

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

Friedrich-Schiller University  
Jena, Germany  
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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. 15

I. Agenda.....	2
II. Participant List.....	3
III. Report.....	4
1. Introduction .....	4
2. Review of Major Activities.....	4
2.1. Surface Flux Maps.....	4
2.1. Repeat Hydrography.....	7
2.3 Time Series Network.....	9
2.4 Underway pCO <sub>2</sub> .....	10
3. Information and Updates .....	10
3.1 Results from the Intercomparison Experiment.....	10
3.2 SOLAS-IMBER Carbon Group .....	12
3.3 Ocean Interior Meeting.....	13
3.4 INSS.....	14
3.5 CARINA .....	15
3.6 Methods Handbook.....	17
3.7 Ocean Carbon Sensor Directory.....	18
4. Project Office Budget.....	19
IV. Action List.....	19
APPENDIX I EU Projects: EPOCA and COCOS.....	21

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## I. AGENDA

<b>IOCCP SSG MEETING</b>	
<b>Jena, Germany</b>	
<b>14-Sep-09</b>	
18 :00-22 :00	
Lecture Room 8, 1st Floor	
Friedrich-Schiller-University, Ernst-Abbe-Platz 1	
<b>18:00</b>	<b>OPENING REMARKS</b>
<b>18:15-19:45</b>	<b>REVIEW OF MAJOR ACTIVITIES</b>
	Surface Flux Maps SOCAT
	Repeat Hydrography GO-SHIP
	Time Series OCEANSITES (follow up of Changing Times ?)
	Underway CO2 OceanObs white papers
	<i>Break</i>
<b>20:00-21:30</b>	<b>INFORMATION AND UPDATES</b>
	Intercomparison
	SOLAS/IMBER carbon group
	Ocean Interior
	INSS
	CARINA
	Methods Handbook
	Ocean Sensor Directory
	EU Projects COCOS EPOCA training, best practices
<b>21:30-22:00</b>	<b>PROJECT OFFICE BUDGET</b>
	<i>Close</i>

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### **III. REPORT**

#### **1. Introduction**

The Fourth IOCCP Scientific Steering Group meeting was held 14 September 2009 in conjunction with the ICDC8 conference in Jena, Germany. IOCCP Chair Chris Sabine (NOAA/PMEL, USA) was joined by members Masao Fukasawa (JAMSTEC, Japan), Dorothee Bakker (UEA, UK), Toste Tanhua (IfM-Geomar, Germany), Alex Kozyr (CDIAC, USA), Ute Schuster (UEA, UK), Pedro Monteiro (CSIR, South Africa), and Yukihiko Nojiri (NIES, Japan). Nicolas Metzl (LOCEAN-IPSL, France) and Nicolas Gruber (ETH, Switzerland) attended as ex-officio members of the IOCCP SSG.

Sabine opened the meeting by welcoming the new project coordinator, Kathy Tedesco, to the IOCCP. Although she has been actively running the IOCCP office in Paris for several months, this was her first SSG meeting. Maria Hood, the former project coordinator, is still working with the IOCCP part time as a consultant leading the GO-SHIP effort.

Sabine reminded the group of our many on-going coordination activities including hydrographic survey cruises, surface observations on volunteer observing ships, time series observations, and ocean color. IOCCP is also actively involved in helping to develop standards and methods such as the recently completed CO<sub>2</sub> Best Practices Guide, a revision of the WOCE methods handbook (coordinated through GO-SHIP), and a recent pCO<sub>2</sub> instrument comparison exercise held in Choshi, Japan. Sabine also noted that in the 7 years since its inception, IOCCP has held 18 workshops or meetings and has published and/or co-sponsored the publication of 16 reports, guides, and strategy documents.

Each of the steering group members reported on the on-going activities and needs of the community for their specialty. Some of the more notable activities IOCCP is contributing to are the development of the Surface Ocean CO<sub>2</sub> Atlas (SOCAT), and the synthesis of global interior ocean carbon data through CARINA and PICES. In 2010, IOCCP will continue to support these important community efforts. Another notable action was the decision to promote the evolution of the GO-SHIP panel into an ongoing international program.

