7_TKHEsn6uggCKlw) and has gathered more than 400 views. Recently, an IMBER Twitter channel, [https://twitter.com/imber\\_ipo](https://twitter.com/imber_ipo) has been developed.

The IMBER GCMD metadata portal has already been mentioned earlier (see, DMC).

Finally, the IPO and RPO staff and several IMBER researchers have presented more than a dozen IMBER poster and oral presentations at many national and international meetings.

### **Selection of IMBER Publications, 2012-2013**

- Ashjian C.J., H.R. Harvey, M.W. Lomas, J.M. Napp, M.I.F. Sigler, P.J. Stabeno and T.I. Van Pelt (2012). Understanding Ecosystem Processes in the Eastern Bering Sea. *Deep Sea Research Part II: Topical Studies in Oceanography*, 65-70, 1-316 – 23 papers
- Dawe E.G., F.J. Mueter, Ö.K. Pálsson (2012). Theme Section on “Effects of climate and predation on subarctic crustacean populations”. In: *Marine Ecology Progress Series*, 469, 191-306 – 9 papers
- Drinkwater K. and P. Pepin (2013). Norway-Canada Comparison of Marine Ecosystems (NORCAN). *Progress in Oceanography*, 114, 1-126. – 8 papers
- Drinkwater K.F., R.R. Hood and N. Mihalopoulos (Eds.) (2013). Large-scale regional comparisons of marine biogeochemistry and ecosystem processes - research approaches and results. *Journal of Marine Systems*, 109-110, p.1-176. – 13 papers
- Drinkwater K.F., G.L. Hunt Jr, O.S. Astthorsson and E.J.H. Head (Eds.). (2012). Comparative Studies of Climate Effects on Polar and Subpolar Ocean Ecosystems: Progress in Observation and Prediction. *ICES Journal of Marine Science*, 69(7), p.1119-1327 – 22 papers
- Friedland K.D., Stock C., Drinkwater K.F., Link J., Leaf R., Shank B., Rose J., Pilskaln C.H. and Fogarty M. (2012). Pathways between primary production and fisheries yields of Large Marine Ecosystems. *PlosOne*, 7: e28945. doi:1371/journal.pone.0028945.
- Friedrich T., Timmermann A. et al. (2012). Detecting regional anthropogenic trends in ocean acidification against natural variability. *Nature Climate Change*, 2, 167-171; doi:10.1038/nclimate1372
- Gaichas S., Gamble R., Fogarty M., Benoît H. et al. (2012). Assembly rules for aggregate-species production models: simulations in support of management strategy evaluation. *Marine Ecology Progress Series*, 459, 275-292.
- Gruber N., Hauri C., Lachkar Z., Loher D., Frölicher T. and Plattner G.K. (2012). Rapid progression of ocean acidification in the California Current System. *Science*, 337(6091), 220-223. doi: 10.1126/science.1216773.
- Hauri C., Gruber N., Vogt M., Doney S.C., Feely R. A., Lachkar Z., Leinweber A., McDonnell A. M. P., Munnich M., and Plattner G.K. (2012). Spatiotemporal variability and long-term trends of ocean acidification in the California Current System. *Biogeosciences Discuss.*, 9, 10371-10428, doi:10.5194/bgd-9-10371-2012.
- Hunsicker M.E., Olson R.J., Essington T.E., Maunder M.N., Duffy L.M., Kitchell J.F. (2012). Potential for top-down control on tropical tunas based on size structure of predator-prey interactions. *Marine Ecology Progress Series*, 445, 263-277
- Krause E., Wichels A., Giménez L., Lunau M., Schilhabel M. B. & Gerds G. (2012). Small changes in pH have direct effects on marine bacterial community composition: a microcosm approach. *PlosOne*, 7: e47035. doi:10.1371/journal.pone.0047035.
- Nisumaa A.M., Schlitzer R., Hansson L. & Gattuso J.P. (2012). EPOCA data management activities: a summary. See [www.imber.info/index.php/Science/Working-Groups/SOLAS-IMBER-Carbon/Subgroup-3/Publications-and-reports/EPOCA-data-management](http://www.imber.info/index.php/Science/Working-Groups/SOLAS-IMBER-Carbon/Subgroup-3/Publications-and-reports/EPOCA-data-management)
- Pedrotti M.L., Fiorini S., Kerros M.E., Middelburg J.J., & Gattuso J.P., (2012). Variable production of transparent exopolymeric particles by haploid and diploid life stages of coccolithophores grown under different CO<sub>2</sub> concentrations. *Journal of Plankton Research*, 34(5), 388-398. doi: 10.1093/plankt/fbs012.

- Perry I., A. Bundy and E. Hofmann (Eds.) (2012). Aquatic and marine systems. *Current Opinion in Environment Sustainability*, 3(3), p.253-374. – 17 papers
- Renner A.H.H., S. E. Thorpe, et al. (2012). Advective pathways near the tip of the Antarctic Peninsula: Trends, variability and ecosystem implications. *Deep Sea Research Part I: Oceanographic Research Papers*, 63, 91-101.
- Roy A.S., Gibbons S. M., Schunck H., Owens S., Caporaso J. G., Sperling M., Nissimov J. I., Romac S., Bittner L., Mühling M., Riebesell U., LaRoche J. & Gilbert J. A. (2013). Ocean acidification shows negligible impacts on high-latitude bacterial community structure in coastal pelagic mesocosms. *Biogeosciences*, 10: 555-566.
- Salinger J. (Ed.) (2013). Climate and Oceanic Fisheries. *Climatic Change*, 119(1) - 16 papers
- Steele J.H., E.E. Hofmann, D.J. Gifford and K. Aydin (Eds.) (2012). End-to-End Modeling: Toward Comparative Analysis of Marine Ecosystem Organization. *Progress in Oceanography*, 102, p.1-114. – 8 papers
- Wang Z.A., Wanninkhof R., Cai W.J., Byrne R. H., Hu X., Peng T.H. & Huang W.J., 2013. The marine inorganic carbon system along the Gulf of Mexico and Atlantic coasts of the United States: insights from a transregional coastal carbon study. *Limnology & Oceanography*, 58(1): 325-342.
- Williamson P., Wallace D.W.R., Law C.S., Boyd P.W., Collos Y., Croot P., Denman K., Riebesell U., Takedai S., Vivian C. (2012). Ocean fertilization for geoengineering: a review of effectiveness, environmental impacts and emerging governance. *Process Safety and Environmental Protection*, 90(6), 475-488. doi: 10.1016/j.psep.2012.10.007.

Overall, IMBER has produced about 900 refereed research papers since its implementation, including about 150 papers and 8 special issues published in 2012-2013.

## **H. Support from SCOR**

IMBER greatly appreciates the ongoing, key support received from SCOR, and the additional support to specific IMBER activities (especially, IMBIZO III and OSC 2014) provided by or channelled through SCOR, from other funding sources. In addition, IMBER welcomes the advice, assistance and information received from the SCOR President and secretariat, especially its Executive Director, Ed Urban, and Financial Officer, Liz Gross.

IMBER is requesting sponsorship to assist students and early career researchers from developing countries to attend the IMBER ClimEco4 summer school (August 2014, Shanghai, China).

## **I. Strategic development**

IMBER is concerned about the potential impact of the emergence of the Future Earth initiative (FE) and the discontinuation of IGBP in late 2015 on the future of the project. Overall, IMBER welcomes the development of FE as a global platform that will further research on global environmental change, with a focus on challenges and solutions that have been recognised as critical for global sustainability. In this respect, SCOR's views and guidance would be greatly appreciated by the IMBER research community.

IMBER is already engaged in research topics that address several of the FE objectives, and many of its coordination and networking activities match the integrated approaches desired by FE. IMBER researchers undertake mainly basic (i.e., fundamental, disciplinary, curiosity-driven) natural science research; however, IMBER is also engaged in interdisciplinary and integrated activities focused on research at the interface between human and natural sciences. Expanding the IMBER research community and its impacts through cooperation with other research initiatives (e.g., SOLAS, LOICZ, CLIVAR, GEOTRACES) and partner organizations (e.g., PICES, ICES, EUROMARINE, US-OCB) will facilitate furthering IMBER goals within the context of FE. Several telecons between the core projects of the GEC programmes and FE and its sponsors, including ICSU have taken place in the past 1.5 years. A dedicated IMBER-FE teleconference is scheduled in late October 2013, and the SCOR Executive Director will participate in this meeting.

IMBER would like to develop an open dialogue with FE in cooperation with its current sponsors, IGBP and SCOR. In this respect, IMBER has already received input from SCOR Executive Director regarding the FE initiative and possible co-sponsoring of IMBER in the future. This information has been transmitted to FE.

Along with these new developments, a request for a five-year IMBER project extension will be presented to SCOR by late summer/fall 2014, in order to help deliver further the IMBER mission and deepen and widen its overall impact.





## **ANNEX 1 – New Endorsed Projects** (as of August 2013)

IMBER has endorsed 35 research projects to date that contribute to the delivery of its objectives. During the last year, 5 new projects were endorsed:

### Variability of Ocean Ecosystems around South America (VOCES) (July 2013)

The overall goal of this project (January 2013 - December 2017) is to assess the impact of climate variability - both natural and anthropogenic - on the Humboldt, Patagonia and South Brazil Large Marine Ecosystems (LMEs). These ecosystems are amongst the most productive of the Southern Hemisphere, sustaining more than 20% of the global fish catch, hosting unique biodiversity and with CO<sub>2</sub> absorption rates comparable with the most significant uptake regions of the world's oceans. To achieve the project's goal we propose a two-pronged activity plan that, on the one hand, will synergize extant research programs through coordination efforts and, on the other hand, will fill research gaps left by those programs by encouraging collaborative research. We will link the efforts of scientists, educators and program managers from Argentina, Brazil, Chile, Peru, Uruguay and the USA.

(<http://sacc.coas.oregonstate.edu/~sacc>)

### Biogeochemical cycles in the SOUTHERN Ocean: Role within the Earth System (BIGSOUTH) (July 2013)

The BIGSOUTH project (January 2010 - November 2014) aims at achieving a detailed understanding of the processes controlling functioning and strength of the oceanic biological pump for representative key areas of the Southern Ocean (Atlantic sector (Weddell Gyre); Indian sector (30°E to Kerguelen Plateau); Australian sector (115° - 147°E); Ross Sea), including open ocean and sea-ice covered areas, in order to upgrade present-day assessments of the carbon sequestration capacity and nutrient cycling in the Southern Ocean and possible impacts on the global ocean. Therefore, we apply a unique combination of stable isotope (natural and spiked isotopic abundances), geochemical tracers, trace element and modelling tools to study the relevant biogeochemical processes and control factors (including Fe) acting on the fluxes of carbon and the two major macronutrients N and Si in the open and seasonally sea-ice covered water column. ([www.co2.ulg.ac.be/bigsouth](http://www.co2.ulg.ac.be/bigsouth))

### Sustainability of Marine Ecosystem Production under Multi-stressors and Adaptive Management (MEcoPAM) (June 2013)

The objectives of the MEcoPAM project (January 2011 - December 2015) are to identify and characterize the interactions of marine biogeochemical cycles and marine ecosystems, and to understand the response of typical marine ecosystem production to multi-stressors (such as physical processes, eutrophication, over-fishing and aquaculture), thereby improving our knowledge of the impact of multi-stressors on the sustainability of marine ecosystem production. The research areas include several unique sub-ecosystems in the Bohai Sea, Yellow Sea, and East China Sea (e.g., the hypoxia zone off the Changjiang Estuary, and aquaculture sites in the Shandong Peninsula). The program is structured around five sub-projects: (1) Biogeochemical Dynamics of Marine Ecosystems; (2) Nutrient Cycles and Response to Multi-stressors; (3) Hydrodynamic Response to Multi-stressors and its Impact on the Supply of Nutrients; (4) Microbial Loop and Coupling with Biogeochemical Cycles; (5) Feedback Mechanisms of Ecosystem Structure and Function to Climate Change and Human Activities. In addition to field observations of the physical, chemical and biological properties of ecosystems in East China Sea, Changjiang Estuary and the coastal area of the Shandong Peninsula, historical data analysis, numerical modelling and microcosm experiments will be undertaken. ([www.imber.info/index.php/Science/National-Network/CHINA/MEcoPAM-project-website](http://www.imber.info/index.php/Science/National-Network/CHINA/MEcoPAM-project-website))

*Atlantic Meridional Transect (AMT) (November 2012)*

The Atlantic Meridional Transect (AMT) is a multidisciplinary programme (1995-present) that undertakes biological, chemical and physical oceanographic research during an annual voyage between the UK and destinations in the South Atlantic - previously the Falkland Islands, South Africa and Chile. These ~50°N to ~50°S Atlantic transects cross a range of ecosystems from sub-polar to tropical and from euphotic shelf seas and upwelling systems to oligotrophic mid-ocean gyres. AMT informs on trends and variability in biodiversity and function of the Atlantic ecosystem during this period of rapid change to our climate and biosphere. AMT is unique in its ability to repeat measurements of core parameters on basin scales on long NS transects of the Atlantic and to provides a platform for excellent multi-disciplinary oceanographic research. This unique spatially extensive decadal dataset continues to be deposited and made available to the wider community through the British Oceanographic Data Centre. An integral part of the AMT, which has resulted in more than 60 completed PhD theses, is to provide a training arena for the next generation of oceanographers. This aim has been enhanced recently through the development of the POGO-AMT fellowship programme (<http://ocean-partners.org>) which supports the participation of students or early career professionals from developing nations. Participants in this fellowship programme benefit from working alongside experienced researchers in the development of research skills, the formation of collaborative links and capacity building for their home institutes and countries. ([www.amt-uk.org](http://www.amt-uk.org))

*Marine Ecosystems Response in the Mediterranean Experiment (MERMEX) (November 2012)*

MerMex (2011-2016) focuses on the understanding of the effects of key natural and anthropogenic forcings on ecosystems (from coastal zones to open-ocean, from pelagos to benthos) and organisms (from viruses to fishes) in Mediterranean Sea including western and eastern basins. Most of the Research objectives studied in MerMex were deduced from the Mermex article (*Progress in Oceanography*, 2011) in which ~100 co-authors so-called 'the MerMex group' presented current knowledge on biogeochemistry in the Mediterranean Sea and highlighted the uncertainty on the responses to global change in the 21th Century. (<http://mermex.com.univ-mrs.fr>)

## Appendix 7

### Surface Ocean – Lower Atmosphere Study (SOLAS)

#### *Annual Report from SOLAS to SCOR*

**Reporting period: June 2012- July 2013**  
**Version of 12 July 2013 by Dr Emilie Brévière**

#### SOLAS International Project Office, Kiel and Node Office, Norwich

The SOLAS Node Office (NO) was located at the University of East Anglia (UEA), UK, the former location of the IPO. The office was staffed by the project officer Kath Mortimer, funded by the UK NERC until the end of Sept. 2012, and benefited from the assistance of a student, Georgia Bayliss-Brown (former project officer) from June 2011 to August 2012 (10 hours per week), funded by IGBP block grant 2010-11. UEA provided office space and the Natural Environment Research Council (UK NERC) supported office activities until March 2012. The node shut down in Sept. 2012.

