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

### IOCCP Progress Report

(May 2006)

#### I. Introduction

This report provides an overview of IOCCP activities since its first Scientific Steering Group meeting on October 1, 2005 to assess progress relative to actions set at that meeting and to highlight new activities that have developed in several program areas. Each section of the report refers to the relevant action item established at the 1<sup>st</sup> SSG meeting (“SSG-1”). The Action Items List from SSG-1 is given in the Summary section of this report (p. 4-17), along with an update of progress against each action. This report is intended to update SSG members on current activities, to stimulate discussion among SSG members about the best way forward on these issues, and to inform the IOCCP sponsors and partner programs of on-going and planned activities.

#### II. IOCCP Project Office Update

IOCCP hires new project coordinator - Following the July 2005 agreements to transition the IOCCP from a pilot project to a standing project of SCOR and IOC with a broader mandate, NSF has funded a second project coordinator to work at the IOCCP office. Roger Dargaville was chosen for the post from a pool of 40 candidates, and started work at the IOCCP project office at UNESCO-IOC in January 2006. Roger hails from Australia, and his expertise lies in the modelling of atmospheric transport of CO<sub>2</sub>, and deducing CO<sub>2</sub> fluxes (both oceanic and terrestrial) by inverse methods. He also has studied physical chemistry and physical oceanography. Many years ago Roger assisted Bronte Tilbrook on two WOCE Southern Ocean cruises aboard the *Aurora Australis*, and worked as a post-doc with Scott Doney at NCAR before moving to France three years ago. During the past 12 months, he worked with Philippe Ciais and Berrien Moore as the coordinator of the Carbon theme of the Integrated Global Observing Strategy (IGOS), where the CO<sub>2</sub> Panel (and in the later stages, the IOCCP) provided the bulk of the input on ocean carbon observations.

Roger has rapidly taken on many project responsibilities, including activities of Repeat Hydrography, Surface CO<sub>2</sub>, Time Series, Friends of Oxygen, the IOCCP-GCP virtual conference, Web design and maintenance, and writing the quarterly news bulletins. He is also continuing some work with the IGOS Carbon Theme, as well as several IOCCP liaison activities with other groups such as OOPC and CLIVAR. Maria Hood will continue to oversee IOCCP activities in GlobColour, data set development and citations, developing a sensor catalog, and trying to deal with “lingering issues” of coastal ocean observations and coordination services for process studies; and of course, helping Roger. Maria is also spending increasing amounts of time on the ocean acidification issue, working on the development of a follow-up symposium to “The Ocean in a High CO<sub>2</sub> World”, and working within the UN system to investigate

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possibilities for funding for ocean acidification research and enhancing the visibility of this issue with the general public.

IOCCP Web Updates - Roger has renovated the Ocean Carbon Directory to better reflect the new range of activities of the IOCCP and to provide more introductory information about each activity. We strongly encourage everyone to review the site ([www.ioccp.org](http://www.ioccp.org)) and provide us your comments. For the hydrography and underway pCO<sub>2</sub> system pages, we have established a collaboration with the CDIAC Ocean CO<sub>2</sub> Program (Alex Kozyr) to make a coordinated set of maps served from the CDIAC site that provide both the current and future plans (“IOCCP maps”) as well as past sites with publicly available data, directly linked to metadata and data pages (“CDIAC maps”). This has eliminated much duplication of effort as well as difficulties with having different map versions and displays between the two sites. We plan to use the same map system for the time-series sites in the very near future.

- Responds to SSG1/Action Item 1: SSG members thought it would be useful to have a short mission statement prominently placed on the Web site to describe more clearly the IOCCP functions.
- Further reading: [www.ioccp.org](http://www.ioccp.org)

IOCCP Budget Overview - The IOCCP receives funds through several sources. The U.S. National Science Foundation provides support for two full-time project office staff at UNESCO. The NSF also provides program support for the IOCCP through a grant to SCOR. The IOC provides direct regular program support to the IOCCP Project Office and for support of carbon and biogeochemistry projects. These various grants operate over different time periods and with different start and end dates, and are managed separately by SCOR or IOC.

In May 2005, NSF augmented ongoing IOCCP funding with an additional \$75,000 for IOCCP activities. The IOC provides approximately \$15,000 per year for the IOCCP project office costs and staff travel. The end-date for the NSF grant is May 31, 2006, but we have asked for an extension of this grant until June 2007, and will submit a new proposal for IOCCP support for anticipated 2007 activities.

From May 2005 – April 2006, major expenditures were as follows:

<b>Activity</b>	<b>Dates</b>	<b>Approximate Costs</b>
International Ocean Carbon Research Program Stakeholders' Meeting	December 2004	US\$13825
International Ocean Carbon Open House and 1 <sup>st</sup> SSG meeting	September / October 2005	\$5992
International Repeat Hydrography and Carbon Workshop	November 2005	\$19732
Carbon representatives to	rolling	\$5200

meetings (e.g., JCOMM SOT, CLIVAR Basin Panels, OOPC, etc.)		(note: >1/2 of these costs paid directly by IOC funds)
Project office costs and travel	rolling	\$14989

As of April 2006, the IOCCP has the following funds remaining:

IOCCP funds at SCOR	\$37015
IOCCP funds at IOC for Project Office	\$6803

For the remainder of 2006, the IOCCP has committed to supporting members of the Friends of Oxygen on Argo working group to meet during one day at the CarboOcean North Atlantic Synthesis workshop in June 2006, as well as providing support for follow-up publications or representatives to key meetings. The IOCCP may also be supporting carbon representatives and/or project office staff to attend several meetings, including the Ocean Observations Panel for Climate, Global Carbon Project Scientific Steering Committee Meeting, Indian Ocean Biogeochemistry Meeting, and the ESSP Open Science Conference.

### III. Observing Programs

#### A. Hydrography Update

JAMSTEC, the IOCCP, and CLIVAR co-hosted an International Repeat Hydrography and Carbon Workshop on November 14-16, 2005, at Shonan Village, Japan. This workshop brought together 49 scientists from 11 countries with expertise in carbon, hydrography, tracers, prognostic modeling, data assimilation, the Argo profiling float program, and data and information managers. The goals of the workshop were to assess current ship-based hydrography programs and whether these activities are sufficient to meet science objectives of research programs, and to develop plans for a robust mechanism to compile information and data from ship-based hydrography. After a session of science talks focused on what we have learned about physical oceanography and ocean carbon from post-WOCE hydrographic activities, participants were asked to address two broad categories of questions: "Is the current design of the hydrographic program appropriate to meet science goals?", and "What are the best approaches for compilation, synthesis, and interpretation of international data sets?"

What emerged was the need for a more coordinated ship-based hydrography program that focuses not only on monitoring decadal changes but also is capable of addressing new research issues, and to set up a system of regular data synthesis and interpretation activities that are driven by science questions. The participants recognized that any synthesis mechanism that will be developed for the future must address new realities of working within the framework of a sustained observation program. Working within a program with no sunset clause, for example, will require the regular production of scientific products on a timescale that is much shorter than

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the traditional 10-year approach carried out through global research programs. A sustained repeat hydrography program will need to continually justify its value through publications and data products, and a mechanism for science-driven data syntheses must be developed to address these needs. Participants outlined action items to develop a small advisory group to provide guidance on the development of a more coordinated ship-based hydrography program; to establish closer links with Argo and other ocean-interior observing programs; to improve data and information coordination of existing systems; and to establish synthesis activities around science questions, beginning with the North Atlantic.

- Responds to SSG 1/Action item 7: Implementation of the International Repeat Hydrography Meeting, November 14-16, Shonan Village, Japan.
- Further Reading: International Repeat Hydrography and Carbon Workshop Report. - <http://ioc.unesco.org/ioccp/Docs/IRHWreportFINAL.pdf>

International Repeat Hydrography and Carbon Advisory Group development – As a follow-up action from the November hydrography meeting, it was agreed to establish a small advisory group to develop a cohesive and comprehensive international repeat hydrography and carbon program. The advisory group will be co-sponsored by IOCCP, CLIVAR-GSOP and the SOLAS/IMBER Carbon Group (hereafter referred to as the “S.I.C. group”). The general topics requiring oversight in this initial phase are:

- Oversee the writing of technical white papers to highlight successes and needs for a sustained and integrated international repeat hydrography and carbon program;
- Facilitate linkages with critical partners such as Argo and OceanSITES time-series network;
- Provide oversight and feedback to data and information management system;
- Provide oversight of basin synthesis activities to encourage multi-disciplinary and multi-platform integration;
- Serve as an international focal point for the development of this program and lobby for its support.

In this initial phase of development, it has been proposed that the work be carried out via email and telephone conferences, with meetings only held as absolutely needed and in conjunction with other meetings where the majority of members will already be participating.

Some of the tasks that need immediate attention include:

- i. the development of a single-site, comprehensive information and data center for all ship-based hydrography (encompassing more than just the official CLIVAR cruises, and combining / coordinating the information, data services, and “community bulletin board” outreach and communication services currently provided by CCHDO, NODC-A, CDIAC, IOCCP, and CLIVAR IPO);
- ii. providing input to the “Friends of Oxygen on Argo” activities;

- iii. providing input to the North Atlantic synthesis, with its first meeting of carbon scientists scheduled for late June 2006, and
- iv. making plans to update the hydrographic program manual as needed.

At the meeting, several names of scientists representing the range of groups and expertise were put forward. Representatives of the sponsor's group (Nico Caltabiano – CLIVAR; Roger Dargaville – IOCCP; Jeff Hare – SOLAS; Sylvie Roy – IMBER) are finalizing the list of potential members. We hope to have the Advisory Group established by the end of May.

- Responds to SSG 1 / Action Item 8: Based on outcomes of the November hydrography meeting, the IOCCP will begin investigating the interest and feasibility of establishing a sustained international project office for repeat hydrography in collaboration with the , CLIVAR, and the GCOS-GOOS-WCRP Ocean Observations Panel for Climate. Continue supporting carbon representatives to CLIVAR basin panels for one more year.
- Responds to SSG 1 / Action Item 21: After the November workshop, discuss with CDIAC the needs for more or additional types of information and data links for hydrography and other platforms

North Atlantic Synthesis Workshop – The International Repeat Hydrography and Carbon workshop recommended an action to establish a mechanism for integrated data syntheses, where syntheses would be developed around scientific issues and use an integrated approach (physics, chemistry, observations and models). The IRHC meeting suggested that these synthesis activities should be carried out on basin scales and through existing global and/or regional research programs. The EU CarboOcean program has taken the lead in planning a preparatory meeting for the North Atlantic.

- For more information, see the “*Synthesis*” section of this report.

