

# Report of the Second Session of the Scientific Steering Group of the International Ocean Carbon Coordination Project

UNESCO, Paris  
Salle 13, Bonvin Building, Miollis Annex  
10 April 2007

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

## IOCCP Report No. 6

I. Agenda .....	2
II. Participant List.....	3
III. Report.....	4
1. Overview of Activities Since SSG I and other informational items.....	4
1a. Sensor Workshop.....	4
1b. Guide of Best Practices.....	6
1c. EU FP7 Proposal: Coordinated Action for a Carbon Observing System .....	7
2. International Repeat Hydrography and Carbon Advisory Group.....	8
3. Initial North Atlantic Synthesis Meeting and Follow-up.....	10
4. Oxygen on Argo Update.....	12
5a. Ocean Surface Carbon vulnerabilities and Variability Workshop.....	13
5b. JCOMM SOT cooperation.....	15
6. Time Series Coordination.....	16
7. Process Studies Coordination.....	17
8. Ocean Colour (GlobCOLOUR) project.....	18
9. Coastal Carbon Coordination.....	20
10. High Precision CO <sub>2</sub> Measurements from VOS Ships.....	20
11. Mesocosm Guidelines Workshop.....	21
12. Communications Services.....	21
IV. Action List.....	23
V. Background Documents ( <i>on-line: <a href="http://www.ioc.unesco.org/ioccp/SSG2.htm">http://www.ioc.unesco.org/ioccp/SSG2.htm</a></i> )	
1. Report from the 1 <sup>st</sup> Session of the IOCCP Scientific Steering Group, October 2005	
2. November 2006 Progress Report	
3. International Repeat Hydrography and Carbon Workshop Report, November 2005	
4. Initial North Atlantic Synthesis Meeting Report, June 2006	
5. O <sub>2</sub> on Argo White Paper, March 2007	
6. JCOMM SOT Background Document, March 2007	

## I. AGENDA

0900-0920	<b>Agenda Item 1: Subject:</b> Overview of Activities Since SSG-I and other informational items (1a) Sensor Inventory (1b) Guide of Best Practices (1c) Monitoring the Global Carbon Cycle
0920-0950	<b>Agenda Item 2: Subject:</b> International Repeat Hydrography and Carbon Update; Development of an Advisory Group on IRHC co-sponsored by IOCCP, CLIVAR, and SIC.
0950-1020	<b>Agenda Item 3: Subject:</b> Initial North Atlantic Synthesis Meeting and Follow-up.
1020-1030	<b>Agenda Item 4: Subject:</b> Friends of O <sub>2</sub> on Argo Update
1030-1045	Coffee
1045-1115	<b>Agenda Item 5: Subject:</b> Underway / Surface CO <sub>2</sub> : (5a) Ocean Surface Carbon Vulnerabilities and Variability Workshop; (5b) JCOMM SOT links
1115-1135	<b>Agenda Item 6: Subject:</b> Time Series Coordination
1135-1155	<b>Agenda Item 7: Subject:</b> Process Studies
1155-1215	<b>Agenda Item 8: Subject:</b> Ocean Colour
1215-1245	<b>Agenda Item 9: Subject:</b> Coastal Carbon
1245-1300	<b>Agenda Item 10: Subject:</b> Communication Services
1300-1400	Lunch
1400 - 1430	<b>Agenda Item 11: Subject:</b> Joint IOCCP – SIC Meeting Issues
1430 - 1445	<b>Agenda Item 12: Subject:</b> Action Items List and Wrap-up
1445-1500	<b>Break to switch over to Joint Meeting</b>
1500-1700	<b>Joint Meeting (agenda to be worked out jointly with SIC).</b> Will cover, <i>inter alia</i> : <ul style="list-style-type: none"> <li>• IRHC Advisory Group</li> <li>• Friends of O<sub>2</sub> on Argo</li> <li>• Synthesis Activities</li> <li>• High-quality atmospheric CO<sub>2</sub> from Ships</li> <li>• Mesocosm Guideline</li> </ul>

## II. PARTICIPANT LIST

<p><b>Chris Sabine</b> (<i>Chair</i>) NOAA/PMEL 7600 Sand Point Way NE Seattle, WA 98115 Tel: (206) 526-4809 Email: <a href="mailto:chris.sabine@noaa.gov">chris.sabine@noaa.gov</a></p>	<p><b>Dorothee Bakker</b> School of Environmental Sciences, University of East Anglia, Norwich NR4 7TJ, U.K. Tel: +44.1603.592648 Email: <a href="mailto:D.Bakker@uea.ac.uk">D.Bakker@uea.ac.uk</a></p>
<p><b>Nick Bates</b> Senior Research Scientist Bermuda Institute of Ocean Sciences 17 Biological Station Lane, Ferry Reach, GE01, Bermuda Tel: (441) 297-1880 x209 Email: <a href="mailto:nick.Bates@bios.edu">nick.Bates@bios.edu</a></p>	<p><b>Truls Johannessen</b> Geophysical Institute and Bjerknes Centre for Climate Research University of Bergen Allégt 70, 5007 Bergen, Norway Tel: +4755584327 Email: <a href="mailto:truls@gf.uib.no">truls@gf.uib.no</a></p>
<p><b>Cindy Lee</b> Marine Sciences Center, SUNY Stony Brook 109 Challenger Hall Stony Brook, NY 11794-5000 Tel: (631) 632-8741 Email: <a href="mailto:Cindy.Lee@stonybrook.edu">Cindy.Lee@stonybrook.edu</a></p>	<p><b>Cyril Moulin</b> Laboratoire des Sciences du Climat et de l'Environnement (CEA/CNRS) CEA Saclay - bat.701 91191 Gif-sur-Yvette, France Tel: (33 1) 69 08 71 20 Email: <a href="mailto:cyril.moulin@cea.fr">cyril.moulin@cea.fr</a></p>
<p><b>Helmuth Thomas</b> Department of Oceanography Dalhousie University 1355 Oxford Street Halifax, NS, B3H 4J1 Room 4635 LSC Tel: (902) 494-7177 Email: <a href="mailto:helmuth.thomas@dal.ca">helmuth.thomas@dal.ca</a></p>	<p><b>Bronte Tilbrook</b> CSIRO Marine Research PO Box 1538 Hobart, Tasmania Tel: +61 3 6232 5273 Email: <a href="mailto:bronte.tilbrook@csiro.au">bronte.tilbrook@csiro.au</a></p>
<p><b>Masao Fukasawa</b> <i>Unable to Attend</i> Japan Agency for Marine Science and Technology (JAMSTEC) 2-15 Natsushima, Yokosuka, Kanagawa 237-0061 Japan Tel: +81-468-67-9470 Email: <a href="mailto:fksw@jamstec.go.jp">fksw@jamstec.go.jp</a></p>	<p><b>Arne Koertzing</b> <i>Unable to Attend</i> Marine Biogeochemistry Leibniz-Institut fuer Meereswissenschaften Dienstgebäude Westufer Duesternbrooker Weg 20 D-24105 Kiel, Germany Tel: +49-431-600-4205 Email: <a href="mailto:akoertzing@ifm-geomar.de">akoertzing@ifm-geomar.de</a></p>
<p><b>Dennis Hansell (for Arne Koertzing)</b> University of Miami RSMAS/MAC 4600 Rickenbacker Causeway Miami, FL 33149 Tel: (305) 361-4078 Email: <a href="mailto:dhansell@rsmas.miami.edu">dhansell@rsmas.miami.edu</a></p>	<p><b>Maria Hood</b> (Secretariat) UNESCO-IOC 1 Rue Miollis Paris, France 75732 Cedex 15 Tel: +33.1.45.68.40.28 Email: <a href="mailto:m.hood@unesco.org">m.hood@unesco.org</a></p>
<p><b>Roger Dargaville</b> (Secretariat) UNESCO-IOC 1 Rue Miollis Paris, France 75732 Cedex 15 Tel: +33.1.45.68.39.86 Email: <a href="mailto:r.dargaville@unesco.org">r.dargaville@unesco.org</a></p>	

Participants joining the meeting for the afternoon joint session with the SOLAS/IMBER Carbon group included: Sylvie Roy, Emily Brevier, Ken Johnson, Nicolas Gruber, Nicolas Metzl, and Toshiro Saino.

