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

International Ocean Carbon Coordination Project Progress Report for SCOR, August 2008

Rotation of the Scientific Steering Group for 2008-2010

The IOCCP was launched as a standing project of IOC and SCOR in 2005 with requirements to develop a rotation scheme for the members of the Scientific Steering Group following the first 3-year term. The Scientific Steering Group is composed of a Chair and 8 members selected for expertise in specific areas of IOCCP activities and ability to provide a global perspective on ocean carbon research and observation activities and plans. For the 2008-2010 term, Chris Sabine (NOAA/PMEL, USA) has agreed to continue as Chair of the SSG, and he is joined by returning members Masao Fukasawa (JAMSTEC, Japan) and Dorothee Bakker (UEA, UK). New members of the SSG for this term include Toste Tanhua (IfM-Geomar, Germany), Alex Kozyr (CDIAC, USA), Ute Schuster (UEA, UK), Melchor Gonzalez (U. Las Palmas de Gran Canaria, Spain), Pedro Monteiro (CSIR, South Africa), and Yukihiro Nojiri (NIES, Japan).

The co-chairs of the SOLAS-IMBER Carbon Coordination Group, Arne Kortzinger (IfM-Geomar, Germany) and Truls Johannessen (Uni. Bergen, Norway), also serve as ex-officio members of the IOCCP SSG. The IOCCP and its sponsors would like to thank the outgoing members for their participation and leadership during these critical first three years of the project's development: Bronte Tilbrook (CSIRO, Australia), Cindy Lee (SUNY-Stony Brook, USA), Helmuth Thomas (Dalhousie, Canada), Cyril Moulin (CNRS, France), and Nick Bates (BBSR, Bermuda).

The Global Ocean Ship-based Hydrographic Investigations Panel (GO-SHIP)

Both the CLIVAR community and the ocean carbon community have recognized the urgent need for better coordination of planning, implementation, standardization, data synthesis and interpretation efforts for hydrography. The hydrography community has also recognized that today's hydrography programs address different issues than were addressed during the WOCE era, issues that require a more integrated approach in terms of variables measured, sampling strategy, and integration of ship-based sampling with other platforms such as Argo and time series stations.

Following an action set at the International Repeat Hydrography and Carbon Workshop (Shonan Village, Japan, November 2005), the IOCCP, CLIVAR, and the SOLAS-IMBER Carbon Coordination Group are sponsoring the Global Ocean Ship-based Hydrographic Investigations Panel (GO-SHIP) to bring together interests from physical hydrography, carbon, biogeochemistry, Argo, OceanSITES, and other users and collectors of hydrographic data, to develop guidelines and advice for the development of a globally coordinated network of

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sustained ship-based hydrographic sections that will become an integral component of the ocean observing system. Panel Members include Masao Fukasawa (JAMSTEC, Japan), Chris Sabine (NOAA, USA), Bernadette Sloyan (CSIRO, Australia), Toste Tanhua and Arne Koertzinger (IfM-GeoMar, Germany), Gregory Johnson (NOAA, USA), and Nicolas Gruber (ETH, Switzerland).

Terms of Reference:

i. To develop the scientific justification and general strategy for a ship-based repeat hydrography network, building on existing programs and future plans, that will constitute the core global network, post-CLIVAR; considerations should include:

1. a set of basic requirements to define a coordinated repeat hydrography network (e.g., sample spacing, repeat frequency, recommended core measurements, etc.);
2. an inventory of existing and planned sections that meet those criteria;
3. an assessment of other observing programs that can either contribute to or use hydrography data (e.g., Argo, OceanSITES, GEOTRACES, etc.);
4. an assessment of data release needs to meet research and operational objectives;
5. an inventory of on-going or planned scientific synthesis activities (basin and global) that might benefit from closer collaboration; and
6. guidelines for the transition from the CLIVAR hydrographic program to the new system, including sections, data and information management, and synthesis activities.

ii. To develop guidelines for a single global information and data center for ship-based repeat hydrography;

iii. To review and provide guidance on the need to update the WOCE hydrographic manual, including a review and update of data quality control issues.

It is envisaged that the advisory group will develop a report within less than two years that will be circulated widely for consultation and consensus on the way forward. The final strategy will be presented at OceanObs09 in Venice, Italy in September 2009. This document may then be used by the sponsoring organizations as well as national agencies to develop a coordinated network of ship-based repeat hydrography that will contribute to the global ocean/climate observing system.

The first meeting was held from 1-2 November 2007 during the PICES annual meeting, and all members except Gruber attended. The agenda covered review and approval of terms of reference, science goals, temporal and spatial sampling considerations, recommended core measurements, contributions from other platforms, data release and sharing, data synthesis, data and information management needs, revision of the WOCE hydrographic manual and needs for new standards or methods, and the way forward, with development of the strategy and plans for the next meeting. A draft strategy was developed at the meeting, and the Panel members will continue to work on this via email over the next several months with a view to making it public

for community review in mid-2008. Revision of the WOCE hydrography program manual began in April, with the goal of having first drafts on-line for community review by September 2008. Alex Kozyr will host the on-line community review on the CDIAC (Carbon Dioxide Information Analysis Center) Web site.

The Surface Ocean CO₂ Atlas (SOCAT) Project

At the “Surface Ocean CO₂ Variability and Vulnerability” (SOCOVV) workshop in April 2007, co-sponsored by IOCCP, SOLAS, IMBER, and the Global Carbon Project, participants agreed to establish a global surface CO₂ data set that would bring together, in a common format, all publicly available surface fCO₂ (fugacity of carbon dioxide, which is the partial pressure of CO₂ (pCO₂) corrected for non-ideal behavior of the gas) data for the surface ocean. This is an activity that has been called for by many international groups for many years, and has now become a priority activity for the marine carbon community. This data set will serve as a foundation upon which the community will continue to build in the future, based on agreed data and metadata formats and standard 1st level quality-control procedures, building on earlier agreements established at the 2004 Tsukuba workshop on “Ocean Surface pCO₂ Data Integration and Database Development”. This activity also supports the SOLAS and IMBER science plans and joint carbon implementation plan.

This data set will serve a wide range of user communities and it is envisaged that, in the future, two distinct SOCAT data products will be made available:

1. a 2nd level quality controlled, global surface ocean fCO₂ data set following agreed procedures and regional review
2. a gridded SOCAT product of monthly surface water fCO₂ means on a 1° x 1° grid with no temporal or spatial interpolation.

An extended 1st level quality-controlled data set has been developed, building on the work started in 2001 as part of the EU ORFOIS project by Dorothee Bakker (UEA), which now continues as part of the EU CARBOOCEAN project, where Benjamin Pfeil and Are Olsen (Bjerknes Centre for Climate Research) have compiled the publicly available surface CO₂ data held at CDIAC into a common format database based on the IOCCP recommended formats for metadata and data reporting. This compilation will include data from more than 10 countries, producing an initial database composed of more than 1250 cruises from 1972 - 2007 with approximately 4.5 million measurements of various carbon parameters, available in a common-format, 1st level quality-controlled data set.

A small technical meeting was held in Bremen, Germany, on 5 December 2007 (associated with the 3rd CarboOcean Annual Meeting) to agree on 1st level QC for the data set and to decide on a way forward for the 2nd level QC issues.

The IOCCP, along with CarboOcean and the SOLAS-IMBER Carbon Coordination Group, held a 2nd technical workshop at UNESCO, Paris, from 16-17 June 2008 to develop internationally

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agreed 2nd level quality-control procedures and to discuss the coordination of regional scientific groups to conduct the 2nd level quality control analyses. The goals for this meeting were to:

- Reach international agreement on 2nd Level QC procedures
- Identify approaches for gridding and interpolation
- Identify major science issues for each basin and globally
- Develop a short report for distribution to all relevant networks

The meeting report will be available in August 2008. Over the next few months the regional groups will become firmly established, will identify and submit missing data sets and will explore which 2nd level quality control checks may be performed in each region (deadline 1 September 2008). After 15 September 2008 the regional groups are asked to carry out 2nd level quality control on the SOCAT data and address key process-related scientific questions requiring large-scale joint synthesis efforts, while aiming for scientific presentations at ICDC-8 (International Carbon Dioxide Conference) in September 2009 and a first public release of the two SOCAT products by late 2009. Marine CO₂ scientists and modelers keen to participate in the above activities are encouraged to contact regional or global group leaders.