#### Friends of Oxygen on Argo

Following the IRHC Workshop, a small group (the "Friends of Oxygen on Argo", FOA) was established to develop plans and proposals for a large-scale extension of the current small-scale deployments of Argo floats instrumented with O<sub>2</sub> sensors. It was agreed that the IOCCP should facilitate the work of this group.

- For more information, see the “*Pilot Projects*” section of this report (p. 4-12).

### **B. Underway / Surface pCO<sub>2</sub> Update**

The IOCCP and the S.I.C. Group are developing plans for an international workshop on Surface CO<sub>2</sub>. The workshop will be held at UNESCO in Paris from April 11-13, 2007. These dates were chosen to correspond with the EGU General Assembly in Vienna the following week. An organizing committee has been formed, consisting of:

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Nicolas Metzler\* (IPSL, France), Bronte Tilbrook\* (CSIRO, Australia), Dorothee Bakker (U. East Anglia, UK), Kitack Lee (Pohang Uni., Korea), Scott Doney (WHOI, USA), Dick Feely (NOAA, USA), Jeff Hare (U. East Anglia, UK), Sylvie Roy (U. Brest, France), Roger Dargaville (UNESCO, France). \*co-chairs

The overall goals of the workshop are to:

- Review the current knowledge base of the magnitude, variability and processes governing ocean sources and sinks of carbon: from observations, process-based models and atmospheric and oceanic inversions
- Review the current network of underway pCO<sub>2</sub> and future plans, and the current understanding of network design for underway pCO<sub>2</sub> measurements
- Develop firm plans for an internationally distributed network
- Develop firm plans for an internationally supported data synthesis effort

The committee has begun work on developing the format of the workshop and the agenda, and identifying potential speakers. It has also been suggested that this opportunity be used for a second joint meeting of the IOCCP SSG and the SOLAS/IMBER Carbon Group.

Associated with this activity, a working group on the feasibility of installing high-precision continuous atmospheric sensors on VOS in conjunction with the underway pCO<sub>2</sub> system has been established. Working with Britt Stephens, Roger Dargaville (IOCCP) has assembled a group of experts on the technical aspects of taking high-precision measurements of atmospheric CO<sub>2</sub> and modellers with expertise in the field of interpreting such data. The group comprises Peter Rayner (LSCE), Rachel Law (CSIRO), Britt Stephens (NCAR), Andy Watt (NCAR), Bronte Tilbrook (CSIRO), Marcel van der Schoot (CSIRO), David Baker (NCAR), Rik Wannikhof (NOAA) and Frederic Chevallier (LSCE). Email discussions have produced a short report on the current status of the measurement technology and the options for modelling studies to assimilate and interpret the data. Options for instruments currently include the CSIRO LoFlo and the NCAR AIRCOA instruments. Each has various accuracy and cost benefits – the modelling groups (NCAR and LSCE) will plan and run synthetic data experiments to estimate the optimal network of onboard and land-based continuous instruments and flask samples, with a focus on the Southern Ocean, reporting the results at the surface pCO<sub>2</sub> meeting in April 2007 in Paris.

- Responds to SSG 1 / Action Item 2: Both the SSG and the S.I.C. recognize the importance of having joint meetings, and agreed to try to co-locate / co-host the meetings of these two groups whenever possible.
- Responds to SSG 1 / Action Item 5: The S.I.C. Working Group on the Surface Ocean will take the lead on determining how best to establish a closer link to the atmospheric CO<sub>2</sub> community for measurements from underway ships.
- Responds to SSG 1 / Action Item 9: Begin plans for an international workshop on developing the scientific basis for VOS Network Design and Data Synthesis efforts, joint with the S.I.C. group.

- Responds to SSG 1 / Action Item 10: Establish a partnership with the Joint IOC-WMO Technical Commission on Oceanography and Marine Meteorology Ship Observations Team (JCOMM SOT) and work with this group to develop an informational document on how the carbon community can use this group for on-going and future negotiations with shipping companies. [Note: JCOMM SOT has been contacted and will develop a short informational brochure to describe their services for assisting scientists in setting up observing systems on commercial ships. This may be introduced as an informational item at the workshop.]
- Responds to SSG 1 / Action Item 11: Continue developing the draft document, *Underway pCO<sub>2</sub> Systems*, with a goal of developing a generic document describing underway pCO<sub>2</sub> systems and ship requirements for use with the JCOMM SOT group. [This action may be folded into follow-up activities of this workshop with the same goal.]
- Responds to SSG 1 / Action Item 17: Continue work on getting surface pCO<sub>2</sub> data holdings at CDIAC into a common format, and encouraging the public release of existing datasets to CDIAC for incorporation in the dataset. (Note: CarboOcean's Benjamin Pfeil reports that this dataset should be completed and publicly available by mid-2006).
- Further Reading: [http://ioc.unesco.org/ioccp/pco2\\_2007.htm](http://ioc.unesco.org/ioccp/pco2_2007.htm)

### C. Time-Series Stations Update

Based on the compilation developed by Nick Bates for SSG 1 and subsequent inputs from the community, a table of currently active time series stations measuring ocean carbon has been developed and put on the Web (<http://ioc.unesco.org/ioccp/TStable.htm>). The table provides information on ship-based stations, permanent moorings, and coastal moorings. This information will be used to develop a map of time-series sites in partnership with CDIAC. The OceanSITES project has recently revised its Web site to include maps of time-series stations, including one for ocean carbon measurements. However, the information provided on that map mixes ongoing activities with planned activities that are not yet operational, and the OceanSITES map does not have the same information included in the IOCCP inventory. Discussions are underway with OceanSITES to determine how best to harmonize these projections.

- Responds to SSG 1/ Action Item 13: Finalize the inventory of information on current and planned time-series stations with carbon measurements
- Responds to SSG 1 / Action Item 14: Determine an initial map / table display for the time-series information, and work with CDIAC to determine need and feasibility to develop a more sophisticated database for all information displays.
- Further reading: [http://ioc.unesco.org/ioccp/Prog\\_TimeSeries.htm](http://ioc.unesco.org/ioccp/Prog_TimeSeries.htm)

#### D. Ocean Colour Update

The IOCCP hosted the first meeting of the GlobColour science team on 3-4 January 2006 at UNESCO to review System Requirements and Validation Protocols for the GlobColour project. The IOCCP focal point for this activity is Cyril Moulin (Cyril.Moulin @ cea.fr).

The European Space Agency (ESA) has launched a project called GlobColour, which aims to develop and demonstrate a service supporting global ocean carbon-cycle research. An understanding of the cycling of carbon by the ocean biosphere is critical for developing scientifically based response to the sequestration of anthropogenic carbon emissions. ESA has one mission aboard ENVISAT: the Medium Resolution Imaging Spectrometer Instrument (MERIS), NASA has three missions in orbit to assess ocean biological processes by measuring the colour of the sea, the Sea-viewing Wide Field of view Sensor (SeaWiFS) and two flight models of the Moderate Imaging Spectrometer (MODIS) on the Terra and Aqua Earth Observing System (EOS) missions and CNES has now launched a new POLDER on board Parasol. In the coming years, the VIIRS, on the NPOESS Preparatory Project (NPP) will be deployed while ESA will deploy the Sentinel GMES-1 mission. In addition to ESA and NASA, several international space agencies have planned and deployed satellite ocean colour missions. As of today, there are 12 moderate resolution ocean colour imagers in orbit ([www.ioccg.org/sensors/500m.html](http://www.ioccg.org/sensors/500m.html)) although many of these are pilot missions and do not produce research-quality data. Clearly, there are many ocean colour data products for researchers, educators, students and policymakers to choose from.

These ocean colour missions have been developed to answer many of the most basic questions of how the ocean biosphere operates. Is the amount of vegetal biomass in the ocean increasing or decreasing in time? What is the role of climate change on the ocean biosphere? How do anthropogenic processes (in particular increasing atmospheric CO<sub>2</sub>) influence the ocean biosphere and can these changes be detected? It seems obvious that better ocean colour data products will come from the merging of different data sets:

- i. Different satellites following specific orbits observe clouds in different times and locations. Hence, one would expect coverage to improve by merging data sets (e.g., Gregg and Woodward, 1998);
- ii. The precision of merged data products will also increase simply due to the small sample statistics (once inter-satellite calibration issues are resolved).

The differences and similarities of the spectral observations can be taken advantage of in the merging process leading to improved accuracy and measurable uncertainties (e.g., Siegel, 1998; Maritorena et al. 2002). Finally, the merging process must be well justified and documented so all users understand its implications. The latter points to the importance of unified climate data records of ocean colour products with measured and documented uncertainties where the merging process is transparent for all users.

The project will provide scientists with a long time series of consistently calibrated global ocean colour information, according to requirements specified by the global ocean colour user

community, as represented by the user group. GlobColour will also put in place the capacity to continue the ocean colour service in the future. The IOCCP, working with the International Ocean-Colour Coordinating Group, will serve as links between the ocean carbon community and this project, to provide input into the development of the data products to ensure they are useful for the ocean carbon community.

The time line and milestones for the project are provided on the GlobColour Web site.

- Responds to SSG 1 / Action Item 12: Moulin will attend the first GlobColour Meeting in early 2006 and report back to the IOCCP on how the carbon community can assist this project.
- Further reading: [visit the GlobColour Web site for full information about this project](#)

## **E. Ocean Climate System Update**

Ocean Observations Panel for Climate - The IOCCP provides advice on ocean carbon observations to the OOPC for use in development of the Global Climate Observing System implementation plan in support of the UN Framework Convention on Climate Change (UNFCCC). In addition, the IOCCP and OOPC have a number of common interests and possibilities for collaborations. Roger Dargaville will be attending the 12<sup>th</sup> Session of the OOPC in Tokyo on May 17-20 2006, and will discuss

- Collaborations on development of an on-line sensor database jointly with ORION and OceanSITES (for more information, see “Sensors” section of this report) (seeking endorsement and/or collaboration and co-sponsorship);
- Results from the International Repeat Hydrography and Carbon workshop (seeking comments and advice on the way forward);
- Friends of Oxygen on Argo (seeking comments and advice on the way forward);
- Digital Object Identifiers for datasets (seeking endorsement and collaboration for wide-scale adoption in the oceanographic community).

as discussed elsewhere in this report.

Joint IOC-WMO Technical Commission on Oceanography and Marine Meteorology (JCOMM) Observations Coordination Group Review – The IOCCP is considered a “dotted line” program of JCOMM, meaning that we provide input on ocean carbon observations, but are not officially part of the operational system. The IOCCP has two main interactions with JCOMM – sending representatives to the Ship Observations Team (JCOMM SOT) to discuss underway CO<sub>2</sub> systems and lines, to ensure compatibility and information exchange with other underway programs; and sending representatives to the JCOMM system overview meetings, held jointly with the NOAA Office of Climate Observation annual system review. On May 9-12, 2006, Maria Hood will attend a JCOMM Operational Center System review, and Roger Dargaville and Chris Sabine will

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attend the Climate Observing System review. Chris will provide a 20 minute overview on ocean carbon observations.