### **III. REPORT**

Note: All background documents can be found at: <http://www.ioc.unesco.org/ioccp/SSG2.htm>. Following the SSG meeting, the SSG met with the SOLAS-IMBER Joint Carbon Group (hereafter referred to as the S.I.C.) to discuss joint activities. The discussions and decisions from that joint session have been integrated into the SSG report sections rather than documenting them separately.

#### **1. Overview of Activities Since SSG-I**

Maria Hood provided a brief overview of progress on action items established at SSG I ([Background Document 1](#)). The November 2006 Progress Report and the updated list of action items provide comprehensive overviews ([Background Document 2](#)). She noted that all actions had been completed or are on-going as planned except for process studies, coastal carbon coordination, and several activities undertaken jointly with SIC (namely, mesocosm guidelines and atmospheric CO<sub>2</sub> from ships.) She focused on three informational issues that are not included in other sections of the meeting: the Sensor Inventory (Action Item 4), the publication of the Guide of Best Practices for Oceanic CO<sub>2</sub> Measurement and Data Reporting, and the development of a new EU FP 7 program on Monitoring the Global Carbon Cycle.

##### **1a. Sensor Inventory**

###### **Background**

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-I 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 2006, 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. IOCCP 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.

After several months of consultation, a large consortium has formed and proposed a 5-day "Symposium on Multi-disciplinary Sensors and Systems for Autonomous Observations of the Global Ocean" (OceanSensors08). Participating groups include the Ocean Research Interactive Observatory Network (ORION), OceanSITES, the IOCCP, the GCOS-GOOS-WCRP Ocean Observations Panel for Climate, and the US National Science Foundation. The group, being led by Ralf Prien from Warnemuende, has developed the following objectives for the symposium (note: IOCCP did not comment on these proposals):

1. Provide a forum for the exchange of information concerning autonomous ocean sensing. Stakeholders in this forum are ocean scientists as the drivers and end users, scientists and engineers active in the development of ocean sensors and platforms and those developing sensors for other fields (e.g. space, automotive, industrial), scientists and engineers active in the development of new sensing technologies (but not necessarily focusing on the oceans), scientists

active in the development of cross-cutting technologies (e.g. nanotech, materials science) and representatives of funding agencies.

2. Assess observing system and research goals and the specifications for ocean observing technologies to meet these goals. Identify the gaps in available ocean observing technologies and identify R&D priorities and requirements (including expected timelines) to close these gaps.

3. Produce a book that documents the state of autonomous ocean sensing and includes views toward future opportunities to make advances using emerging technologies and collaborative efforts.

4. Initiate development of an international community website that would be used to communicate new information concerning all aspects of ocean sensing and observing.

5. Serve as an important starting point for a general ocean observations symposium to be held in the next few years as the natural follow-on to the OceanObs99 Symposium, which was held in St. Raphael, France and resulted in a book.

#### Discussion and Decisions

The SSG agreed that the IOCCP should be involved with this initiative in order to ensure that carbon and biogeochemistry issues and needs are well-represented and that the eventual development of an on-line guide of sensors will be adapted to our sensors. In order to make this happen, it will be essential for sensor developers in our community to participate in this activity. It was agreed that at least 2 focal points need to be identified – one for carbon sensors and one for other biogeochemical sensors. After SSG-I, the IOCCP developed a small email group to discuss these issues. The SSG reviewed that list and added a few names, and suggested that the IOCCP re-contact this group to get their input into the developing OceanSensors08 conference and to identify two committee members from this list to provide direct guidance for the symposium. Communications will be re-initiated with this group, encouraging the group members to include any colleagues they feel would be interested in this initiative.

The SSG also decided that it would still be useful for the IOCCP site to provide basic information and news updates about the most often used instruments for ocean carbon system measurements. Nick Bates agreed to be the focal point for this, and Cindy Lee provided a report developed by OCTET several years ago with some information to build on.

The SIC group noted that these sensor workshops rarely lead to increased coordination or funds for research and development. Ken Johnson specifically raised the issue that scientists are slow to incorporate new techniques and instruments into their programs, and that it is often most beneficial to hold sensor workshops targeted at students. The SIC group discussed the possibilities of developing a summer school based on new sensor techniques for biogeochemistry. The SSG supported this idea, and suggested that the email list that was developed for the original sensor inventory activity could be used by the SIC to investigate the interest and feasibility of this summer school activity. It was decided that a joint email would be developed to explain to the email group how the inventory activity is being integrated into the OceanSensors08 initiative, and then SIC will describe the summer school idea.

**Action Item 1:** The IOCCP will continue to be active on the committee for OceanSensors08 and will identify 2 focal points for carbon and biogeochemical sensors to provide direct guidance to the committee. The IOCCP will develop an email group to provide information to the community and to generate enthusiasm and participation in this activity. [*Responsible: Maria Hood, Chris*

*Sabine, Arne Koertzing; Timeframe: begin communications activities immediately; Financial Implications: Low.]*

**Action Item 2:** The IOCCP will work with the SIC to develop a single email group to inform the group about the OceanSensor08 initiative and for SIC to describe their proposal for a summer school on biogeochemical sensors. [*Responsible: Maria Hood, Ken Johnson, Sylvie Roy; Timeframe: immediate; Financial Implications: None.*]

**Action Item 3:** The IOCCP project office will develop web-pages to provide basic information and news about the most often used sensors. [*Responsible: Maria Hood, Nick Bates; Timeframe: by 3<sup>rd</sup> quarter 2007; Financial Implications: None.*]

## **1b. Guide of Best Practices for Oceanic CO<sub>2</sub> Measurement and Data Reporting**

### Background

Together with PICES, the IOCCP co-sponsored this update of the 1994 DOE Handbook by Andrew Dickson. Since the beginning of this project, the IOCCP has contributed approximately \$15,000 to the development and publication of the manual. The manuscript has been sent to the community for comments and review, and should be ready for publication by the middle of 2007. The manuscript will be made available on the CDIAC Ocean CO<sub>2</sub> web-site and hard copies will be printed.

In 2002, the CO<sub>2</sub> Panel agreed that the manual should be used to hold a series of training courses for early career scientists or scientists new to ocean carbon to encourage the use of common practices and to facilitate global coordination and data syntheses.

The EU framework 7 proposal for Ocean Acidification (EPOCA) is being led by Jean-Pierre Gattuso and Ulf Riebesell, and they have asked the IOC to serve as a no-cost affiliate partner to facilitate international coordination and communication, with a special emphasis on technical coordination and training. They have requested that the IOC (via the IOCCP) consider the possibility of hosting training courses using the Guide, with some enhancement to include issues specific to ocean acidification standards (e.g., pH, etc.).

### Discussion and Decisions

The SSG agreed that the IOCCP should promote training courses based on the revised manual, but that we should try to get this initiative integrated into existing programs rather than developing our own stand-alone workshops. The IOCCP should promote a core program covering high quality measurements of basic carbon system parameters and the importance of using standard data / metadata reporting procedures. The EU EPOCA project offers an opportunity to hold such a workshop in Europe with an added emphasis on ocean acidification issues. The SSG also identified Arthur Chen's Southeast Asia Regional Carbon (SARCS) group as another possible forum for a workshop, where there would be an added emphasis on coastal carbon issues. Chen has expressed interest in adopting this approach for his November 2008 SARCS school, where the format would include up to 10 lecturers with each lecturer covering a specific aspect of ocean carbon measurements. He cautioned, however, that many of the students and scientists who attend the workshop would not have access to measurement instruments at their home institutions, and instead make very basic carbon measurements in the coastal zone. The SSG felt, however, that it was a good investment to reach this network of scientist and emphasize the importance of appropriate metadata and data reporting practices as well as introducing this community of scientists to the wider international network. Chen also suggested

that Liqi Chen's group from the State Oceanic Administration of China might be willing to translate the Guide into Chinese. Liqi Chen agreed that this would indeed be something his group would be willing to help with.