Changing Times: An International Ocean Biogeochemical Time-series Workshop

Time-series studies comprised a major component of the Joint Global Ocean Flux Study and are providing a continuing legacy of biogeochemical observations over time frames that are now becoming long enough to examine a range of climate forcing factors. The Hawaii Ocean Time-series, Bermuda Atlantic Time-Series and the CARbon Retention In A Colored Ocean time series, for example, now have close to twenty years' of data including a wide array of biogeochemical observations in different ocean regions. Literally hundreds of publications have come from the time-series sites and a whole generation of scientists has had some connection to these sites.

Despite repeated acknowledgement by the international community that time-series stations are critical for understanding the processes controlling ocean carbon and biogeochemical cycles, maintaining funding support for these platforms has been difficult. Without a coordinated network of scientists using the stations in an organized effort, the community has not coalesced, and research carried out on the stations has focused more on individual PI-based investigations or sensor development. Without international support, it is possible that many stations will not continue in the future.

In 1999, an international group of scientists formed the OceanSITES program to develop a coordinated, interdisciplinary international network of stations, research programs, and scientists to sustain and enhance the use of time-series observations. Although the physical oceanographic community is strongly tied into OceanSITES, the biogeochemical community is not yet connected.

To support and strengthen the ocean carbon and biogeochemical time-series effort, the IOCCP, OceanSITES, and the Partnership for Observations of the Global Ocean (POGO) are sponsoring

a workshop at the Scripps Institute of Oceanography on 5-7 November 2008. The Scientific Committee includes Chris Sabine (Chair, NOAA/PMEL, USA), Richard Lampitt (NOC, UK), Bob Weller (WHOI, USA), Uwe Send and Tony Koslow (SIO, USA), Melchor Gonzalez (Uni Las Palmas, Spain), Nick Bates (BBSR, Bermuda), Matt Church (UH, USA), and Trevor Platt (BIO, Canada).

The goals of the meeting are to mobilize the community to participate in this international network and to highlight the critical research that can only be carried out using time series (both ship-board and autonomous) observations. The workshop will also assess the future of time-series observations in an age when it is becoming technically feasible to develop basin- and global-scale networked arrays of ocean time-series stations, offering a new tool with enormous potential to cover a range of spatial and temporal scales never before possible. The time is right for the international ocean carbon and biogeochemistry community to examine how time-series observations can be used most effectively to advance our understanding of ocean processes and how these processes vary in time and space. Specific goals of the workshop are

- To identify on-going activities and plans using time-series observations;
- To examine the suite of observational methods and try to develop standard approaches that will allow more direct comparison of results from different sites;
- To review emergent science from the existing ocean time-series sites;
- To review the balance between ship-based and moored time-series sites;
- To identify carbon and biogeochemistry research priorities that can best be addressed through time-series observational programs;
- To analyze gaps in the network for addressing research priorities;
- To encourage and facilitate the development of new collaborations using time-series networks;
- To explore the potential for using basin-scale and globally networked time-series stations;
- To inform the ocean carbon and biogeochemistry community of the OceanSITES global network and data management system for the array; and,
- To facilitate incorporation of ocean time-series data into model ground-truthing, sensitivity and error analyses, and model-data fusion activities.

Standards for Ocean Acidification Research and Data Reporting

The need for standardized protocols and reporting of data has been highlighted at numerous ocean acidification workshops over the past few years. Common methods are crucial if we are to identify differences (or lack thereof) in calcification among various taxa, regions, and over time. It is also imperative that data be reported in a manner that will be comprehensible and accessible to scientists several decades from now if changes are to be detected. Specifically, the international research community needs to establish agreed protocols for calcification rate measurements and mesocosm/perturbation experiments, as well as protocols for data reporting.

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At its kick-off meeting on 10-13 June 2008, the European Project on Ocean Acidification (EPOCA) agreed to merge several standards and protocol activities into a single activity, and the IOCCP agreed to work with EPOCA to develop an international workshop on standards for ocean acidification research and data reporting. The advisory group includes Ulf Riebesell (IfM-GEOMAR, Germany), Deborah Iglesias-Rodriguez (NOC, UK), Richard Bellerby (Univ. Bergen, Norway), Kitack Lee (Pohang Uni, Korea), Victoria Fabry (California State Univ/San Marcos., USA), and Dick Feely (PMEL, NOAA, USA).

The meeting will be held tentatively at the end of November at IfM-GEOMAR in Kiel, Germany in order to meet EPOCA deliverable dates. The workshop will produce short technical reports for each major topic covered (e.g., perturbation experiments, calcification experiments, etc.), as well as a Guide to Best Practices for Ocean Acidification Research and Data Reporting. Participants at the kick-off meeting pointed out that many experimental aspects of ocean acidification research are still in the developmental stages and it may be too early to set agreed standards or protocols for many things. It is also clear that one workshop under tight deadlines may not be sufficient to produce a comprehensive guide. However, participants noted that research is moving forward rapidly and a dialogue about protocols and standards must begin now. There are already many aspects of carbon chemistry applicable to acidification research that have been thoroughly documented in the Guide to Best Practices for Oceanic CO₂ Measurement (available at http://cdiac.ornl.gov/oceans/Handbook_2007.html), and application of these protocols to acidification research would greatly improve the current situation. In the end, the first version of the guide will most likely end up being a mixture of standards, guidelines, and, most critically, reporting and documentation requirements, so that individual experiments are fully comprehensible and reproducible. To ensure full community participation and input, drafts of the guide will be made available on-line for an open community review period before publishing.

Ocean Carbon in the Southern Ocean Observing System Strategy

The IOCCP has established a small group to provide input to the strategy development of the SCOR/SCAR/POGO/CoML/GOOS Southern Ocean Observing System. The group consists of Nicolas Gruber (ETH, Zurich), Bronte Tilbrook (CSIRO, Australia), Chris Sabine (NOAA/PMEL, USA), Nicolas Metzl (L'Ocean, France), Mario Hoppema (AWI, Germany), Dorothee Baker (UEA, UK), Andrew Lenton (L'Ocean, France), Pedro Monteiro (CSIR, South Africa), and Richard Bellerby (Uni Bergen, Norway).

The IOCCP developed a background document on carbon observations for the Southern Ocean for the planning meeting held from 1-3 October 2007 in Bremen, Germany and Mario Hoppema attended. Richard Bellerby attended the follow-up meeting in St Petersburg, Russia in July 2008. Richard Bellerby is a member of the SOOS Panel and has offered to represent the group at future meetings.

Ocean Carbon Sensor Directory

The OceanSensors08 workshop was held at the Leibniz Institute for Baltic Sea Research, IOW, in Warnemünde, Germany, from 31 March to 4 April 2008 (<http://www.oceansensors08.org/>). In special sessions, draft white papers were discussed, including for sensors for fluxes through the sea surface (headed by Arne Körtzinger, IFM-GEOMAR, Germany), and sensors and instruments for oceanic carbon measurements (headed by Ute Schuster, UEA, UK). Manuscripts are now being prepared for submission to a special issue in the journal *Ocean Science*, <http://www.ocean-science.net/index.html>.

In addition to the manuscript for oceanic carbon measurements, an Internet-based directory of sensors and instruments has been developed by the IOCCP. The first version site can be viewed at: www.ioccp.org >Sensors. The development of this directory stimulated great interest by the workshop participants, as it provides an overview of available technologies of interest to scientists aiming to start oceanic carbon measurements and to developers aiming to improve on technologies utilized. The issue of Technology Readiness Levels (TRLs, see e.g. http://en.wikipedia.org/wiki/Technology_Readiness_Level), was also discussed. TRLs have been adapted for marine research, where the aim is to provide documentation (publications, cruise reports, laboratory reports, project reports, etc.) that describes the level of development for each sensor/instrument. The IOCCP will continue to develop this directory and actively seeks input and suggestions from the ocean carbon community.

UN Interagency Coordination Group on Ocean Fertilization

On 5 February 2008, the Scientific Groups of the International Maritime Organization's Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (1972) and its 1996 Protocol (also known as the "London Convention") requested scientific and technical input from the IOC on the issue of ocean iron fertilization aimed at sequestering atmospheric CO₂, to be presented at the 31st Session of the London Convention Scientific Groups (Guayaquil, Ecuador, 19–23 May 2008).