The SOLAS IPO is currently hosted at the GEOMAR Helmholtz-Centre for Ocean Research Kiel in Kiel, Germany. The office is staffed by the executive officer, Dr. Emilie Brévière, and the project officer, Stefan Konradowitz. GEOMAR provided office space and funds for both staff salaries until January 2013. The IPO activities were supported until January 2013 by the German Ministry of Education and Research (BMBF). The IPO in Kiel has benefited since August 2011 from the assistance of a student, Roberto Benavides (75 hours per month) funded by BMBF and from July 2012 to March 2013 from the assistance of another student, Jasmin Mögeltönder (75 hours per month), also funded by BMBF.

Since February 2013 and until January 2016, GEOMAR is providing office space and the salary of the executive officer, Dr. Emilie Brévière. The salary of the project officer, Stefan Konradowitz is covered by BMBF, via the SOPRAN Phase 3 funding. The IPO benefited until July 2013 from the assistance of Roberto Benavides (75 hours per month) funded by BMBF.

#### **SOLAS Scientific Steering Committee**

Since July 2011, Eric Saltzman (USA) has served as Scientific Steering Committee (SSC) Chair. Veronique Garcon (France) served as the SOLAS SSC Vice-Chair from July 2011 to Dec. 2012, and Cecile Guieu (France) has filled this role since May 2013. Ilan Koren from Israel joined the SSC in Jan. 2013. Since May 2013, SOLAS has had an Executive Committee composed of the Chair, Vice Chair, and SSC members Lisa Miller and Roland von Glasow. The 13<sup>th</sup> SOLAS SSC meeting was held in Tsukuba, Japan, on 27-30 May 2013. The current membership of the SSC is listed below:



Last name	First name	Country of employment	Gender	Scientific expertise	SOLAS expertise	Term end in 31 Dec
Dai	Min-Han	China-Beijing	M	Coastal carbon/acidification	Focus 3 - SIOA	2014
Engel	Anja	Germany	F	Microbial biogeochemistry, sea surface microlayer	MTS Marine Aerosols	2014
Gao	Huiwang	China-Beijing	M	Atmospheric deposition and ecological effect	MTS Nut Deposition - Task Team ADOES	2014
Gaiero	Diego	Argentina	M	Aerosol chemical composition/deposition	MTS Nut Deposition	2013
Garbe	Christoph	Germany	M	Air-sea physical interaction	Focus 2 - MTS EBUS - Liaison ESA	2013
von Glasow	Roland	UK	M	Atmospheric halogens/modelling	Task Team HitT- MTS Ship Plumes	2013
Graco	Michelle	Peru	F	Biogeochemical cycles in upwelling systems, OMZ	MTS EBUS	2014
Guieu	Cecile	France	F	Marine ecosystems/nutrients	MTS Nut Deposition	2014
Heinze	Christoph	Norway	M	Carbon cycle modeling/paleocean	Focus 3 - Paleo	2015
Koren	Ilan	Israel	M	cloud physics	Focus 1 - Cloud	2015
Miller	Lisa	Canada	F	Sea-ice/CO <sub>2</sub> exchanges	Focus 3 - MTS Sea Ice	2013
Nojiri	Yukihiro	Japan	M	Ocean carbon	Focus 3 - SIOA	2015
Quinn	Patricia	USA	F	Aerosols/atmos chemistry	MTS Marine Aerosols	2014
Saltzman	Eric S.	USA	M	Atmospheric chemistry	Focus 1&2	2014
Simo	Rafel	Spain	M	Ocean biogeochemistry /trace gases	MTS Marine Aerosols	2014
Stefels	Jaqueline	Netherlands	F	Sulfur cycle/sea ice	MTS Sea Ice	2013
Ward	Brian	Ireland	M	Air-sea physical interaction	Focus 2- Liaison WCRP	2013

In December 2013:

- Roland von Glasow and Jacqueline Stefels will rotate off the SOLAS SSC after two terms.
- Brian Ward, Christoph Garbe, Lisa Miller and Diego Gaiero will end their first terms on the SOLAS SSC.

#### SOLAS National Networks

Twenty-eight nations are part of the SOLAS network. Each has at least one representative:

Australia: Sarah Lawson and Andrew Bowie  
Belgium: Christiane Lancelot  
Brazil: Amauri Pereira de Oliveira

Canada: Maurice Levasseur  
Chile: Laura Farias  
China (Beijing): Minhan Dai

China (Taipei): Gwo-Ching Gong  
Denmark: Lise Lotte Soerensen and Mikael Sejr  
France: Remi Losno  
Germany: Hermann Bange and Ulrich Platt  
India: Dileep Kumar  
Ireland: Brian Ward  
Italy: Chiara Santinelli  
Finland: Gerrit de Leeuw  
Japan: Mitsuo Uematsu  
Korea: Kitack Lee  
Mexico: Jose Martin Hernandez Ayon

Netherlands: Jacqueline Stefels  
New Zealand: Cliff Law  
Norway: Abdirahman Omar  
Peru: Michelle Graco  
Russia: Sergey Gulev  
Spain: Rafel Simo  
Southern Africa: Carl Palmer  
Sweden: Katarina Abrahamsson  
Turkey: Baris Saglihoglu and Mustafa Koçak  
UK: Phil Williamson  
USA: Bill Miller

Starting in Jan. 2009, the national representatives of the SOLAS nations have been asked to report annually about the SOLAS activities in their countries. To facilitate the reporting effort, a template form is provided. In January 2013, 19 reports were received and posted on the SOLAS website. Information contained in the reports is a great source of information for the IPO to report to sponsors, but also to facilitate coordination of research and to distribute the results and progress from some nations to the rest of the SOLAS community via the Newsletters and the website. All the reports received during the reporting period are available in an Addendum to this report (see [http://www.scor-int.org/2013EC/SOLAS\\_National\\_Reports.pdf](http://www.scor-int.org/2013EC/SOLAS_National_Reports.pdf)).

#### **Development of the SOLAS Mid-term Strategy (MTS)**

Since 2008, SOLAS has supported the development of the Mid-term strategy (MTS) themes, identified as areas where progress can be accelerated significantly with the support of an international programme such as SOLAS. An overview article at the MTS themes was published in the journal *Environmental Chemistry* in early 2013.

Law C. *et al.* (2013) Evolving Research Directions in Surface Ocean - Lower Atmosphere (SOLAS) Science. *Environmental Chemistry*. Available on our SOLAS website and at [http://www.publish.csiro.au/view/journals/dsp\\_journals\\_pip\\_abstract\\_Scholar1.cfm?nid=188&pip=EN12159](http://www.publish.csiro.au/view/journals/dsp_journals_pip_abstract_Scholar1.cfm?nid=188&pip=EN12159)

The SOLAS News Issue 15 (Summer 2013) contains scientific articles relating to many of the MTS themes. Each theme is at a different stage in its implementation, but there is a major amount of scientific activity ongoing and planned:

#### **• Sea-ice biogeochemistry and interactions with the atmosphere**

Recent activities of the MTS on sea-ice are intrinsically linked to SCOR WG 140, co-chaired by Jacqueline and Nadja Steiner. Their first unofficial meeting took place during the SOLAS OSC 2012 in the United States. The Full Members met officially for the first time virtually via Skype in Dec. 2012 and they had their first in-person meeting in March 2013 at the Gordon Research Conference on Polar Marine Science in Ventura, California, USA. They met in plenary and in task groups, TG1 on Methodologies and intercomparisons, led by Lisa Miller and Lynn Russell; TG2 on Data collection, led by Klaus Meiners and Martin Vancoppenolle; and TG3 on Modelling, led by Nadja Steiner and Clara Deal.

TG1 has 3 primary goals: 1) The methodological survey is well underway, over 100 pages to be submitted to the e-journal *Elementa: Science of the Anthropocene-Oceans* by the end of summer; 2) for the intercomparison of methods, the idea is to bring ice cores back from the field, to set up the scene to have lab/ice-tank studies and ice camp; 3) either a biogeochemistry section of a guide of best practices is planned to be added to the next edition of Hajo Eicken's sea-ice methods book or a type of 'living' on-line document will be produced.

TG2 has 2 primary goals. For the first, the group started to produce data inventories. The first dataset on Chl-a from Antarctica has been published Meiners *et al.* GRL 39, 2012, doi:10.1029/2012GL053478; from the Arctic, Michel and Gosselin are collating the data. Other parameters such as POC/N, DOC/N, nutrients, temperature and bulk salinity will be added to the dataset at some point after a person is hired to do the task. For the second goal, the standardized data-collection protocol will be written into the review of the TG1 and/or the manual of best practices.

TG3 has four primary goals. 1) A short paper/report will be written by modelers to help observationalists to better understand what kind of data and variables modelers need. 2) An overall review paper on the ‘Role of sea ice in global biogeochemical cycles: emerging views and challenges’ has been published in *Quaternary Science* by Vancoppenolle et al. (2013). Some more review papers on major biogeochemical processes are being discussed (DIC-system, Fe and nutrient distribution, light penetration, algal release from ice, ice-atmosphere coupling). 3) Four different 1D-intercomparison exercises were identified (L. Tedesco): general phytoplankton, DMS, physical ice-ocean, ice-atmosphere: long time-series data sets are being identified for this exercise. 4) Link to regional modeling and global Earth system models: there is a strong link with activities within the AOMIP/FAMOS program.

WG 140 will meet two or three additional times; the next meeting is likely to take place in March 2014 in Hobart, Tasmania, in conjunction with the IGC sea-ice symposium. It was identified that small workshops would facilitate the progress of the MTS and in preparing for fieldwork.

Linkages are in place with BEPSII and OASIS (<http://oasishome.net/>). OASIS will be endorsed by SOLAS in the coming months.

In a near future the leader of the MTS will approach the WCRP core project CliC (<http://www.climate-cryosphere.org/>) and look into the MOSAiC initiative (Multidisciplinary Drifting Observatory for the Study of the Arctic Climate-<http://www.mosaicobservatory.org/index.html>).

#### • **Atmospheric control of nutrient cycling and production in the surface ocean**

In Dec. 2010, an EU COST Action 735-funded workshop took place in Istanbul, Turkey on “Atmospheric versus land based controls of nutrient cycling and production in the surface ocean: from fieldwork to modelling” (coord. C. Guieu and B. Salihoglu). After a set of rejections by *Science*, *Nature Geosciences* and *PNAS*, the authors of what is now more a research paper and includes new model runs envision to submit it to *Global Biogeochemical Cycles* (Guieu C., O. Aumont, A. Paytan, L. Bopp, C.S. Law, N. Mahowald, E. P. Achterberg, E. Mara  n, 2013, Complex biological responses to atmospheric deposition in Low Nitrate Low Chlorophyll regions of the ocean). Another clear outcome of this long publishing process is the birth of a new community composed of modellers and observers. Another product related to this theme and supported by SOLAS was a review paper was published in *Nature Geosciences*, as an outcome of the IGBP/SCOR Fast Track Initiative ‘Upper Ocean Nutrient limitation: processes, patterns and potential for change’. Moore et al., 2013, Processes and patterns of oceanic nutrient limitation, *Nature Geoscience*, doi:10.1038/ngeo1765. Finally, this MTS theme was largely covered in chapter 4 ‘Ocean-Atmosphere interactions of particles’ of ‘Ocean-Atmosphere Interactions of Gases and Particles’, which marked the end of COST Action-735. Lead Authors: G. de Leeuw and C. Guieu. Contributing authors (alphabetical): A. Arneth, N. Bellouin, L. Bopp, P. Boyd, H. Denier van der Gon, K. Desboeufs, F. Dulac, C. Facchini, B. Langmann, N. Mahowald, E. Maranon, C. O’Dowd, N. Olgun, E. Pulido-Villena, M. Rinaldi, E. Stephanou, T. Wagener.

With regard to conferences, two session topics under the theme ‘ocean and Atmosphere’ of the Goldschmidt 2014, CA, USA, June 9-13 are relevant to the MTS: ‘Atmospheric nutrient supply to the surface ocean’ and ‘Ocean acidification, nutrient availability and impact on ecosystems’.

Six national projects have been endorsed by SOLAS are related to this MTS. To achieve further progress, small thematic workshops on some hot topics, such as dust/ashes impacts, could be envisioned. The MTS leaders will get in contact with the bioGEOTRACES (<http://www.geotraces.org/science/biogeotraces>.) leaders (Phil Boyd, Carol Robinson and Maite Maldonado), especially on the dust/ash topic.

#### • **Air-sea gas fluxes at Eastern Boundary upwelling systems**

In the context of the EUR-OCEANS Flagship, Ivonne Montes started a post-doctoral fellowship in Sept. 2011 between Toulouse, Lima, and Kiel on this theme and will continue for an additional year at GEOMAR Kiel until September 2014. The ESA OceanFlux ‘upwelling’ project is progressing well (see later section). A series of field studies have been carried out: 1) the East South Pacific Cruises *Meteor*, German SFB754, Oct. 2012-March 2013. All cruises have been completed with great success; 2) a very successful SOPRAN *Meteor* cruise off Peru in Dec. 2012; 3) mesocosm experiments off Peru, between Feb. and Apr. 2015; 4) AMOP Mooring deployment carried out on Jan. 5, 2013. The mooring will be in place for 3 years; 5) Mooring site visit by R/V *Olaya* or R/V *Humboldt* in summer 2013; 6) AMOP Cruise hopefully early 2014, R/V *L’Atalante* and *Olaya* together; 7) Training of Peruvian

students: On the road course, ONTROC, IMARPE(?)–IGP–GEOMAR–LEGOS, 6 days between Feb. and Apr. 2014 in Lima, Peru.

Activities are underway to set up a meteorology and oceanographic station at Hormigas Islands (OceanSITES). The station is located close to the AMOP mooring. There is already a lighthouse at the site. A successful workshop sponsored by SOLAS, IRD/LEGOS, SOPRAN and IGP took place at IGP in Nov. 2012 entitled “Towards an integrative regional coupling in the EBUS”. It was co-organised by Ken Takahashi, Veronique Garçon and Boris Dewitte. A wide range of physical and biogeochemical topics were covered and a one-day series of talks for Peruvian students took place on the 28th. A SCOR Working Group proposal has been submitted on microbial biogeochemistry of low oxygen waters (OMZ mainly EBUS and coastal hypoxia) led by Sean Crowe from the University of British Columbia. The proposal is highly interdisciplinary, gathering biogeochemists, microbial oceanographers, modellers and physical oceanographers. Regarding the future plans, there will be 1) a plenary lecture on deoxygenation at the EUR-OCEANS Hot topics Conference in Las Palmas, Spain, 6-8 Nov. 2013; 2) session during the IMBER Open Science Conference in Bergen, Norway, 23-27 June 2014; and 3) a theme on Ocean Deoxygenation “Losing breath in the Ocean: what is next?” at the 46th Liege colloquium, 5-9 May 2014, Liege, Belgium. With regard to interaction between SOLAS, CLIVAR and IMBER, some discussions took place between Véronique Garçon and Ken Drinkwater from Bergen (CLIVAR SSG member and IMBER SSC member) to join forces on this MTS. Indeed, CLIVAR and IMBER have formed a group around a research opportunity on upwelling about a year ago and a report was written and presented by Drinkwater at the CLIVAR SSG meeting, early May 2013, Kiel, Germany. CLIVAR interest lies in the lack of resolution in the GCMs in upwelling areas that leads to biases in those GCMs and the role of large-scale circulation and its effects on upwelling variability. IMBER’s interest lies into the influence of upwelling on biogeochemistry and ecology in these regions. The leader was recently encouraged to contact GEOTRACES members and leaders of the PICES Working Group on North Pacific Climate Variability and Change (No. 27) chaired by Mike Foreman, Shoshiro Minobe and Emanuele Di Lorenzo.