The SSG also noted that the Guide does not cover some aspects of organic carbon, and that this is a large omission for our community, especially with an increasing emphasis on the coastal carbon cycle. While there is no agreement in the community about "standard methods" for organic carbon variables, there are several methods being widely used that should be described, and it is essential to emphasize metadata and data reporting that will allow for comparison and interpretation of results obtained from different methods. Cindy Lee and Dennis Hansell agreed to develop standard operating procedure chapters on organic carbon parameters to include with the Guide for publication by mid 2007.

**Action Item 4:** The IOCCP will work with co-sponsor PICES to finalize the Guide, including electronic publication at CDIAC and printing of hardcopies of the manual in accordance with earlier agreements with PICES and financial support already provided by IOCCP. [*Responsible: Maria Hood, Chris Sabine; Timeframe: initiate in mid 2007; Financial Implications: None.*]

**Action Item 5:** Cindy Lee and Dennis Hansell will initiate the development of SOPs for organic carbon variables for inclusion in the revised Guide. [*Responsible: Cindy Lee, Dennis Hansell; Timeframe: immediately with delivery by July-August 2007; Financial Implications: Low.*]

**Action Item 6:** The IOCCP will work with the EU EPOCA program and Arthur Chen to initiate the development and implementation of training workshops based on the new Guide. Chen has requested a letter proposing this activity be sent to him as soon as possible so that he can apply for funds for the 2008 workshop. [*Responsible: Maria Hood, Chris Sabine; Timeframe: initiate contacts immediately; Financial Implications: Medium.*]

## **1c. Coordinated Action for a Carbon Observing System**

### Background

The IOCCP has been asked to assist with the development of a proposal for the EU Framework Programme 7 called "Coordinated Action for a Carbon Observing System" (COCOS), which will build on the early work of the IGOS partners Integrated Global Carbon Observations theme (in which IOCCP coordinated marine input) and on the network advances made in the EU through and CarboEurope. The proposal development is being led by Han Dolman and Christophe Heinze, and the initial email group developing the proposal includes Annette Freibauer, Andrea Volbers, Riccardo Valentini, Philippe Ciais, Antonio Bombelli, Andrew Watson, Alberto Vieira Borges, Douglas Wallace, James Orr, Reiner Schlitzer, Riccardo Valentini, Maria Hood (for IOCCP), Roger Dargaville (for IGOS-P IGCO). Marine contributions are being sought from Andy, Doug, Reiner, Alberto, Jim, and Maria.

In early March, a planning group met in Rome to develop the initial proposal, which is being developed through 5 work packages:

- WP1 - Enhancing interoperability of existing networks in land and ocean
- WP2 - Efficient use of data in models and data assimilation
- WP3 - Integration of multiple data sources for regional carbon budgets
- WP4 - Filling in gaps in data of vulnerable global carbon pools and fluxes on land
- WP5 - Filling in gaps in data of vulnerable global carbon pools and fluxes in the ocean

- WP6 - The European contribution to a global observing system for carbon

The IOCCP is being specifically asked to contribute to WP1, WP5, and WP6, where the IOCCP's role would be to ensure that the work of these EU groups is compatible and coordinated with activities and plans in other countries. This proposal aims to fund a series of workshops (10 small, 6 intermediate, 1 large at the end) and some post-doc time for synthesis work and organization of workshops as well as report writing. The proposal and objectives are currently being mapped onto the Global Earth Observations Societal Benefit Areas.

#### Discussion and Decisions

The SSG noted that international coordination was crucial for this activity, but it was not entirely clear how the appropriate level of international input could be developed through the current proposal. Andy Watson contacted the SSG shortly after the meeting to propose a new section of the proposal that would fund an international coordination activity to develop regular global seasonal flux maps based on data from the current network in order to prove the utility of the surface ocean observations networks and to argue for their continuation. These issues will be further discussed under section 5a of this report. The SSG agreed to continue to watch the development of this EU FP7 project and to decide how the IOCCP could usefully assist with coordination issues.

Further discussions and decisions about this topic are integrated into section 5a of this report.

## **2. International Repeat Hydrography and Carbon Update; Development of an Advisory Group on IRHC co-sponsored by IOCCP, CLIVAR, and SIC**

#### Background

Chris Sabine introduced this item. As a follow-up action from the November hydrography meeting ([Background Document 3](#)), 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 (SIC).

At the November meeting, participants outlined the following general topics requiring oversight in this initial phase:

- 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; and
- Serve as an international focal point for the development of this program and lobby for its support.

They also outlined some of the tasks that need immediate attention, including:

- 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 “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.

Since this meeting, items *ii* and *iii* have been carried out in partnership with SIC (Gruber and Koertzinger) and CARBOOCEAN, respectively.

In December 2006, CLIVAR-GSOP panel met and approved the concept for an Advisory Group for repeat hydrography and carbon, but suggested that the terms of reference and scope should be better defined. In discussions with members of the Argo Steering Team, the CLIVAR IPO, and US CLIVAR PO, several issues have been raised:

1. The priority need is for a single web-based directory and community bulletin board of all repeat hydrography program information, as well as update of the manual (*see IRHC report for details on what would qualify as repeat hydrography, etc.*). Once such a system is developed, it can be determined if a more structured program is required or if individual scientists and national programs can self-organize with minimal outside support to meet research objectives. The initial Atlantic synthesis workshop and on-going synthesis efforts that followed the November meeting may serve as test cases for this type of organization.
2. Several felt strongly that the data center directors should not form part of the Advisory Group, as originally suggested. The Advisory Group should be comprised of scientists (from physical hydrography, carbon hydrography, Argo, OceanSITES, etc) in order to develop a comprehensive vision of what is needed by the research community and how best to meet those needs, building on parts of existing systems if they are considered to be working well.

#### Discussions and decisions

The SSG agreed that we should move forward with the development of the Advisory Group, although noted that the terms of reference for this group need to be refined. For example, several of the urgent needs for the group that were established at the November 2005 hydrography meeting have moved on without this Advisory Group. The SSG agreed that the principal purpose of this Advisory Group should be to define what the international community wants to see in a comprehensive international repeat hydrography and carbon network, including what information should be compiled and maintained as part of this network, how to develop a single information source and/or data directory for ship-based repeat hydrography, needs for updating the hydrographic program manuals, and how best to coordinate with other programs looking at ocean interior changes such as Argo, CLIVAR, and OceanSITES.

Several members of the SIC group put forth the idea of this group also being an oversight group over the ocean interior synthesis activities being developed, and questioned whether it might be more logical to make this a sub-group of the SIC ocean interior working group. The SSG chair explained that there needs to be a distinction between 1) a group to develop a coordinated observation network using the model of the Argo or OceanSITES project to promote ship-based repeat hydrography, and 2) synthesis activities that need to go beyond just ship-based hydrography. There is an important trend in developing observation networks outside of the global research programs because they are developed to be sustained indefinitely rather than as part of a research project with a sunset clause. But the research programs provide a crucial link to

these programs to integrate new science into the networks and to drive the scientific synthesis activities. The SIC group agreed that this was a logical way to move forward.

The SSG and SIC reviewed the list of potential committee members that were put forward at the November meeting and agreed that the list represented the range of issues well.