#### **2. Review of Major Activities**

##### **2.1 Surface water fCO<sub>2</sub> data set and gridded product (SOCAT)**

Dorothee Bakker reviewed the goals and status of the of the Surface Ocean CO<sub>2</sub> Atlas (SOCAT) Project. At the “Surface Ocean CO<sub>2</sub> Variability and Vulnerability” (SOCOVV) workshop in April 2007, co-sponsored by IOCCP, SOLAS, IMBER, and the Global Carbon Project, participants agreed to establish a global surface CO<sub>2</sub> data set that would bring together, in a common format, all publicly available surface fCO<sub>2</sub> data for the

surface ocean. This activity has been requested by many international groups for many years, and has now become a priority activity for the marine carbon community. This data set will serve as a foundation upon which the community will continue to build in the future, based on agreed data and metadata formats and standard 1<sup>st</sup>-level quality-control procedures, building on agreements established at the 2004 Tsukuba workshop on “Ocean Surface pCO<sub>2</sub> Data Integration and Database Development”. This activity also supports the SOLAS and IMBER science plans and joint carbon implementation plan.

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

1. a 2<sup>nd</sup>-level quality controlled, global surface ocean fCO<sub>2</sub> (fugacity of CO<sub>2</sub>) data set following agreed procedures and regional review, and
2. a gridded SOCAT product of monthly surface water fCO<sub>2</sub> means on a 1° x 1° grid with no temporal or spatial interpolation.

An extended 1<sup>st</sup>-level quality-controlled data set has been developed as part of the EU CARBOOCEAN project, where Benjamin Pfeil and Are Olsen (Bjerknes Centre for Climate Research) have compiled the publicly available surface CO<sub>2</sub> data held at CDIAC (Carbon Dioxide Information Analysis Center) and other public data into a common format, 1<sup>st</sup> level quality-controlled, database based on the IOCCP-recommended formats for metadata and data reporting.

#### Status

The IOCCP, along with CARBOOCEAN and the SOLAS-IMBER Joint Carbon Group, held a 2<sup>nd</sup> technical workshop (SOCAT-2 meeting) at UNESCO, Paris, on 16-17 June 2008 to develop internationally agreed 2<sup>nd</sup>-level quality-control procedures and to discuss the coordination of regional scientific groups to conduct the 2<sup>nd</sup>-level quality control analyses. For more information, please refer to the background document SOCAT-II Report ([http://ioc3.unesco.org/ioccp/Docs/SOCAT2\\_Final2.pdf](http://ioc3.unesco.org/ioccp/Docs/SOCAT2_Final2.pdf))

The SOCAT dataset now contains more than 2,100 cruises from 1968-2007. Benjamin Pfeil and Steve Hankin have agreed that the best way to access the dataset is to keep each cruise as an individual file and to use a LAS system to serve all the data. The regional groups will use LAS to download data, based on definitions of regional boundaries.

The regional groups and chairs are:

- Atlantic and Arctic Ocean – Schuster, Lefèvre
- Indian Ocean – VVSS Sarma
- Pacific Ocean – Feely, Nojiri
- Southern Ocean – Tilbrook, Metzl
- Coastal seas – Borges, Chen.
- Global group – Bakker, Olsen, Sabine, Pfeil, Metzl

## SOCAT QC-II Definitions of Regional Boundaries

1. **Tropical Pacific** -- Between 30°S and 30°N, between North America and Asia. The boundary between the Indian and the Pacific oceans is Malaysia, Sumatra, Java, and Timor and a line at 130°E to Australia through the Timor Sea.
2. **North Pacific** -- North of 30°N and between North America and Asia, including cruises that go north of Alaska into the Arctic Ocean.
3. **Southern Ocean** -- Everything south of 30°S
4. **Indian Ocean** -- North of 30°S, bounded on the east by the line described above, and on the west by Africa and the Suez Canal.
5. **Atlantic Ocean** -- North of 30°S including the Mediterranean, Black Sea, Barents Sea, and Labrador Sea.
6. **Coastal (a.k.a. "continental margins")** -- All ocean surface within 400 km of land\* excluding the Southern Ocean Region.

\* The intent of the various working groups was to exclude the margins around small, isolated islands, so the Distance-To-Land variable is calculated from a 20-minute resolution land mask that was altered (through guidance from Burke Hales) to eliminate such islands. The altered land mask retains New Zealand, Iceland, and Madagascar as 'land' and Caribbean islands that show up at the 20 minute resolution, as well as other islands like Tasmania, Sri Lanka, Japan, etc. The following islands were explicitly masked out: Reunion/Mauritius, New Caledonia, Vanuatu, Solomon Islands, Manus Island (N of New Guinea), Galapagos, Smith Island (Indian Ocean; Bay of Bengal), Hawaii, Azores, South Georgia, Macquarie (south of NZ), French Southern and Antarctic Lands.