An informal Consultative Group of Experts was developed to respond to this request, consisting of Dr. Ken Caldeira (Carnegie Institute, Stanford, USA), Ulf Riebesell (IfM-GEOMAR, Germany), Andrew Watson (Uni East Anglia, UK), Philip Boyd (Uni Otago, New Zealand), and Chris Sabine (NOAA/PMEL, USA). This group developed a statement (http://ioc3.unesco.org/oanet/OAdocs/IOC_OF_Statement%20with%20add.pdf) in response to a series of scientific and technical questions posed by the London Convention Scientific Groups, and the Chair of the Consultative Group, Dr. Ken Caldeira, attended the meeting as an observer.

This input was considered by the Working Group on Ocean Fertilization of the London Convention Scientific Groups in order to determine the implications for protection of the marine environment from ocean fertilization and to provide a scientific and technical basis for evaluating such activities. The decision of the London Convention Scientific Groups was, *inter alia*, that the London Convention Scientific Groups' Statement of Concern Regarding Iron

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Fertilization of the Oceans to Sequester CO₂ (November 2007) remained valid. That statement (http://ioc3.unesco.org/oanet/OAdocs/IOC_LCSGStatement.pdf) noted with concern the potential for negative environmental impacts and recommended that any such operations be evaluated carefully to ensure that they were not contrary to the aims of the Convention and Protocol. The Scientific Groups also noted that it is important to have scientific and technical expertise included in the delegations when ocean fertilization is discussed further at the next meeting of the governing bodies, and that better coordination is needed among the UN organizations, programmes, and agencies dealing with this issue.

On May 19-30 2008, the 9th Conference of the Parties to the Convention on Biological Diversity (CBD) adopted a decision concerning ocean fertilization activities, referring to the on-going legal and scientific analyses being carried out by the IMO London Convention (<http://www.cbd.int/decisions/cop9/?m=COP-09&id=11659&lg=0>). This decision urges governments to ensure that ocean fertilization activities do not take place until there is an adequate scientific basis on which to justify such activities, with the exception of small-scale research studies in coastal waters. The decision also called for a global transparent and effective control and regulatory mechanism for ocean fertilization activities.

The IOC ad hoc Consultative Group on Ocean Fertilization responded to this decision in an addendum to their original submission to the IMO London Convention, expressing concern about the limitation of experiments to the coastal zone, which may impede legitimate research activities, as well as the lack of distinction between legitimate research activities and those proposed to sequester CO₂ that may fall under the proposed global regulatory mechanism. This addendum was submitted to the London Convention Secretariat and circulated to the Chairs of the Governing Bodies, Scientific Groups, Working Group on Ocean Fertilization, and the Secretariat of the CBD.

The 41st session of the UNESCO - IOC Executive Council (June 2008) reviewed the report by the IOC ad hoc Consultative Group of Experts and recent actions and decisions by IMO and CBD (<http://ioc3.unesco.org/oanet/OAdocs/INF1247-1.pdf>). They agreed that proposals to use ocean fertilization to sequester carbon in the ocean are a cause for concern, that there is insufficient understanding of the potential impacts of such activities on the marine ecosystem, and that a precautionary approach is appropriate until safeguards can be established. They further agreed to initiate a UN-interagency partnership with IMO, CBD, and UNEP to coordinate advice and actions on ocean fertilization, and to compile and synthesize scientific information on potential impacts from ocean fertilization for consideration at the 10th Conference of the Parties to the CBD. In addition, they encouraged the IOC to continue to work with SCOR on the Ocean Carbon Sequestration Watching Brief, and to work with the SCOR Working Group 131 in compiling and synthesizing information about ocean fertilization experiments.

The ocean fertilization working group of the IMO London Convention Scientific Groups and a Legal Intersessional Correspondence Group will continue their work to determine if ocean fertilization activities are counter to the aims of the Convention. Their next session will be held in October 2008 and will address what further action should be taken towards regulation of ocean fertilization under the Convention and Protocol.

International Nutrients Scale System Workshop

The IOCCP has been requested to support the INSS project. The IOC is providing funds to support and host the first workshop. The IOCCP SSG will discuss officially endorsing this as an IOCCP activity at the SSG-III meeting in October.

2009 INSS International Workshop
10–12 February 2009
UNESCO Headquarters, Paris, France
1 rue Miollis, 75015 Paris, France

Organizing Committee:

- Michio AOYAMA, Meteorological Research Institute, Japan
- Andrew DICKSON, University of California at San Diego, Scripps Institution of Oceanography, La Jolla, CA, USA
- David HYDES, National Oceanography Centre, Southampton, UK
- Akihiko MURATA, Japan Agency for Marine-Earth Science and Technology (JAMSTEC), Japan
- Jae OH, IAEA Marine Environment Laboratories, Monaco
- Patrick ROOSE, QUASIMEME, Wageningen, The Netherlands
- Malcolm WOODWARD, Plymouth Marine Laboratory, UK

Objectives of the workshop:

- 1) Update the manual of nutrient analysis.
- 2) Review the use of nutrient data in oceanography and necessity of INSS.
- 3) Prepare summary report of 2008 RMNS (Reference Material for Nutrients in Seawater) intercomparison experiments.
- 4) Update plan for “short-term stability experiment – characterization of RMNS” in 2009–2011;
- 5) Report on the progress of certification of RMNS by the National Metrology Institute of Japan.
- 6) Expand current RMNS for DOC, DON and DOP references
- 7) Organize an international INSS working group under an international organization such as IOCCP-IOC-UNESCO.

Background:

The comparability and traceability of data on nutrients in the global ocean are fundamental issues in marine science, particularly for studies of global climate change. Our community has been continuing to improve the comparability of nutrient data in many ways, including by intercomparison experiments and the development of nutrient reference materials. However, as *Climate Change 2007 – The Physical Science Basis* (IPCC 2007) stated, adequate comparability and traceability have not yet been achieved. The IPCC 2007 report comments as follows on nutrient comparability:

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Using the same data set extended to the world, large regional changes in nutrient ratios were observed (Li and Peng, 2002) but no consistent basin-scale patterns. Uncertainties in deep ocean nutrient observations may be responsible for the lack of coherence in the nutrient changes. Sources of inaccuracy include the limited number of observations and the lack of compatibility between measurements from different laboratories at different times. (Bindoff et al., 2007).

The IOC-IAEA-UNEP Group of Experts on Standards and Reference Materials (GESREM, 1993) drew attention to an urgent need for certified reference seawater for nutrients. Dickson (2001) drew attention to the need to develop certified reference seawater covering several determinants in the one bottle.

During the World Ocean Circulation Experiment (WOCE) period, the WOCE Hydrographic Program Planning Committee (WHPPC) recognized the importance of worldwide comparability of WOCE nutrient data.

In the 1990s a number of studies were organized under the ICES umbrella. These studies were well documented (see Aminot et al., 1995 and Aoyama, 2006 for details). In Europe, this led to the setting up of QUASIMEME (Topping, 1997), which annually validates the procedures of individual laboratories. But this system is inadequate for supporting the traceability that is required to link measurements from day to day in order to improve the overall precision within a laboratory or to achieve a known level of comparability between different laboratories.

In 2000 and 2002, the National Oceanic and Atmospheric Administration, USA and the National Research Council of Canada (NOAA/NRC) conducted two intercomparisons to certify MOSS-1 (Willie and Clancy, 2000; Clancy and Willie, 2003). However, adequate comparability and traceability of nutrients data have not yet been achieved. Various efforts have been made to change it, but these have been on too small a scale to meet the needs of the global community in measuring nutrients in seawater.

In 2003, Michio Aoyama, of the Meteorological Research Institute, Japan, organized an intercomparison study that included 18 laboratories (Aoyama, 2006; Aoyama et al., 2007). In 2006, Aoyama organized a second intercomparison study that included 55 laboratories worldwide (Aoyama, 2008 in preparation). Both studies clearly showed that the global use of reference materials for nutrients in seawater would greatly improve the comparability of nutrient data worldwide.

In early 2007, Aoyama visited the National Oceanography Centre in Southampton to discuss the results of the inter-calibration. The European participants in the inter-calibration and other interested nutrient chemists were then invited to attend discussions at NOC.