#### • Ship plumes: impacts on atmospheric chemistry, climate, and nutrient supply to the oceans

A paper from Hasseløev et al. 2013 accepted in GRL informed that shipping contributes to ocean acidification, according to the global model study. Pre-2012 attempts to engage the ocean science community to focus on this topic were not so successful, although atmospheric scientists are interested. Recently, some projects on ship emissions, pollution and climate started, such as Clean North Sea Shipping and MeSMarT. A postdoc just started to work on impacts of ship emissions on the ocean at the Ocean University of China (Gao, Yao).

#### • Ocean-derived aerosols: production, evolution and impacts

A workshop took place in Raleigh, North Carolina on 4–6 June 2012 on “Status and prospects of sea spray aerosol research”. A summary paper from the workshop was accepted in *Atmospheric Science Letters*. Some recommendations were to ensure that the terminology is consistent among oceanographers, atmospheric scientists, etc., to create a size-resolved sea salt aerosols (SSA) observational database that includes composition, number concentration, etc. and to improve communication between interdisciplinary fields. A SOLAS workshop took place in Kiel, Germany, on 11–13 Dec. 2012 on ‘Marine polymer’, during which many questions were asked related to the “gel theory of marine aerosols”. The products of the meeting are not yet available. A SCOR WG 141 on Sea-Surface Microlayers, started in 2013, will contribute to the SOLAS MTS on ocean-derived aerosols. The group met at EGU in April 2013 but there is not yet a summary report from the meeting. Several field experiments have been planned and/or discussed: 1) WACS II, Western Atlantic Climate Study II, 17 days if ship time on RV *Atlantis* between Miami and Barbados with 30 scientists onboard in April–June 2014 with the goals to generate and characterize nascent SSA, simultaneously characterize the surface seawater properties and assess the relationships between SSA OC and ocean DOC and POC. 2) The PEGASO project (Plankton-derived Emission of Gases and Aerosols in the Southern Ocean) led by Rafel Simo has been funded. Its core activity is an oceanographic expedition to the Southern Ocean aimed at studying plankton production of aerosols and seeking evidence for biological influence in cloud waters. The cruise will be in Nov.–Dec. 2014 for 42 days. 3) The CORMORANT project (Cumulus Ocean Radiation Measurement Over a Natural Tropical Site), proposal was submitted to US DoE. The study area would be the Galapagos Islands, with field campaigns in Aug.–Sept. 2016 and March–Apr. 2017. The project scientific questions of relevance to SOLAS are the following: What is the relationship between boundary layer clouds, aerosols, air-sea fluxes and upper ocean properties around the relatively pristine region of the Galapagos? What are the effects of biological and organic sources of aerosols associated with ocean upwelling near the Galapagos on CCN and the evolution of clouds? How does the vertical structure of the boundary layer change with strong variations in the SST

and air-sea fluxes about the Galapagos and what is the impact on cloud properties. 4) the SOCRATES project (Southern Ocean Cloud, Rain/Radiation, Aerosol Transport Experimental Study) between New Zealand and Antarctica is likely in Jan.-Feb. 2018. The scientific questions related to SOLAS are the following: Why do models systematically under-predict cloud cover over the Southern Ocean, particularly on the pole-ward side of the storm tracks? What processes determine the concentrations of cloud-forming aerosols, cloud droplets and ice crystals over the Southern Ocean? The project is seeking endorsement from SOLAS.

### **SOLAS Open Science Conference 2015**

Plans for the OSC15 are well underway. The OSC15 will take place in Kiel, Germany at the Christian-Albrechts-Universität zu Kiel during the week of 14-18 September 2015. Advantages are that Kiel is easy to access internationally through Hamburg airport and a good shuttle services to Kiel in 1h-1.5h, hotels can be found in different price categories (from 50 to 120 euro per night), and it is a maritime environment where GEOMAR is located. The conference venue would be the University of Kiel. The capacity of the rooms available ranges from 20 to 800 seats. The meeting rooms are fully equipped, with space for poster boards, registration, and catering in the same building. The venue is not far from the centre of Kiel and good bus connections are available.

The local organising committee (LOC) has been formed and is composed of Hermann Bange (GEOMAR), Gernot Friedrich (Univ. Kiel), Christa Marandino (GEOMAR), Birgit Schneider (Univ. Kiel) and Emanuel Soeding (Future Ocean Cluster of Excellence Kiel).

The SOLAS OSC15 will be taking place in conjunction with two major events 1) the SOPRAN final meeting, to take place on the Monday, Sept. 14 (a day before the start of the OSC15) and 2) the OSC15 will be part of the Future Ocean Cluster of Excellence semester theme on “Processes at Ocean Interfaces: from science to society”. The OSC15 is one of the events of this summer theme; significant funding will then be dedicated to the OSC15. The Scientific Organising Committee will be composed of the SOLAS SSC and one member of the LOC. The first announcement was released in the SOLASnews Issue 15 in June 2013.

### **International SOLAS Summer School 2013 (<http://mel.xmu.edu.cn/solassummerschool/>)**

The 6<sup>th</sup> SOLAS Summer School will take place for the first time in Xiamen, China, from 23 Aug. to 2 Sept. 2013, after five editions of the school being held in Cargèse, Corsica, France.

The 6<sup>th</sup> SOLAS Summer School (SSS) is continuing the format and styles of previous SSSs, with adaptation in terms of special sessions and practicals made to better suit the local facilities and settings. Things are on track for holding another successful SSS. This time again the Summer School benefits from the generous support from numerous Chinese and international sponsors, including SCOR.

### **COST Action 735**

In late 2006, SOLAS was awarded networking funds from the European Coordination in the field of Scientific and Technical Research office (COST) for a dedicated ‘Action’ 735 which seeks to develop global air-sea flux data sets of gases and aerosols. The SOLAS IPO administered the networking funds.

The Action ended in October 2011 and to pull together its achievements, a final action event took place in November 2011 and a high-level textbook for publication in 2013 is currently underway. The book is entitled “Ocean-Atmosphere Interactions of Gases and Particles” and will be published by Springer. Information written on the Springer page:

<http://www.springer.com/earth+sciences+and+geography/earth+system+sciences/book/978-3-642-25642-4>

→ Arguably the only book dealing with exchange of energy including heat, chemicals and biological organisms across the interface between ocean and atmosphere

→ First synthesis of a set of disparate topics into a coherent treatment of the exchange of matter across the sea surface

→ Deals with a very important topic required for an understanding of how the earth system operates

The oceans and atmosphere interact in a myriad of ways, including the exchange of energy including heat, chemicals

and biological organisms across the interface between the two media.

In this book the leading experts in this field internationally provide a state of the art account of these exchanges, particularly concentrating on the exchange of chemicals. They examine how gases and particles formed in the oceans affect the chemistry and physics of the atmosphere when they move from ocean to atmosphere. They also demonstrate how material deposited into the oceans from the atmosphere affects the biogeochemistry of the oceans. The mechanisms by which these exchanges occur is critically presented.

One chapter is devoted to the role of oceans in the uptake of natural and manmade CO<sub>2</sub> examining the ocean as a source of greenhouse gases CH<sub>4</sub> and N<sub>2</sub>O to the atmosphere.

The final chapter shows the role that atmosphere-ocean interactions play in earth systems science.

Keywords → Atmosphere ocean interaction - Biogeochemistry - COST 735 - Chemical Exchanges - SOLAS - Trace gases - air-sea interface

Chapter 1: Short-lived trace gases in the surface ocean and the atmosphere

Chapter 2: Transfer across the air-sea interface

Chapter 3: Air-sea interactions of natural long-lived greenhouse gases (CO<sub>2</sub>, N<sub>2</sub>O, CH<sub>4</sub>) in a changing climate

Chapter 4: Ocean-Atmosphere interactions of particles

Chapter 5: Perspectives and Integration in SOLAS science.

Cost of the book: 53.45 euro

#### ***Fast-Track Initiatives***

In May 2009, IGBP launched two fast-track initiatives (FTIs) proposed by SOLAS and other IGBP core projects. Both FTIs were co-endorsed by SCOR and both came to an end in 2011. The FTI publications appeared in 2012/2013.

→ **Megacities and the Coastal Zone: air-sea interactions** (2009-2011). Scientific coordinators: Roland von Glasow (UEA, UK) and Tim Jickells (UEA, UK).

As the world's population and urbanisation increase simultaneously, so does the number of cities with over 10 million inhabitants – megacities.

Many megacities, such as Mumbai and Los Angeles, are located in coastal regions. This juxtaposition leads to particular environmental consequences that have a direct impact on the health and prosperity of people living in and around such cities. The environmental and ecological effects of the alteration of coastlines and input of sewage from cities have received much attention over the years. But the effect of urban atmospheric emissions on the adjacent coastal waters and that of emissions from coastal waters on urban air quality have received lesser attention.

The results of the workshop held in Norwich, UK in April 2010 were presented via a poster at the IGBP Planet Under Pressure conference, in March 2012, London, UK; at the SOLAS OSC2012, in May 2012, Washington State, USA and via an oral presentation at the EGU, April 2012, Vienna, Austria. A paper from the workshop was recently published in *AMBIO*:

von Glasow R et al. (2012) Megacities and Large Urban Agglomerations in the Coastal Zone: Interactions Between Atmosphere, Land, and Marine Ecosystems. *AMBIO*, doi: 10.1007/s13280-012-0343-9  
<<http://link.springer.com/article/10.1007/s13280-012-0343-9/fulltext.html>>

→ **Upper Ocean Nutrient Limitation: processes, patterns and potential for change** (2009-2011). The scientific coordinators are Mark Moore (NOCS, UK) and Matt Mills (Stanford Univ., USA). A workshop took place in Southampton, UK on 3-5 Nov 2010 to address the FTI-specific goals. An outcome of this workshop is a review paper published in *Nature Geoscience*:

Moore et al. (2013) Processes and patterns of oceanic nutrient limitation, *Nature Geoscience*. doi:10.1038/NGE01765



## Task teams

### **SOLAS/IGAC Task Team: Halogens in the Troposphere (HitT)**

The primary objective of the SOLAS/IGAC Halogens in the Troposphere task team (HitT) is to determine and quantify the importance of reactive halogen compounds in tropospheric chemistry and climate forcing. The goal of HitT is to facilitate international collaboration between laboratory, field, and model activities regarding tropospheric halogen chemistry especially in the following domains: polar regions, salt lakes, marine boundary layer (both remote and coastal), volcanoes, free troposphere, and urban areas.

The co-chairs are Roland von Glasow <mailto:R.von-Glasow@uea.ac.uk> (University of East Anglia, UK) and Ulrich Platt <mailto:ulrich.platt@iup.uni-heidelberg.de> (University of Heidelberg, Germany). Everyone interested by the activities of this task team can subscribe to the HitT mailing list at <http://www.hitt-task.net/>

### Activities of the past year:

- During the SOLAS OSC12 conference in Washington State, a discussion session took place on the "Climate impact of seasalt-derived Cl atoms" that explicitly focused on the importance of the reaction of the Cl atom with the greenhouse gas methane. A brief report was published in the SOLAS newsletter issue 14 (<http://www.solas-int.org/publications/latest-newsletter.html>).
- A session contributing to the HitT Task team took place at the AGU Fall meeting, 3-7 Dec 2012, San Francisco, CA, USA. Session: A075: Tropospheric Chemistry and Tropical Oceans, Conveners: Rainer Volkamer, Alfonso Saiz-Lopez, Mitsuo Uematsu, Roland von Glasow.
- A workshop on Climate impact of seasalt-derived Cl atoms took place on 17-19 December 2012 at GEOMAR in Kiel, Germany, led by Roland von Glasow and Eric Saltzman. The workshop was co-sponsored by IGAC. The report and meeting minutes are available on the SOLAS website at <http://www.solas-int.org/activities/task-teams.html>.
- A session AS3.2 'Halogens in the Troposphere' was organised at EGU General Assembly, 7-12 April 2013, Vienna, Austria. Conveners: R. von Glasow, R. Sander, R. Volkamer, J. Plane and A. Saiz-Lopez. <http://meetingorganizer.copernicus.org/EGU2013/session/11585>.
- Polar session at DACA 2013, 8-12 July 2013, Davos, Switzerland [http://www.daca-13.org/program/index\\_EN](http://www.daca-13.org/program/index_EN).

### Endorsed projects

Over the reporting period, SOLAS endorsed one project:

- DONUT-Dependence of Dissolved Organic matter cycling on atmospheric NUTrient inputs in the surface oligotrophic ocean. French project.

Information about obtaining support letters and endorsement are accessible on the new website. The endorsement submission forms and update reports will be shortly available on the SOLAS website. The submission form of the newly endorsed project and update reports received during the reporting period are available in an Addendum to this report.