**Action Item 7:** The IOCCP will contact CLIVAR and SIC to develop a final list of potential members for the Advisory Group and will develop an invitation letter describing the activity. The group will determine the best opportunity to meet (concurrent with another meeting if possible), and work will proceed via email as much as possible. At its first meeting, the group should work to refine its terms of reference and select a group chair. Once established, the group should aim to produce a report with their recommendations for developing a more coordinated and comprehensive network for ship-based repeat hydrography. [*Responsible: Maria Hood, Nico Caltabiano (CLIVAR), Sylvie Roy (SIC); Timeframe: begin immediately with initial goal of final report by early 2008; Financial Implications: Medium*].

### 3. Initial North Atlantic Synthesis Meeting and Follow-up

#### Background

Chris Sabine introduced this item. This workshop was held in Laugarvatn from 28-30 June 2006, and brought together 23 participants from 9 countries, with expertise ranging from ship-based hydrography and carbon measurements, physical oceanography, surface pCO<sub>2</sub> variability, CFC and tracer measurements, O<sub>2</sub> on profiling floats, modeling, and data synthesis and management ([Background Document 4](#)). Workshop participants developed three coordinated synthesis groups: Arctic and Nordic Seas, Sub-Polar and Sub-Tropical Gyres, and Southern Ocean.

As a follow-up to the Initial Atlantic Carbon synthesis meeting, the working groups met at IFM-GEOMAR in Kiel from 21-23 April to review progress and establish work plans and deadlines for the groups. The groups reviewed the scientific goals for the synthesis:

#### Arctic Mediterranean Seas

- Systematic determination of the Atlantic C<sub>ant</sub> inventory.
- Suitable method of C<sub>ant</sub> estimation.
- How does C<sub>ant</sub> enter the region?
- How is C<sub>ant</sub> transferred afterwards?
- How much is transferred to adjacent basins?
- What is the rate of change?
- Changes in saturation state of carbonate minerals?
- What future measurements do we need?

#### North Atlantic

- Add the Mediterranean C<sub>ant</sub> inventory to the global.
- Depth distribution of C<sub>ant</sub>.
- Variability of oxygen. Drivers.
- Close the C<sub>ant</sub> budget based on transport and storage estimates.
- Shifts in LSW ventilation rate and effects on C<sub>ant</sub>.
- Variability of mode waters.
- Ventilation pathways of the sub-polar and subtropical gyres.
- C<sub>ant</sub> inventory increase, really smaller than the Pacific?
- Is organic carbon important for the carbon budget?

- Feedback of MOC variability on carbon balance

#### Southern Ocean

- Which is the optimal method to determine  $C_{\text{ant}}$  in the Southern Ocean?
- Estimate the regional or whole SO  $C_{\text{ant}}$  inventory, using as many data as possible.
- Compare  $C_{\text{ant}}$  with CFCs. Any agreements / disagreements?
- Compare observations with models. Sensitivity to changes in circulation / physics.
- Separating  $C_{\text{ant}}$  from natural DIC changes.

The groups received an update on the CARINA database development from Bob Key, for which approximately 140 cruises have been submitted. Key estimates that primary QC for the compiled dataset will be completed by June 2007, but the individual cruise data sets have been made public (CCHDO and CDIAC). Working group lists have been established for each region, and these groups will be notified as Bob completes each "new" CARINA cruise, with the cruise file and metadata posted to CDIAC and CCHDO.

The meeting discussed secondary QC issues and challenges at length. The group decided to develop software (Matlab routines) to semi-automate some of the secondary QC procedures. Significant time was also devoted to discussion of all methods used during GLODAP work which might be appropriate for this project. Bob will soon be assembling and distributing subsets of GLODAP for secondary QC to each of the working groups and another file which will include recent CLIVAR/CARBOOCEAN data that can be used as "standards" to help QC the CARINA collection. Bob will also distribute a merged CARINA file for each working group. Based on this, one of the new goals is to create a new data product (2<sup>nd</sup> level QC), that can be presented next to the database (only 1<sup>st</sup> level QC).

The meeting also discussed coordination with the Pacific synthesis efforts, and Masao Ishii presented an overview of that work. That effort was begun in 2004 as part of the "Understanding North Pacific Carbon-cycle changes: A Data synthesis and modeling Workshop". The workshop resulted in a special issue of JGR in 2006. Most progress was made on surface CO<sub>2</sub> because water column data were not readily available in accessible format.

For hydrographic data, the synthesis work is divided into three groups: North Pacific (Sabine, Murata, Ishii), Equatorial Pacific (Feely, Ishii), and South Pacific (Tilbrook), and a "data manager" (Bob Key). Bob will compile the Pacific data as they come in, using the same approach as for the work in the Atlantic. The Atlantic Group agreed on the necessity for close cooperation with the Pacific effort, particularly for the Southern Ocean group, where substantial overlap exists. One of the lessons learned from the Pacific Group was that the participation of modelers from the beginning was helpful. Bob Key will represent the work of the Atlantic Group at the next Pacific Group meeting.

The Atlantic Group set action items and deadlines, including development of the Matlab routines for cross-over and MLR analyses, as well as translating the CO<sub>2</sub>sys program of Lewis and Wallace into Matlab (all of which are planned for completion by mid-May). The next meeting of the groups will be tentatively scheduled for the week proceeding the next CARBOOCEAN meeting in early December in Bremen. The second level QC for the CARINA data set should be completed by this time.

The IOCCP has been asked to assist these groups with their activities (e.g., keeping the community informed of progress and helping to make information available on the web; ensuring international participation; assisting with meetings, etc.). There are also a number of other

synthesis activities being planned and it is imperative to ensure that those activities are proceeding in a fashion compatible with the work being done in the Atlantic. The IOCCP may need to provide technical assistance to these groups.

#### Discussions and decisions

The SSG agreed strongly that the IOCCP should assist these groups with technical coordination issues, but also pointed out that these new Atlantic efforts also need to be coordinated with ongoing activities in the Pacific, and potential new activities that may be developing in the Indian Ocean in the coming years. There are several points of overlap between the Pacific and Atlantic activities, including QC issues, but also the fact that both groups have sub-groups for the Southern Ocean. At the recent Kiel meeting, the Pacific and Atlantic Southern Ocean groups agreed to collaborate, but the SSG proposed that the two groups should perhaps merge. The SSG also noted that there is a general lack of information about what all of the synthesis groups are doing, and they felt that the groups may not have made a sufficient effort to contact scientists who may have relevant data to contribute (especially organic carbon measurements that may contribute to the syntheses) to such a synthesis. The SSG recognized that the coordination efforts are developing in 2 stages: first, data identification, compilation, and QC issues; and the second dealing with scientific interpretation. The SSG felt that it was appropriate for the IOCCP to assist with the first stage technical coordination issues as well as to make a strong effort on communications about these activities to the rest of the community. This communication effort should include providing up-to-date information about the activities and people involved, progress and plans, agreements on QC practices, and wide distribution and promotion of the QC routines being developed by the Atlantic group. The SSG also recognized that assisting with coordination issues for these groups may require financial assistance to ensure appropriate participation at critical meetings.

The SIC group agreed with this approach, and also mentioned that there may also be a gap in the Arctic that should be considered as these global coordination efforts move forward.

**Action Item 8:** Develop a web-based information resource on the Atlantic and Pacific synthesis activities and encourage wider participation in these activities. Include information as possible on other regions that should eventually be integrated into a global synthesis, including the Indian Ocean and Arctic Ocean. [*Responsible: Maria Hood et al.; Timeframe: begin immediately in partnership with CARBOOCEAN and PICES groups; Financial Implication: low*].

**Action Item 9:** Work with PICES and CARBOOCEAN to discuss coordination needs between the two activities, including the possible merging of the two Southern Ocean groups, and to ensure that all scientists and groups who might contribute to these activities are fully engaged. [*Responsible: Chris Sabine, Maria Hood; Timeframe: begin immediately; Financial Implications: Medium*].

## **4. O<sub>2</sub> on Argo Update**

### Background

Maria Hood and Roger Dargaville introduced this item. This group developed a white paper ([Background Document 5](#)), which was presented by Nicolas Gruber at the 8<sup>th</sup> Argo Steering Team meeting held at UNESCO in Paris on 7-9 March 2007.