## The Carbon Office of the IGOS Partners

The Integrated Global Observing Strategy (IGOS) is a partnership between the agencies and research programs for global observations relating to climate and atmosphere, oceans and coasts, the land surface and the Earth's interior. Partners include the United Nations sponsors of the global observing systems (UNESCO, WMO, FAO, UNEP), the observing systems themselves (GCOS, GAW, GOOS, GTOS), and the sponsors of major research programs (ICSU, WCRP, IGBP). The IGOS Partnership works to harmonize the common interests for observations and data from in situ and space-based systems around themes.

The IOCCP (and as its predecessor, the SCOR/IOC Panel on Ocean CO<sub>2</sub>) has strong links to the Carbon theme of IGOS-P, having provided the bulk of the input on the strategy for global carbon observations in the ocean for the theme report which was published in 2004. In 2005 the Implementation Plan for the theme was compiled, again with the bulk of the input coming from the IOCCP. The next step in the theme's progress is to oversee the coordination of the Implementation Plan, and to do so will require an official office to be established. With the Carbon theme coordinator (Roger Dargaville, providing oceanography and atmospheric expertise) now at the IOCCP, and the potential for strong links between UNESCO/IOC and other IGOS partners such as FAO, it appears that UNESCO is the ideal IGOS partner to host the Carbon Theme Office. FAO has indicated willingness to provide expertise in the terrestrial domain, perhaps by sending a terrestrial carbon scientist to work at the carbon office at UNESCO. Thus the office could be established with relatively little expense. A UNESCO proposal will be submitted to IGOS-P plenary in May in Geneva to have the Carbon Theme Office at UNESCO approved.

For the IOCCP, this means the potential to become the "ocean pillar" of the Carbon Office, where coordination services similar to those of the IOCCP would be developed for atmospheric CO<sub>2</sub> and terrestrial carbon observations, and the activities and services of the three domains would come together to contribute to an integrated overview of global carbon observations. In practical terms, little would change for the IOCCP except the eventual development of a common integrated Web site and database portal with the other domains. Benefits might include increased funds and staff to share common technical tasks, the possibility for users of the system to look at either the full carbon observing system or just a zoom into the ocean observing system, and integrated technical coordination activities to move forward the development of fully integrating information and data systems for carbon cycle observations and research. In addition, this broader connection to other domains and the wider IGOS partnership will provide increased visibility for ocean carbon observations required to address climate research.

Following the IGOS-P meeting in May, the Project Office will inform the SSG and IOCCP sponsors of the proposal to develop a Carbon Office at UNESCO, and we will seek input and guidance on whether IOCCP should accept (and under what conditions) to constitute part of this integrated office.

#### **IV. Standards and Methods**

Ocean CO<sub>2</sub> Guide of Best Practices - At the kickoff meeting of the IOCCP in January 2003, the IOCCP set an action item to standardize measurement and data reporting techniques, starting with the publication of an updated Guide of Best Practices for Oceanic CO<sub>2</sub> Measurement and Data Reporting. The update of the Guide had been initiated by the North Pacific Marine Science Organization (PICES) Working Group 17, and the IOCCP co-sponsored this activity. The Guide was originally to be published in mid-2004. As of May 2006, the Guide has not been completed, and the PICES Working Group has disbanded.

CDIAC has recently informed us that the original handbook from 1994 is now out of print, and requested input from IOCCP and PICES as to whether they should finance a new reprinting of the 1994 manual. With the new initiative for a more coordinated international repeat hydrography and carbon program, CLIVAR and IOCCP have begun discussions about an effort to revise the hydrographic manual. Both of these issues require immediate attention.

Andrew Dickson, the author of the manual and PICES Working Group co-chair, has been encouraged to finish this important work by November 2006, and the IOCCP has offered assistance for final editing as required. If this Guide is not completed by November, the IOCCP will need to undertake the development of a new Guide as part of the 2007 work program.

Mesocosm Guidelines – The SSG set an action item (No. 3) to assist the S.I.C. Working Group on Climate Sensitivities and Feedbacks to develop guidelines and protocols for mesocosm experiments. Maria Hood and Ulf Reibesell have worked on this issue for several months, and decided that it would be most beneficial to develop this activity as part of a larger project on mesocosms. Reibesell has proposed the development of an international open-ocean large mesocosm facility in the North Atlantic Ocean as a contribution to German SOLAS, and if this project is funded, the first kick-off meeting would be an ideal opportunity to address standardization issues.

#### **V. Data and Products**

Digital Object Identifiers for Datasets - In order to encourage rapid data release and appropriate acknowledgement for data contributions, data centers are exploring the options for identifying data sets with Digital Object Identifiers. Nicolas Dittert, WDC-MARE described their system, and the IOCCP has agreed to work with Nicolas and with the WDC and IODE systems to explore how to make this practice widely used. For more information, please see the “Pilot Projects” section of this report (p. 4-12).

WAVES System at CDIAC – The IOCCP has several action items dealing with making datasets at CDIAC available through Live Access Server or a similar visualization and extraction capability. The following “community letter” submitted by Alex Kozyr provides an update on those activities and a request for the community to provide feedback on the system that has been

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developed. It is anticipated that the surface pCO<sub>2</sub> data holdings at CDIAC will also use this system once the data are compiled in a common format (Benjamin Pfeil of CarboOcean is working on this and anticipates it will be completed by mid-2006).

Dear Carbon Scientists,

The Web-Accessible Visualization and Extraction System (WAVES) Version 1.0 is now available through CDIAC at: <http://cdiac3.ornl.gov/waves/>. Before we make an announcement to wide scientific community about WAVES, I would like to ask for your help in testing the system. Could you please play with it and tell us what would you add, remove, fix, any other advise on the system. Any suggestion would help us to improve WAVES before we open it for public use. Just a few help points: the + and - buttons on a map indicate zoom in and zoom out options and map would zoom on a center location. The navigate button (little hand) gives you an option to move the map around after you zoom it in. The middle button puts map back to full extent. The "i" button can be used to chose the area of the ocean by clicking and dragging. After you select the area, the section name and cruise ID information on each cruise/section in the box you selected appears in the metadata window below the map (section names and cruise ID are clickable and link to the Mercury metadata information for each cruise/section) and new coordinates would appear in the Query parameters window (we will try to make the selected area zoom-able in a future). So far it is necessary to select the Ocean in the Geographical Region first and then to use "i" button to select a part of the ocean. Note, that we are still working on the map options, for example at this point we cannot make the Pacific Ocean to be in a center and not divided by the 180 meridian.

The WAVES also has a simple property-property graphic output option, output form as an on-screen table, and you can download file in the CSV, TCV or NetCDF formats. The most important idea of WAVES is to combine the full data search using all parameters with complete metadata information on each cruise. The WAVES gets metadata information from Mercury. So far we have only discrete data available through WAVES, but we plan to work on the underway database soon. Thank you for help, Alex.

## **VI. Synthesis Activities**

North Atlantic Synthesis Preparatory Meeting - CarboOcean is taking the lead in hosting a workshop from 28-30 June in Laugarvatn, Iceland to begin the organization of the international synthesis of Atlantic Basin ocean interior carbon changes and transports. While it was agreed at the IRHC meeting that syntheses should be integrated and interdisciplinary, this first meeting has been developed to focus mostly on identifying the carbon and transport issues requiring large-scale synthesis and to establish collaborative working groups and common methodologies for carrying out the syntheses. U.S. and Canadian scientists will also participate. An agenda for the meeting will be available shortly. The IOCCP is hosting the Friends of Oxygen on Argo working group meeting during this event.

## VII. Pilot Projects

Friends of Oxygen on Argo - Following the IRHC Workshop, a small group (the "Friends of Oxygen on Argo", FOA) was established to develop plans and proposals for a large-scale extension of the current small-scale deployments of Argo floats instrumented with O<sub>2</sub> sensors. It was agreed that the IOCCP should facilitate the work of this group. Polarographic oxygen sensors have been deployed on Argo floats since at least as early as 2002. Published studies (Körtzinger et al., 2004, 2005) have also demonstrated the feasibility of a new instrument technology, the optode, which takes advantage of dynamic luminescence of luminophores, which fluoresce with a dependence on the O<sub>2</sub> concentration. For example, two prototype oxygen optode instruments were deployed on autonomous floats in the Labrador Sea in September 2003 and data collected over the following year showed very promising results demonstrating the required accuracy and stability (Körtzinger et al., 2004). In fact, several groups have successfully deployed Argo float with both types of O<sub>2</sub>-sensors, bringing the total number of O<sub>2</sub> sensors on floats to over 60. The plan is to build on these small pilot projects and scale them up to a large internationally coordinated project for the benefit of the physical and biogeochemical communities alike.

Led by Nicolas Gruber (UCLA), FOA will produce a white paper to present the utility and practicality of adding O<sub>2</sub> sensors to a portion of the Argo array as a pilot project. Issues such as the number of sensors required, interpretation of the resulting data, and technical issues including the sensor design, calibration accuracy and stability, power usage, satellite communication requirements, and additional cost will be addressed. The Argo Chair and Project Coordinator welcome and support this initiative.

- Further reading: <http://ioc.unesco.org/ioccp/FOA.htm>.

Digital Object Identifiers (DOIs) for Datasets - During the International Repeat Hydrography and Carbon workshop, participants recognized that to facilitate rapid release of data, a system must be developed to appropriately recognize the efforts of data contributors. While the system of having data contributors participate in synthesis activities for co-authorship may resolve many of these issues, there will be cases where data contributors may not be able to participate actively in the synthesis work. And ultimately, the system needs to evolve to the point that data sets are released as soon as possible without waiting for the start-up of another 2-3 year synthesis activity. In the carbon community there has been a persistent phobia that data made public will be used without recognizing the contribution made by the contributor, although participants emphasized that, in practice, there are very few examples of this ever happening. However, participants felt that it is still important to establish community-wide practices to standardize how to appropriately acknowledge data contributors.