The various regional groups met in 2009 to evaluate the initial data quality, learn to use the LAS tools for conducting 2<sup>nd</sup> level quality control, and determine a course of action for performing the 2<sup>nd</sup> level quality control checks. The Coastal group meeting was held in Kiel in January 2009 with financial support assembled by the SOLAS International Project Office from various sources including the European COST Action 735. The Pacific regional group met in March 2009 at the Tsukuba, Japan funded by the National Institute for Environmental Studies and IOCCP. The Atlantic and Southern Ocean regional groups met in June at the University of East Anglia supported by COST Action 735 (arranged by SOLAS), and IOCCP and IMBER. Bakker provided an overview of discussions during the regional group meetings. E.g. the Atlantic and Southern Ocean groups have decided to delay the first SOCAT release to mid-2010.

### Discussion and Action Items

The SSG discussed the quality control workload and the possibility of hiring a contractor to assist Olsen and Pfeil. Also, because LAS is used for 2<sup>nd</sup> level QC it was suggested that Hankin and Malczyk develop LAS guidelines to be made available to the project members through the IOCCP Web-site.

It was also decided that regional meetings should be organized, as needed, by regional group leaders in 2010, with the option of conference calls. In addition, the SSG would like to sponsor a SOCAT Science Meeting for early 2011 with support requested from SOLAS and IMBER. It was suggested to combine a SOCAT science meeting with an Ocean Interior science meeting (Action Item 9).

### **Action Item 1**

SOCAT 2<sup>nd</sup> level QC recommended approaches will be developed (*Responsible: Olsen and Bakker. Timeframe: Immediate. Financial implications: None*)

### **Action Item 2**

The IOCCP SSG recognized there is a lot of work involved in correcting the 1<sup>st</sup> level QC issues and addressing the 2<sup>nd</sup> level QC findings. The IOCCP will discuss with Pfeil and Olsen how best to assist with this workload. (*Responsible: Tedesco will work with IOC to determine if a contractor can be hired. Pfeil and Olsen will identify possible candidates. Timeframe: Immediate. Financial implications: Medium/High*).

### **Action Item 3**

SOCAT Regional Meetings to be held in 2010, as needed. (*Responsible: Regional group chairs. Timeframe: Throughout 2010. Financial Implications: Medium*)

## **2.2 Repeat Hydrography**

Masao Fukasawa and Toste Tanhua presented the Repeat Hydrography agenda item, including an update on the Global Ocean Ship-based Hydrographic Investigations Panel (GO-SHIP). The IOCCP and CLIVAR, in collaboration with the joint SOLAS-IMBER carbon working group, developed the Global Ocean Ship-based Hydrographic Investigations Panel (GO-SHIP) to bring together interests from physical hydrography, carbon, biogeochemistry, Argo, OceanSITES, and other users and collectors of survey data to consider how future global ship-based hydrography can build on the foundations established by the global surveys of GEOSECS, WOCE, JGOFS, and CLIVAR.

GO-SHIP held its first meeting in November 2007 with the following Panel members: Masao Fukasawa (JAMSTEC, Japan), Chris Sabine (NOAA, USA), Bernadette Sloyan (CSIRO, Australia), Toste Tanhua and Arne Koertzing (IfM-GeoMar, Germany), Gregory Johnson (NOAA, USA), and Nicolas Gruber (ETH, Switzerland). The Panel agreed to the following Terms of Reference:

- i. To develop the scientific justification and general strategy for a ship-based repeat hydrography network, building on existing programs and future plans, that will constitute the core global network, post-CLIVAR; considerations should include:
  1. a set of basic requirements to define a coordinated repeat hydrography network (e.g., sample spacing, repeat frequency, recommended core measurements, etc.);

2. an inventory of existing and planned sections that meet those criteria;
  3. an assessment of other observing programs that can either contribute to or use hydrography data (e.g., Argo, OceanSITES, GEOTRACES, etc.);
  4. an assessment of data release needs to meet research and operational objectives;
  5. an inventory of on-going or planned scientific synthesis activities (basin and global) that might benefit from closer collaboration;
  6. guidelines for the transition from the CLIVAR hydrographic program to the new system, including sections, data and information management, and synthesis activities.
- ii. To develop guidelines for a single global information and data center for ship-based repeat hydrography;
- iii. To review and provide guidance on the need to update the WOCE hydrographic programme operations manual, including a review and update of data quality control issues.