An International Workshop on Chemical Reference Materials in Ocean Science was held in Tsukuba, Japan, on 29 October to 1 November 2007. It focused on the measurement of nutrients and of ocean CO₂ parameters. The current status of available chemical reference materials, especially for nutrients references in ocean science were discussed, and the participants agreed to start a collaborative program, called the International Nutrients Scale System (INSS), to establish

global comparability and traceability. The agreements at the workshop in Tsukuba 2007 marked an epoch in the history of nutrients comparability. The 2009 INSS workshop in Paris is a follow-up meeting of 2007 workshop in Tsukuba to advance international collaboration to establish global comparability of nutrients data in the world ocean.

New IOCCP Director Sought for 2009

After 10 years managing the IOC's ocean carbon programs, Maria Hood will be leaving the IOC at the end of December 2008, but will continue to work as a part-time consultant for the IOCCP to facilitate the transition to a new director and to assist with the ever-expanding work load of the project. A DRAFT job announcement (below) will be sent out in mid-August to email networks, newsletters, and EOS to search for a new director.

International Ocean Carbon Coordination Project (IOCCP) Director

The International Ocean Carbon Coordination Project (www.ioccp.org) promotes the development of a global network of ocean carbon observations for research through technical coordination and communication services, international agreements on standards and methods, and advocacy and links to the global observing systems. The IOCCP is co-sponsored by the Intergovernmental Oceanographic Commission of UNESCO and the Scientific Committee on Oceanic Research.

The IOCCP is seeking to appoint a director for the project, located at the IOC Secretariat in Paris, France. The director will be assisted by a Ph.D.-level consultant and an administrative assistant. The responsibilities of the director are to assist the IOCCP Scientific Steering Group in developing and implementing targeted workshops; fostering the development of international agreements on global observation strategies, data-sharing practices, and standards; facilitating data collection and syntheses; maintaining an international directory of ocean carbon observations; maintaining a communication network through web and email-based publications; maintaining the Ocean Acidification Network web-site; assisting with implementation of the Ocean in a High CO₂ World symposium series; fund-raising and managing the project's finances; representing the IOCCP at international meetings; reporting to the sponsors regularly; and responding to ocean carbon issues in UN conventions and other intergovernmental activities as requested by IOC Member States.

For this post, we seek a candidate with a Ph.D. in chemical oceanography or closely related field with 7-10 years of experience, preferably with several years' experience in program management at the international level. The candidate should have a good knowledge of current ocean carbon observation and research priorities, and have excellent IT skills, including web design. The candidate must be fluent in English and have excellent verbal and written skills, as well as very good interpersonal skills and the ability to work in a multi-cultural environment. International travel will be required. The initial appointment is for one year, starting in January 2009, and is renewable, subject to satisfactory performance and continued extra-budgetary funding. Starting salary will be approximately US\$75,000, paid in

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euros, and is exempt from income tax. UNESCO offers an attractive benefits package including 30 days' annual vacation, home travel, pension plan and medical insurance.

Candidates should send a Curriculum Vitae along with full contact information for 3 professional references no later than **30 September 2008** to Dr. Maria Hood by email (m.hood@unesco.org) or mail (UNESCO – IOC, 1 Rue Miollis, Paris 75732 Cedex 15, France).



3rd Session of the IOCCP Scientific Steering Group

The IOCCP SSG will be meeting on 3-4 October 2008 at Laboratoire d'Océanographie, Villefranche-sur-Mer, France, immediately before the symposium on The Ocean in a High-CO₂ World. The draft agenda follows.

Agenda

Day 1, October 3

	SESSION I: OPENING AND PROGRAM AREA REVIEW (5-10 minute introduction of yourself and your research + 10-15 minute overview on your area of expertise for IOCCP ... what are the major issues, mysteries, what's new, what's needed, etc.)
0900-0930	Opening, Welcome, and Introductions of the 2008-2010 SSG <i>Chris / all</i>
0930-0950	Decadal Carbon Inventories and Repeat Hydrography – Chris (standing in for Masao).
0950-1010	Ocean Interior Data Syntheses – Toste
1010-1030	Surface CO ₂ Data Synthesis Work - Chris (standing in for Dorothee)

1030-1100	<i>Coffee Break</i>
1100-1120	Surface Flux Maps and Data Assimilation – Ute
1120-1140	Time Series – Melchor
1140-1200	Underway pCO ₂ Networks – Pedro
1200-1220	Integrated Greenhouse Gas Monitoring Networks - Yukihiro
1220 - 1240	Data Management News – Alex
1240-1400	<i>Lunch</i>
	SESSION II: REVIEW OF MAJOR ACTIVITIES
1400-1430	GO-SHIP Update Chris for Masao
1430-1500	SOCAT Update Chris / Maria for Dorothee
1500 - 1530	Changing Times Workshop Update Chris / Melchor
1530-1600	<i>Coffee Break</i>
	SESSION III: REVIEW OF ACTIVITIES REQUIRING DECISION ABOUT FOLLOW-UP
1600 - 1630	Sensor Meeting / Catalogue Update Ute
1630 - 1700	Southern Ocean Observing System strategy Maria / Chris
1700 - 1730	EU Projects: <ul style="list-style-type: none"> • Coordinated Action Carbon Observing System (EU COCOS) - Maria / Toste • EPOCA training workshop / fundamentals of

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	biogeochemistry – Maria
1730 - 1800	SOLAS – IMBER Carbon Group Review Truls and Arne
1800	Close of Day 1

Day 2, October 4

	SESSION IV: NEW ISSUES FOR CONSIDERATION (Brief presentations and open discussion)
0900-0930	UN interagency group on ocean fertilization Maria
0930-1000	Standards for Ocean Acidification Research and Data Reporting Maria
1000-1030	Co-sponsorship of INSS group Maria
1030-1100	<i>Coffee Break</i>
1100-1115	Links to OOPC / Direct reporting to GOOS GSSC Maria
1115-1130	Hiring of new Director for IOCCP / Staffing for 2009+ Maria / Chris
1130-1200	Observation Monitoring Center Developments Maria
1200-1230	OTHER ??
1230-1400	Lunch

4.2 SCOR/IOC Symposium on the Ocean in a High-CO₂ World

Committee Charge:

The planning committee will determine the scope of the symposium, plan the agenda, develop the list of invited participants, and handle any publications that result from the symposium.

Chair:

James Orr
Marine Environment Laboratories (MEL-IAEA)
4, Quai Antonie 1er
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Tel: +377 9797 7229
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Members:

Ken Caldeira (USA)
Victoria J. Fabry (USA)
André Freiwald (Germany)
Jean-Pierre Gattuso (France)
Peter M. Haugan (Norway)

Patrick Lehodey (France)
Silvio Pantoja G. (Chile)
Hans-O. Poertner (Germany)
Ulf Riebesell (Germany)
Tom Trull (Australia)

SCOR Liaison: Ed Urban

IOC Liaison: Maria Hood

IGBP Liaison: Wendy Broadgate

Symposium Manager: Elizabeth Gross

Executive Committee Reporter: Bob Duce

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2008 Progress Report on Planning for the Second Symposium on The Ocean in a High-CO₂ World

The purpose of this symposium is to provide an interdisciplinary forum to assess what is known about ocean acidification and priorities for future research. SCOR, IOC, IGBP, and the International Atomic Energy Agency (IAEA) are co-sponsoring the symposium. Funding for the symposium is being provided by grants from the U.S. National Science Foundation, and contributions from IAEA, the Prince Albert II Foundation, ICES, PICES, and local sources in Monaco. The symposium will be held on 6-8 October 2008. The announcement of the symposium has been circulated widely. Approximately 250 individuals will participate, with about 50 oral presentations and 110 posters.

The symposium will include both invited and contributed presentations on the following topics:

- Scenarios of ocean acidification
- Effects of changes in seawater chemistry on nutrient and metal speciation
- Ocean carbon system from deep-time to the present to the distant future
- Paleo-chemistry
- Mechanisms of biocalcification
- Impacts on benthic and pelagic calcifiers
- Physiological effects: From microbes to fish
- Adaptation and (micro)evolution
- Fisheries, food webs, and ecosystem impacts
- Biogeochemical consequences and feedbacks to the Earth system
- Economic consequences
- CO₂ disposal

The symposium will include plenary presentations, discussion sessions on research priorities, and a poster session. Because of time limitations, most contributed abstracts will be presented as posters. Manuscripts based on presentations at the symposium can be submitted to a special issue of *Biogeosciences* (closing date is 8 November) and research priorities will be published separately for the benefit of ocean scientists and research program managers worldwide. Several publications are planned, to reach the scientific community, policymakers, and public.