The Argo Steering Team was impressed with the document and the presentation of the proposal, and encouraged its continuation and close coordination with Argo. However, owing to concerns

about the unknown legal framework of taking O<sub>2</sub> measurements in Exclusive Economic Zones and concerns about impacts of these new floats on the basic Argo network sustainability, the Steering Team stated that it would not be possible to officially endorse this activity as an Argo project.

#### Discussion and decisions

In joint discussions with the SIC group and Nicolas Gruber, it was agreed that the initial technical coordination issues for development of a pilot project have been successfully completed, and now this project has moved into the implementation of both a technical proof-of-concept experiment but also one that has a significant scientific component to demonstrate the scientific value of such a system. Nicolas noted that the core activities that will contribute to this pilot project are implemented at the national level, and that in this initial phase, the organization will be managed through a “grass roots” team of the scientists themselves. At a later stage of development, the group will decide if it requires some sort of higher level organization. It was agreed that the next phase of coordination required by this group was more aligned to SIC responsibilities, and it was agreed jointly to transfer the web-resource information about the O<sub>2</sub> on Argo project to the SIC web site. The IOCCP will continue to promote the development of this activity and closer integration between this project and the ship-based repeat hydrography activity.

**Action Item 10:** Transfer the O<sub>2</sub> on Argo web information on the IOCCP site to the SIC project officers. [*Responsible: Maria Hood; Timeframe: immediate; Financial Implications: None.*]

### **5a. Underway / Surface CO<sub>2</sub>: Surface Ocean CO<sub>2</sub>: Variability and Vulnerability (SOCOVV) Workshop**

#### Background

Bronte Tilbrook introduced this item. Preparations for the workshop have been completed and the workshop will be held on April 11-14 at UNESCO in Paris. Information about the workshop can be found on the web-site at: [http://www.ioc.unesco.org/ioccp/pCO2\\_2007.htm](http://www.ioc.unesco.org/ioccp/pCO2_2007.htm).

For the IOCCP, the outcomes of working groups II and III will be important. Goals and possible outcomes include:

Working Group II: Observation Strategies - Discussion Leader / WG 2 Leader: Bronte Tilbrook  
Rapporteur: Roger Dargaville

*Overarching questions:* Considering our largest unknowns, data and gas exchange uncertainties, interpolation / extrapolation techniques, new measurement technology, and observing system experiments, what have we learned and where do we go from here to develop observation strategies to meet research objectives?

*Outcomes:*

- Discussion and agreement: what observations do we really need to meet scientific objectives ? (1. What are those scientific objectives?; 2. Are these best met through process studies or global quasi-synoptic observations? 3. What does the current system look like and what are the biggest missing parts?)
- Agreement on whether the international community would benefit from labeling certain activities as “operational”; agreement on what it means to be “operational”. (Is the community ready for near real-time data release?)
- Journal article or technical report on observations needed to meet research objectives and agreements on the way forward with observation strategies.

Working Group III: Data and Scientific Syntheses - Discussion Leader / WG 3 Leader: Dorothee Bakker; Rapporteur: Helmuth Thomas

*Overarching questions:* Considering existing projects, new results, and recent data releases, what needs are there for coordination and data synthesis activities? Should we begin developing a “GlobalView Ocean CO<sub>2</sub>” database? Should we develop scientific synthesis groups?

*Outcomes:*

- A list of on-going or planned data compilation and synthesis activities
- Agreement on whether these existing or planned syntheses meet the needs of surface CO<sub>2</sub> science; if not, get agreements on whether those syntheses should be expanded or whether new synthesis groups need to be developed.
- Agreement and Technical Report on whether a GlobalView Ocean CO<sub>2</sub> database should be developed; who are the users; what would be the requirements for data submitters or data managers; how would this link to the atmospheric databases?

#### Discussion and decisions

The SSG recognized that the organization of this workshop has been complicated and keeping the focus on the initial interests of the IOCCP has not been easy. However, the SSG noted that there should be some very exciting outcomes from the working groups that will have impact on the IOCCP’s work.

There is currently no agreed strategy for a coordinated surface observation network, and the community has largely been arguing to maintain existing operations and expand onto new ships/lines where possible. In the last several years, we have seen an increase of approximately 60% in the number of CO<sub>2</sub> systems on ships, and we are beginning to reach a situation where we have sufficient data in some regions to do meaningful seasonal flux maps. Millions of new data points are being generated, but only partly through coordinated efforts. It was noted that at least 5 different groups are developing regular global seasonal flux maps, all using different techniques and reporting significantly different results. The SSG agreed that technical coordination and joint data synthesis work is greatly needed and that we will watch the development of the workshop working groups to see how the community wants to move forward with this. Bronte noted that there is a need to develop a sustained observing system with strong international coordination. In developing the observing system we should also consider what other measurements (e.g. nutrients, oxygen and other carbon parameters) are needed to understand the CO<sub>2</sub> sources and sinks.

The workshop, which took place immediately following the SSG-II meeting, developed the following recommendations that have implications for the IOCCP:

- Chris Sabine will lead a comparison of the global data sets currently being used by different groups to generate seasonal flux maps to examine which data have been incorporated into the datasets and how those data are treated to generate the global compilation. This analysis should provide the information necessary for the community to decide which global data set should be considered the standard global community dataset on which we should continue to build. Based on this, Dorothee Bakker and Benjamin Pfeil will be asked to provide guidance and assistance to develop appropriate secondary QC procedures.
- Along with this analysis, Chris Sabine will lead an evaluation of the methods used to generate global seasonal flux estimates to understand why there is such a significant discrepancy among them. This may also include involvement of a larger group of investigators to also examine and evaluate the various methods for estimating surface CO<sub>2</sub> using satellite data and proxy techniques.

- Once a standard global data set is chosen, the community will be asked to decide on data products that may be produced regularly. A global seasonal pCO<sub>2</sub> map (e.g. without extrapolation of data points, at a high resolution (1° x 1°) for successive years) was discussed. Modelers preferred this to flux maps, since they will generate fluxes in their models according to their own methods.
- The workshop established surface CO<sub>2</sub> synthesis groups for the North Atlantic (including Arctic), the Pacific, the Southern Ocean, the Indian Ocean, and the Coastal Ocean. Scientists active in the Equatorial and South Atlantic may join the Atlantic synthesis group or create another regional group. These groups were asked to identify key science questions in their regions that require regional and global datasets, and to identify data in their regions that are not yet part of the global data set (e.g., until Sabine's analysis is complete, it is assumed that the CDIAC / CARINA compilation of Pfeil will be chosen as the standard data set).
- The workshop participants recognized the need for sustained funding for the global surface ocean pCO<sub>2</sub> network from volunteer observing ships, and suggested that an international agreement recognizing the importance of these networks may be required.
- Yukihiro Nojiri presented an overview on the March 2003 intercomparison experiment results and has proposed for the community to carry out another intercomparison experiment in 2008. The SSG was very supportive of this proposal and will follow its development.