The Panel agreed that the main deliverables (e.g., guidelines for a coordinated repeat hydrography network and information center and the updated operations manual) would be developed for the OceanObs09 conference in September 2009, where the guidelines would be published as a Community White Paper.

The IOCCP SSG at its 3<sup>rd</sup> meeting (October 2008) noted that the OceanObs09 should mark the end of the mandate for the GO-SHIP Panel and that continuation of the effort to develop a global strategy, post-CLIVAR, will depend on the response of the community to the white paper at the conference, and particularly on having a few champions in the community to step forward to agree to lead the development of a coordination project. The SSG also agreed that coordination is needed now, especially an email list to allow rapid communication with the international hydrography community, and a web-based bulletin board/news service. The SSG set an action time to develop a communication / coordination activity for repeat ship-based hydrography as an interim activity until the GO-SHIP strategy is published and follow-up activities are developed.

#### Status

An email list ([go-ship@lists.unesco.org](mailto:go-ship@lists.unesco.org)) was established in March and an email was circulated widely inviting interested scientists to subscribe to the list. At present there are 133 subscribers. The list has been used to distribute the GO-SHIP community white paper and to share information about cruise plans and updates.

A draft strategy was developed by the GO-SHIP Panel in late February and distributed on the email list for review and comments by the wider hydrography community. More than 40 scientists commented on the draft and/or provided text and are listed as contributing authors. The first draft was submitted to the OceanObs09 conference organizers on 31 March for open community review, the conference white paper was submitted on 1 September, and the final conference paper was submitted on 27 October.

Because the final conference paper was limited to 5000 words, the introduction and scientific justification sections were greatly reduced for the conference version. The full strategy will be published as an IOC Technical Report by IOCCP and CLIVAR, and the URL for this is referenced in the shorter conference version.

The update of the hydrographic manual is approximately 60% complete with 7 of 17 chapters still pending. The chapters have been made available for open community review at CDIAC (<http://cdiac3.ornl.gov/hydrography/>). Hood has contacted each of the authors of the pending chapters once per month since February, and all respond that they intend to submit their chapters. The most recent request emphasized that the chapters should be finalized by the end of November. Final editing and compiling of the chapters will be carried out in December, and electronic publication should be launched in January.

#### Discussion and Action Items

The discussion on this item revolved around the follow-up of GO-SHIP since the work of the GO-SHIP panel will end at OceanObs09 (with manual submissions and publication finalized by IOCCP and CLIVAR staff). The IOCCP SSG suggested the IOCCP co-host a GO-SHIP side meeting during the Ocean Sciences Meeting in Portland, OR in early 2010.

#### **Action Item 4**

Completion of the hydrographic methods manual. (*Responsible: Hood will continue to follow up with authors. Timeframe: Ongoing. Financial Implications: None*)

#### **Action Item 5**

GO-SHIP side meeting will be held during the Ocean Sciences Meeting in Portland, OR in early 2010 (*Responsible: Hood, Tanhua, and Fukasawa will develop the agenda, invite speakers, and reserve the meeting space. Timeframe: Immediate. Financial Implications: Low*)

### **2.3 Time Series Network**

Sabine led the discussion of IOCCP time series efforts including the ‘Changing Times: An International Ocean Biogeochemical Time-series Workshop’, sponsored by the IOCCP, OceanSITES, and the Partnership for Observations of the Global Ocean (POGO) held at the Scripps Institute of Oceanography in November 2008 to support and strengthen the ocean carbon and biogeochemical time-series effort.

The goals of the meeting were to mobilize the community to participate in this international network and to highlight the critical research that can only be carried out using time-series (both ship-board and autonomous) observations. The workshop also assessed the future of time-series observations in an age when it is becoming technically feasible to develop basin and global scale networked arrays of ocean time series stations, offering a new tool with enormous potential to cover a range of spatial and temporal

scales never before possible. The time is right for the international ocean carbon and biogeochemistry community to examine how time-series observations can be used most effectively to advance our understanding of ocean processes and how these processes vary in time and space.