At the meeting, Nicolas Dittert described a system currently being used by WDC-MARE that involves identifying data sets with DOIs (Digital Object Identifiers). The DOI system provides a framework for identification and management of intellectual content across all forms of electronic media (e.g., electronic publications as well as data sets). Once a data set has been given a DOI, it can be referenced in the same manner as a publication in a journal article. Each

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dataset is linked to a URL where the data are available at the data centre, and these URLs are associated with the DOIs. For example, an article would cite and reference the data set in the following way:

“This article uses and cites: Shackleton, N.J. (2001):  $\delta^{13}\text{C}$  (*Cibicidoides wuellerstorfi*) of sediment core MD95-2042, *Pangaea*, [doi:10.1594/PANGAEA.58229](https://doi.org/10.1594/PANGAEA.58229)”

In this example, the DOI is directly linked to the URL where the data are available in the PANGAEA data inventory at the World Data Center. Registering the DOIs can be done either manually or automatically for data holdings by the data center.

WDC-MARE, together with the DOI Foundation (IDF), the Technical Library in Hannover (TIB) and a number of other World Data Centers have built up a global registry for scientific data using DOIs. This project has been running for 3 years, and the group is currently working to establish “data publications” as a new publication type. The WDC panel showed great interest for the DOI concept and some other WDCs have already indicated their intention to adopt it. The UNESCO-IOC International Oceanographic Data and Information Exchange (IODE) project has also begun investigating this method, and are collaborating with Dittert and his group to determine the best way forward to implement this in a consistent manner in the national, regional, and world data centre systems.

- Responds to SSG 1 / Action Item 17: Continue work on getting surface pCO<sub>2</sub> data holdings at CDIAC into a common format, and encouraging the public release of existing datasets to CDIAC for incorporation in the dataset.
- Responds to SSG 1 / Action Item 19: Encourage CDIAC to provide clear instructions on each dataset about how to acknowledge the data contributors. Provide information and instructions in a visible place on the IOCCP web-site.

Virtual Conferencing – through the encouragement of the Global Carbon Project, the IOCCP is investigating methods of virtual conferencing that could be tested through several small pilot-project type workshops or meetings in order to introduce the ocean carbon community to video and/or Web conferencing with the goals of eventually reducing our own CO<sub>2</sub> emissions and travel time, as well as encouraging the participation of more young scientists and a wider range of scientists who may not otherwise attend a conference on ocean carbon. The IOCCP project office at UNESCO will investigate options for both video conferencing and web-based conferencing and rely on the SSG for input and participation in these tests.

## VIII. Sensors

At the first meeting of the S.I.C. group, the group outlined the need for a central information source on sensor / instrument development for carbon and biogeochemical variables, and decided that this was an appropriate task for the IOCCP to undertake as a service for all the research programs. During the IOCCP SSG meeting, this was discussed further, and the group decided that the Web-based inventory of sensors should be developed using a standard template of

information that would include information on the sensor's development status, with additional information about the sensor's success and failure rates, and detailed contact information.

In early March, the IOCCP sent out an email to approximately 20 members of the community who work directly with the development of sensors to get their input on this activity. The purpose of this catalogue would be to inform the ocean carbon and biogeochemistry community, observing system developers, and program managers about instruments that are either available commercially, available through a research lab, or are under development. It could also serve as a community bulletin board and forum to highlight the contributions of instrument developers and the exciting possibilities of new devices. The IOCCP proposed that the scope be restricted to instruments that are in situ, autonomous instruments (or quasi-autonomous in the case of underway pCO<sub>2</sub> systems), suitable for open ocean measurements, and have a minimum operational lifetime or deployment time of at least 6 months. Primary interest is for instruments measuring one or more of the following: DIC, pCO<sub>2</sub>, Alkalinity, pH, POC, PIC, DOC, O<sub>2</sub>, and major nutrients. The IOCCP also developed an initial template of information to collect for the catalogue:

- Instrument name
  - Company or PI contact
  - Variables measured (or calculated)
  - Method of measurement (e.g., spectrophotometric, based on optical absorbance of pH indicator solution)
  - Stage of development (commercially available, available via contract with lab, available via collaboration, under development, etc.) (if under development: lab tests, field tests (describe), etc.)
  - Range
  - Accuracy
  - Precision
  - Stability over time
  - Sampling rate
  - Data recording / transmitting
  - Depth rating
  - Temperature range of operation
  - Power supply / requirements
  - Battery life
  - Dimensions
  - Weight
  - Platform possibilities
  - Publications; Web-site information available

We received several positive responses, with one response encouraging us to broaden the catalogue to include essentially all oceanographic instruments. While this is clearly beyond the scope of the IOCCP, we decided to investigate the possibility of joining with other organizations to develop a single comprehensive catalogue.

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The Ocean Research Interactive Observatory Network (ORION) program of the U.S. NSF and the international OceanSITES program have both expressed interest in collaborating on the development of an on-line sensor catalogue. The ORION program has a sensors committee that has already compiled much information about autonomous oceanographic sensors. This committee met in late April, and decided to submit a short proposal to the ORION office for a collective and interactive Web site and clearinghouse on sensors, sensor platforms (AUVs, gliders, profiling moorings, etc) and enabling technologies (e.g., biofouling). Recently, EUROCEANS also sponsored a workshop where the Sensors working group expressed interest in collaborations, and have recommended convening a major international workshop on the topic.

- Responds to SSG 1 / Action Item 4: The IOCCP will develop an on-line inventory of autonomous sensors available or under development.

## **IX. Technical Coordination for Research**

Coastal Issues – the SSG set an action item (No. 15) to develop an email discussion list of coastal ocean carbon scientists and modelers to determine what is useful and feasible for information and coordination services for this community. At the IOCCP Open House in September 2005, the NACP / OCCO group outlined some activities dealing with coastal carbon, and later that year, the Global Carbon Project highlighted the need and interest to develop an activity around coastal carbon. While a more coordinated research effort may clearly be needed, it is not clear what technical coordination issues may be helpful and appropriate for the IOCCP to undertake. The IOCCP is beginning to integrate coastal monitoring activities into the networks for time series. This is an issue that requires some input from the SSG about the feasibility of pursuing or of encouraging the global research programs to pursue.

Process Studies – the SSG set an action item (No. 16) to initiate a discussion with SOLAS, IMBER, and POGO/SCOR about plans for an information database on biogeochemical process studies, cruises, etc. It was stated that the IOCCP should assist, but not take a leading role in this activity. POGO has put out a request for bids for a research cruise database and is evaluating proposals now; their plans do include an inventory of process studies. The IOCCP has recently taken the lead in developing a compilation of ocean carbon field programs in polar areas in preparation for the International Polar Year. As the International Polar Year approaches, there is a need to compile information about on-going and planned ocean carbon research in the polar areas. Building on information collected during the November International Repeat Hydrography and Carbon workshop, the regular inventories of the IOCCP, and compiled information from SOLAS and IMBER, we have developed an initial compilation of on-going or planned field programs for the Arctic and Antarctic regions. Many of these projects are not affiliated with or funded by the International Polar Year program, and many are multi-disciplinary programs that deal with a broad range of issues. In partnership with the research programs, the IOCCP will continue to develop this compilation and create a Web site database for this information. We would like to ask the community to please look over this initial compilation and provide us with corrections or additions (send comments to Maria Hood: m.hood@unesco.org). The programs covered in this initial inventory include:

**I. Arctic**

Baffin Bay / Davis Straights Hydrographic Sections  
 Barrow Straights Hydrographic Sections  
 MERICA program / Hudson Bay  
 Joint Western Arctic Climate Study (JWACS)/ Canadian Archipelago  
 Study of Environmental Arctic Change (SEARCH)  
 International Pan-Arctic Shelf-Basin Exchange Study (SBE)  
 Ocean-Atmosphere-Sea Ice-Snowpack (OASIS)  
 AR7W Hydrographic Section  
 75N Hydrographic Section  
 OWS Mike Hydrographic Program  
 Nuke Arctica VOS line  
 North Sea VOS line  
 St. Laurent and Laurier VOS lines

**II. Antarctic**

Post-WOCE Hydrographic Sections (approx. 40 lines)  
 OISO Hydrographic Program  
 Astrolabe VOS Line  
 Drake Passage VOS Line  
 CANOPO and Argau Program (hydrography and VOS)  
 SCACE Project  
 SAZ-SENSE Project  
 Synoptic Antarctic Shelf-Slope Interactions Study (SASSI)  
 CLIVAR SR3 Line  
 Climate of Antarctica and Southern Ocean Program (CASO)

For the details of all of these projects, [download the MS Word document](#) (128Kb)

**X. Summary**Progress against Action Items from SSG-1

1. SSG members thought it would be useful to have a short mission statement prominently placed on the Web site to describe more clearly the IOCCP functions. [*Responsible member: MH. Timeframe: immediate. Cost Implications: 0.*]  
**Status:** Completed. See Section II.
2. Both the SSG and the S.I.C. recognize the importance of having joint meetings, and agreed to try to co-locate / co-host the meetings of these two groups whenever possible. [*Responsible members: Hood, Sabine, Johannessen, Koertzinger. Timeframe: 1 year. Cost Implications: 0.*]

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**Status:** Completed / On-going. SSG-2 is tentatively scheduled to meet with the SOLAS/IMBER Carbon Group in April 2007.

3. The IOCCP will assist S.I.C. Working Group on Climate Sensitivities and Feedbacks to develop guidelines and protocols for mesocosm experiments. [*Responsible members: K. Lee, C. Lee, Hood, Riebesell. Timeframe: email discussion group to begin within the month. Cost implications: up to \$10k for 1 meeting + publication.*]  
**Status:** Postponed. See Section IV.
4. The IOCCP will develop an on-line inventory of autonomous sensors available or under development. [*Responsible members: Hood, Sabine, Koertzinger. Timeframe: email discussion group to begin within the month. Cost Implications: 0.*]  
**Status:** On-going. Activity is developing via large-scale / large scope collaborations with ORION, OceanSITES, and Eur-Oceans. See Section VIII.
5. The S.I.C. Working Group on the Surface Ocean will take the lead on determining how best to establish a closer link to the atmospheric CO<sub>2</sub> community for measurements from underway ships. [*Responsible members: Britt Stephens and Roger Dargaville. Timeframe: email discussion group to begin within the month. Cost implications: 0.*]  
**Status:** On-going. See Section III.B.
6. The S.I.C. agreed to review the proposal to co-sponsor a meeting on climate-relevant carbon and biogeochemical processes in the Indian Ocean. [*Responsible members: Hood to send proposal to Hare and Roy for follow up. Timeframe: immediate. Cost Implications: 0 for IOCCP.*]  
**Status:** Completed. IOCCP is providing funding to support the participation of Chris Sabine and Tommy Dickey.
7. Implementation of the International Repeat Hydrography Meeting, November 14-16, Shonan Village, Japan. [*Responsible members: Fukasawa, Sabine, Hood, Tilbrook. Timeframe: November 2005, with on-line report of meeting available by early 2006. Cost Implications: \$40-50k.*]  
**Status:** Completed. See Section III.A.
8. Based on outcomes of the November hydrography meeting, the IOCCP will begin investigating the interest and feasibility of establishing a sustained international project office for repeat hydrography in collaboration with the S.I.C., CLIVAR, and the GCOS-GOOS-WCRP Ocean Observations Panel for Climate. Continue supporting carbon representatives to CLIVAR basin panels for 1 more year. [*Responsible members: Hood, Sabine. Timeframe: Late 2005 / early 2006 with report to interested groups on feasibility and necessary steps. Cost Implications: \$8k for Basin Panel Rep Travel.*]  
**Status:** On-going through development of an Advisory Group. See Section III.A.
9. Begin plans for an international workshop on developing the scientific basis for VOS Network Design and Data Synthesis efforts, joint with the S.I.C. group. [*Responsible*