From these, the IOCCP may consider the following Action Items:

**Action Item 11:** The IOCCP will facilitate and support the work of Chris Sabine to lead a comparison of global data sets currently being used by different groups to generate seasonal flux maps to examine which data have been incorporated into the datasets and how those data are treated to generate the global compilation. The IOCCP will serve as a forum for discussion of the outcome of this analysis to reach international consensus on development of a standard global surface CO<sub>2</sub> dataset. The IOCCP will further support and facilitate the work of Dorothee Bakker to provide guidance on secondary QC required for the global standard dataset. [*Responsible: Chris Sabine, Dorothee Bakker, Maria Hood; Timeframe: 3<sup>rd</sup> quarter 2007; Financial Implications: Low.*]

**Action Item 12:** The IOCCP will investigate the interest and feasibility of hosting a workshop on methods to estimate global seasonal pCO<sub>2</sub> flux as well as methods to estimate surface CO<sub>2</sub> based on satellite data and proxy techniques. This workshop would also decide on the regular development of data products. [*Responsible: Chris Sabine, Cyril Moulin, Maria Hood; Timeframe: early 2008; Financial Implications: Medium to High.*]

**Action Item 13:** The IOCCP will provide communication and coordination support for the regional synthesis groups established in order to facilitate their progress and provide a global point of coordination amongst the regional groups. The IOCCP will also work with the regional groups to define the objectives, ways and means for developing a sustained ocean carbon observing system. In addition, the IOCCP will work with the groups to facilitate collaborations with other relevant synthesis activities, such as the ocean interior synthesis groups developed from the Iceland workshop in June 2006. [*Responsible: Maria Hood et al., Timeframe: Immediate; Financial Implications: Low.*]

## 5b. JCOMM SOT links

### Background (JCOMM SOT links)

Maria Hood introduced this item. The IOC-WMO Joint Commission on Oceanography and Marine Meteorology (JCOMM) is the group responsible for implementation coordination of the global elements of the global ocean / climate observing system, and includes the VOS network, the XBT network, the SOOP network, the Data Buoy Cooperation Panel, as well as links to research-based groups developing sustained systems such as Argo and OceanSites. The IOCCP is a member of the JCOMM Observations Coordination Group to provide information about the developing network of ocean carbon observations that may one day move towards a sustained system. The Ship Observations Team of the JCOMM brings together all ship-based observation groups, and IOCCP has been working with this group for the past 4 years to provide information about the underway CO<sub>2</sub> programs.

At its last meeting, the JCOMM SOT was interested to know if the CO<sub>2</sub> lines could provide near-real time temperature and salinity data into their data assembly center system. After a technical presentation and discussions, it was agreed that it was too soon for most operators to comply with this request, but IOCCP agreed that it was important to maintain links with the JCOMM SOT as the systems develop.

The 2007 JCOMM SOT meeting will be held the week following the SOCOVV workshop, and the IOCCP provided a background report to update the group on underway CO<sub>2</sub> programs and technical issues related to developing an automated sustained network ([Background Document 6](#)).

### Discussion and Decisions

The SSG agreed that the IOCCP should maintain a communication link with this group, but that closer links were not feasible at this time.

## **6. Time Series Coordination**

### Background

Roger Dargaville presented an overview of the new maps and table inventories developed with CDIAC for time series. 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. The table provides information on ship-based stations, permanent moorings, and coastal moorings. The IOCCP has been working with CDIAC to try to make data links from these sites. The OceanSITES project has recently revised their 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 that the IOCCP inventory has.

### Discussion and Decisions

The SSG reviewed the current maps and tables, and Nick Bates led a discussion about whether the ocean carbon community using time-series stations has coordination needs that are not being met. While the IOCCP has been collaborating with the OceanSITES group, it was felt that that group did not have sufficient momentum or visibility in the carbon and biogeochemistry community to generate enthusiasm for the science or development of a coordinated network in the same way as for repeat hydrography or even the VOS carbon network. While all agree that time-series data are both unique and crucial, keeping these sites funded is still precarious. It was noted that carbon and biogeochemistry studies at time-series stations are often sensor limited, and

that the upcoming sensor workshop may help. In the joint session with SIC, Ken Johnson suggested that one of the limitations is not necessarily the availability of new sensors but simply that scientists are slow to begin using new instruments that are developed. The SSG also noted that process studies are often centered around the time-series stations, but that there is little communication or collaboration amongst programs at different sites. In general, the SSG felt that time-series stations are in “survival mode” and that this is a critical issue for carbon studies, including ocean acidification issues.

The SSG decided that it was critical to re-engage fully with the OceanSITES group, but that we should also investigate the interest and feasibility of developing an international workshop on carbon and biogeochemistry at time series stations with the goals of reinvigorating enthusiasm in the community for the unique and critical observing system platforms offered by time series and a network of time series stations. This workshop should also work to develop a more dynamic and coordinated international science community to promote time series work (both shipboard and using in situ instrumentation) for carbon and biogeochemistry science.

**Action Item 14:** Investigate the interest and feasibility of developing a workshop to enhance coordination and scientific advocacy for carbon and biogeochemistry time series work. *[Responsible: Nick Bates, Chris Sabine, Maria Hood; Timeframe: begin immediately with a view to implementation of a meeting in 1 year; Financial Implications: High.]*

## **7. Process Studies**

### **Background**

Cindy Lee and Maria Hood introduced this item. Initially, the IOCCP was to develop a database of on-going and planned process studies relevant to ocean carbon that could serve as a community source of information. Several early attempts were made, but it became clear that this required some strict guidelines to make the task manageable. For example, what level of information would be both useful and feasible to maintain? Would we only document major national programs (and what does that mean ?) and international activities? What scope should this include? (“relevant to ocean carbon” may cover a wide range of activities). Who would be the users of such information and what do they really need? Once such a database is developed, the technical coordination issues may become clear, and the database itself would be a useful tool for the community.

The IOCCP has developed a compilation of ocean carbon research being carried out during the International Polar Year. This has been recognized by the IPY secretariat as a contribution to their information system and they provide links to our pages.

The IOC serves as a no-cost affiliate partner in the EU CARBOOCEAN program, and has been invited to be a no-cost affiliate partner the proposed EU Ocean Acidification Project (EPOCA) to provide an international forum for coordination and communication. Both of these activities of the IOC are carried out via the IOCCP. For CARBOOCEAN, the IOCCP has been involved in the work package on ocean interior changes (hydrography), principally assisting with making EU synthesis efforts international. For EPOCA, the IOCCP has been asked to serve on work package 3: Present Day Observations of Ocean Chemistry and Biogeography, and work package 14: Dissemination and Outreach. In addition, IOCCP has been asked to co-lead a training component of the project, jointly with the University of Bergen (R. Bellerby). This item is mentioned above in section 1b.

### Discussion and Decisions

Cindy noted that the real need for technical coordination in process studies boils down to databases – where are the data from past studies and are those data available in a format useful for future studies? One major issue is that there are currently no agreements on how to record process study data such as rates and fluxes for DOC and POC. While most process studies try to be coherent within themselves, the results of different process studies are not readily comparable. Standards are rarely used, and metadata and information about techniques and methods are crucial. Another issue is simply keeping track of final data from process studies once they have been completed. Chris also noted that on several occasions he had been approached by participants in physical oceanographic process studies and asked if there were carbon-related process studies that could potentially collaborate. Without an overview of these activities, it is not possible to facilitate coordination and communication between appropriate groups. While it was agreed that this is probably outside the mandate of the IOCCP, it is sufficiently important that IOCCP should make an effort to assist if no other groups are willing to take this on. The SIC group also noted that this issue will become more important as biogeochemical sensors develop and are capable of directly measuring more than simple concentrations (e.g., rates, fluxes, etc.).

**Action Item 15:** Investigate the feasibility of developing a small workshop to develop recommended practices for metadata / data reporting in process studies, with a special emphasis on coastal carbon issues. Investigate the interest and ways of developing a directory of carbon-relevant process studies (including links to data from completed programs) with other groups, especially the SIC. [*Responsible: Cindy Lee, Maria Hood; Timeframe: begin immediately; Financial implications: low/medium*]

## **8. Ocean Colour**

### Background

Cyril Moulin introduced this item. The IOCCP is a partner in the European Space Agency's GlobColour Project, 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 policy makers 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; Maritorea 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 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. IOCCP representative Cyril Moulin attended the first GlobColour user consultation workshop held in December 2006. Over 50 participants attended the workshop and provided useful feedback to set GlobColour in a wider context and ensure better development of products to meet user needs.