### SOLAS- IMBER Carbon Group

Much of the science of SOLAS Focus 3 overlaps with IMBER and thus a joint SOLAS/IMBER Carbon Group (SIC) was formed during a meeting held in Colorado in Oct. 2005. This group is working in close collaboration with International Oceanic Carbon Coordination Project (IOCCP). The SIC group is currently subdivided into three working groups:

- **WG1-Surface Ocean Systems.** Chair: Andrew Lenton (Australia)
- **WG2-Interior Ocean.** Chair: Nicolas Gruber (Switzerland)
- **WG3-Ocean Acidification.** Chair: Jim Orr (France) since Nov 2012

### **WG1-Surface Ocean Systems**

To document SOCAT, two papers in *Earth Syst. Sci. Data* were published in 2013, 'A uniform, quality controlled Surface Ocean CO<sub>2</sub> Atlas (SOCAT)' by Pfeil et al. and 'Surface Ocean CO<sub>2</sub> Atlas (SOCAT) gridded data products'

by Sabine et al.. The SOCAT version 2 (1968-2011) was released on 4 June 2013 at the ICDC9. It includes 10.1 million fCO<sub>2</sub> data points from 2,660 cruises. A paper is in preparation by Bakker et al. in ESSD. SOCAT has been a huge community effort since 2007; there are more than 100 contributors and data providers with multiple sources of funding, but unfortunately no long-term funding. Scientific results using the SOCAT database have begun to be published, for example, Rödenbeck et al. 2013, *Ocean Science* and Schuster et al. 2013, *Biogeosciences*. The activity of the Global Carbon Project RECCAP 1990-2009, Regional Carbon Cycle Assessment and Processes also contribute to this WG1. RECCAP aims to establish the mean carbon balance of large regions of the globe at the scale of continents and large ocean basins, including their component fluxes by comparing and reconciling multiple bottom-up estimates with the results of regional top-down atmospheric inversions, with attribution to main flux components. As part of this project the ocean community, with input from more than 20 countries from different modelling and observational communities, has produced 5 papers, of which SOLAS/IMBER WG1 members have authored or co-authored 4 of the 5 papers. Results such as in Lenton et al. (2013), showing a revised estimate of global ocean uptake based on new wind products and a convergence between approaches at the annual mean and basin scales, were presented at the ICDC9. However, at seasonal and interannual timescales there is little agreement between models and approaches, particularly at high latitudes; there is still work to do in this area. It is therefore difficult to say much about robust trends and longer-term changes in key areas such as the Southern Ocean. There is a critical need for ongoing observations. Plans for RECCAP2 were discussed at ICDC9. There will be a joint session between the WG1 and WG2 of SIC and IOCCP on 'the ocean carbon cycle at a time of change: Data syntheses, analyses and modelling' at the IMBER Open Science Conference Future Oceans, 23-27 June 2014, Bergen, Norway. A small initial meeting sponsored by SOLAS took place as a side event at the ICDC9 in Beijing to start planning on the comparison of pCO<sub>2</sub>-based ocean CO<sub>2</sub> flux estimates. The event was organized by C. Rödenbeck. Discussions are underway about a potential meeting or side-meeting (e.g., IMBER 2014) to discuss the Southern Ocean and the detection of change in the marine biogeochemistry and the carbon cycle to contribute to the Southern Ocean Observing System (SOOS). Regarding future plans, it was mentioned that the WG1 would like to meet in person in the next year, maybe at the 2014 Ocean Sciences meeting in Hawaii.

Geoengineering is also increasingly discussed, with significant implications, analogous to volcanic eruptions, for which surface ocean feedbacks can be large. SIC WG1 may be able to contribute in a positive way to understanding this issue. WG1 plans on having a closer integration with WG3 given that many of expected changes with ocean acidification such as ecosystem structure, nutrient cycling and carbon uptake will be seen in the surface ocean.

### **WG2-Interior Ocean**

The members of WG2 met in Salt Lake City in Feb. 2012 and their next meeting is scheduled to take place at Ocean Sciences 2014. The global synthesis of the repeat hydrography initiative is progressing since 2009, but slower than originally planned; participants have encountered some data quality control issues. The next steps of the group with regard to reaching the objective of the synthesis (to determine the global-scale oceanic accumulation of anthropogenic CO<sub>2</sub> since the 1990s) are to create an ad-hoc steering committee to oversee and coordinate the synthesis (Tanhua, Ishii, Mathis and Gruber), to have a small workshop at the ICDC9 in Beijing in June, to propose sessions at Ocean Sciences 2014 and at IMBER OSC 2014, to organize a large workshop for Ocean Science 2014 and have the synthesis completed by mid-2014. Other activities of the group lie in Oxygen+ on Argo, which had a special session at Ocean Sciences meeting in Feb 2012. A SCOR working group on sensor calibration was accepted, led by Arne Körtzinger (Germany) and Ken Johnson (USA).

### **WG3-Ocean Acidification**

The most recent annual meeting from the group was on 13 May 2013 in Villefranche sur mer and 14 May 2013 in Monaco, supported financially by SOLAS. The SIOA proposed a central office as key to communicate, promote, and facilitate international OA research. The International Coordination Centre for Ocean Acidification Research (OA-ICC) is funded via IAEA and has been running since Jan. 2013. The Scientific Coordinator is Jim Orr, the Project Officer is Lina Hansson, and the programme manager is Michel Warnau. The office has an initial duration of three years. Its tasks are to implement overarching activities to accelerate advances internationally and avoid unnecessary duplication. A communication assistant is to be hired and a data curator to be hired and located in China. [www.oceanunderstress.com](http://www.oceanunderstress.com), [www.iaea.org/nael/OA-ICC](http://www.iaea.org/nael/OA-ICC), [oceanacidification.wordpress.com](http://oceanacidification.wordpress.com)



The activities of the center are to

- 1) Develop global observation network, leader Dick Feely;
- 2) Promote joint platforms and facilities, leader Ulf Riebesell;
- 3) Develop collaboration between natural and social sciences, leader Jelle Bijma;
- 4) Promote exchange of students and postdocs, leader Jelle Bijma;
- 5) Intercomparison exercises, leader Minhan Dai;
- 6) Joint ocean acidification experiments, leader Jim Barry;
- 7) Promote best practices in OA research, leader Jean-Pierre Gattuso;
- 8) Online bibliographic database, leader Jean-Pierre Gattuso;
- 9) Data management, leader Jean-Pierre Gattuso;
- 10) Capacity building, leaders Lisa Robbins and Nelson Lagos
- 11) Information sharing and communication, leaders Dan Laffoley and Carol Turley.

A side event at 9th International Carbon Dioxide Conference, in Beijing, China on 3-7 June 2013 took place on 'shaping tomorrow's carbon cycle research: knowledge gaps, international collaboration, and funding priorities'. The side event was organized by the SOLAS-endorsed EU project CARBOCHANGE and the European Commission. The summary of the discussion and a brochure on EU carbon cycle projects produced by the European Commission are available at <http://carbochange.b.uib.no/media-centre/public-outreach/>

#### SOLAS Project Integration

In mid-Feb. 2013, the SOLAS project Integration office in Norwich shut down. For the past 2 years the project integrator, Shital Rohekar, has worked with the aerosol community to assemble the available aerosol/rain data, which has been submitted to the British Oceanographic Data Centre (BODC). The database contains more than 1,200 data points and is available at

[http://www.bodc.ac.uk/solas\\_integration/implementation\\_products/group1/aerosol\\_rain/](http://www.bodc.ac.uk/solas_integration/implementation_products/group1/aerosol_rain/)

#### OceanFlux three projects update: collaboration between ESA and SOLAS

The European Space Agency (ESA) used funding from the project 'support to science element (STSE) OceanFlux' (STSE) to organise a topical conference entitled Earth Observation for Ocean-Atmosphere Interactions Science. ESA also led a special issue in *Ocean Science/Biogeosciences* Inter-Journal, closed in Jan 2013.

ESA has 3 OceanFlux projects established in collaboration with SOLAS:

- 1) 'Ocean-derived aerosols: production, evolution and impacts (OSSA)' main leader Gerrit De Leeuw, ending 31 Oct 2013, <http://oceanflux.fmi.fi>;
- 2) 'Air-sea flux of CO<sub>2</sub> and other long-lived radiatively active gases', main leader David Woolf ending 30 Nov 2013, <http://www.oceanflux-ghg.org>. The data processing system is online and will allow users to generate their own climatology using a huge selection of different model and EO datasets
- 3) 'Air-sea gas fluxes at Eastern boundary upwelling and Oxygen Minimum Zone', main leader Christoph Garbe, ending 31 Oct 2013, <http://upwelling.eu/>.

The end of the OceanFlux projects coincides with topical workshops: Sea Spray aerosol workshop for the OSSA theme, 30 Sept. and 1 Oct. 2013 in Galway, Ireland and 'air-sea Gas Flux Climatology, progress and future prospects' for the themes on GHGs and upwelling, 24-27 Sept. 2013, in Brest, France. ESA is very interested in continuing the collaboration with SOLAS though additional funding, depending on its budget. Possible future themes should be communicated to ESA in a near future.

Long time series of multi-sensor, gridded, global satellite data sets are being put together, designed for climate scientists by an ESA activity named Climate Change Initiative. Early data sets are now available. An overview of the relevant data set is included in the SOLAS Newsletter issue 15 released in June 2013. Also, ESA is updating its science strategy document from 2006. Key science challenges in 5 Earth systems domains (one being ocean) that satellite data can contribute to solving have been identified. A writing team is currently updating the challenges; SOLAS feedback has been invited. The SOLAS MTS paper will be passed to the writing team for information. Input will be invited online (details to come in Sept.) and there will be a feedback session at the Living Planet Symposium (9-13 Sept. 2013 in Edinburgh). Christoph Garbe will represent SOLAS at the Symposium, supported by ESA/IGBP

funds. Another new project (GlobCurrent) will start in the autumn on developing high-resolution ocean surface current information services for a wide variety of applications.

#### Other SOLAS activities

Additional activities involving an active IPO staff participation and/or use of SOLAS funding include the following:

→IGAC 2012 ‘Atmospheric Chemistry in the Anthropocene Conference’, Beijing, China on 17-21 Sept. 2012. SOLAS partially sponsored two speakers.

→PICES 2012 Annual Meeting “Effects of natural and anthropogenic stressors in the North Pacific ecosystems: Scientific challenges and possible solutions”, Oct. 12-21, 2012, Hiroshima, Japan. SOLAS sponsored Lisa Miller and two invited speakers to the sessions 10 and 14.

→Workshop on ‘Towards an integrative regional coupling in the Eastern Boundary Upwelling Systems (EBUS)’ 26-28 Nov. 2012, Instituto Geofísico del Perú (IGP), Lima, Peru  
Contribution to the SOLAS Mid-Term Strategy initiative on “Air-sea gas fluxes at Eastern boundary upwelling and Oxygen Minimum Zone (OMZ) systems”

→Workshop on ‘Marine gels and their impact on atmospheric aerosol and cloud’, 11-13 Dec. 2012, GEOMAR, Kiel, Germany. Co-sponsored by IGAC. Contribution to the SOLAS Mid-Term Strategy initiative on “Ocean-derived aerosols: production, evolution and impacts”

→Workshop on HitT- Climate impact of seasalt-derived Cl atoms, 17-19 Dec 2012, GEOMAR, Kiel, Germany. Co-sponsored by IGAC. Contribution to the SOLAS/IGAC Task Team HitT

#### SOLAS communication

SOLAS website: <http://www.solas-int.org/>

The new SOLAS website was launched in early November 2012. It is hosted in Germany and has a clearer navigation system. This website is mobile device-friendly and can host password-protected pages. All comments about it are welcomed by the IPO.

As a consequence of the staff shortage that occurred in 2012, it was decided at the SOLAS Executive Committee meeting in September 2012 that the project would issue only one newsletter per year from 2012 on instead of two. The issue 14 was published in September 2012 and focused on the SOLAS Summer School (SSS) 2011 and the Open Science Conference 2012; the scientific contributions were from former SSS students. Issue 15 was distributed in June 2013. It proposes a general update on various topics of SOLAS science and is organised by sections.

The SOLASNews newsletter emailed to ~2000 scientists and airmailed to ~150 scientists mainly, from developing countries. Copies are held by the SOLAS IPO for distribution at SOLAS-relevant conferences and meetings. The Newsletter is also available from the website. The SOLAS News is printed and airmailed from China courtesy of State Key Laboratory of Marine Environment Science, Xiamen University. Since issue 11, SOLAS also implemented an on-screen reader pdf version.

Regarding publications, the COST 735 synthesis book is currently with the publisher Springer to formatted and released in 2013, and an article in *Environmental Chemistry* entitled ‘Evolving research directions in Surface Ocean – Lower Atmosphere Study (SOLAS) science’ by Law et al. was published early in 2013 and describes the five SOLAS Mid-term Strategy themes.

E-bulletins are sent to over 2000 SOLAS scientists roughly every 6 weeks and previous issues are archived on the website at <http://www.solas-int.org/archive.html>. The bulletins contain news from SOLAS, opportunities for meetings, abstract submission deadlines, recent publications, vacancies and news from relevant partner project and collaborators.

## Appendix 8

### GEOTRACES SCIENTIFIC STEERING COMMITTEE ANNUAL REPORT TO SCOR 2012/2013 July 2013

#### SCOR Scientific Steering Committee (SSC) for GEOTRACES

The SSC membership (listed above) includes members from 14 different countries, with diverse expertise, including marine biogeochemistry of carbon and nutrients; trace elements and isotopes as proxies for past climate conditions; land-sea fluxes of trace elements/sediment-water interactions; trace element effects on organisms; hydrothermal fluxes of trace elements; tracers of ocean circulation; tracers of contaminant transport; controls on distribution and speciation of trace elements; and ocean modelling.

#### **1. SSC meeting**

The seventh meeting of the GEOTRACES SSC was held on 29-31 October 2013 in Goa, India. The meeting was hosted by Sunil Kumar Singh from the Physical Research Laboratory (a Unit of Department of Space Government of India, Ahmedabad, India).

The meeting was attended by 16 members of the 2011/2012 SSC. Other attendees included Bob Anderson (Past SSC co-chair); Chris Measures (Co-chair of the Data Management Committee); Reiner Schlitzer (Co-chair of the Data Management Committee); Greg Cutter (Chair of the Standards and Intercalibration Committee); Ed Urban (SCOR); Ed Mawji (GEOTRACES Data Assembly Centre); and Catherine Jeandel (GEOTRACES International Project Office).

The morning of the first day was spent in presentations of national reports detailing GEOTRACES activities of the last year in 16 countries and also of the COST Action ES0801 (EU cross-national activities). The afternoon started with presentation of activities of the International Project Office. Subsequent discussion addressed GEOTRACES publications and outreach. The day concluded with a review of the international partnerships.

The morning of the second day of the SSC meeting focused on data management and intercalibration. An important discussion item was the Intermediate Data Product to be released in Spring 2014. During the afternoon, the GEOTRACES section cruises were reviewed. This included a presentation of the GEOTRACES International Arctic Program, the GEOTRACES Mediterranean Cruise plans, and the BioGEOTRACES initiative. The day ended with discussion about GEOTRACES funding and rotations of SSC and Data Management Committee (DMC) members.

The third and final day of the SSC meeting started with a review of the applications from ten studies to become GEOTRACES Process Studies. Subsequent discussion addressed past and future GEOTRACES workshops and special sessions at scientific meetings. The meeting concluded with a discussion of GEOTRACES capacity building activities.

The next SSC meeting is scheduled for 2-4 October 2013 in Bremerhaven (Germany) and will be hosted by Reiner Schlitzer at the Alfred Wegener Institute for Polar and Marine Research.

#### **2. GEOTRACES Intercalibration**

The GEOTRACES Standards and Intercalibration (S&I) Committee (G. Cutter, Chair; P. Andersson, L. Codispoti, P. Croot, R. Francois, M. Lohan, H. Obata, and M. van der Loeff) met on 1-3 May 2013 at the Swedish Museum of Natural History in Stockholm, Sweden to review Atlantic Ocean crossover station results and discuss several issues of relevance to the committee; the meeting was hosted by Per Andersson. The S&I Committee's charge is to ensure

that accurate and precise data are generated in the GEOTRACES Program through the use of appropriate sampling protocols, analytical standards, and certified reference materials, and to ensure the active sharing of methods and results. There are few reference materials that actually represent real ocean waters, so as much as possible GEOTRACES cruises occupy stations along their transects that have been occupied by another GEOTRACES cruise, thus creating the "crossover" stations. Data from these crossover stations, particularly those in deeper waters, can be directly compared and if statistically significant differences are found, the investigators who generated the data can work together to resolve any underlying issues, for example, differences in calibration or blanks. To date, the S&I Committee has now examined more than 8,000 data points for trace elements and isotopes, mainly in the Atlantic Ocean, and water column hydrography (temperature, salinity, nutrients, and oxygen concentrations as a function of depth). Much of the data reviewed will be incorporated into the 2014 GEOTRACES Intermediate Data Product. Notices related to the S&I Committee evaluations have been sent to all the data suppliers, and the Committee will meet again in late September 2013 for a re-evaluation of results that have been resubmitted after a thorough intercalibration by the cruises' participants.