*members: Tilbrook, Sabine (Feely), Hood, Johannessen, Koertzing. Timeframe: begin email discussion group by the end of the month, with a major effort beginning after November workshop. Cost Implications: \$50k IOCCP.]*

**Status:** On-going. See Section III.B.

10. Establish a partnership with the JCOMM SOT and work with this group to develop an informational document on how the carbon community can use this group for on-going and future negotiations with shipping companies. [*Responsible member: Hood, Sabine. Timeframe: begin email discussions by the end of the month. Cost Implications: 0.]*  
**Status:** On-going. See Section III.B and III.E.
11. Continue developing the draft document, *Underway pCO<sub>2</sub> Systems*, with a goal of developing a generic document describing underway pCO<sub>2</sub> systems and ship requirements for use with the JCOMM SOT group. [*Responsible members: Tilbrook, Hood, with open community participation. Timeframe: begin circulating a new draft document by end November 2005 and/or after further discussions with JCOMM SOT to optimise needs for the document. Cost Implications: 0]*  
**Status:** Postponed. To be re-addressed as part of Surface pCO<sub>2</sub> Workshop in April 2007. See Section III.B.
12. Moulin will attend the first GlobColour Meeting in early 2006 and report back to the IOCCP on how the carbon community can assist this project. [*Cost Implications: \$1.5k.]*  
**Status:** Completed / On-going with follow-up meetings.
13. Finalize the inventory of information on current and planned time-series stations with carbon measurements. [*Responsible members: Bates, Sabine, Hood. Timeframe: end of the month. Cost Implications: 0.]*  
**Status:** Completed. See Section III.C.
14. Determine an initial map / table display for the time-series information, and work with CDIAC to determine need and feasibility to develop a more sophisticated database for all information displays. [*Responsible members: Hood, Sabine, Kozyr. Timeframe: initial maps and table to be added to the site by end of 2005; plans for new information display tools should begin soon, with a decision on how to implement a new system by early 2006. Cost Implications: possibly up to \$10k for database development.]*  
**Status:** On-going. See Section III.C.
15. Develop an email discussion list of coastal ocean carbon scientists and modelers to determine what is useful and feasible for information and coordination services for this community. [*Responsible members: Thomas, Sabine, Hood. Timeframe: try to establish a plan and initial inventory by mid-2006. Cost Implications: 0.]*  
**Status:** No actions taken on email discussion. An initial inventory of ocean carbon modeling projects has been put on the Web site. See Section IX.

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16. Initiate a discussion with SOLAS, IMBER, and POGO/SCOR about plans for an information database on biogeochemical process studies, cruises, etc. IOCCP should assist, but not take a leading role in this activity. [*Responsible members: Hare, Roy, Urban, Hood. Timeframe: begin email discussions as soon as possible, and provide input to Urban by Dec. 13. Cost Implications: 0.*]  
**Status:** Completed. No immediate actions for IOCCP. IOCCP has taken the lead in developing a compilation of ocean carbon field programs in polar areas. See Section IX.
17. Continue work on getting surface pCO<sub>2</sub> data holdings at CDIAC into a common format, and encouraging the public release of existing datasets to CDIAC for incorporation in the dataset. [*Responsible members: Bakker, Pfeil, Kozyr. Timeframe: open-ended. Cost Implications: 0.*]  
**Status:** On target for mid-2006 release (work undertaken by CarboOcean). No actions for IOCCP.
18. NOAA PMEL will continue its experiments with making CDIAC datasets available via Live Access Server. [*Responsible members: Sabine. Timeframe: open-ended. Cost Implications: 0.*]  
**Status:** Completed through CDIAC WAVES system. See Section V.
19. Encourage CDIAC to provide clear instructions on each dataset about how to acknowledge the data contributors. Provide information and instructions in a visible place on the IOCCP Web site. [*Responsible members: Hood, Sabine, Kozyr. Timeframe: immediately. Cost Implications: 0.*]  
**Status:** Completed through CDIAC WAVES system. See Section V. Also See Section VII on Digital Object Identifiers Pilot Project, On-going.
20. Continue the e-based newsletters on a quarterly basis and maintain the web-site structure as is for the present. Include updates on time-series inventories as discussed in section 7 above. [*Responsible member: Hood. Timeframe: on-going / open-ended. Cost Implications: 0.*]  
**Status:** On-going quarterly.
21. After the November workshop, discuss with CDIAC the needs for more or additional types of information and data links for hydrography and other platforms. See also discussion / actions in section 7. [*Responsible members: Sabine, Hood, Fukasawa, Kozyr, all. Timeframe: December 2006 for initial discussions. Cost Implications: 0.*]  
**Status:** On-going via IRHC Advisory Group. See Section III.A.

### Planned meetings and workshops:

#### **JCOMM Observations Coordination Group Review**

May 9-12, NOAA Office of Climate Observations

IOCCP Representatives: Chris Sabine, Maria Hood, Roger Dargaville

**11<sup>th</sup> Session of the Ocean Observations Panel for Climate**

May 16-20, Ocean Research Institute of the University of Tokyo

IOCCP Representatives: Roger Dargaville

**13<sup>th</sup> Session of the IGOS Partnership**

May 22-24, WMO, Geneva

IOCCP Representatives: Roger Dargaville (Carbon Theme Coordinator)

**North Atlantic Synthesis Preparatory Meeting / Friends of Oxygen on Argo Working Group Meeting**

June 28-30, Laugavartn, Iceland

IOCCP Representatives: Chris Sabine, Arne Koertzing, Maria Hood

**Global Carbon Project SSC-6**

31 August – 2 September, Mexico City, Mexico

IOCCP Representatives: Chris Sabine

**International Surface pCO<sub>2</sub> Workshop and SSG-2 Joint with SOLAS/IMBER Carbon Group**

April 11-13, 2007 UNESCO, Paris

IOCCP Representatives: all SSG

**Meetings and workshops under discussion:** Virtual Conference pilot project (possibly using SSG members as test subjects); International Oceanographic Sensors workshop (possible collaboration between ORION, OceanSITES, Eur-Oceans, OOPC, and IOCCP).

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## 4.2 SCOR/IOC Symposium on the Ocean in a High-CO<sub>2</sub> 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  
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### **Members:**

**TBA**

**IOC Liaison:** Maria Hood

**IGBP Liaison:** Beatriz Balino

**Executive Committee Reporter:** Bob Duce

## 2006 Progress Report on Planning for the Second Symposium on The Ocean in a High-CO<sub>2</sub> World

SCOR, IOC, IGBP, and ICSU representatives met with Jim Orr in Paris on 19 June 2006 to finalize the list of members for the planning committee for the second symposium on The Ocean in a High-CO<sub>2</sub> World. The SCOR Executive Committee approved the proposed committee membership and the sponsors are in the process of polling approved committee members for meeting dates in late 2006 to early 2007.

Funding for the symposium is nearly completed, including funding from the U.S. National Science Foundation in grants to SCOR (US\$51,800) and carry-over and expected new registration fees (\$25,400). SCOR has requested that IOC and IGBP each contribute \$10,000 for the symposium.

The most likely time for the symposium will be late 2008, to avoid timing conflicts with other major meetings in early 2008. Discussions are underway to hold the symposium in Monaco, which also may help fund some local costs for the event.

## 4.3 Other Activities

### 4.3.1 SCOR Summit 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 received support from the Alfred P. Sloan Foundation to convene a second meeting of the representatives of these projects, which will be held at the Royal Society (UK) in London in December 2006. Information about the meeting can be found at [www.jhu.edu/scor/ProjCoord2.htm](http://www.jhu.edu/scor/ProjCoord2.htm).

## *Second SCOR Meeting on Coordination of International Marine Research Projects Agenda*

### **7 December (Thursday)** - Royal Society, Conference Room

Morning - CLIVAR-hosted planning meeting for conference on Applications of Climate Information to Marine Research Projects - Additional details will be provided later.

**14:00** Background, Introductions, and Goals – Peter Burkill/Bjorn Sundby and Ed Urban

**14:30** Update on Project Data/Metadata Management Activities

- Review of Project Data Management Policies and Areas of Potential Cooperation - Peter Liss/Jeff Hare (SOLAS), Julie Hall/Sylvie Roy (IMBER), and Gideon Henderson (GEOTRACES) - **30 minutes each**

**16:00** Break

**16:30** Continued Discussion of Data Issues

- Project Interactions with World Data Centers, Data Dictionaries, Metadata Standards - Robert Gelfeld (WDC-A) and Hannes Grobe (WDC-MARE) - **60 minutes**
- Getting species-related project data into OBIS and using data from OBIS - Mark Costello - **30 minutes**

**18:00** Adjourn for the Day

### **8 December (Friday)** - Royal Society, Kohn Centre

**9:00** Continued Discussion of Data Management

- Status of Research Cruise Meta-database - Ed Urban - **30 minutes**
- Data Visualization - Murray Brown - - **60 minutes**
- General Discussion - **30 minutes**

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**10:30** Break

**11:00** Updates on Opportunities for GOOS-Project Interactions

- Ocean Observing Panel for Climate -
- Coastal GOOS - Tom Malone

GOOS Regional Alliances - Keith Alverson

**13:00** Lunch

**14:30** Time-series stations

- OceanSITES update - Bob Weller - **30 minutes**

Project Needs - All

**16:00** Break

**16:30** Southern Ocean Research and Observations

- Project plans for IPY - All
- Mechanisms for continued interactions: SCAR/SCOR Group of Experts on Oceanography - Colin Summerhayes - **20 minutes**
- Multi-beam bathymetric data

**18:00** Adjourn for the Day

**19:00** Group Dinner

**9 December (Saturday)** - British Academy (next door to Royal Society)

**9:00** Education and Capacity Building

- SCOR's activities - Ed Urban - **20 minutes**
- Project Activities and Ideas - All

**10:30** Break

**11:30** Satellite Availability and Needs - All

**13:00** Lunch

**14:30** GEO Marine Habitat Classification - Mark Costello

**15:30** Additional Topics Raised by Projects

**16:00** Break

**16:30** Conclusions and Recommendations

- To SCOR and other organizations
- To projects
- To GOOS and other observing networks
- To governmental agencies and inter-governmental organizations

To others?