#### Discussion and Decisions

The SSG agreed that it was useful for the community to have the IOCCP continue to work directly with the GlobColour group. However, Cyril remarked that the product from this project will not radically change or improve information required for ocean carbon cycle models or bring us any closer to being able to estimate ocean CO<sub>2</sub> from remotely sensed ocean colour. He suggested that the IOCCP should think about how to promote the creation of marine CO<sub>2</sub> products from satellites. The ocean carbon modeling community is currently constrained by the lack of measurements for validating or estimating global scale issues. There is also a growing interest in operational biogeochemical products from satellite data. There are currently no clear algorithms for ocean CO<sub>2</sub> from satellite data, although there is much research on proxy techniques, neural network methods, and data assimilation methods that are moving us towards this goal. While there have been workshops in the recent past on carbon from space, these workshops either focused on atmospheric or terrestrial carbon estimation techniques, and the ocean issues have been limited to ocean colour or biomass / productivity estimates. Even though the ocean CO<sub>2</sub> methods are still very much in the research phase, the SSG agreed that the community may benefit greatly from having a targeted workshop to bring together groups working towards this common goal to compare methods, techniques, and results. Note that this topic is related to the flux map discussions under items 1a and 5c.

**Action Item 16:** Investigate the interest and feasibility of developing a workshop on methods for estimating “ocean CO<sub>2</sub> from space” including reviews of proxy methods, CASIX-type work, neural network techniques, etc. This should be carried out in close partnership with the IOCCG

and the modeling community. Alternatively this could be folded into potential activities related to the evaluation of flux maps. At this point IOCCP will investigate all options and evaluate the best course of action [*Responsible: Cyril Moulin, Maria Hood; Timeframe: begin immediately to develop a proposal for IOCCG's consideration in the February 2008 meeting; Financial implications: Medium*].

## **9. Coastal Carbon**

### Background

Helmuth Thomas introduced this item. At SSG I, 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 / OCCC 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. In September 2007, IMBER and LOICZ are co-sponsoring an international continental margins conference.

While a more coordinated research and observation 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.

### Discussion and Decisions

Helmuth provided an overview of some of the principle coordination issues in the coastal carbon community, including the need to identify programs and data that exist in many countries that do not traditionally participate in international programs. He mentioned that the upcoming LOICZ/IMBER Continental Shelf science symposium will highlight many of these issues, and the outcome of that meeting will be a global implementation plan for coastal biogeochemical science. The SSG agreed that this was a crucial issue for ocean carbon studies, but that it was largely outside of the mandate of the IOCCP. One issue that the IOCCP could undertake is the promotion of best practices, standards, and methods for carbon-relevant coastal studies. The SSG agreed that this should be linked to the process studies actions outlined in section 7 of this report.

## **10. High-Precision Atmospheric CO<sub>2</sub> from VOS Ships**

### Background

Roger Dargaville introduced this item. An email-based working group was developed to investigate the feasibility and utility of installing high precision continuous atmospheric sensors on VOS in conjunction with the underway pCO<sub>2</sub> network has been established. Working with Britt Stephens (SIC), Roger Dargaville has assembled a group of experts on the technical aspects of taking high-precision measurements of atmospheric CO<sub>2</sub> and modelers 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 Wanninkhof (NOAA) and Frederic Chevallier (LSCE). Email discussions have produced a short report on the current status of the measurement technology and the options for modeling studies to assimilate and interpret the data. Options for instruments included the CSIRO LoFlo and the NCAR AIRCOA instruments. The group outlined a computer model experiment to evaluate the reduction in uncertainty in surface flux estimates for an atmospheric assimilation system. After this initial set-up of the experiments

required, the project stalled when the group decided that this was a very time-consuming undertaking and there did not seem to be a significant push from either the atmospheric or oceanic communities to continue.

#### Discussion and Decisions

The SSG and SIC discussed the utility of this exercise and suggested that perhaps a more useful exercise would be to look at the best-quality atmospheric CO<sub>2</sub> data already being collected from VOS ships in the Southern Ocean region. It was also felt that the extra cost and effort of installing such instruments on current VOS lines would be greater than the scientific interest for the ocean community but may have value for the atmospheric community. The SSG remarked that this activity was originally supposed to be led by the SIC, and that perhaps it was an issue that would be best addressed by a more integrated group such as the Global Carbon Project.

**Action Item 17:** Discuss this project with the GCP to see if they are interested in pursuing it. *[Responsibility: Chris Sabine; Timeframe: immediately; Financial Implication: none.]*

## **11. Mesocosm Guidelines**

#### Background

Maria Hood introduced this item. The SSG set an action item at SSG-I to assist the SIC Working Group on Climate Sensitivities and Feedbacks to develop guidelines and protocols for mesocosm experiments. Maria Hood and Ulf Riebesell discussed this issue over a period of several months, and decided that it would be most beneficial to develop this activity as part of a larger project on mesocosms, possibly as part of Ulf's development of an international open-ocean large mesocosm facility in the North Atlantic. Continued discussions of interest and means of implementing this activity have not led to any clear actions.

#### Discussion and Decisions

The SSG and SIC group agreed that this is a difficult issue to address, and that perhaps the focus on mesocosm alone was too narrow. Dick Feely mentioned that there are now many techniques for measuring calcification that have never been compared, and suggested that certain techniques and approaches should be examined more rigorously before large research programs move forward in the coming years. There was also a concern that data from these mesocosm studies were not properly recorded, stored, or made public.

The SSG agreed that this is an issue for the SIC to pursue through its working group if they feel that there is a sufficient need and interest in the community.

## **12. Communications Services**

#### Background

Maria Hood and Roger Dargaville introduced this item. One of the primary goals for the IOCCP is to serve as a communications service for the ocean carbon community. This has been undertaken through the web-based information data-bases on observation activities, through the web and e-mail based news services, and the email list / bulletin board service. One suggestion has been to develop a brochure that could be passed out at meetings to describe the work and services of the IOCCP for groups who may not be familiar with IOCCP.

#### Discussion and Decisions

The SSG expressed appreciation for the current organization and information content on the IOCCP web-site. Several features that were particularly appreciated were the menu listing based on issues (e.g., observing systems, standards, data, etc.), the quick links to other carbon programs, and the image gallery (useful for teaching purposes and pulling together presentations). The SSG suggested using Google Analytics to track usage statistics and prioritize development and maintenance efforts accordingly.

The SSG also expressed their appreciation for the format of the email news bulletins, specifically receiving the news in the text of the email message rather than as an attachment, and having the titles of the articles presented at the top of the message. The SSG remarked that, since the full articles on the web are rarely much longer than the text summaries presented in the email, it may be helpful to present the full news story in the email and only require people to go to the web-site if they want to download attached documents for further reading.

The SSG liked the quarterly news bulletins and did not feel that they needed to be more frequent. However, the SSG agreed that there is sometimes a need to provide news updates and information to the community more frequently than is possible with the news bulletin, and it is not reasonable to expect that the community will regularly look at the web-site for updates. The SSG suggested a sort of “news flash” system to bring important news updates to people’s attention when necessary. Examples include the current work to develop information about the synthesis groups or the development of the EU FP7 programs.

Chris raised the issue of developing a brochure to pass out at meetings to describe the work of the IOCCP and to encourage people to go to the web-site for further information. He mentioned that he had been at meetings where the IOCCP was mentioned as a means of undertaking some activities and some participants had not heard of the IOCCP and were not familiar with our work. The SSG agreed that there was a need to better communicate the work of the IOCCP, but were not enthusiastic about a brochure, stating that people look at them quickly and then throw them away without retaining the “take home” messages. The SSG put forward the idea of developing small business cards instead that would use both sides of the card to communicate the essential message of the IOCCP work, and provide contact information and the web-site address. It was felt that this would be a more direct means of getting people to understand the basic message of our work and lead them to the web-site for further information.