The symposium Web site can be found at <http://www.confmanager.com/main.cfm?cid=975>. The final day of the symposium will provide a science summary, talks on economics and sociological aspects of ocean acidification, and a press conference. Prince Albert II of Monaco will make comments on Day 4. In the afternoon of that day, an outreach session for local students and teachers is planned.

**Second Symposium on the Ocean in a High-CO₂ World
Detailed Programme**

Version of September 5, 2008

(a few of the speakers have cancelled, but we are still working on replacements)

SUNDAY, 5 OCTOBER

Ice-Breaker Reception (and Registration)

17:00 – 18:00 **Registration** (access to the Musée Océanographique after registering)

18:00 – 19:30 **Ice-Breaker Reception** (registration continues; access to 1st floor access only)

DAY 1: MONDAY, 6 OCTOBER

8:00 – 9:00 **Registration**

9:00 - 9:30 **Opening & Welcome (preliminary)**

9:00 - 9:15 Robert Calcagno, Minister of the Environment. Monaco

9:15 - 9:20 Jean-Louis Etienne – Director, Musée Océanographique

9:20 - 9:30 James Orr – MEL/IAEA, Monaco, Chair, Planning Committees

Scenarios of ocean acidification – James Orr, Chair

9:30 – 10:00 *Invited:* Present and future changes of carbonate systems in the global oceans – **Richard Feely**, NOAA/PMEL, Seattle, USA

10:00 – 10:15 Impact of climate change mitigation on ocean acidification projections – **Gian-Kasper Plattner**, ETH Zurich, Switzerland

10:15 – 10:30 CO₂ emission targets for future changes in ocean carbon chemistry – **Richard Zeebe**, University of Hawaii, USA

10:30 – 10:45 High vulnerability of Eastern boundary upwelling systems to ocean acidification – **Nicolas Gruber**, ETH Zurich, Switzerland

10:45 – 11:15 **Coffee Break**

Impacts on benthic and pelagic calcifiers – André Freiwald, Chair

11:15 – 11:45 *Invited:* Impact of ocean acidification on benthic organisms – **Jean-Pierre Gattuso**, LOV, Villefranche-sur-mer, France

11:45 – 12:00 When will reef building cease? Threshold for net carbonate production – **Chris Langdon**, University of Miami, USA

12:00 – 14:00 **Lunch**

14:00 – 14:15 The impact of ocean acidification and temperature on the reproduction and development of oysters and the potential of genetic differences to ameliorate climate change – **Laura Parker**, University of Western Sydney, Australia

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- 14:15 – 14:30 Latitudinal variation in calcification: vulnerability of Antarctic benthic calcifiers to ocean acidification – **Sue-Anne Watson**, National Oceanography Centre Southampton, UK
- 14:30 – 15:00 *Invited*: Pelagic calcifiers: pteropods and forams – **Victoria Fabry**, Cal. State University, San Marcos, USA
- 15:00 – 15:15 Interannual variability of pteropod shell weights in the high-CO₂ Southern Ocean – **Donna Roberts**, Antarctic Climate & Ecosystems CRC, Hobart, Australia
- 15:15 **Coffee break**

Ocean carbon system: past & present – Peter Haugan, Chair

- 15:45 – 16:15 *Invited*: Controls on evolution of ocean carbonate chemistry over the past 10⁹ years – **Ken Caldeira**, Department of Global Ecology, Carnegie Institution, Stanford, USA
- 16:15 – 16:30 Boron isotope evidence of ocean acidification in the Neoproterozoic – **Simone Kasemann**, University of Edinburgh, UK
- 16:30 – 16:45 Reduced calcification in modern Southern Ocean planktonic foraminifera – **Andrew Moy (William Howard)**, Antarctic Climate & Ecosystems CRC, University of Tasmania, Australia
- 16:45 – 17:00 Current rates of change in pH and calcium carbonate saturation in the high latitude North Atlantic Ocean – **Jon Olafsson**, Marine Research Institute, Reykjavik, Iceland
- 17:00 – 17:15 Low winter CaCO₃ saturation in the Baltic Sea and consequences for calcifiers – **Toby Tyrrell**, National Oceanography Centre, Southampton University, UK

Effects of ocean acidification on nutrient and metal speciation – Silvio Pantoja, Chair

- 17:15 – 17:45 *Invited*: Ocean acidification and metal speciation – **Hein de Baar**, Royal Netherlands Institute for Sea Research, the Netherlands
- 17:45 – 18:00 Ocean acidification effects on iron speciation in seawater – **Eike Breitbarth**, Department of Chemistry, University of Gothenburg, Sweden
- 18:00 – 20:00 **Poster Session 1** (with refreshments)

DAY 2: TUESDAY, 7 OCTOBER

Mechanisms of Calcification – Joanie Kleypas, Chair

- 8:30 – 9:00 *Invited*: Biomineralization mechanisms in marine calcifiers in view of ocean acidification – **Jonathan Erez**, Institute of Earth Sciences, Hebrew University of Jerusalem, Israel
- 9:00 – 9:15 Effect of acidification on coral calcification: working hypothesis towards a physiological mechanism – **Francesca Marubini (Denis Allemand)**, Centre Scientifique de Monaco

9:15 – 9:30 Predictions of carbon fixation during a bloom of *Emiliana Huxleyi* is highly sensitive to assumed response to shift in pCO₂ – **Olivier Bernard**, INRIA-COMORE, Sophia-Antipolis, France

Physiological effects: from microbes to fish – Victoria Fabry, Chair

9:30 – 10:00 *Invited*: Physiological Mechanisms Linking Climate to Ecosystem Change: Effects of Ocean Acidification on Marine Animals in Times of Ocean Warming – **Hans-Otto Pörtner**, Alfred Wegener Institute for Polar and Marine Research (AWI), Germany

10:00 – 10:30 *Invited*: Impacts of Ocean Change on Primary Producers – **Ulf Riebesell**, Leibniz Institute of Marine Sciences (IFM-GEOMAR), Germany

10:30 – 11:00 **Coffee Break**

11:00 – 11:30 *Invited*: Physiology overview of Microbes – **Antje Boetius**, MPI für Marine Microbiology, Bremen, Germany

11:30 – 11:45 Effects of hypercapnic acidification of seawater on the biology of non-calcifying marine organisms – **Erik Thuesen**, Evergreen State College, Laboratory, Olympia, USA

11:45 – 12:00 Predicting the impact of ocean acidification on benthic biodiversity: what can animal physiology tell us? – **Stephen Widdicombe**, Plymouth Marine Laboratory, UK

12:00 – 14:00 **Lunch**

Fisheries, food webs, and ecosystem impacts (PICES-ICES session) – Patrick Lehodey, Chair

14:00 – 14:30 *Invited*: Consequences of Ocean Acidification for Fisheries – **Jan Helge Fosså**, Institute of Marine Research, Bergen, Norway

14:30 – 15:00 An ocean acidification simulation experiment with benthic animals using a precise pCO₂ control system – **Yukihiro Nojiri**, CGER/NIES, Tskuba, Japan

15:00 – 15:15 Natural CO₂ vents reveal ecological tipping points due to ocean acidification – **Jason Hall-Spencer**, Marine Institute, Biological Sciences, University of Plymouth, UK

15:15 – 15:30 Salmon pHishing in the northeast Pacific; an archaeological dig in the North Pacific survey data (1956–1964) – **Skip Mckinnell**, North Pacific Marine Science Organization, Sidney, Canada

15:30 – 16:00 **Coffee Break**

CO₂ Disposal – Ken Caldeira, Chair

16:00 – 16:30 *Invited*: Effects of CO₂ capture and storage on ocean acidification – **Peter Haugan**, Geophysical Institute, University of Bergen, Norway

16:30 – 16:45 Modelling of CO₂ dispersion leaked from seafloor off Japanese coast – **Yuki Kano (Toru Sato)**, AIST (and University of Tokyo), Japan

17:00 – 19:00 **Poster Session 2**

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Tuesday Evening Symposium Events:

19:00 – 20:00 Symposium Cocktail – Aquarium (in the Musée Océanographique)

20:00 – 22:00 Symposium Dinner - 1st Floor of Musée Océanographique (stand-up buffet)