Another significant activity in 2012-2013 was the publication of further results from the GEOTRACES Intercalibration Program in a special issue of *Limnology and Oceanography: Methods* entitled, "Intercalibration in Chemical Oceanography: <http://www.aslo.org/lomethods/si/intercal2012.html>. The editors of this special volume are Greg Cutter (USA), Peter Croot (UK), and Per Andersson (Sweden).

### **3. Data Management for GEOTRACES**

The GEOTRACES Data Assembly Centre (GDAC) is hosted by the British Oceanography Data Centre (BODC), Liverpool, UK. GDAC is responsible for all GEOTRACES data activities from start to finish, including interacting with the Principal Investigators (PI) and national data centres, and will eventually become the central point for all GEOTRACES data.

The office is staffed by a single person: Edward Mawji. Under the present data model, GDAC will not contact a project scientist directly (unless the PI has granted prior permission) and all requests for data are channeled through the local/national data centers. This requires GDAC to have a good working relationship with each national data office. Considerable effort is spent each year trying to establish and maintain good working relationships with national data centers.

#### ***Working with the IPO***

A good working mechanism has been established between GDAC and Elena Masferrer Dodas at the IPO. Information is freely exchanged between the two sites. The IPO has helped GDAC keep up to date with new developments and upcoming cruises; this has been especially important in 2012/2013 with so many GEOTRACES process studies approved at the 2012 SSC meeting.

#### ***Website progress***

In 2011/2012, there was a desire from the GEOTRACES SSC and DMC to have a map interface as the front page of the GEOTRACES data management site hosted by BODC. In response to this request an interactive world map has been developed to aid in cruise and data discovery in a visual manner. With the list of GEOTRACES section cruises and process studies growing, such a capability greatly facilitates navigation.

The following functionalities were developed:

- An interactive map with the ability to load different layers. The layers available are past, future and process studies cruise lines.
- Cruise lines that are mouse-sensitive. When users rest the mouse over such elements they (1) obtain cruise names and (2) obtain a dropdown menu with links to cruise meta-information (dates, chief scientists, parameters/responsible PIs and data holdings).

A working version of this tool is available on the GDAC Web site; however, additional development is required to fix some obvious bugs. After the final version is released, a major Web site overhaul is planned by GDAC to make the maps and delivery mechanism more prominent on the Web site.

### ***GEOTRACES Intermediate Data Project***

In 2014, GEOTRACES plans to release an Intermediate Data Product. In preparation for this product, GDAC has been working closely with the GEOTRACES S&I Committee. Over the past 12 months, GDAC has spent considerable effort collecting and preparing files for the S&I meeting in May 2013. This involved compiling data from crossover stations and producing XML method documentation.

In preparation for the final intermediate data product, GDAC has started to load intercalibrated data from the IPY and GEOTRACES cruises into BODC's database (only data approved by the S&I Committee will be loaded into the database). Detailed data and metadata checks are required and final XML method and quality control documents need to be created.

### ***Data overview***

The data management of the project is now a huge undertaking, with 46 cruises associated with GEOTRACES and 815 data sets identified in BODC's database (expected to rise once missing metadata forms are submitted). More than 200 scientists have taken part in GEOTRACES cruises, with 14 different nations having run a major GEOTRACES/IPY section cruise or process study.

2012/2013 has been a relatively successful year; considerable progress has been made collecting data. With the Intermediate Data Product to be released in 2014, the GEOTRACES research community has made a massive effort to submit data to national data centers and GDAC. U.S. scientists have led the way, with the U.S. Biological and Chemical Oceanography Data Management Office (BCO-DMO) deserving a special mention for working with GDAC.

However, GDAC has noticed a problem with the quality of metadata being submitted. In 2012/2013, a significant amount of time and effort was wasted investigating missing metadata. Unfortunately, data are being submitted with no event information (e.g. CTD cast number), no reference to the bottle the sample was collected from and no methodology. All this information is required to meet the data management principles of BODC and GEOTRACES. This problem has arisen for several reasons. Some data centers do not require the same level of metadata as BODC and hence scientists were never asked by their national data centers to submit these metadata.

This problem is mainly an issue for older IPY/GEOTRACES cruises that make up a large proportion of the IDP. The creation of metadata after the cruise is possible, but time-consuming.

The problem has been reduced somewhat by designing metadata forms for GEOTRACES cruises and encouraging use of these forms.

### ***Summary of GEOTRACES cruises***

- 14 IPY cruises
- 2 compliant cruise
- 11 process studies
- 19 GEOTRACES cruises -13 sections

### ***GEOTRACES section cruises:***

GEOTRACES sections- 19 cruises

Pacific Ocean	GP13	2 cruises Australia and New Zealand
Pacific Ocean	GP03	1 cruise Japanese
Pacific Ocean	GP12	1 cruise France
Pacific Ocean	GP18	1 cruise Japanese
Pacific Ocean	GP02	1 cruise Japanese
Indian Ocean	GI04	1 cruise Japanese
Indian Ocean	GI03	1 cruise India
Atlantic Ocean	GA02	3 cruises Netherlands
Atlantic Ocean	GA10	2 cruises UK
Atlantic Ocean	GA06	1 cruise UK

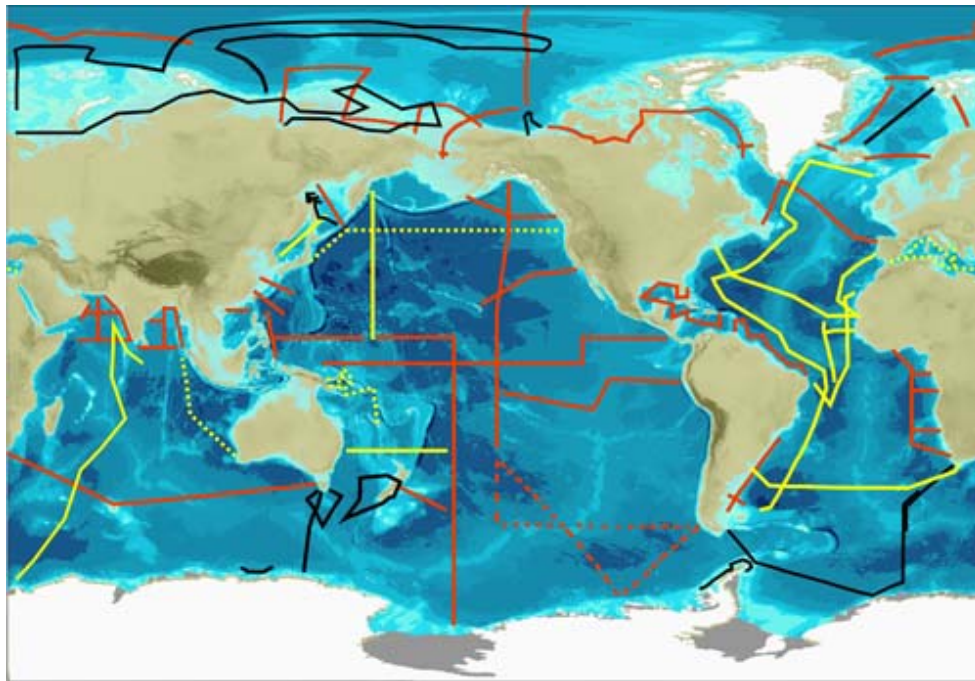
Atlantic Ocean	GA11	1 cruise Germany
Atlantic Ocean	GA03	2 cruises USA
Mediterranean Sea	GA04N	1 cruise Netherlands
Mediterranean Sea	GA04S	1 cruise Spain

With the vast quantity of data from these cruises expected in 2013/2014, it becomes apparent that data need to be submitted by the time line specified. As ever, it is vitally important that scientists submit data following the GEOTRACES/BODC submission guidelines to ensure smooth processing and archiving.

In summary, GDAC policies are proving effective with clear results; PIs are following guidelines and metadata are being submitted.

#### **4. Status of GEOTRACES Section Cruises**

The anticipated decade-long field program is now well underway and is enjoying a successful implementation (Figure 1).



**Figure 1.** Status of GEOTRACES global survey of trace elements and their isotopes. In black: Sections completed as GEOTRACES contribution to the International Polar Year. In yellow: Sections completed as part of the primary GEOTRACES global survey (dotted yellow, completed during the past year). In red: Planned Sections. An updated version of this map can be found on the GEOTRACES home page <<http://www.geotraces.org>>.

#### **5. GEOTRACES International Project Office**

The GEOTRACES International Project Office (IPO) is based at the Laboratoire d'Etudes en Géophysique et Océanographie Spatiales (LEGOS) in Toulouse, France. The IPO is staffed by a single person, the IPO Executive Officer, Elena Masferrer Dodas. She works under the scientific supervision of Catherine Jeandel (CNRS, LEGOS, France). Ms. Masferrer Dodas was on maternity leave from 19 October 2012 to 25 March 2013. During this period, the GEOTRACES IPO was staffed by Ms. Paule Dossi.



The IPO is responsible for assisting the GEOTRACES SSC in implementing the GEOTRACES Science Plan and implementation plans of the program; organizing and staffing meetings of the SSC, working groups and task teams; liaising with the sponsors and other relevant organizations; seeking and managing program finances; representing the project at international meetings; maintaining the project Web site and mailing lists; assisting the GDAC in securing information about upcoming cruises; and interacting with GEOTRACES national committees and groups, as well as with other international projects.

The IPO spent additional time on the following tasks in the past year:

**Outreach:** Two new items deserve description:

*GEOTRACES eNewsletter:* The e-Newsletter has been set up in order to disseminate the main scientific results of the GEOTRACES Program and inform about all GEOTRACES activities. It is a bimonthly on-line publication available on the Web site and distributed through the GEOTRACES International mailing list. It includes highlights of main scientific results of GEOTRACES, summaries of GEOTRACES activities, GEOTRACES news, information about upcoming events (cruises, workshops, etc.) and the latest GEOTRACES-related papers published. The first issue was published in February 2013, with a total of 3 issues published so far. This publication replaces the previous *Science Highlights Newsletter*.

*Outreach Library:* To complement the educational material compilation, the IPO is assembling materials (images, figures, videos, etc.) to create a collection of compelling slides that show GEOTRACES results and work. These materials will be available on the GEOTRACES Web site for anyone to include in their presentations and help advertise the success of the program.

*GEOTRACES Facebook page:* The IPO has set up and maintains a GEOTRACES Facebook page as requested by the SSC during last meeting. So far, 72 persons follow this page regularly. The GEOTRACES Facebook page is available on the following link: <https://www.facebook.com/pages/GEOTRACES/255668524559825?ref=stream>

**Communication tools:** The GEOTRACES IPO has continued to improve and maintain the following communication tools:

*GEOTRACES Web site* <<http://www.geotraces.org>>: The project Web site, which provides up-to-date information about the GEOTRACES cruise program and all GEOTRACES activities, has been overhauled this year. It has a new layout while maintaining the same structure. It also has new functionalities, such as the possibility to link the articles directly to Facebook, a GEOTRACES eNewsletter archive Web page, the possibility to create groups of users and make some pages (for instance, forum streams) only accessible to certain of these groups, etc. Maintaining and upgrading the program Web site has consumed a considerable part of GEOTRACES IPO time this year.

The following addition to the Web site is worth describing:

\*National and Regional Activities map: An interactive map has been set up on the GEOTRACES site. The map provides information about national representatives contact details and activities: <http://www.geotraces.org/science/national-activities>.

*GEOTRACES Poster:* A poster to be presented at international meetings and conferences has been designed and presented to several international conferences. A customizable template is available on the private GEOTRACES site.

*Brochure:* A brochure is available on the GEOTRACES Web site and printed copies can be requested from the GEOTRACES IPO.

**Databases:** The IPO is responsible to maintain the following databases:

*GEOTRACES Peer-reviewed Papers and PhD Dissertations & Masters thesis Databases:* Both databases have been set up by the IPO using the Mendeley free academic reference manager and they are available on the GEOTRACES Web site. The IPO updates them. This year, as requested by the SSC, the PhD dissertation database has been extended

to include Master's theses. So far, 171 GEOTRACES peer-reviewed papers and 14 GEOTRACES-related PhD Dissertations and Master Thesis have been included.

*GEOTRACES Researchers Database:* The IPO worked with the GEOTRACES S&I Committee and the GEOTRACES Intercalibration Coordinators to set up a database of GEOTRACES Researchers' Analytical Expertise. 111 researchers have registered their expertise in the database so far. The S&I Committee has now validated the information for each researcher.

Other main tasks for the GEOTRACES IPO this year have included:

*Funding:* The GEOTRACES IPO has concluded one new funding agreement with the Alfred Wegener Institute (AWI) for Polar and Marine Research (Germany). The contribution initially envisaged for one year (2012) has been extended for another year (2013). French funding has been assured for one year more. Several meetings were held with sponsors.

*Assisting GDAC:* The GEOTRACES IPO is working closely with the GDAC and helps it to secure up-to-date information about new developments and upcoming cruises. This year, it was particularly important to compile information about the 8 new Process Studies approved during 2012 GEOTRACES SSC meeting.

*Meeting organization:* The GEOTRACES IPO helped to organize the GEOTRACES Latin American Workshop (12-15 November 2012, Rio de Janeiro, Brazil), the Russian GEOTRACES Workshop (27-29 November, Moscow, Russia) and the upcoming 2013 SSC and join Data Management and S&I Committee meetings (29 September – 4 October 2013, Bremerhaven, Germany).