**Action Item 18:** Continue with maintenance of the site with the current structure and features; use Google Analytics to determine usage statistics. [*Responsible: Project Office; Timeframe: immediate and on-going; Financial Implications: Low.*]

**Agenda Item 19:** Develop text for a business card to explain and promote the work of the IOCCP, and have a limited number printed for SSG members to pass out at meetings. [*Responsible: Maria Hood et al.; Timeframe: immediate; Financial implications: Low.*]

#### IV. ACTION ITEM LIST

**Action Item 1:** The IOCCP will continue to be active on the committee for OceanSensors08 and will identify 2 focal points for carbon and biogeochemical sensors to provide direct guidance to the committee. The IOCCP will develop an email group to provide information to the community and to generate enthusiasm and participation in this activity. [*Responsible: Maria Hood, Chris Sabine, Arne Koertzinger; Timeframe: begin communications activities immediately; Financial Implications: Low.*]

**Action Item 2:** The IOCCP will work with the SIC to develop a single email group to inform the group about the OceanSensor08 initiative and for SIC to describe their proposal for a summer school on biogeochemical sensors. [*Responsible: Maria Hood, Ken Johnson, Sylvie Roy; Timeframe: immediate; Financial Implications: None.*]

**Action Item 3:** The IOCCP project office will develop web-pages to provide basic information and news about the most often used sensors. [*Responsible: Maria Hood, Nick Bates; Timeframe: by 3<sup>rd</sup> quarter 2007; Financial Implications: None.*]

**Action Item 4:** The IOCCP will work with co-sponsor PICES to finalize the Guide, including electronic publication at CDIAC and printing of hardcopies of the manual in accordance with earlier agreements with PICES and financial support already provided by IOCCP. [*Responsible: Maria Hood, Chris Sabine; Timeframe: initiate in mid 2007; Financial Implications: None.*]

**Action Item 5:** Cindy Lee and Dennis Hansell will initiate the development of SOPs for organic carbon variables for inclusion in the revised Guide. [*Responsible: Cindy Lee, Dennis Hansell; Timeframe: immediately with delivery by July-August 2007; Financial Implications: Low.*]

**Action Item 6:** The IOCCP will work with the EU EPOCA program and Arthur Chen to initiate the development and implementation of training workshops based on the new Guide. Chen has requested a letter proposing this activity be sent to him as soon as possible so that he can apply for funds for the 2008 workshop. [*Responsible: Maria Hood, Chris Sabine; Timeframe: initiate contacts immediately; Financial Implications: Medium.*]

**Action Item 7:** The IOCCP will contact CLIVAR and SIC to develop a final list of potential members for the Advisory Group and will develop an invitation letter describing the activity. The group will determine the best opportunity to meet (concurrent with another meeting if possible), and work will proceed via email as much as possible. The group should aim to produce a report with their recommendations for the ways and means forward for developing a more coordinated and comprehensive network for ship-based repeat hydrography. [*Responsible: Maria Hood, Nico Caltabiano (CLIVAR), Sylvie Roy (SIC); Timeframe: begin immediately with initial goal of final report by early 2008; Financial Implications: Medium.*]

**Action Item 8:** Develop a web-based information resource on the Atlantic and Pacific synthesis activities and encourage wider participation in these activities. Include information as possible on other regions that should eventually be integrated into a global synthesis, including the Indian Ocean and Arctic Ocean. [*Responsible: Maria Hood et al.; Timeframe: begin immediately in partnership with CARBOOCEAN and PICES groups; Financial Implication: low.*]

**Action Item 9:** Work with PICES and CARBOOCEAN to discuss coordination needs between the two activities, including the possible merging of the two Southern Ocean groups, and to

ensure that all scientists and groups who might contribute to these activities are fully engaged. [Responsible: Chris Sabine, Maria Hood; Timeframe: begin immediately; Financial Implications: Medium].

**Action Item 10:** Transfer the O2 on Argo web information on the IOCCP site to the SIC project officers. [Responsible: Maria Hood; Timeframe: immediate; Financial Implications: None.]

**Action Item 11:** The IOCCP will facilitate and support the work of Chris Sabine to lead a comparison of global data sets currently being used by different groups to generate seasonal flux maps to examine which data have been incorporated into the datasets and how those data are treated to generate the global compilation. The IOCCP will serve as a forum for discussion of the outcome of this analysis to reach international consensus on development of a standard global surface CO<sub>2</sub> dataset. The IOCCP will further support and facilitate the work of Dorothee Bakker to provide guidance on secondary QC required for the global standard dataset. [Responsible: Chris Sabine, Dorothee Bakker, Maria Hood; Timeframe: 3<sup>rd</sup> quarter 2007; Financial Implications: Low.]

**Action Item 12:** The IOCCP will investigate the interest and feasibility of hosting a workshop on methods to estimate global seasonal pCO<sub>2</sub> flux as well as methods to estimate surface CO<sub>2</sub> based on satellite data and proxy techniques. This workshop would also decide on the regular development of data products. This could be combined with Action Item 16. [Responsible: Chris Sabine, Cyril Moulin, Maria Hood; Timeframe: early 2008; Financial Implications: Medium to High.]

**Action Item 13:** The IOCCP will provide communication and coordination support for the regional synthesis groups established in order to facilitate their progress and provide a global point of coordination amongst the regional groups. The IOCCP will also work with the regional groups to define the objectives, ways and means for developing a sustained ocean carbon observing system. In addition, the IOCCP will work with the groups to facilitate collaborations with other relevant synthesis activities, such as the ocean interior synthesis groups developed from the Iceland workshop in June 2006. [Responsible: Maria Hood et al., Timeframe: Immediate; Financial Implications: Low.]

**Action Item 14:** Investigate the interest and feasibility of developing a workshop to enhance coordination and scientific advocacy for carbon and biogeochemistry time series work. [Responsible: Nick Bates, Chris Sabine, Maria Hood; Timeframe: begin immediately with a view to implementation of a meeting in 1 year; Financial Implications: High.]

**Action Item 15:** Investigate the feasibility of developing a small workshop to develop recommended practices for metadata / data reporting in process studies, with a special emphasis on coastal carbon issues. Investigate the interest and ways of developing a directory of carbon-relevant process studies (including links to data from completed programs) with other groups, especially the SIC. [Responsible: Cindy Lee, Maria Hood; Timeframe: begin immediately; Financial implications: low/medium];

**Action Item 16:** Investigate the interest and feasibility of developing a workshop on methods for estimating “ocean CO<sub>2</sub> from space” including reviews of proxy methods, CASIX-type work, neural network techniques, etc. This should be carried out in close partnership with the IOCCG and the modeling community. Alternatively this could be folded into potential activities related to the evaluation of flux maps from Action Item 12. At this point IOCCP will investigate all options and evaluate the best course of action [Responsible: Cyril Moulin, Maria Hood; Timeframe:

*begin immediately to develop a proposal for IOCCG's consideration in the February 2008 meeting; Financial Implications: Medium].*

**Action Item 17:** Discuss this project with the GCP to see if they are interested in pursuing it. *[Responsibility: Chris Sabine; Timeframe: immediately; Financial Implication: None.]*

**Action Item 18:** Continue with maintenance of the site with the current structure and features; use Google Analytics to determine usage statistics. *[Responsible: Project Office; Timeframe: immediate and on-going; Financial Implications: Low.]*

**Agenda Item 19:** Develop text for a business card to explain and promote the work of the IOCCP, and have a limited number (500?) printed for SSG members to pass out at meetings. *[Responsible: Maria Hood et al.; Timeframe: immediate; Financial implications: Low.]*

**Annexes for this report are available on line at:** <http://www.ioc.unesco.org/ioccp/SSG2.htm>

- Annex 1. Report from the 1<sup>st</sup> Session of the IOCCP Scientific Steering Group, October 2005
- Annex 2. November 2006 Progress Report
- Annex 3. International Repeat Hydrography and Carbon Workshop Report, November 2005
- Annex 4. Initial North Atlantic Synthesis Meeting Report, June 2006
- Annex 5. O<sub>2</sub> on Argo White Paper, March 2007
- Annex 6. JCOMM SOT Background Document, March 2007