**18:00** Adjourn Meeting

Second SCOR Meeting on Coordination of International Marine Research Projects  
Invited Participants

Keith Alverson	GOOS Project Office Director
Bob Anderson or Gideon Henderson	GEOTRACES Planning Committee Co-chairs
Beatriz Balino	IGBP
Manuel Barange	GLOBEC Executive Officer
Andrea Bergamasco or Alejandro Orsi	iAnZone Co-chairs
Murray Brown	IODE Ocean Teacher
Peter Burkill	UK SCOR, Meeting Co-chairs
Susan Carbotte	InterMARGINS
Howard Cattle	CLIVAR Director
Mark Costello	Chair, OBIS International Committee
Henrik Enevoldsen	IOC/GEOHAB
Robert Gelfeld	World Data Center on Oceanography, Silver Spring
Jian Lin or Chris German	InterRidge
Fred Grassle	CoML Scientific Steering Committee Chair
Hans Grobe	World Data Center for Marine Environmental Data
Julie Hall	IMBER Scientific Steering Committee Chair
Jeff Hare	SOLAS Executive Officer
Hartwig Kremer	LOICZ Executive Officer
Peter Liss	SOLAS Scientific Steering Committee Chair
Tom Malone	GOOS
Ron O'Dor	CoML Senior Scientist
Josef Pacyna	LOICZ Scientific Steering Committee Chair
Robin Raine	GEOHAB Scientific Steering Committee Chair
Sylvie Roy	IMBER Executive Officer
Ralph Schneider	IMAGES Executive Director
Colin Summerhayes	SCAR Executive Director
Bjørn Sundby	SCOR President, Meeting Co-chair
Ed Urban	SCOR Executive Director
Bob Weller	OceanSITES
Cisco Werner	GLOBEC Scientific Steering Committee Chair
Bob Whitman	GEBCO
James Yoder	IOCCG Chair

### 4.3.2 Panel on New Technologies for Observing Marine Life

#### Terms of Reference:

- To review the Census of Marine Life (CoML) Research Plan and make recommendations about technologies that could be applied to CoML projects.
- To communicate with CoML project leaders on a regular basis to discuss project technology needs.
- To identify and bring to the attention of the international community of fisheries scientists, marine biologists and others, the potential benefits of emerging technologies in the detection of marine life.
- To explore the relative merits of different technologies and identify those that deserve further research based on their potential for making significant contributions to the detection of marine life.
- To summarize the Panel's discussions on its Web site and in published articles, so as to make it as widely available as possible.

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#### Members

Geoff Arnold	UK
David Farmer	USA
Gaby Gorsky	FRANCE
John Gunn	AUSTRALIA
Antonio Pascoal	PORTUGAL
Heidi Sosik	USA
Song Sun	CHINA-Beijing
Bob Ward	AUSTRALIA

#### Liaisons

William Karp	ICES and NOAA)
Ron O'Dor	CoML
Peter Pissierssens	IOC
Edward Vanden Berghe	IODE Group of Experts on Biological and Chemical Data Management and Exchange Practices)

**Executive Committee Reporter:** Annelies Pierrot-Bults

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The SCOR Panel on New Technologies for Observing Marine Life met in November 2005 in conjunction with the Census of Marine Life (CoML) All Projects Meeting in Frankfurt, Germany. (The report of the meeting is appended below.) In addition to attending the Panel meeting, Panel members also attended the meetings of CoML field projects, as well as the plenary session that described the progress of CoML.

In 2006, the SCOR Executive Committee approved the addition of a Vice-Chair for the Panel, Dr. Alex Rogers, to assist the chair.

The Panel will meet next in Kobe, Japan in conjunction with Techno-Ocean 2006 and an international conference of the CoML program's Natural Geography in Shore Areas (NaGISA) project. The Panel will convene a special session at the Techno-Ocean meeting to attract technology companies to work on CoML-related issues. The special session will focus on tagging technologies and autonomous underwater vehicles (AUVs) as they could be applied to CoML projects. The 2007 meeting of the panel will be held in November 2007 in Auckland, New Zealand, before or after the CoML All Projects Meeting there. Panel Members Bob Ward and Sun Song (as well as Ed Urban) participated in the CoML Barcoding meeting in Amsterdam, The Netherlands in May 2006.

## SCOR Panel on New Technologies for Observing Marine Life

### Meeting Summary

#### Meeting #2

Frankfurt, Germany

6 November 2005<sup>1</sup>

**Panel Members and Staff Present:** Elgar de Sa (chair), Geoff Arnold, John Gunn, Antonio Pascoal, Alex Rogers, Sun Song, Bob Ward, Ed Urban (SCOR)

**Guests:** Rusty Brainard (CReefs), Mark Costello (OBIS), Francois Gerlotto (ICES), Yoshihisa Shirayama (NaGISA), Mitchell Sogin (ICoMM), Michael Stoddart (CAML)

#### Objectives of the Meeting, Review of Panel's Terms of Reference, Review of Agenda, and Actions Since Last Meeting

Elgar de Sa, the chair of the SCOR Panel on New Technologies for Observing Marine Life, asked meeting participants to introduce themselves. De Sa then reviewed the Panel's terms of reference and provided an overview of the Panel's work. The job of the Panel is to continuously examine the implementation plans and methods of the CoML projects and to make recommendations about new technologies that could be useful to specific projects. The Panel

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<sup>1</sup> Panel members attended various CoML events from 2 Nov. through 7 Nov.

will publish reviews of CoML-relevant technologies in a variety of general and technical ocean science and engineering publications, including forward-looking “concept” articles. The Panel will also use its Web site to disseminate information, but it has been difficult so far to obtain input for it. The Panel decided at its first meeting in Goa, India to put special effort into two specific technologies: (1) electronic tags for marine animals and (2) molecular methods for identifying individual species, specifically “barcoding.”

Ed Urban presented an overview of the Panel’s modes of operation and strategy:

1. Focus on technologies that are key to CoML
2. Panel members will attend meetings of the projects, particularly the new projects, both at CoML All Program Meetings and between these meetings.
3. Involve projects more through seeking their input through questionnaires and meeting with them in conjunction with All Program Meetings
4. Use the Panel Web site to give review papers on different technologies and to highlight new developments.
5. In the future: Small workshops?

Urban continued with a description of the actions taken since the Panel’s first meeting in Goa:

- Circulated minutes of Goa meeting and recommendations to CoML projects
- Article on Molecular Techniques by Alex Rogers and Bob Ward
  - In review for publication in *Oceanography Magazine* [Oceanography asked for major revisions to the article, so it is on hold]
- Article drafted on zooplankton sensors by Gaby Gorsky
- Panel members attend project meetings and All-Program Meeting and participate in the technology session there
- Panel Web site revised
- Identified project technology representatives

#### Reports on Meetings Attended by Panel Members and Inputs from Projects

##### Census of Antarctic Marine Life (CAML)

John Gunn began the discussion of the CAML meeting that he and Bob Ward attended earlier in the week. Gunn was impressed with the energy and momentum of the group already, which seems to be a function of their success in already hiring a coordinator. Dan Costa (of the CoML Tagging of Pacific Pelagics [TOPP] project) is a key technology person advising CAML. Costa is using tags on elephant seals to take profiles of oceanographic parameters, although better calibration is needed to make these data more usable by oceanographers. TOPP is linking to the Sea Mammal Research Unit (see <http://www.smru.st-and.ac.uk/>) of St. Andrews University in the United Kingdom. The data-logging aspect of tags is well worked out. For animals from which researchers expect to get the tags back, very sophisticated tags can be deployed. The situation is different for fish because the return rate for tags is much lower (generally 20% or

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less); less expensive, and thus less sophisticated, tags must be used. Toothfish are being tagged now, which has applications to CAML.

The TOPP and CAML scientists who are accumulating data on tagged animals need help in analysis of data and correlations between animal behavior and environmental characteristics, for example, using systems science and complex systems modeling. Other problems that need to be overcome are battery life in polar environments (with temperature fluctuations from 2°C in water to -70°C in air) and taxonomy of organisms sampled. CAML is interested in barcoding. Novel benthic sampling is being used by the Antarctic benthic deep-sea biodiversity (ANDEEP) project.

Gunn asked Michael Stoddart (chair of CAML) whether remotely operated vehicles (ROVs) are being considered by CAML. (Diving is difficult and expensive in the Antarctic, so it is useful to explore the use of ROVs.) Stoddart answered that not many icebreakers are equipped to handle ROVs. However, CAML is planning to work with the Census of Continental Margins (CoMargE) where the French and Australian areas of Antarctica abut; a French ROV-capable ship will work with an Australian icebreaker. It would be useful to increase the capabilities of ROVs on Antarctic research vessels. Antonio Pascoal added that an Italian group headed by Gianmarco Veruggio ([veruggio@ian.ge.cnr.it](mailto:veruggio@ian.ge.cnr.it)) has developed an ROV (Romeo) that is currently being used to transmit video pictures from Antarctica. The ROV is operated through a hole in the ice, and is used primarily for habitat mapping, but also is being used to provide live video to schools in Italy. Pascoal also mentioned an on-going project named Exocet (Extreme ecosystem studies in the deep Ocean: Technological Developments - <http://www.ifremer.fr/exocetd>), coordinated by IFREMER (FR) that aims to push the development of technologies for marine habitat mapping, namely in what regards the combined use of vision and acoustic sensors. De Sa noted that the issue of cameras is important to consider in relation to ROVs.

CAML will put significant effort into barcoding and will even have a barcoding subprogram. Ward offered to help CAML with barcoding of fish and Alex Rogers offered to help in relation to small invertebrates. Stoddart continued by adding that Alison Murry from CAML is interested in barcoding microbes, which will be a major effort in CAML. The British Antarctic Survey has requested funding for a barcoding manager for CAML. Ward reminded meeting participants that a Barcode of Life Database has been established (<http://www.barcodinglife.org/>), but there is no requirement for CoML projects to submit data to it. Australia and France will cooperate in a fish survey.

## Census of Coral Reefs (CReefs)

Rusty Brainard (co-chair of CReefs) noted that his program in NOAA (<http://www.pifsc.noaa.gov/cred/>) has thousands of hours of video of reef areas. It is very time consuming to analyze such videos manually. It would be great to have a way to automate identification of organisms from video, such as through techniques of image analysis, pattern recognition, and anomaly detection. Ed Urban responded that Gaby Gorsky works in this area and might be able to identify experts to help deal with this challenge.