#### Decisions and Action Items

Since the Changing Times Workshop no new time series data has been submitted to CDIAC. The SSG agreed that these data would benefit the SOCAT project. The IOCCP decided to wait and see if the Ocean Carbon and Biogeochemistry Program plans to fund a time series workshop. If not, IOCCP may host a meeting and ask OCB to be a co-sponsor.

### **2.4 Underway pCO<sub>2</sub>**

The IOCCP provided coordination support for a community white paper on the VOS network for the OceanObs09 meeting. The paper entitled “**A global sea surface carbon observing system: assessment of sea surface CO<sub>2</sub> and air-sea CO<sub>2</sub> fluxes**” by **Monteiro et al., 2009** outlines a strategy for carbon measurements on commercial Volunteer Observing Ships. It is currently in final revision based on reviewer comments.

Other relevant white papers submitted to OceanObs09 include:

Borges, A.V. et al., 2009. A Global Sea Surface Carbon Observing System: Inorganic and Organic Carbon Dynamics in Coastal Oceans.

Byrne, R. et al., 2009. Sensors and Systems for Observations of Marine CO<sub>2</sub> System Variables.

Claustre, H., 2009. Biogeochemistry and ecosystems observing system.

Cronin, M. F. et al., 2009. Monitoring ocean - atmosphere interactions in western boundary current extensions

Gruber, N. et al., 2009. Adding Oxygen to Argo: Developing a Global in-situ Observatory for Ocean Deoxygenation and Biogeochemistry.

#### Discussion and Action Items

The group discussed assisting SOLAS/IMBER sub-groups in planning for the Surface and Interior Ocean meeting to be held at UNESCO in early 2011 (see section 3.2).

#### **Action Item 6**

Contact Joellen Russell and Andrew Lenton to get an update on the status of the surface CO<sub>2</sub> network design. (*Responsible: Monteiro and Metzl will contact Russell and Lenton. Timeframe: early 2010. Financial Implications: None*)

### **3. Information and Updates**

#### **3.1 International ocean pCO<sub>2</sub> instrument inter-comparison using indoor seawater pool**

Yukihiro Nojiri presented results of an international ocean pCO<sub>2</sub> instrument inter-comparison, including underway and autonomous buoy systems that was held at National Research Institute of Fishery Engineering in Kamisu City, Ibaraki, Japan using the indoor seawater pool. The campaign was supported by pCO<sub>2</sub> buoy project by JAMSTEC/MEXT and pCO<sub>2</sub> data analysis project by NIES/MOE. Seven underway systems and seven buoy systems were gathered for the campaign.

#### List of underway systems

- NIES Tandem equ. + LICOR 7000 (A1 and A2) by Kimoto Electric Co.  
Down sized Tandem equ. + LICOR6262 (B) by Kimoto Electric Co.
- NOAA Serial shower equ. + LICOR 7000 (C1) by General Oceanic Co.
- NIO Serial shower equ. + LICOR 7000 (C2) by General Oceanic Co.
- NIWA Shower equ. + LICOR 6251 (D), laboratory made
- PML Beads equ. + LICOR 840 (E) by Dartcom Co.

#### List of buoy systems

- NIES Goatex tube equ. + LICOR 840 (W1 and W2) by Kimoto Electric Co.
- NOAA Bubbling equ. + LICOR 840, NOAA/PML MAPCO<sub>2</sub> System with MBARI
- Montana Univ. SAMI colorimetry with tube equ. (Z1 and Z2) by Sunburst Sensors Co.
- JAMSTEC Colorimetric detection with tube equ. (Y1 and Y2), laboratory made (equ.=equilibrator)

The pool has a nominal volume of 170 m<sup>3</sup> and is enable to be kept at a stable pCO<sub>2</sub> over night because of the small temperature change. The pool water was well circulated by submergible pumps. Main water line of 300 L/min flow rate was installed at the pool side and water is supplied for underway systems. Because the line water temperature was warmed by heat from the water line pump, underway pCO<sub>2</sub> result was critically corrected by the measured difference of line and pool waters. It was in between 0.04 to 0.06 degree C during the inter-comparison period.

Five overnight comparisons were run on Feb. 27, 28, Mar. 1, 2 and 3. First, second and third night runs were fixed pCO<sub>2</sub> comparison at 281, 437, and 357 ppm, respectively. In the fourth and fifth night runs, pCO<sub>2</sub> was abruptly changed at mid night by HCl or NaOH.