## **6. GEOTRACES Science Highlights**

### **GEOTRACES scientists discover new variability in iron supply to the oceans with climate implications**

Researchers based at the National Oceanography Centre Southampton (UK) and at the University of South Carolina (USA) have found that the amount of dissolved iron released into the ocean from continental margins displays variability not currently captured by ocean-climate prediction models. This could alter predictions of future climate change because iron, a key micronutrient, plays an important role in the global carbon cycle. The amount of iron leaking from continental margin sediments was previously assumed to reflect rates of microbial activity within the sediments. Dr. William Homoky and co-authors found that the rate of iron release from seafloor sediments close to continents is actually far more varied between regions because of local differences in weathering and erosion on land. The results of this study are published in *Nature Communications*:

[http://www.geotraces.org/images/stories/documents/Publications/13\\_Homoky/ncomms3143.pdf](http://www.geotraces.org/images/stories/documents/Publications/13_Homoky/ncomms3143.pdf)



**Figure 2.** The image shows a satellite-captured view of a productive ocean margin in the western South Atlantic Ocean. Visible milky-blue swirls of ocean colour are blooms of tiny phytoplankton taking up carbon dioxide in the surface ocean. These blooms are caused by ocean currents, which stir nutrient-laden waters from the continental margins into the sunlit surface ocean. Rivers, like the South American Río de la Plata or River Plate shown here, are an important source of nutrient-rich material to shelf systems. Credit: NASA <http://visibleearth.nasa.gov/view.php?id=75351>

### **Latest Recommendations for Successful Analysis of Dissolved Osmium in Seawater**

Analysis of osmium in seawater presents complex challenges, linked to its very low (femtomolar) concentrations and multiplicity of possible oxidation states. Early insights were provided by Karl Turekian's group at Yale where it was realized that osmium tends to concentrate both in oxidizing Fe-Mn nodules and in reducing organic-rich marine sediments. Efforts to directly



measure the seawater osmium isotope composition and concentration began in earnest following the developments in early 1990s of highly sensitive N-TIMS and ICP-MS. Initial techniques that attempted to pre-concentrate osmium using column chromatography (Minoru Koide and collaborators at Scripps Institution of Oceanography) and co-precipitation (Mukul Sharma and collaborators at Caltech) were only partially successful, due to a lack of equilibrium between seawater and tracer osmium. A breakthrough came in 1998, when Sylvain Levasseur in Claude Allegre's group in Paris simultaneously oxidized and pre-concentrated osmium in liquid bromine at 90°C. Oliver Woodhouse and coworkers at the Woods Hole Oceanographic Institution developed another procedure of directly distilling osmium from seawater and sparging it into an ICP-MS. These procedures appeared robust but yielded conflicting results. Subsequent work at Dartmouth (Sharma and collaborators) and Nancy (Maxence Paul and collaborators) has demonstrated that much higher temperatures and longer durations are required to fully equilibrate sample and tracer osmium. The complexities involved in storage of seawater osmium have also become apparent (see link to *Eos* report below). These findings resulted from U.S. National Science Foundation-funded GEOTRACES intercalibration efforts in the Pacific and Atlantic oceans. The new insights call into question much of the earlier data on the marine distribution of this important biogeochemical tracer and raise new issues: How actively is osmium cycled in the water column? What is the relative importance of the various sources? How important are anthropogenic inputs? The workshop on "Dissolved Osmium Isotope Analysis" held at the Palais de Congrès de Montreal on 24 June 2012 before the annual Goldschmidt Conference summarized the latest recommendations for successful seawater osmium analyses.

Reference:

Peucker-Ehrenbrink, B., M. Sharma, and L. Reisberg (2013), Recommendations for Analysis of Dissolved Osmium in Seawater, *Eos Trans. AGU*, 94(7), 73.

For further information: <http://onlinelibrary.wiley.com/doi/10.1002/2013EO070006/abstract>

#### A global compilation of dissolved iron measurements: focus on distributions and processes in the Southern Ocean

A data synthesis effort recently compiled more than 13,000 observations of dissolved iron concentrations that more than doubled the previous data compilation. A systematic analysis of the distribution of data in the Southern Ocean was performed using four regions, six basins and five depth intervals as a framework. Substantial variability in the depth-dependent trends were found between different basins and regions, which were indicative of the possible underlying influence of ocean physics, chemistry and biology. Alessandro Tagliabue's and co-authors (Tagliabue et al. 2012) analysis was able to highlight where observations are lacking in particular regions and times of year, which they hope will assist future sampling efforts. *Overall, more observations have been collected in the past 5 years under the auspices of the International Polar Year and GEOTRACES efforts than were collected in the prior ~15 years.* Nevertheless, despite this progress the seasonal cycle of iron that can be extracted from the well-sampled region south of Tasmania remains enigmatic. From more than 160 observations, the authors found little evidence of 'winter recharge' in iron concentrations and instead find the highest iron concentrations to be coincident with the highest phytoplankton biomass levels. This might reflect gaps in seasonal sampling between July and November or the influence of the so-called 'ferrous wheel' in driving the recycling of iron. This clearly highlights the need for more measurements of iron at 'seasonal transitions', even in well-sampled areas.

This dataset will prove useful for other regional synthesis studies or the evaluation of ocean biogeochemical models. It continues to be maintained by A. Tagliabue and is available from [GEOTRACES Data Assembly Centre web site](http://www.bodc.ac.uk/geotraces/) (<http://www.bodc.ac.uk/geotraces/>) and [http://pcwww.liv.ac.uk/~atagliab/LIV\\_WEB/Home.html](http://pcwww.liv.ac.uk/~atagliab/LIV_WEB/Home.html).

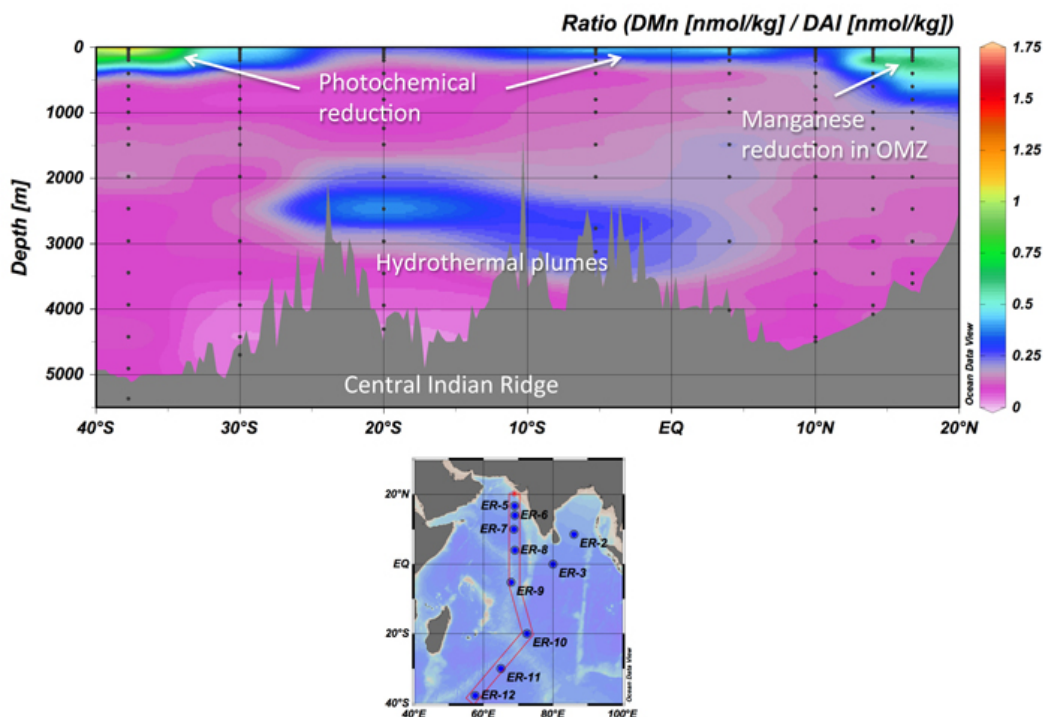
Reference:

Tagliabue, A., et al. (2012) A global compilation of dissolved iron measurements: focus on distributions and processes in the Southern Ocean, *Biogeosciences*, 9, 2333-2349, doi:10.5194/bg-9-2333-2012.

#### Substantial intra-basin variation of the dissolved metal/phosphorus ratio in the different water masses of the Indian Ocean

The first simultaneous, full-depth, and basin-scale section distribution of dissolved (D) aluminum (Al), manganese (Mn), iron (Fe), cobalt (Co), nickel (Ni), copper (Cu), zinc (Zn), cadmium (Cd), and lead (Pb) is reported in the Indian Ocean. In addition to widespread co-limitation for phytoplankton production by dissolved iron (DFe) and occurrence of redox-related processes, the authors observe an important variability of the dissolved metal/phosphorus ratio among

the water masses within the Indian Ocean (up to a factor of 300 between Arabian Surface waters and Lower Circumpolar Deep Water). The Cu/P, Zn/P, and Cd/P ratios are within the same order of magnitude for both phytoplankton and deep water, whereas the Mn/P, Fe/P, and Co/P ratios of phytoplankton can increase 100-fold or more compared to those in deep water. Such results are questioning the validity of using an "extended Redfield ratio" to trace metals. The consistent mechanism yielding these variations remains to be understood.



**Figure 3.** Meridional section distribution ( $\sim 70^{\circ}\text{E}$ ) of the DMn/DAI ratio

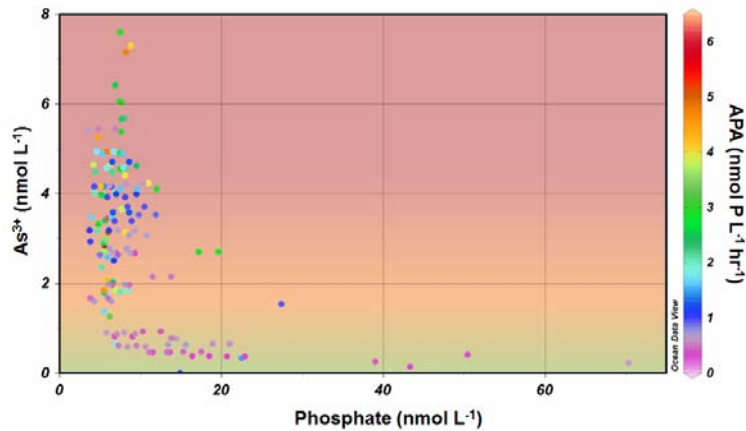
Reference:

Thi Dieu Vu, H., Sohrin, Y. (2013) Diverse stoichiometry of dissolved trace metals in the Indian Ocean, *Scientific Reports* 3, DOI: 10.1038/srep01745

Available at : <http://www.nature.com/srep/2013/130429/srep01745/full/srep01745.html>

#### Arsenic detoxification by phytoplankton reveals that As species could be good proxies of P limitation

Some phytoplankton species have the capacity to modify surface water arsenic speciation, inhibiting its toxicity. Such detoxification is operative in oligotrophic waters when phosphate concentrations are below those for As. During the U.S. GEOTRACES North Atlantic transect, fine determination of As speciation allowed establishing the potential use of these detoxification products as indicators of P limitation. The new As indicator has been used to assess P-limitation in the North Atlantic Ocean, improving on the contradictory assessments using conventional proxies. The coupled relationship between As and P is a classic example of a biogeochemical cycle, and how such relationship can be used as a tool in oceanography.



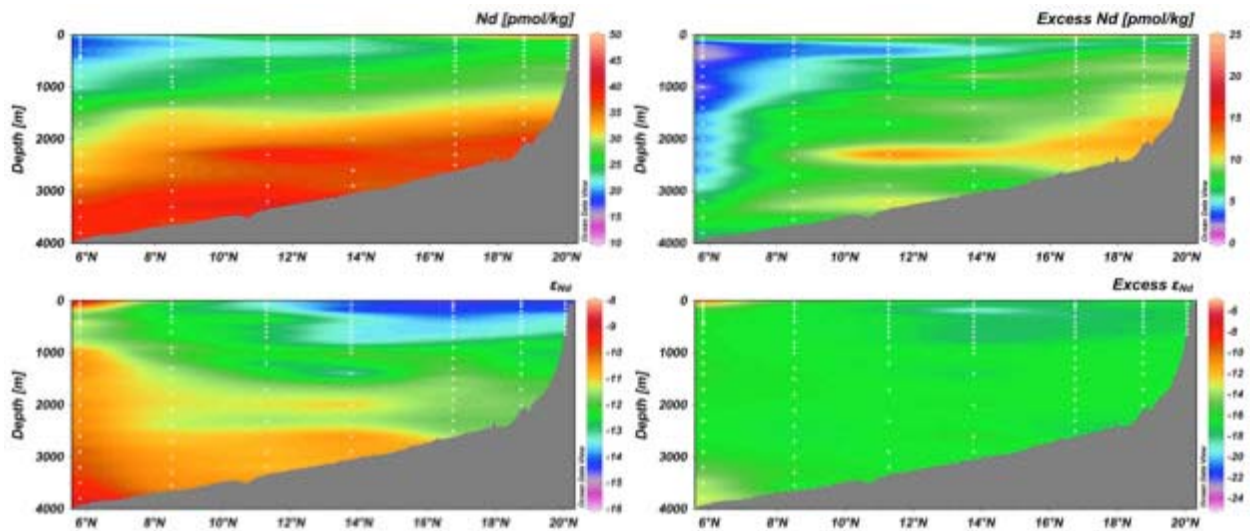
**Figure 4.** Relationship between inorganic phosphate, arsenite ( $\text{As}^{3+}$ ) and alkaline phosphate activity (APA), the latter being an enzyme to cleave organic-bound phosphate and typically increasing with decreasing inorganic phosphate. Arsenate ( $\text{As}^{5+}$ ) uptake by phytoplankton increases under low phosphate availability due to the chemical similarities between them. Detoxification includes reduction and excretion of  $\text{As}^{3+}$ , consequently indicating moderate (orange background) and extreme (red background) limitation of phosphate. No phosphate limitation occurs if  $\text{As}^{3+}$  levels are below  $1 \text{ nmol L}^{-1}$  (green background).

Reference:

Wurl, O., L. Zimmer, and G.A. Cutter. 2013. Arsenic and phosphorus biogeochemistry in the ocean: Arsenic species as proxies for P-limitation. *Limnol. Oceanogr.* 58: 729-740.

Significant role of dissolved/particulate Nd from the Ganga–Brahmaputra river system and Bay of Bengal margin in contributing to the dissolved Nd budget of the global oceans

Data on dissolved Nd concentrations and isotopic compositions measured along a  $87^\circ\text{E}$  transect (GI01 section, "Indian GEOTRACES") have been used in an inverse model in order to identify the respective effects of water mass mixing and Nd release from particulate matter in balancing this tracer budget in the Bay of Bengal. Results clearly underline that release from particulate phases supplied by the Ganga–Brahmaputra river system is required to explain both the distribution and budget of the Nd parameters. Calculations also suggest that supply of Nd from continental margin sediments is occurring at places identified as "hotspots of Nd release".