DAY 3: WEDNESDAY, 8 OCTOBER

Adaptation and microevolution – Ulf Riebesell, Chair

8:30 – 9:00 *Invited:* A brief history of skeletons in the ocean – **Andrew Knoll**, Harvard University, USA

9:00 – 9:15 Adaptation of coccolith calcification to seawater carbonate chemistry – **Patrizia Ziveri**, Institute of Environmental Science and Technology, Autonomous University of Barcelona, Spain

New concerns – Ulf Riebesell, Chair

9:15 – 9:30 Impact of ocean acidification underwater sound: reduced low frequency absorption, increased noise levels, potentially higher stress for marine mammals – **David Browning**, Department of Physics, University of Rhode Island, USA

9:30 – 9:45 Experimental approaches of carbonate chemistry manipulation in CO₂ perturbation studies – **Kai Schulz**, Leibniz Institute for Marine Sciences (IFM-GEOMAR), Germany

Biogeochemical consequences and feedbacks to the Earth system – Tom Trull, Chair

9:45 – 10:15 *Invited :* Biogeochemical consequences of ocean acidification – **Laurent Bopp**, Laboratoire des Sciences du Climat et de l'Environnement CEA-CNRS-UVSQ, IPSL, Gif-sur-Yvette, France

10:15 – 10:45 **Coffee Break**

10:45 – 11:00 Dissolution of CaCO₃ in shallow water carbonate environments in the high CO₂ world of the Anthropocene – **Andreas Andersson**, Bermuda Institute of Ocean Sciences, Bermuda

11:00 – 11:15 Impacts of ocean acidification on marine biogenic trace gas production – **Frances Hopkins**, Laboratory for Global Marine and Atmospheric Chemistry, School of Environmental Sciences, University of East Anglia, Norwich, UK

11:15– 11:30 From laboratory manipulations to Earth system models: an 'Eppley curve' for calcification rate? – **Andy Ridgwell**, University of Bristol, UK

11:30 – 13:00 **Lunch**

13:00 – 15:15 **Breakout sessions**

1. Natural and Artificial Perturbation Experiments to Assess Acidification (e.g., paleoceanography, spatial variability, and mesocosm studies, modeling)

2. Observational Networks for Tracking Acidification and its Impacts (e.g., sensor development, observation networks, ecosystem responses, modelling)
3. Scaling Organism to Ecosystem Acidification Effects and Feedbacks on Climate (e.g., organism dose-response, modeling)

15:15 – 15:45 **Coffee Break**

15:45 – 17:00 **Reports from Breakout sessions**

Closing summaries for 3-day science meeting – James Orr, Chair

17:00 – 17:40 Scientific Perspectives – 1 or 2 speakers (To be determined)

17:40 – 18:00 **James Orr**, Planning committee chair (statements from planning committee)

DAY 4: THURSDAY, 9 OCTOBER (STILL PRELIMINARY)

Beyond natural science

09:00 – 09:30 Science summary from 1st three days of the symposium – **Carol Turley**

09:30 – 10:00 Basic Economics of Ocean Acidification – **Hermann Held**

10:00 – 10:30 Ocean acidification for Policymakers – **to be determined**

10:30 – 10:45 Address by HSH Prince Albert II of Monaco

10:30 – 11:00 **Coffee Break**

Press conference

11:30 – 12:30 Press conference in English and French

12:30 – 13:30 **Lunch**

Outreach for local students and teachers (in French)

14:00 – 16:00 Presentations and hands-on workshop potentially organized with CarboSchools, EPOCA EU Project, Musée Océanographique, Océanopolis, & l'Education Nationale de Monaco

4.3 Other Activities

4.3.1 SCOR Summits of International Marine Research Projects

Large-scale ocean research programs and projects are sponsored by several different international organizations, each with a different focus. For example, SCOR covers all areas of ocean science, IGBP focuses on biological and chemical aspects of global change, the World Climate Research Programme (WCRP) focuses on physical aspects of global change, and IOC brings together national governments to sponsor research and infrastructural activities related to aspects of ocean science that are of greatest importance to society. Some research programs, such as the Census of Marine Life and InterRidge, are independent but affiliated with related organizations. The programs and projects have interacting interests, but because they are not all sponsored by a single organization, they do not typically come together to discuss opportunities for cooperative activities and ways to address common concerns. The programs and projects tend to operate under tight budgets and are usually reluctant to spend their funds for coordination meetings. SCOR has received support from the Alfred P. Sloan Foundation to convene two project summits, in 2004 (see http://www.scor-int.org/Project_Summit_1/ProjCoord.htm) and 2006 (see www.jhu.edu/scor/ProjCoord2.htm). The Sloan Foundation is providing support for another Project Summit in 2009.

Follow-up from 2006 Summit—The main recent action to follow-up from the 2006 Summit was a meeting hosted by the International Oceanographic Data and Information Exchange (IODE) program in Oostende, Belgium in June 2008, on the topic of data publication. A draft article for *EOS* follows. This will be submitted when the meeting report is finalized (this article is likely to be revised again before we submit it).

Data Publication: A New Approach for Ocean Sciences?

Roy Lowry, Ed Urban and Peter Pissierssens

Data are collected from ocean science activities that range from a single investigator working in a laboratory to large teams of scientists cooperating on large, multinational, global ocean research projects. What these activities have in common is that all result in data, some of which are used as the basis for publications in peer-reviewed journals. However, two major problems regarding data remain:

- Much data that are valuable for understanding ocean physics, chemistry, geology, biology and how the ocean operates in the Earth system are never archived or made accessible to other scientists.
- When scientists do contribute data to databases, their data become freely available, with little acknowledgement and with no contribution to their career advancement.

The Scientific Committee on Oceanic Research (SCOR) and the International Oceanographic Data and Information Exchange (IODE) of UNESCO's Intergovernmental Oceanographic Commission (IOC) are discussing how to provide better access to these data through increased submission to approved, open on-line resources. New infrastructure and new approaches to data

publication could help scientists who observe the ocean and model its processes. Most importantly, it is now timely to:

- Increase the availability of data used to create figures, tables, and statistical analyses in traditional journal articles.
- Encourage the expansion of journals that specialize in “data publications” or “data briefs.”

Data publications are short (as little as a few paragraphs of text) descriptions, not interpretations, of data sets. They provide “persistent” pointers to the data in an approved data repository and references citable in papers using the data and in authors’ curricula vitae. Journals in the ocean sciences that already welcome such publications include *Marine Micropaleontology*; *Geochemistry*, *Geophysics*, *Geosystems*; *Ecological Archives*, and *Earth System Science Data*. Other journals also acknowledge the benefits of submitting the data underlying traditional publications to approved databases. This is standard practice in other domains such as the molecular biology, in which gene sequences described in peer-reviewed publications must be submitted to GenBank. SCOR and IODE will bring together a meeting of ocean science journal editors and publishers to discuss how to implement greater use of data publication. [This meeting is tentatively scheduled to be held in conjunction with the Fall AGU meeting in San Francisco in December 2008.]

To archive and serve data related to journal publications, additional infrastructure in the data management system is required, which must be implemented with minimal costs to avoid impeding the publication process. The e-Repository technology developed by the digital library community delivers such functionality. However, it does not provide the value added—in terms of harmonisation, quality control and metadata enhancement—associated with the IODE data centre network. A workable compromise would be to use e-Repository technology for the ingestion “front ends” of data centres serving ingested data sets “as is” in the short term and value-added data sets through existing data management infrastructure in the medium and long terms. This new infrastructure should improve the data publication review process through closer collaboration between data centres and journal editors.

SCOR and IODE will work with existing data centres to promote the development of the infrastructure required to provide ocean sciences publications with an effective “digital backbone”. More details are available at [URL].

Plans for 2009 Summit—The 2009 SCOR Project Summit will be held on 30 March to 1 April in Newark, Delaware (USA), hosted by the SCOR Secretariat. Tentative topics include data management/data publication/project data legacy, capacity building, observing technology/ocean biology observatories, project visibility/publicity, modeling, and interactions with intergovernmental organizations. SCOR has funds to pay for a smaller number of participants than in the past, with the expectation that the projects and other organizations will send some participants at their own expense.