Brainard continued to report on the CReefs meeting. The group realizes that they need a project manager to make faster progress. As Nancy Knowlton mentioned this week, there are an enormous number of species on reefs (estimates are 1 to 9 million). They need to train para-taxonomists to speed identifications. One activity that CReefs is planning is to deploy standardized matrices on reefs in different places to be able to quantify which organisms colonize the materials. Another idea that may be explored by CReefs is to monitor and analyze the noise created on reefs by different organisms. The acoustic signatures collected from different reefs can be compared. Elgar de Sa suggested that reef health also could be monitored by placing instrumented pods in reef areas, including video cameras for the public to view. Brainard responded that NOAA has deployed reef monitors for physical oceanographic measurements, but they need to improve imaging technology to reduce fouling and make time-series photos possible.

### Census of Seamounts (CenSeam)

Alex Rogers reported on the CenSeam meeting he had attended earlier in the day. The project is starting to attract some ship time, with the approval of four months of ship time for exploration on seamounts in the Fiji Islands from end of 2006 to the end of 2007. The CenSeam group has adopted the Panel's earlier recommendations. Barcoding is also a technology of interest for this project. One goal of the group will be to continue to improve the Seamounts Online database (<http://seamounts.sdsc.edu/>). Acoustics will be used in the Fiji explorations for physical oceanography and mapping, and for studies of the acoustics of the deep scattering layer versus topography. Benthic sampling also will be conducted. It is possible to add other measurements and sampling, if new national funding is provided. Rogers will be involved in the cruises, as well as a meeting sponsored by the International Seabed Authority (ISA), to produce a report for the Intergovernmental Oceanographic Commission (IOC) that summarizes existing data.

Rusty Brainard asked how CenSeam is doing its habitat mapping. (NOAA is using laser line scans.) Rogers replied that they will do the mapping using multibeam acoustics, and should work with CReefs, since the seamounts are relatively shallow ones with coral reefs. It would be nice to be able to put a laser line scan on an AUV, but these laser devices are currently very large and are typically towed. Brainard added that there will be NOAA work in American Samoa. Elgar de Sa and John Gunn asked about using AUVs in the Fiji expedition. Rogers replied that there won't be time to add this aspect of sampling. Gunn noted that his agency (Commonwealth Scientific and Industrial Research Organisation: CSIRO) is using clusters of AUVs for exploration on the Great Barrier Reef.

Antonio Pascoal noted that most AUVs are designed to "fly" along a preferred direction of motion, without slow-motion or even hovering capabilities. What is needed for some applications are vehicles that are more like ROVs, capable of moving slowly in all directions and exploring the complex topography of seamounts, but without resorting to an umbilical connection. This concept is now slowly materializing in the form of so-called "Intervention AUVs" that are designed to manipulate underwater, like an ROV, but without a tether ([http://www.scandoil.com/moxie\\_issue/issue\\_1-2/2004\\_1-2/alive-an-autonomous-light.shtml](http://www.scandoil.com/moxie_issue/issue_1-2/2004_1-2/alive-an-autonomous-light.shtml)). These AUVs move slowly, commanded through acoustic links. Most of the

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intelligence and decision-making capacity resides onboard the AUV. Pascoal reported that his institution has been involved in joint work with the Department of Oceanography and Fisheries (DOP) (<http://www.horta.uac.pt/>) of the University of the Azores in Portugal towards the development of technologies (including ROVs and AUVs) for the study of seamounts. DOP has a strong program devoted to the study of seamounts and marine habitat mapping around the Azores islands.

John Gunn suggested that integrating a suite of technologies would provide a significant increase in understanding of marine systems. For example, tags could be deployed with other technologies around seamounts to determine the residence time of animals around seamounts. Alex Rogers responded that this could help study the idea of the role of seamounts in trophic focusing. Evidence suggests that seamounts don't promote primary production, but that the main reason for the observed productivity of seamounts is that they offer a location where the deep scattering layer can intersect hard substrate. Little energy needs to be expended by organisms on seamounts because the currents and movement of the deep scattering layer bring food to them. Fish tagged on seamounts in the Azores did not move significantly from one observation to the next one, two years later.

Francois Gerlotto confirmed the value of integrated multiple data sources, as shown by the observations of a change in the North Sea ecosystem around 1982.

## Discussion on CoML Barcoding Meeting and Other Molecular Technology

Mitchell Sogin (Chair of the International Census of Marine Microbes: ICoMM) reviewed the topic of pyro-sequencing (<http://www.nature.com/nbt/journal/v21/n12/full/nbt1203-1425.html>). This technique is an alternative to standard polymerase chain reaction (PCR) methods and creates sequences of 100-120 base pairs. It is fast and inexpensive because it can be conducted in massively parallel format. The cost of the technique is primarily in the sequencing machine (\$500,000), with each sequence read costing about US\$0.02 (standard PCR costs about US\$2-3 per read). One machine could potentially be used CoML-wide because of the high throughput. It is not useful for analyzing single organisms, but is well suited to doing environmental genomics/metagenomic sequencing. With these approaches, the molecular composition and population structure of one ecosystem can be compared with that of another ecosystem. Typically, the analyses are conducted on particles between 1 and 20 microns in diameter filtered from seawater.

Bob Ward reported that the CoML barcoding meeting earlier in the week was attended by about one dozen individuals, who helped Ann Bucklin finalize a proposal to the Sloan Foundation for a CoML barcoding workshop. The current plan is to hold the workshop on 15-17 May 2006 in Amsterdam, The Netherlands. Ed Urban listed the draft working group topics in two sessions:

### 1. Working Groups on Taxonomic Groups

- Viruses, microbes, and protists
- Meiofauna (infaunal)

- Mesofauna (invertebrates)
  - Megafauna (vertebrates)
2. Working Groups on Major Issues
- Database and data management needs
  - Specimen and materials handling
  - Capacity development: training workshops, student exchanges
  - Molecular protocols
  - Use of museum specimens; formalin preservation
  - Implementation: sequencing centers, at-sea sequencing

### Other Technologies

John Gunn commented that the U.S. Mars Lander is designed to operate relatively autonomously and to do a lot of onboard decision making. How can we transfer such technologies to underwater use? Can we get some scientists from space agencies to meet with ocean scientists?

On controlling AUVs, Alex Rogers suggested that AUVs could have antennae like the wires on XBTs. Antonio Pascoal suggested that an autonomous surface vehicle could serve as a communication link between AUVs and a surface ship. Alex Rogers added that an array of communication buoys could be deployed in a survey area to work with the AUVs.

On the idea of new ways to get data back from tags remotely, Gunn noted that ship-mounted Simrad fish sonar collect data from individual fish tags within 7 km of the sonar. Alex Rogers suggested that similar data loggers could be attached to Continuous Plankton Recorder (CPR) units, which are self-contained plankton sampling devices towed behind commercial vessels in some ocean areas ([http://192.171.163.165/cpr\\_survey.htm](http://192.171.163.165/cpr_survey.htm)); the longest record is from the North Atlantic Ocean. Geoff Arnold noted that getting data back from animals is a real bottleneck to using tags. He noted that Simrad has produced a system to encode the GPS position of a vessel and transmit it underwater via a sonar signal and Star-Oddi has built a data storage tag with an integral hydrophone to receive the sonar signal. The tag records the encoded GPS signal and the time of reception. The maximum range is 7 km and will probably be less in most circumstances. The system is under evaluation and results can be found on the Star-Oddi web site ([www.star-oddi.com](http://www.star-oddi.com)). Like most other simple data storage (archival) tags, the Star-Oddi tags don't have the ability to transmit data. Two manufacturers, however, make pop-up archival tags that transmit data via Argos satellites and Vemco make a system for downloading data from acoustic tags, using fixed listening stations. Data transmission with both types of system is currently rather limited.

Francois Gerlotto reported that the International Council for the Exploration of the Seas (ICES) has a Fisheries Technology Committee (see <http://www.ices.dk/iceswork/FTC.asp>), which sponsors a Working Group on Fisheries Acoustics Science and Technology (see <http://www.ices.dk/iceswork/wgdetail.asp?wg=WGFAST>). This working group has common interests with the Technology Panel in new techniques for observing marine life. The ICES working group could take up some issues identified by the Panel and both could help implement new technologies.

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On speeding up taxonomy, Yoshihisa Shirayama made a PowerPoint presentation. In places sampled for the first time, most species have not been described previously. There is a need to speed up the following process:

1. Field sampling
2. Sorting of organisms. Sorting is time consuming and requires knowledge. It can be expensive to have it done. Attempts have been made to design an automatic sorter, but this is not yet successful.
3. Mounting of organisms. This step is also time consuming, and requires knowledge and skill. It is probably not amenable to automation because it requires delicacy to put the specimens on slides and put on a cover slip.
4. Microscopic observation. The steps in this phase include optical section observation, reconstruction to a three-dimensional image (in the observer's brain), and drawing a two-dimensional image showing the characteristic structures. Available software for two- and three-dimensional visualizations do not fulfill research needs. Some promising techniques that also present challenges include the holographic microscope and the x-ray microscope
5. Identification
6. Description
7. Data analyses

Digital information may be utilized in terms of the original description database, automatic identification (application of fingerprint identification technology), automatic description (e.g., the DELTA system aids in creating an automatic description), and GIS analyses (e.g., through OBIS).

## Other Comments from the All Program Meeting

Alex Rogers reported from the MAR-ECO meeting. One major concern was about the user friendliness of OBIS and the curation of OBIS data. What happens to records in OBIS when taxonomic names are changed? MAR-ECO is also concerned about communication and coordination among projects.

Ed Urban reported that the NaGISA project is interested in automated sorting, identification, and digital taxonomy, as described by Yoshihisa Shirayama in his presentation to the Panel.

OBIS—Alex Rogers asked Mark Costello if OBIS updates species names when they are changed. Costello responded that the component databases are usually up to date. The International Commission on Zoological Nomenclature (ICZN: <http://www.iczn.org/>) is responsible for international recognition of new species names. In principle, OBIS will eventually allow data without associated species names to be put in, which will be necessary for getting environmental genomics data into OBIS, particularly related to microbes and meiofauna. Costello asked the Panel to re-visit this issue later.

OBIS would like to do a companion article to the Panel article planned for *Sea Technology*.