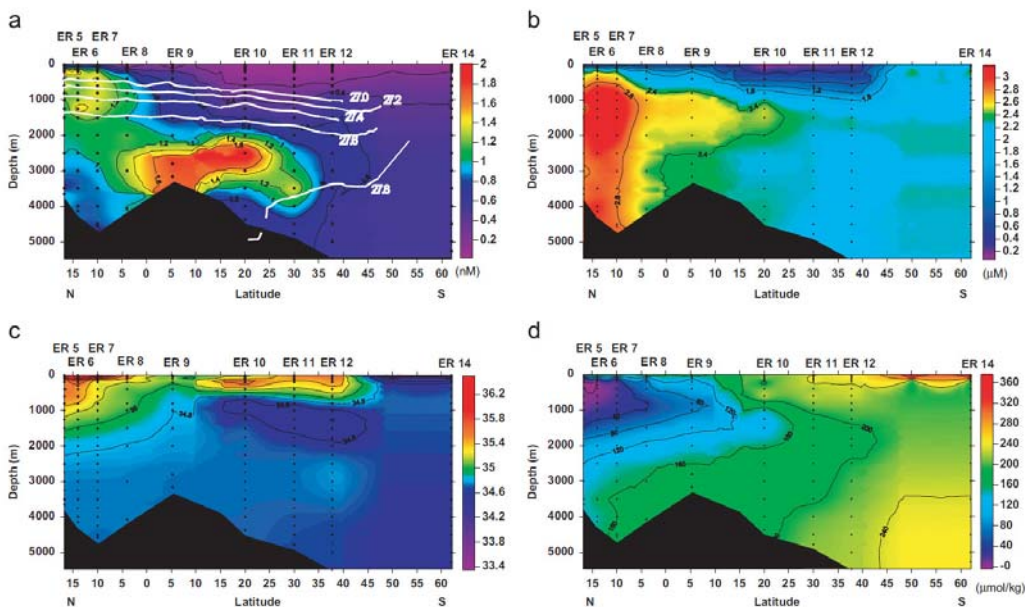
**Figure 5.** The distribution of concentration and isotope composition of dissolved Nd along the  $87^\circ\text{E}$  transect in the Bay of Bengal.

Reference:

Satinder Pal Singh, Sunil Kumar Singh, Vineet Goswami, Ravi Bhushan, Vinai Kumar Rai (2012), Spatial distribution of dissolved neodymium and  $\epsilon\text{Nd}$  in the Bay of Bengal: Role of particulate matter and mixing of water masses: *Geochimica et Cosmochimica Acta* 94:38-56, DOI: 10.1016/j.gca.2012.07.017.

#### Hydrothermalism: A Significant Dissolved Iron Source For The Deep Waters?

A north-south basin-scale full-depth section profile of dissolved Fe was realized in the Indian Ocean as part of the first GEOTRACES Japanese cruise (Nov. 2009-Jan. 2010). The data clearly show that hydrothermal Fe is distributed over 3000 km distance around a depth of  $\sim 3000$  m, and that a large fraction of this Fe is truly dissolved. Several other sources supplying dissolved Fe to deep waters (e.g., terrestrial Fe input) with a persistent condition in the oxygen minimum zone (OMZ), were also evident.



**Figure 6.** Vertical section profiles of (a) dissolved Fe concentration, (b) phosphate, (c) salinity, (d) dissolved oxygen. White number and line (a) indicate isopycnal surface.

Reference:

Jun Nishioka, Hajime Obata, Daisuke Tsumune (2013), Evidence of an extensive spread of hydrothermal dissolved iron in the Indian Ocean: *Earth and Planetary Science Letters* 361:26-33, DOI: /10.1016/j.epsl.2012.11.040

#### Basin-scale inputs of cobalt, iron, and manganese from the Benguela-Angola front to the South Atlantic Ocean

The African coast appeared to be a major source of dissolved total dissolved cobalt, iron, manganese, and labile cobalt to the South Atlantic basin, with high cobalt concentrations in the oxygen minimum zone of the Angola Dome and extending 2500 km into the subtropical gyre. Linear relationships between cobalt,  $\text{N}_2\text{O}$ , and  $\text{O}_2$ , as well as low surface aluminum supported a coastal rather than atmospheric cobalt source. Point sources of the scale observed in this study likely serve as vital drivers of these tracer oceanic cycles.

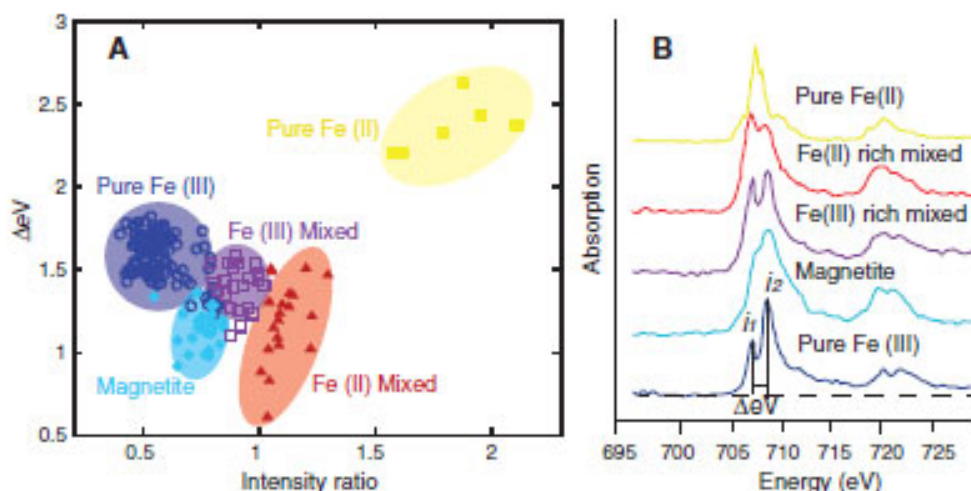
Reference:

A.E. Noble, C.H. Lamborg, D.C. Ohnemus, P.J. Lam, T.J. Goepfert, C.I. Measures, C.H. Frame, K.L. Casciotti, G.R. DiTullio, J. Jennings, M.A. Saito (2012), Basin-scale inputs of cobalt, iron, and manganese from the Benguela-Angola front to the South Atlantic Ocean : *Limnology and Oceanography* 57 (4) p. 989-1010, DOI: 10.4319/lo.2012.57.4.0989



### New beautiful results on marine particle speciation, a challenge for the GEOTRACES community

Advanced Light Source x-ray spectromicroscopy (XANES) allows a fine description of the marine Fe pool chemical speciation and mineralogy. This work describes diverse arrays of iron particles (20- 700 nm), showing impressive variations in the oxidation state and composition of these iron particles between the coasts of South Africa and Antarctica. Moreover, different iron pools are occurring in different frontal zones. Because particle speciation is directly linked to the element solubilities, these differences may affect the production of bioavailable dissolved iron.



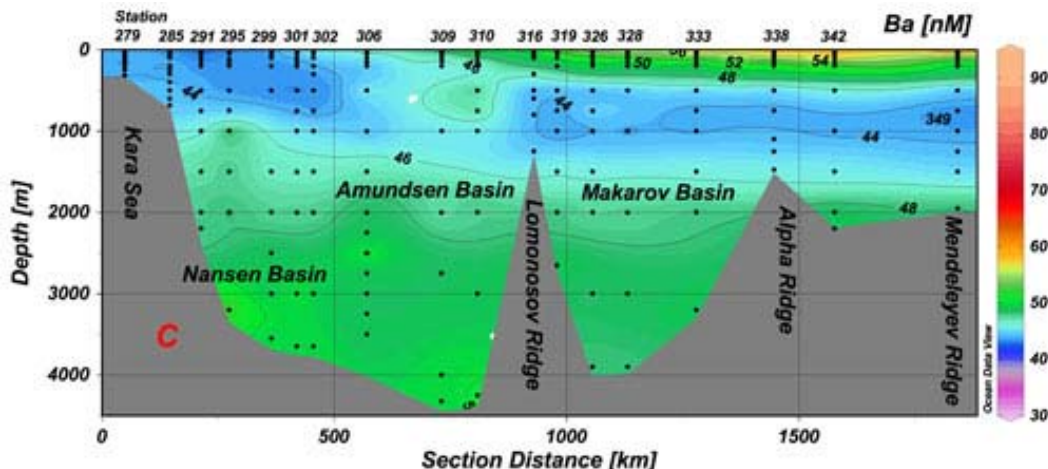
**Figure 7.** (A) Iron particle speciation plotted and defined accordingly to the particles' spectral features. Pure Fe(III), pure Fe(II), and magnetite phases occupy discrete fields, the mixed-valence species are distinguished by their variations in the spectral intensity ratios. (B) Generalized Fe L-edge XANES spectra of the five species identifies in the South Atlantic and Southern oceans; colors correspond to the fields in (A). The  $\Delta E_V$  value is calculated as the energy difference between peaks  $i_1$  and  $i_2$ ; the intensity ratio value is given as absorption intensity  $i_1/i_2$ .

#### Reference:

B.P. von der Heyden, A.N. Roychoudhury, T.N. Mtshali, T. Tylicszak, S.C.B. Myneni. (2012). Chemically and Geographically Distinct Solid-Phase Iron Pools in the Southern Ocean: *Science* 338 (6111):1199-1201, DOI: [10.1126/science.1227504](https://doi.org/10.1126/science.1227504)

#### Results from the GEOTRACES cruise section GIPY11

An interesting comparison of data of dissolved barium (Ba) and data of dissolved aluminum (Al) and silicate (Si) collected onboard the GEOTRACES cruise GIPY11 (ARK-XXII/2 *Polarstern* expedition) is presented in the article of Roeske and colleagues (Roeske et al., 2012). This comparison is used to distinguish between signals produced by the regeneration of sinking particles and signals derived from entrainment of shelf waters, adding to the analysis of Al and Si data of the same cruise by Middag et al. (2009). The two papers investigate whether the relationships between Ba, Si and Al differ between water masses and between the various deep Arctic Basins, and whether these differences can help us to infer deep water circulation and shelf water inputs.



**Figure 8.** Distribution of Ba on section C, which reaches from the Kara Sea at 81.25°N to the Alpha Ridge at 84.5°N. Isolines are at 2 nM intervals. Source: *Marine Chemistry*.

#### References:

- Middag, R., de Baar, H.J.W., Laan, P., Bakker, K., (2009). Dissolved aluminium and the silicon cycle in the Arctic Ocean. *Marine Chemistry* 115, 176-195
- Roeske T., Rutgers vd Loeff M., Middag R, Bakker K. (2012), Deep water circulation and composition in the Arctic Ocean by dissolved barium, aluminium and silicate, *Marine Chemistry* 132-133, (56-67).

## 7. Workshops and events

### Russian GEOTRACES Workshop

The first Russian GEOTRACES Workshop was held on 27-29 November 2012 in Moscow at the Shirshov Institute of Oceanology, Russian Academy of Sciences. About 90 persons participated, including Russian scientists from seven institutes, together with scientists leading the GEOTRACES program in Europe and the United States. During the workshop about 30 oral presentations were made (including 8 talks by young Russian scientists), along with 15 poster presentations. The workshop showed that research themes of Russian scientists in many respects correspond to the main GEOTRACES scientific goals. Particular Russian interests include estuarine chemistry (trace metals, radionuclides, and organic carbon compounds) of major rivers, biogeochemical processes (including trace metals and gases such as methane) on the Russian shelf, sedimentary and chemical fluxes between the shelf and open Arctic Ocean as well as the fluxes from atmosphere to the Arctic Seas.

The Russian workshop established international contacts and identified priorities for research into the marine chemistry of the Arctic Ocean. Research cruises that would address the main GEOTRACES scientific goals have been identified during discussion at the workshop. Issues linked with correct clean sampling and analysis of trace metals were discussed, since one of the main Russian problems is lack of special equipment to collect uncontaminated seawater samples for analysis of heavy metals. An obvious necessity is participation of Russian scientists in intercalibration of the sampling procedures followed by the trace metal analysis, as well as training of young Russian scientists in the leading GEOTRACES' laboratories. All the participants supported a joint declaration ([http://www.geotraces.org/images/stories/documents/workshops/Russian/Russian\\_GEOTRACES\\_Statement.pdf](http://www.geotraces.org/images/stories/documents/workshops/Russian/Russian_GEOTRACES_Statement.pdf)). Workshop participants suggested the rapid formation of a Russian GEOTRACES Committee to develop GEOTRACES activities and guide the scientific goals and implementation of the program in Russia.

### GEOTRACES Latin American Workshop

To foster the involvement of Latin American (LA) scientists in the GEOTRACES program, the GEOTRACES SSC held a workshop in Rio de Janeiro (12-15 November 2012, Rio de Janeiro). About 40 scientists participated in the

workshop, including representatives from 7 Latin American countries, scientists leading the GEOTRACES program in Europe and the United States, and 11 students. About 33 presentations were made during the workshop. The abstract collection is available on the following GEOTRACES web site:

[http://www.geotraces.org/images/stories/documents/workshops/LA/2012\\_LA\\_Workshop\\_Abstracts\\_edited081112.pdf](http://www.geotraces.org/images/stories/documents/workshops/LA/2012_LA_Workshop_Abstracts_edited081112.pdf).

The Workshop had the following objectives: (1) Define scientific questions of global interest that are geographically proximal to LA nations; (2) Define scientific questions of national or regional interest that are too large, or too complex, to be addressed by a single nation or by small projects, and which therefore would benefit from international collaboration; (3) Identify opportunities and strategies for collaboration within the scope of the GEOTRACES Program; (4) Identify opportunities for technology transfer and training that would increase the capacity of scientists in LA nations to undertake GEOTRACES-related research. Participants at the meeting agreed on a final statement outlining important GEOTRACES science in the LA region, and synergies between GEOTRACES Activities and other science in LA:

[http://www.geotraces.org/images/stories/documents/workshops/LA/GEOTRACES\\_LA\\_Statement.pdf](http://www.geotraces.org/images/stories/documents/workshops/LA/GEOTRACES_LA_Statement.pdf).

#### GEOTRACES-COST Workshop –Stable isotopes of biologically important trace metals

A successful workshop was held at the Department of Earth Science and Engineering of Imperial College London (13-14 September 2012) to bring together, for the first time, the community of people working on stable isotopes of biologically important trace metals. The focus of the workshop was on the stable isotopes of Zn, Cd, and Fe, but isotope systems of other micronutrient and contamination-prone elements (particularly Pb) were also considered. Almost 50 people from 12 countries attended the workshop to share novel data and discuss analytical issues related to sampling and the isotopic measurements in the context of the GEOTRACES program. The Report of the Workshop is available on the GEOTRACES Web site at [http://www.geotraces.org/images/stories/documents/workshops/Stable\\_Isotopes/workshop\\_Stable\\_isotopes\\_report\\_final.pdf](http://www.geotraces.org/images/stories/documents/workshops/Stable_Isotopes/workshop_Stable_isotopes_report_final.pdf).

The workshop was supported by COST Action ES0801 and SCOR. For further information: <http://www.geotraces.org/meetings/meetings-by-year/eventdetail/121/-/geotraces-cost-workshop-stable-isotopes-of-biologically-important-trace-metals>.

#### GEOTRACES-COST Voltammetric Workshop

This workshop was held in the frame of research activities at marine station Martinska, Rudjer Bošković Institute, Šibenik, Croatia on October 7-9. The meeting, which was very successful, gathering 40 participants from 14 countries, among them 14 PhD students and post-doctoral fellows. The event was co-organized by GEOTRACES, COST action ES801 and the Ruđer Bošković Institute. All the participants expressed their interest and will to organize a follow-on meeting in two years as a necessity to discuss the role and use of electrochemistry in analysis and study of biogeochemical processes in aquatic systems. The Report of the Workshop is available on the GEOTRACES Web site at

[http://www.geotraces.org/images/stories/documents/workshops/Voltammetry/VoltammetryWorkshopReport\\_COST\\_ActionES0801.pdf](http://www.geotraces.org/images/stories/documents/workshops/Voltammetry/VoltammetryWorkshopReport_COST_ActionES0801.pdf). For further information about this workshop, see <http://www.geotraces.org/meetings/meetings-by-year/eventdetail/119/-/cost-geotraces-voltammetry-workshop>.