4.3.2 Panel on New Technologies for Observing Marine Life

Terms of Reference:

1. Write cross-project synthesis of technology used by CoML projects, for publication as a special issue of a peer-reviewed journal or a book.
2. Write a synthesis paper or chapter, also placed on the Panel Web site, that will summarize (for a wide audience) the state of the art of technologies for observing marine life, including the limits of knowledge.
3. Plan and convene a Workshop on ocean biology observatories in conjunction with the OceanObs09 meeting in Venice, Italy (see <http://www.oceanobs09.net/>).
4. Revise and maintain Panel Web site, with information for the research and observations community, and for the public.
5. Oversee two activities on electronic tags that have been proposed as part of the CoML synthesis: (1) Developing New Tag Technologies – Integrating the Marine Animal Tracking Products from TOPP and POST and (2) Animals as Ocean Sensors in the Global Oceans.

Chair:

Alex Rogers
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Tel: 44-(0)20 7449 6669
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Members

(to be announced)

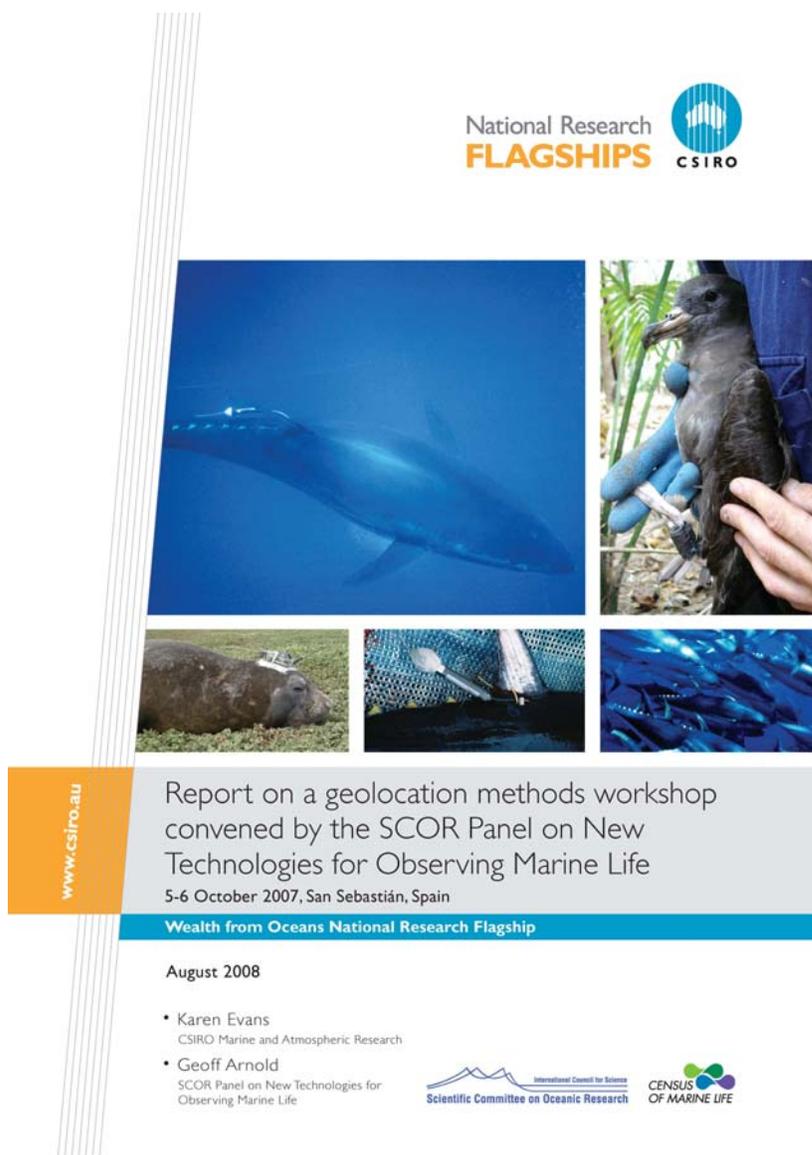
Executive Committee Reporter: Annelies Pierrot-Bults

SCOR Panel on New Technologies for Observing Marine Life Activities in 2007-2008

Panel activities since the 2007 SCOR Executive Committee Meeting have included a Panel-sponsored meeting on electronic tags, the annual Panel meeting, and submission of a successful renewal proposal to the Alfred P. Sloan Foundation for continuation of the Panel's work through the completion of the first Census of Marine Life in 2010.

Geolocation Methods Workshop

The Panel was requested by the CoML Scientific Steering Committee to help on the topic of geolocation of electronic tags that are attached to marine turtles, mammals, fish, birds, and even squid. The Panel convened a workshop on geolocation methods in conjunction with a major meeting on electronic tags in Spain in October 2007. A workshop report has just been issued through CSIRO (see http://www.scor-int.org/Publications/SCORfinalreport_pdf.pdf).



The image shows the cover of a report. At the top right is the National Research FLAGSHIPS CSIRO logo. Below it is a collage of five images: a whale swimming underwater, a person handling a bird, a seal resting on a grassy shore, a squid-like creature, and a school of fish. The title and subtitle are printed in a grey box, and the date 'August 2008' is in a blue box. The bottom of the cover features logos for the International Council for Science Scientific Committee on Oceanic Research and the Census of Marine Life.

National Research
FLAGSHIPS CSIRO

www.csiro.au

Report on a geolocation methods workshop
convened by the SCOR Panel on New
Technologies for Observing Marine Life
5-6 October 2007, San Sebastián, Spain

Wealth from Oceans National Research Flagship

August 2008

- Karen Evans
CSIRO Marine and Atmospheric Research
- Geoff Arnold
SCOR Panel on New Technologies for
Observing Marine Life

International Council for Science
Scientific Committee on Oceanic Research

CENSUS
OF MARINE LIFE

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EXECUTIVE SUMMARY

The last decade has seen many improvements in geolocating tag technology, position estimation and the development of useful models of movement for marine animals. Considerable effort has been invested in identifying factors that affect accuracy and precision of position estimates, quantifying the associated errors, deriving behavioural signals from resulting tracks and obtaining a better understanding of the spatial dynamics of tagged animals. However, positions estimated with geolocation techniques are still subject to significant errors and a number of problems remain relating to the identification and quantification of the factors affecting accuracy and precision of estimates. In response to concerns over the reliability and accuracy of underwater geolocation techniques and the ability to integrate oceanographic data with data from tagged animals, the Scientific Committee on Oceanic Research Panel on New Technologies for Observing Marine Life convened a workshop. The purposes of the workshop were to bring together scientists and engineers involved in all aspects of geolocation – from tag design to track interpretation – to identify key issues and possible solutions and to encourage further collaboration with users of the technology.

Detailed aims set out for the workshop were to:

- exchange results and outcomes of the latest work being conducted by participants;
- identify significant areas of common interest;
- arrange in-depth discussion by break-out groups and endeavour to resolve outstanding issues and scope future directions;
- develop co-operative and/or collaborative efforts for proposals to funding agencies at various levels;
- extend the results of the workshop to the broader electronic tagging community by presenting a report to the 2nd International Symposium on Tracking and Tagging Marine Fish with Electronic Devices, and publishing a summary account in the Symposium proceedings; and
- provide feedback to the SCOR Panel on New Technologies for Observing Marine Life and thence advice to the Scientific Steering Committee of the Census of Marine Life.

After reviewing progress made over the last decade, participants were assigned to two working groups, which met in parallel sessions and dealt separately with two primary areas of research: (1) the estimation of position (based on both light and other environmental variables) and (2) management and interpretation of position estimate data. The following key issues were identified as a result:

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- a need for better sensor performance and the development of tags with wider capabilities, including new sensors;
- a need for complementary data that can be integrated with tag data: (i) to provide more accurate estimates of position; and (ii) to investigate population and ecosystem effects;
- a consequential need to improve interactions with groups associated with the collection, handling, analysis and distribution of complementary data;
- improved co-ordination in the development of analytical methods and the associated software required to improve position estimation and identify behavioural states of tagged animals;
- increased co-ordination to standardise quality control and achieve greater transparency in data handling and processing, particularly in relation to comparative studies; and
- sharing of data to specify and then collect an ‘ideal’ set of data with which to compare the performance of existing methods of geolocation and develop improvements.