#### Panel Representation at Project and Other Meetings

- 11<sup>th</sup> Deep-Sea Biology Symposium (9-14 July 2006 at Southampton, UK) -- see [http://www.noc.soton.ac.uk/GDD/DEEPSEAS/symp\\_pages/symphome.html](http://www.noc.soton.ac.uk/GDD/DEEPSEAS/symp_pages/symphome.html)). Alex Rogers will attend this meeting and an associated CenSeam meeting.
- New Zealand meeting on Marine Acoustic Telemetry – John Gunn
- International Seabed Authority Meeting – Alex Rogers
- CoML Scientific Steering Committee, Iceland, Summer 2006 – Elgar de Sa and David Farmer
- TOPP Meeting, Monterey – John Gunn and Geoff Arnold
- Look for a nanotechnology meeting to send a Panel member or two to.
- CAML – June 2006 in Bremerhaven – Gunn or Ward?
- CoML Barcoding Meeting (funding pending) – Amsterdam, The Netherlands, 15-17 May 2006 – Bob Ward, Alex Rogers, Ed Urban

#### Panel Web site

Elgar de Sa reviewed the current version of the Panel Web site and described its operation. He encouraged Panel members to contribute articles for the Web site, to describe emerging technologies relevant to CoML. Some actions still to pursue:

- List all the CoML projects on the top navigation bar
- Work on copyright permissions for materials on site
- Still need to populate the site. Panel members can load information themselves or can ask Ed or Elgar to do it.
- Need to replace draft agenda (for first meeting) with final agenda.
- What do the usage statistics mean?
- Get CoML to link new Panel site on the CoML portal
- Add ICES WG on Fisheries Technology to Web site

#### Additions/Replacements to Panel

Yogi Agrawal has resigned from the Panel due to time constraints. Meeting participants discussed potential replacements, but asked for additional time to develop potential nominations. The Panel chair and staff will work with members over the coming months to identify one or two additional members.

#### Next Panel Meetings

2006—The next meeting of the Panel will be held in Kobe, Japan on 18-20 October 2006, in conjunction with the NaGISA World Congress (18-20 October) and Techno-Ocean 2006 (16-18 October). The Panel will participate in a session on technologies relevant to CoML on the afternoon of 18 October. The purpose of the session is to motivate manufacturers to commercialize some of the technologies needed by CoML projects. John Gunn noted that the

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best way to motivate companies is to tell them how they can make money selling the technologies. The presentations should present the science and its challenges.

Meeting participants discuss five potential topics for the Kobe meeting, including

1. Tags – can a standard tag be developed and manufactured in large numbers, to reduce costs? What features would the ideal standard tag include?
2. Long-range acoustics for detecting marine life;
3. Underwater sampling and observing technologies – AUVs, ASVs, landers;
4. Barcoding and other molecular techniques; and
5. Sorting/imaging/digital taxonomy for organisms.

It was decided that it would be appropriate to pick two of these topics and the tags and underwater sampling and observing technologies were selected as being most appropriate. An abstract for the tags session will be developed by John Gunn and Geoff Arnold and an abstract for the underwater sampling and observing technologies will be developed by Elgar de Sa and Antonio Pascoal. Abstracts are due by the end of March 2006. Yoshihisa Shirayama will plan the session, with input from the Panel. All the papers would be invited, rather than contributed.

2007—Panel members appreciated the opportunity to attend the CoML All Program Meeting and tentatively plans to participate in the 2007 All Program Meeting.

## Actions Items

Actions	Who	By when
Update de Sa PowerPoint slides to include all 14 CoML projects	De Sa	ASAP
Transmit de Sa's PowerPoint presentation to Urban	De Sa	ASAP
Article about formation of the Panel, in <i>Sea Technology</i> and/or <i>EOS</i>	De Sa/Urban	Done
Read document on technologies being used by CoML projects and send comments	Panel	Jan. 31
Make suggestions of new Panel members: industry, acoustics, satellite technology, visualizations	Panel	Jan. 31
Produce summary article about pyro-sequencing for Panel Web site	Mitchell Sogin	??
Look for a nanotechnology meeting to send a Panel member or two to.	All	Continuing
Find out whether alternatives are being considered to the Argos satellites	Ed	Dec. 31
Approach tag manufacturers to see if they will attend Techno-Ocean 2006	John, Geoff	March 31

Approach AUV manufacturers to see if they will attend Techno-Ocean 2006	Elgar, Antonio	March 31
Finalize article on zooplankton sensors for Web site and/or publication	Gaby	Jan. 31
Investigate what panel could do in terms of advancing image analysis applications	Gaby	Jan. 31
Plan special session at Kobe Techno-Ocean meeting	Shira, Elgar, David	After registration closes in March
<p>Web site actions:</p> <ul style="list-style-type: none"> <li>List all the CoML projects on the top navigation bar</li> <li>Work on copyrights for materials on site</li> <li>Still need to populate the site. Panel members can load information themselves or can ask Ed or Elgar to do it.</li> <li>Need to replace draft agenda (for first meeting) with final agenda.</li> <li>What do the usage statistics mean?</li> <li>Get CoML to link new Panel site on the CoML portal</li> <li>Add ICES WG on Fisheries Technology to Web site</li> </ul>	<p>Elgar</p> <p>Ed</p> <p>Panel</p> <p>Elgar</p> <p>Elgar</p> <p>Ed</p> <p>Ed</p>	ASAP

### Recommendations

- OBIS should allow input of data without species names, to make it possible to input molecular data from environmental genomics. OBIS should also determine how constituent databases will update species names and how OBIS should deal with this issue.

### **Web sites related to topics in report:**

<b>Web site</b>	<b>Mentioned by (see text)</b>
Sea mammal Research Unit, St. Andrews University: <a href="http://www.smru.st-and.ac.uk/">http://www.smru.st-and.ac.uk/</a>	John Gunn
Extreme ecosystem studies in the deep Ocean: Technological Developments <a href="http://www.ifremer.fr/exocetd">http://www.ifremer.fr/exocetd</a>	Antonio Pascoal
Barcode of Life database: <a href="http://www.barcodinglife.org/">http://www.barcodinglife.org/</a>	Bob Ward

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NOAA Coral reefs: <a href="http://www.pifsc.noaa.gov/cred/">http://www.pifsc.noaa.gov/cred/</a>	Rusty Brainard
Seamounts Online: <a href="http://seamounts.sdsc.edu/">http://seamounts.sdsc.edu/</a>	Alex Rogers
AUV movie <a href="http://www.scandoil.com/moxie_issue/issue_1-2/2004_1-2/alive-an-autonomous-light.shtml">http://www.scandoil.com/moxie_issue/issue_1-2/2004_1-2/alive-an-autonomous-light.shtml</a>	Antonio Pascoal
Department of Oceanography and Fisheries (DOP) <a href="http://www.horta.uac.pt/">http://www.horta.uac.pt/</a>	Antonio Pascoal
Pyro sequencing: <a href="http://www.nature.com/nbt/journal/v21/n12/full/nbt1203-1425.html">www.nature.com/nbt/journal/v21/n12/full/nbt1203-1425.html</a>	Mitchell Sogin
Data loggers behind CPR: <a href="http://192.171.163.165/cpr_survey.htm">http://192.171.163.165/cpr_survey.htm</a>	Alex Rogers
Star-Oddi web site <a href="http://www.star-oddi.com">www.star-oddi.com</a>	Geoff Arnold
WG on Fisheries Acoustics S&T: <a href="http://www.ices.dk/iceswork/FTC.asp">http://www.ices.dk/iceswork/FTC.asp</a> , <a href="http://www.ices.dk/iceswork/wgdetail.asp?wg=WGFAST">http://www.ices.dk/iceswork/wgdetail.asp?wg=WGFAST</a>	Francois Gerlotto
International Commission on Zoological Nomenclature: <a href="http://www.iczn.org/">http://www.iczn.org/</a>	Mark Costello
11 <sup>th</sup> DeepSea Biology Symposium: <a href="http://www.noc.soton.ac.uk/GDD/DEEPSEAS/symp_pages/symphome.html">http://www.noc.soton.ac.uk/GDD/DEEPSEAS/symp_pages/symphome.html</a>	Alex Rogers

### 4.3.3 SOLAS/INI Workshop on Anthropogenic Nitrogen Impacts on the Open Ocean

#### Surface Ocean – Lower Atmosphere Study (SOLAS)/International Nitrogen Initiative (INI) Workshop on Anthropogenic Nitrogen Impacts on the Open Ocean

17-20 November 2006

University of East Anglia, Norwich, UK

Conveners: Robert Duce (Texas A&M Univ., USA) and Julie LaRoche (IFM-GEOMAR, Germany)

#### Statement of Work

The goal of this workshop is to evaluate the effects of atmospheric inputs of anthropogenic nitrogen on the open ocean environment and to produce a major synthesis paper for *Science* or *Nature* and additional papers for more specialized journals. Each participant will be assigned to at least one of the 10 key questions listed below and a 4- to 6-page background paper will be prepared for the workshop for each of the questions. Each of these background papers will describe the state of knowledge and outstanding uncertainties in that topic area. The papers will be circulated to all participants before the meeting to stimulate discussions at the workshop; each background paper will be presented orally at the workshop, followed by extensive discussion.

#### Key Questions

1. What are the major fluxes (natural and anthropogenic), uncertainties and forcing factors in the present global nitrogen cycle? What will drive them in the future?
2. What is the relative contribution of denitrification vs annamox in the cycling of oceanic nitrogen?
3. What can we learn from the paleo-record about the major factors influencing the marine nitrogen cycle, including the long-term balance of nitrogen in the ocean, and how these factors have been impacted by anthropogenic inputs?
4. What is the distribution of atmospheric anthropogenic and natural nitrogen species and what are their fluxes to the global ocean?
5. Which coastal areas and processes result in significant exchange of anthropogenic and natural species of nitrogen with the open ocean?
6. What are the relative contributions (i.e., budgets and fluxes) to marine primary productivity of the atmospheric and other fluxes of nitrogen species?
7. What regulates the extent and fate of marine nitrogen fixation and how can this be altered by human activities?
8. What are the effects of anthropogenic nitrogen species on the marine ecosystem and their potential feedbacks (e.g.,  $N_2O$ ,  $NH_3$ , etc.) to the global environment?
9. What can marine microbial genomics tell us about nitrogen transformation pathways and the impact of increased anthropogenic inputs on the nitrogen cycle?
10. What are the sources, sinks, and role of dissolved organic nitrogen (DON) in the ocean/atmosphere system?

The workshop will identify other unanswered questions in the marine nitrogen cycle and will attempt to identify regional and global patterns. 22 individuals with expertise to answer the above questions will be invited to participate in the workshop. Past experience indicates that the primary paper should be ready to submit to *Science* or *Nature* approximately 6 to 8 months after the meeting and the other papers will follow later. Partial funding for the workshop will be provided by SOLAS, SCOR, and NOAA.