### **8. Special sessions at international conferences featuring GEOTRACES findings**

Several special sessions with relevance to GEOTRACES were held at major international meetings including the following:

American Geophysical Union Fall 2012, 3-7 December 2012, San Francisco, USA

For further information: <http://fallmeeting.agu.org/2012/>

*\*OS013: Isotope Tracers in the 21st Century Ocean: New Results, Interesting Challenges, and Unique Opportunities*  
Conveners: Steven L Goldstein (Columbia University), Alison E Hartman (Lamont-Doherty Earth Observatory),  
Howie D Scher (University of South Carolina) and Torben Stichel (University of Hawaii at Manoa)

*\*OS036: Sources, Sinks, and Speciation of Marine Micronutrient Trace Elements*  
Conveners: Jessica N Fitzsimmons (MIT) and Christopher T Hayes (Columbia University)

ASLO 2013, Aquatic Sciences Meeting, 17-22 February 2013, New Orleans, Louisiana, USA

For further information: <http://www.aslo.org/meetings/neworleans2013/>

*\*SS57: Trace Elements and Isotopes in the Ocean and Atmosphere: the International GEOTRACES Program*  
Conveners: Peter Morton, Florida State University; Carl Lamborg, Woods Hole Oceanographic Institution

*\*SS08: Biogeochemistry of Metal-binding Organic Ligands in the Ocean: Sources, Composition and Impacts on Trace Metal Cycling*  
Conveners: Maeve C. Lohan (University of Plymouth); Sylvia G. Sander (University of Otago); Kristen N. Buck (Bermuda Institute of Ocean Sciences)

2013 Asia Oceania Geosciences Society Annual Meeting, 24-28 June 2013, Brisbane, Australia

For further information: <http://asiaoceania.org/aogs2013/public.asp?page=home.htm>

*\*Controls on the Biogeochemistry of the Northwestern Pacific Ocean and its Adjacent Marginal Seas*  
Main Convener: Dr. Tung-Yuan Ho (Academia Sinica, China-Taipei)  
Co-conveners: Dr. Sohrin Yoshiki (Kyoto University, Japan), Prof. I-I Lin (National Taiwan University, China-Taipei)  
and Dr. George T F Wong (Academia Sinica, China-Taipei)

Forthcoming:

The 2013 Gordon Research Conference on Chemical Oceanography, 4-9 August 2013, Biddeford, Maine, USA

For further information: <http://www.grc.org/programs.aspx?year=2013&program=chemocean>

Goldschmidt 2013, 25-30 August 2013, Florence, Italy

For further information: <http://goldschmidt.info/2013/index>

*\*16h. Chemical Weathering in Marginal Environments*  
Convenors: Bernhard Peucker-Ehrenbrink and Morgan Jones  
Keynote: Catherine Jeandel (LEGOS, Toulouse)

*\*17a. The ins and outs of mud: chemical fluxes between sediments and seawater*  
Convenors: Silke Severmann and Rachel Mills  
Keynote: Ronnie N. Glud (University of Southern Denmark)

*\*17b. Constraining rates of ocean processes*  
Convenors: Laura Robinson and Matt Charette  
Keynote: Bill Jenkins (WHOI)

*\*17d Isotope geochemistry of the modern oceans*  
Convenors: Seth John, Julie Granger, Katharine Pahnke and Gregory F. de Souza  
Keynote: Curtis Deutsch (University of Washington)



\*17g Metal-biota interactions in seawater

Convenors: Jay Cullen, Maeve Lohan and Martha Gledhill

Keynote: Mak Saito (Woods Hole)

## **9. Capacity building**

**At-Sea Training** GEOTRACES gratefully acknowledges support from SCOR to enable one scientist per year from a developing nation to participate in a GEOTRACES cruise. These opportunities are vital to the development of technical expertise in sampling and sample handling for contamination-prone elements aboard “dirty” ships.

**Sampling Systems** It is a goal of GEOTRACES that every nation carrying out oceanographic research should have access to a trace metal-clean sampling system. GEOTRACES offers guidance based on past experience in the design and construction of sampling systems as well as advice in operating these systems as shared facilities. A complementary goal is to establish a program whereby scientists who have accrued experience in operating these systems can share that knowledge with scientists from nations that are in the process of acquiring clean sampling systems.

An updated status of trace metal-clean sampling systems to support GEOTRACES research is provided in the table below. Scientists interested in developing one of these systems for their own use are encouraged to contact the GEOTRACES IPO or any member of the SSC, who will arrange for contact with an appropriate person to provide technical information about the design, construction and cost of a system.

<b>Nation</b>	<b>Status</b>	<b>System/ Carousel</b>	<b>Bottles</b>	<b>Depth</b>
Australia	Complete (2nd system planned)	Powder coated aluminum, autonomous 1018 intelligent rosette system	12 x 10-L Teflon-lined Niskin-1010X	6000 m; 6 mm Dynex rope
Canada	Complete	Powder coated aluminum with titanium CTD housing, Seabird Rosette	24 X 12-L GO-Flo	2300 m; conducting Vectran soon to be upgraded with 5000 m conducting Vectran 06/2013
China - Beijing	Complete	Towed fish	NA	Surface
China - Taipei	Complete	Teflon coated rosette	Multi- size GO-Flo	3000 m; Kevlar line
France	Complete	Powder coated aluminum with titanium pressure housing for CTD	12 X 12-L GO-Flo	8000 m; conducting Kevlar
Germany	CTD and bottles purchased, winch planned	Powder coated aluminum with titanium pressure housings and fittings	27 x 12-L OTE GO-Flo	8000 m; conducting Kevlar
India	Complete	Powder coated aluminum with titanium pressure housings and fittings	24 X 12-L Niskin-X	8000 m; conducting Kevlar
Italy	Complete	Go-Flo bottles on Kevlar line	5 x 20-L Go-Flos	Kevlar
Japan	Complete	Powder coated aluminum	12-L Niskin-X	10000 m; titanium armored cable
Netherlands	Complete	Titanium frame	24 X 12-liter GO-Flo	10000 m; conducting Kevlar
Netherlands	Complete	Titanium frame	24 X 27-liter ultraclean	10000 m; conducting Kevlar

			PVDF	
New Zealand	Complete	Powder coated aluminum	5-L Teflon-lined Niskin-X	2000 m; 8 mm Kevlar line
South Africa	Complete	Powder coated aluminum, titanium housing/fittings	24 X 12-liter GO-Flo	6500 m; Kevlar cable
UK	In testing phase	Titanium frame, Ti pressure housings	24 10-L OTE	8000m conducting Kevlar
USA - CLIVAR	Complete	Powder coated aluminum	12 X 12-L GO-Flo	1500 m; conducting Kevlar
USA - GEOTRACES	Complete	Powder coated aluminum with titanium pressure housings and fittings	24 X 12-L GO-Flo	8000 m; conducting Kevlar
USA- University of Alaska Fairbanks	Complete	Seabird Rosette. Powder coated aluminum with Ti parts and pressure housing. Fires at pre-programmable depths	12 X 5-L Teflon-lined Niskin-X	No Kevlar line available yet.
USA- Old Dominion University	Complete	Seabird Rosette. SBE-19plusV2 CTD unit. Powder coated aluminum with Ti parts and pressure housing. Fires at pre-programmable depths	12 X 5-L Teflon-lined Niskin-X	2000 m 0.5-inch Kevlar wire
USA – Polar Programs	Complete	Powder coated aluminum with titanium pressure housings and fittings	12 X12-L Niskin-X	3000 m; conducting Kevlar

### **Acknowledgements**

We offer our special thanks to Ed Urban, who continues to provide tremendous support and valuable advice to the planning of the GEOTRACES program.

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## Appendix 9

### Post-Audit Financial Statement for 2012 (discretionary funds in USD)

	Approved in Helsinki	Revised in Halifax	Actual
	Discretionary	Discretionary	Discretionary
<b>Income</b>			
Membership Dues	\$313,273.00	\$313,273.00	\$321,092.57
NSF funds for WGs groups and other non-project activities	\$70,000.00	\$66,223.00	\$47,971.15
Interest income	\$0.00	\$9.00	\$11.07
Registration fees	\$0.00	\$0.00	\$22,470.86
Miscellaneous income	\$5,000.00	\$14,545.00	\$10,540.06
<b>Total Income</b>	<b>\$388,273.00</b>	<b>\$394,050.00</b>	<b>\$402,085.71</b>
<b>Expense</b>			
WG 125 - Zooplankton Time Ser	\$0.00	\$926.00	\$925.76
WG 131 - Iron	\$0.00	\$7,000.00	\$3,532.20
WG 133 - OceanScope (with IAPSO)	\$0.00	\$1,733.00	\$1,732.87
WG 134 - Microbial Carbon	\$13,500.00	\$3,262.00	\$3,261.86
WG 135 - Hydrothermal Carbon	\$12,000.00	\$0.00	\$0.00
WG 136 - Climatic Importance of the Agulhas Current	\$8,000.00	\$8,000.00	\$7,143.57
WG 137 - Patterns of Phytoplankton	\$15,000.00	\$15,000.00	\$4,234.82
WG 138 -Forams	\$15,000.00	\$403.00	\$402.91
WG 139 - Organic Ligands	\$15,000.00	\$3,634.00	\$3,830.48
WG 140 - Sea Ice	\$15,000.00	\$0.00	\$0.00
WORKING GROUPS - Other	\$0.00	\$0.00	\$1,188.19
SOLAS	\$0.00	\$0.00	\$158.66
IOCCP	\$0.00	\$0.00	\$6,475.98
Technololgy Panel for CoML	\$0.00	\$0.00	\$163.47
Southern Ocean Observing System	\$10,000.00	\$19,130.00	\$20,122.90
Ocean in a High-CO2 World	\$0.00	\$0.00	\$2,114.62
Pigment Editorial Group	\$0.00	\$0.00	\$312.77
SCOR/IODE Data Publication Group	\$5,000.00	\$5,000.00	\$2,537.75
Outreach	\$4,000.00	\$0.00	\$0.00
SCOR Lecture at UD	\$2,500.00	\$0.00	\$0.00
Committee on Capacity Building	\$10,000.00	\$10,000.00	\$12,081.64
Other Scientific Expenses	\$0.00	\$0.00	\$506.49
Salaries and Benefits	\$176,393.00	\$178,259.00	\$194,905.10
Audit and Accounting Services	\$20,000.00	\$21,644.00	\$11,643.75
Representational Travel	\$10,000.00	\$10,000.00	\$9,435.09
Publications	\$6,000.00	\$0.00	\$0.00
Leased Software	\$6,901.00	\$8,400.00	\$6,667.17
Bank charges and other fees	\$0.00	\$0.00	\$2,316.33
Annual Meetings	\$30,000.00	\$30,000.00	\$43,281.72
Postage and Courier	\$2,338.00	\$2,300.00	\$1,320.77
Telephone, Fax and Long Distanc	\$0.00	\$0.00	\$752.11
Office Supplies	\$0.00	\$0.00	\$863.10
Office Equipment	\$2,500.00	\$2,500.00	\$464.90
University overhead charges	\$26,500.00	\$31,500.00	\$37,918.44
Insurance	\$2,419.00	\$2,410.00	\$2,410.00
Miscellaneous Office Expenses	\$5,400.00	\$5,400.00	\$0.00
Exec Dir Professional Exp	\$0.00	\$0.00	\$145.27
<b>Total Expense</b>	<b>\$413,451.00</b>	<b>\$366,501.00</b>	<b>\$382,850.69</b>
<b>Net Income</b>	<b>-\$25,178.00</b>	<b>\$27,549.00</b>	<b>\$19,235.02</b>

## Appendix 10

### SCOR-Related Meetings (2013-2015)

#### 2013

28-31 January	IMBER IMBIZO III	Goa, India
16 February	SCOR WG 139 on Organic Ligands – A Key Control on Trace Metal Biogeochemistry in the Ocean WG 140 on Biogeochemical Exchange Processes at the Sea-Ice Interfaces	New Orleans, Louisiana, USA
16 March	WG 140 on Biogeochemical Exchange Processes at the Sea-Ice Interfaces	Ventura, California, USA
11 April	WG 141 on Sea-Surface Microlayers	Vienna, Austria
22-23 April	International Ocean Carbon Coordination Project Scientific Steering Group	Norwich, UK
25-27 April	GEOHAB Open Science Meeting	Paris, France
20-24 May	SOOS Scientific Steering Committee and Asian Workshop	Shanghai, China
27-31 May	SOLAS Scientific Steering Committee	Tsukuba, Japan
17-19 June	IMBER Scientific Steering Committee	Canary Islands, Spain
19-22 June	WG 138: Two Parallel Workshops on Planktonic Foraminifera	Prague, Czech Republic
1-5 September	SCOR/IAPSO/IAPWS Joint Committee on the Properties of Seawater	London, UK
30 September-4 October	GEOTRACES Scientific Steering Committee, Data Management Committee, and Standards and Intercalibration Committee	Bremerhaven, Germany
2-4 November	WG 137 on Patterns of Phytoplankton Dynamics in Coastal Ecosystems: Comparative Analysis of Time Series Observation	San Diego, California, USA
25-28 November	SCOR Executive Committee Meeting	New Zealand
3-5 December	GEOHAB Scientific Steering Committee	Barcelona, Spain

#### 2014

21 February	WG 143 on Dissolved N <sub>2</sub> O and CH <sub>4</sub> Measurements: Working Towards a Global Network of Ocean Time Series Measurements of N <sub>2</sub> O and CH <sub>4</sub>	Honolulu, Hawaii, USA
22 February	IOCCP Scientific Steering Group	Honolulu, Hawaii, USA
23 February	WG 139 on Organic Ligands: A Key Control on Trace Metal Biogeochemistry in the Ocean	Honolulu, Hawaii, USA
1 March	WG 142 on Quality Control Procedures for Oxygen and Other Biogeochemical Sensors on Floats and Gliders	Honolulu, Hawaii, USA

16 March	WG 140 on Biogeochemical Exchange Processes at the Sea-Ice Interfaces	Hobart, Tasmania
18-21 March	Workshop on Ecosystem Essential Ocean Variables in the Southern Ocean	New Brunswick, New Jersey, USA
29 April, 2 May	SCOR/InterRidge WG 135 on Hydrothermal Energy Transfer and its Impact on the Ocean Carbon Cycle	Vienna, Austria
16-20 June	SOLAS Scientific Steering Committee Meeting	Israel
18-20 June	SOOS Scientific Steering Committee	Tromsø, Norway
23-27 June	IMBER Open Science Meeting	Bergen, Norway
15-18 September	SCOR General Meeting	Bremen, Germany
6-10 October	GEOTRACES SSC and DMC Meetings	South Africa

## 2015

7-11 September	SOLAS Open Science Conference	Kiel, Germany
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