The result of inter-comparison was very successful and we confirmed well designed NDIR pCO<sub>2</sub> systems will give very tight agreement for wide pCO<sub>2</sub> range even for underway and buoy application. Under way system agreement of three NIES, two NOAA/NIO and NIWA systems can be stated the range is generally within plus minus 0.5ppm in xCO<sub>2</sub> scale, and NIES and NOAA/MBARI buoys are generally within plus minus 1ppm compared with standard underway value. Colorimetric buoy has been improved and very stable operation for the whole comparison period was achieved for SAMI, however, situation of buoy pCO<sub>2</sub> system may be similar to the first international

inter-comparison of pCO<sub>2</sub> system organized at Scripps Institute for Oceanography by in 1994, when some system worked stable but some not.

### **Action Item 7**

Recommendations based on the intercomparison experiment to be posted on the IOCCP website. (*Responsible: Nojiri will write up recommendations. Tedesco will post on the Web-site. Timeframe: By the end of 2009. Financial Implications: none*).

## **3.2 SOLAS-IMBER Carbon Group**

The joint IMBER/SOLAS Carbon Working Group is currently being restructured. The Chairs of the three sub-groups that were formed to move the implementation of the carbon research group forward, now report directly to the IMBER and SOLAS SSCs and work closely with the International Ocean Carbon Coordination Panel (IOCCP). The Chairs will also serve as ex-officio members of the IOCCP SSG meetings. The Joint SOLAS/IMBER Carbon Research Implementation Plan (2007) is available at (<http://www.imber.info/products/Carbon Plan final.pdf>).

### **Sub-group 1 (SG1) Surface Ocean (Chair: Nicolas Metz)**

New Terms of Reference are currently being developed and membership of the group may be increased. The group deals with natural and anthropogenic variability of CO<sub>2</sub> air-sea fluxes and the processes controlling surface ocean CO<sub>2</sub> and air-sea fluxes. Its aim is to determine the uptake of anthropogenic CO<sub>2</sub> on timescales ranging from months to decades.

Subgroup 1 is a large sponsor (with ideas, time and effort) of SOCAT (see section 2.1) and will play a key role in organizing a Surface and Interior Science meeting in 2011 (Action Item 9).

### **Sub-group 2 (SG2) Ocean Interior (Chair: Nicolas Gruber)**

New Terms of Reference are currently being developed and membership of the group may be increased. The group deals with inventory and observations, natural variability and transformation. Its aim is to determine the uptake, transport and storage of anthropogenic CO<sub>2</sub> in decadal timescales.

As part of the global synthesis SG2 organised the *Decadal Variations of the Ocean's Interior Carbon Cycle: Synthesis and Vulnerabilities* symposium at the Centro Stefano Franscini in Ancona (Switzerland) on July 13-17, 2009 (see section 3.3).

Following the rationale that oxygen is very sensitive to global change, a pilot program - Oxywatch O<sub>2</sub> (putting oxygen sensors on ARGO floats) was developed. A White Paper was finalized in February 2007, but as yet the program is not funded. A Community White Paper has been approved for OceanObs 09, where Niki Gruber will deliver the keynote address.

Another activity related to this sub-group is the CARbon dioxide In the North Atlantic (CARINA) (see section 3.5).

**Sub-group 3 (SG3) Ocean Acidification (Chair: Jean-Pierre Gattuso)**

The third IMBER/SOLAS Carbon Research sub-group on Ocean Acidification was launched in August 2009 ( [http://www.imber.info/C\\_WG\\_SubGroup3.html](http://www.imber.info/C_WG_SubGroup3.html))

The tasks of this group are to:

1. coordinate international research efforts in ocean acidification, and
2. undertake synthesis activities in ocean acidification at the international level.

During the first meeting, which will be held before the end of the year, the sub-group will identify and prioritise topics for immediate attention, with an indication of proposed deliverables and a plan to achieve them.

Discussion and Action Items

The group recommended that the SOLAS/IMBER sub-groups outline their relationship and plans for interactions with the IOCCP in their new terms of reference. Once these terms of reference have been approved by their parent organizations, the IOCCP will review its terms of reference and determine what modifications are needed to interface with the new sub-groups. The IOCCP SSG also proposed a joint Surface and Interior meeting be held in the summer of 2011 at UNESCO. Since this is primarily a research meeting we anticipate that the SOLAS/IMBER sub-groups would take the lead in organizing this workshop, but the IOCCP can contribute by providing the venue and some logistical assistance through Kathy Tedesco.