After discussing these key issues and the actions required for resolution, the workshop agreed upon the following recommendations:

1. A working group should be established to focus on the advancement of analytical techniques and software needs in relation to geolocation estimation.
2. Existing datasets, which include data from individuals tagged with both archival (geolocating) and satellite tags, should be made available for a comparison of current analytical methods and to define ideal datasets and the experimental design required to acquire them.
3. Tag manufacturers should make available tags for the collection of ideal datasets to be used for comparing various methodologies and quantifying errors associated with different methods of geolocation.
4. Service Argos should provide an error field around each Argos position estimate and clear documentation on how each error field is calculated.
5. Tag manufacturers should make available information on how data are compressed and processed so that it is clear to users how the data have been treated prior to starting their own analyses.
6. The existing dialogue between scientists using data from tagged animals and those in the oceanographic, ecology and resource management communities should be expanded.
7. Sessions should be developed at appropriate conferences to focus on two areas: (i) the identification of fundamental ecological questions that can be answered with archival tag technology and (ii) the application of archival tag technology for informing resource management.
8. Data sharing and exchange should be facilitated through the development of a seamless interface between users and data via a data manager.
9. Interactions among other research groups studying the movements of marine animals should be encouraged as they develop data storage/management tools.
10. Data quality control functions already developed should be compiled and made available.
11. Dialogue among groups that have already developed or are developing data visualisation tools should be encouraged and avenues for possible development of such tools to suit archival tags should be investigated.

2007 Panel Meeting

The Panel's meeting in 2007 was held in Auckland, New Zealand in November in conjunction with the CoML All Program meeting. After participating in the All Program meeting, Panel members and guests from several CoML projects reviewed the outcome of the geolocation meeting and planned their work for 2008-2010. This second phase of the Panel's work is particularly important as it relates to the synthesis of technology that has been important for CoML.

Panel Web site

The Panel Web site is being redesigned by the group at the University of Rhode Island that handles the CoML Web portal, so that we can integrate the excellent public information on the CoML site related to observing technologies with more technical information from the Panel.

Panel Work Plan for 2008-2010

The Panel's work in 2008-2010 will be planned to contribute to the synthesis of technology pioneered by CoML and/or which has been most responsible for the program's success. This will involve production of a book or special issue of a journal as well as a workshop on ocean biology observatories, which will contribute to the Global Ocean Observing System. The Sloan Foundation has approved the work plan and will provide funding to the SCOR Secretariat for it.

The Panel's work plan for 2008-2010 includes the following components:

6. Cross-project synthesis of technology used by CoML projects—This activity would document technologies used by CoML projects, particularly in terms of technologies that CoML has advanced. This product would take the form of a special issue of an open-access journal or a stand-alone book, and information on the Panel Web site. A number of journals could be good locations to publish the Panel's work, such as the new *Journal of Operational Oceanography* (<http://www.imarest.org/proceedings/joo/>) and the *Marine Technology Society Journal* (<http://www.mtsociety.org/publications/?fa=journal>). This activity will produce the cross-project synthesis product on technologies for a “transparent ocean”, led by Ed Urban and assisted by the Technology Panel and others. The major meeting to kick off the synthesis will take place at the University of Delaware in December 2008. A follow-up meeting will take place in Long Beach, California, in February 2009 in conjunction with the CoML synthesis meeting there.
7. A synthesis paper or chapter, also placed on the Panel Web site, will summarize (for a wide audience) the state of the art of technologies for observing marine life, including the limits of knowledge. This document will discuss how new observation technologies have been used to move our understanding of some CoML realms from the unknown to known, or at least to offer the promise of making organisms in these realms knowable in the near future.
8. Workshop on ocean biology observatories to contribute to the Global Ocean Observing System (GOOS)—For some time, physical oceanographers have been able to make intensive and extensive observations on a wide range of time and space scales using drifters, moored buoys, towed devices, autonomous vehicles, and, of course, satellite instruments. With a few exceptions (e.g., ocean color satellite sensors), marine biologists

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have not had access to advanced technologies that match those available for physical measurements, although a number of biological instruments have been developed by individual scientists for experimental purposes. The development of long-term biological monitoring programs in the ocean is critical in monitoring the impacts of climate change and other human impacts on marine ecosystems. This workshop would identify what the marine science community regards as the most pressing needs in terms of long-term biological observations. (Such information is available in documents related to GOOS and national observing systems, but needs to be pulled together and updated.) Workshop participants will then identify the most promising technological advances to meet these needs (both those technologies adopted by CoML projects already and complementary technologies that have not yet been used by the projects) and initiate activities to stimulate their transition to use as ocean biology observatories. The workshop will result in a summary publication and a more detailed science and implementation plan. The Panel has been increasing its interactions with the Global Ocean Observing System (GOOS) over the past three years. In the next period, the Panel would work with GOOS (and perhaps the Partnership for Observation of the Global Oceans: POGO), on the idea of ocean biology observatories, which would contribute directly to GOOS. The Panel will convene a workshop to evaluate the needs of the marine science community in terms of long-term monitoring of biological parameters (beyond measurements of chlorophyll) and to assess different technologies for observing marine life. It will propose how available and developing biological measurements could be combined within single nodes or at single sites to produce synergistic observation benefits and to decide on the appropriate scale and distribution of such nodes globally. A node might include moored observation instruments, with autonomous vehicles that use the node as a home base, regular visits by manned platforms, and access to satellite data for the site. The Ocean Tracking Network GOOS pilot project developed from the CoML POST and TOPP projects under the umbrella of the CoML Canada Committee will be a test of some of these technologies. The Panel's workshop will promote long-term biological monitoring and assist collaboration among scientists and managers interested in such monitoring.

This workshop will be held in conjunction with the OceanObs09 meeting in Venice, Italy (see <http://www.oceanobs09.net/>) and will focus on ocean biology observatories. This meeting will gather individuals related to GOOS, POGO, and national observatory efforts. The goal would be to produce a brief science and implementation plan that could be used by national GOOS projects and incorporated into international GOOS planning. The meeting will use as background the available national and international documents on biological observations. Panel members would also present one or more papers at the OceanObs09 meeting.

9. Panel Web site—The Panel's Web site is its major vehicle for disseminating information. The site includes short descriptions of key technologies, including key references, links to other information about the technologies, relevance for CoML projects, and other information that is useful for the CoML projects and the broader community of ocean scientists. The Panel includes on its Web site synthesis information about molecular techniques, animal tags, and other technologies important within and beyond CoML. In the next period, the range of technologies covered will be increased and the existing

technology information on the CoML Web portal designed for the public will be integrated with the Panel's more technical information. The Panel Web site will be re-designed by the CoML Education and Outreach team at the University of Rhode Island to make it a more useful resource for the CoML community and the public (see cost estimate in Appendix III). (The CoML Web site is being re-designed to employ a content-management system, which will make it easy to update the content of the Web site on a regular basis.) The Web site will include links to existing technology-relevant sites and documents. New information would be added as part of the Panel's continued work.

10. The Panel will oversee two activities on electronic tags that have been proposed as part of the CoML synthesis: (1) Developing New Tag Technologies – Integrating the Marine Animal Tracking Products from TOPP and POST and (2) Animals as Ocean Sensors in the Global Oceans (see Appendix IV). The Panel's role would be to help tie these activities into the overall synthesis of CoML-related observation technologies, and to ensure that the recommendations from the Panel's workshop on tag geolocation are considered. The Panel will provide technical oversight of these activities. SCOR would assist with logistics and handle reimbursements to meeting participants, as well as providing financial oversight of the activities.

4.3.3 SOLAS-International Nitrogen Initiative (INI) Workshop on Anthropogenic Nitrogen Impacts on the Open Ocean *MacCracken, Duce*

Robert Duce (USA) and Julie LaRoche (Germany) co-convened this workshop in Norwich, UK on behalf of SOLAS and INI and partially funded by SCOR. A synthesis paper appeared in *Science* in May 2008.¹

¹ R.A. Duce, J. LaRoche, K. Altieri, K.R. Arrigo, A.R. Baker, D.G. Capone, S. Cornell, F. Dentener, J. Galloway, R.S. Ganeshram, R.J. Geider, T. Jickells, M.M. Kuypers, R. Langlois, P.S. Liss, S.M. Liu, J.J. Middelburg, C.M. Moore, S. Nickovic, A. Oschlies, T. Pedersen, J. Prospero, R. Schlitzer, S. Seitzinger, L.L. Sorensen, M. Uematsu, O. Ulloa, M. Voss, B. Ward, L. Zamora. 2008. Impacts of Atmospheric Anthropogenic Nitrogen on the Open Ocean. *Science* **320**:893-897; DOI: 10.1126/science.1150369