**Action Item 8**

Provide information and feedback as requested to assist the SOLAS/IMBER sub-groups as they prepare their terms of reference. (*Responsible: Urban, Metzl, Gruber, Sabine. Time frame: Ongoing. Financial Implications: None*)

**Action Item 9**

Assist SOLAS/IMBER sub-groups in planning for the Surface and Interior Ocean meeting to be held at UNESCO in early 2011. (*Responsible: Gruber and Metzl will organize meeting. Tedesco will reserve space at UNESCO for 100 people. Timeframe: Begin organizing in early 2010. Financial Implications: None*)

**3.3 Ocean Interior Meeting**

Gruber presented a summary of the Ocean Interior Meeting held from 13-17 July 2009 at the Centro Stefano Franscini at Monte Verità, Ascona, Switzerland in order to discuss variability and changes in the ocean's interior carbon cycle on decadal time-scales. An international group of 23 scientists (from 10 countries on 4 continents) attended the 4.5 day program , which consisted of a series of presentations, a half day where the

participants split into two working groups, and several open discussion sessions (see detailed program in the attachment). Each speaker was given a substantial time slot in order to provide her with the time to present the material with the sufficient depth, and to also have sufficient for discussions. The program was organized along the objectives, with the first three days devoted to the assessment of the available research, while the 4<sup>th</sup> and the 5<sup>th</sup> days were focused on the processes and future planning.

The meeting occurred in a stimulating and open atmosphere with intense and pointed discussions, creating the community that is required in order to be able to assemble the data stemming from many scientists and countries into a globally consistent data base – the starting point for the determination of the decadal change in the ocean’s carbon content. The meeting participants also agreed to the goal of having a peer-reviewed paper published by August 2012 that reports the globally integrated change in the ocean’s carbon content since the mid 1990s, as well as its spatial distribution. That date was selected in order to meet the deadline of the 5<sup>th</sup> assessment of the IPCC. In order to achieve this goal, an ambitious timeline was developed, consisting of basin-scale working groups, i.e. one each on the Arctic, Atlantic, Indian, Pacific, and Southern Ocean, that would report their regional estimates by the summer of 2011 at the latest. A global synthesis group would then take these estimates and produce a global estimate by early 2012. In order to ensure consistent approaches in each basin, a method group was created that pushes the methodologies and also establishes best practices guides. In addition, it was agreed that many of the tools that are being developed will be shared between the working groups, building on the successful model of the CARINA synthesis. A follow-up meeting will be organized for next summer, with a larger meeting being planned for summer of 2011 jointly with the group that focuses on surface ocean pCO<sub>2</sub>, i.e. the SOCAT group. Thus, the first objective of the meeting was fully met.

### **3.4 International Nutrients Scale System Workshop**

The comparability and traceability of data on nutrients in the global ocean are fundamental issues in marine science, particularly for studies of global climate change. Our community has been continuing to improve the comparability of nutrient data in many ways, including by intercomparison experiments and the development of nutrient reference materials. However, as *Climate Change 2007 – The Physical Science Basis* (IPCC 2007) stated, adequate comparability and traceability have not yet been achieved. The IPCC 2007 report comments as follows on nutrient comparability: “Using the same data set extended to the world, large regional changes in nutrient ratios were observed (Li and Peng, 2002) but no consistent basin-scale patterns. Uncertainties in deep ocean nutrient observations may be responsible for the lack of coherence in the nutrient changes. Sources of inaccuracy include the limited number of observations and the lack of compatibility between measurements from different laboratories at different times (Bindoff et al., 2007).”

An International Workshop on Chemical Reference Materials in Ocean Science was held in Tsukuba, Japan, on 29 October to 1 November 2007. It focused on the measurement of

nutrients and of ocean CO<sub>2</sub> parameters. The current status of available chemical reference materials, especially for nutrient in ocean science were discussed, and the participants agreed to start a collaborative program, called the International Nutrients Scale System (INSS), to establish global comparability and traceability. The agreements at the workshop in Tsukuba 2007 marked an epoch in the history of nutrients comparability.

### Status

The IOCCP co-sponsored and hosted the INSS workshop on 10-12 February 2009 at UNESCO headquarters in Paris. This workshop, led by Dr. Michio Aoyama, followed several workshops and intercomparison experiments held over the last several years to establish nutrient standards for marine science. The INSS organizers included Michio Aoyama, Andrew Dickson, David Hydes, Akihiko Murata, Jae Oh, Patrick Roose, and Malcolm Woodward.

The meeting brought together 37 participants from 11 countries to update the manual of nutrient analyses by the INSS group, review the usage of nutrient data and carbonate system data in oceanography, summarize the 2008 reference materials intercomparison experiments, plan for a short-term stability experiment in 2009-2011, and to hear reports on reference materials development from several groups. A workshop report is in preparation.

The group is also finalizing its “Recommendations for the determination of nutrients in seawater to high levels of precision and inter-comparability using Continuous Flow Analysers” as a contribution to the GO-SHIP project to revise the WOCE Hydrographic Program manual.

To carry out the INSS work outlined, including the development of a review of the status of QC techniques for ocean biogeochemistry measurements, the organizers submitted a proposal for the establishment of a joint ICES-IOC working group. This proposal was approved by the 25<sup>th</sup> IOC Assembly in June 2009.

### **3.5 CARINA**

CARINA was formed as an informal, unfunded project in 1999, organized by Ludger Mintrop and Douglas Wallace in Kiel. The result was the assembly of a large collection of previously unavailable carbon data. During the last couple of years, the CARINA data base has grown significantly, and four meetings have addressed data quality control and synthesis issues (Laugarvatn, Iceland, in 2006, Kiel, Germany in March 2007, and Delmenhorst, Germany in November 2007). CARINA held its final meeting at UNESCO in Paris from 18-19 June 2009. During an intense two day meeting, 24 scientists from Europe and the US met to agree on a set of 2<sup>nd</sup> level (i.e. consistency control) adjustments of the CARINA data. The workshop was co-sponsored by the EU Integrated Project CARBOOCEAN – Marine Sources and Sinks Assessment, and the International Ocean Carbon Coordination Project (IOCCP). In early 2009, the 1<sup>st</sup> and 2<sup>nd</sup> level quality control of the data was finalized.

Identified data biases were subjectively compared to predetermined accuracy limits, and special consideration is given to the fact that some of the regions studied are known to have experienced real change over the time period covered by the various cruises (1982-2007). Experience with the previous GLODAP synthesis project has shown that it is essential that the results obtained by the different methods of quality control can be compared and systematically assessed. In this way, a consistent data product can be produced containing data from many different cruises by many different laboratories in very different regions of the world oceans. We have gone to great lengths to document our efforts in CARINA, and the user should be able to find information about and justifications for adjustments to the data in the documentation. This effort of secondary quality control is a key step towards reaching the goals of CARINA and CarboOcean.

During the Paris workshop, the three CARINA research groups (Arctic, Atlantic & Southern Ocean) completed secondary quality control of the CARINA data set. Parameters considered include salinity, oxygen, nitrate, phosphate, silicate, alkalinity, total inorganic carbon, pH, CFC-11, CFC-12 and CFC-113. The nature of the QC procedure is such that various data recording errors are also identified. The extraordinary amount of work completed at the meeting was possible largely because of the internet based software developed specifically for this task and both the automated and manual methods developed for the required data comparisons.

#### Status

The CARINA collection now includes data and metadata from 188 cruises. Approximately 80% of the cruise data included in CARINA has not been previously available to the community. The majority of the cruises were contributed by European CARBOOCEAN participants; however, valuable additional data is included from the U.S. CLIVAR, WOCE and NOAA programs, Japan, Canada, Australia and Russia. Attribution to the various contributors is made via a Cruise Summary table that is available now at: [http://cdiac.ornl.gov/oceans/CARINA/Carina\\_table.html](http://cdiac.ornl.gov/oceans/CARINA/Carina_table.html) along with the data sets and in the individual cruise metadata. The value of the Cruise Summary table is enhanced by extensive reference to publications that have already used the various data sets.

The CARINA data base consist of the individual cruise data files, with short meta-data in the file header of the exchange format files, as well as 3 merged data products (one for each region: Arctic Mediterranean Seas, North Atlantic, Southern Ocean). The merged data files contain data adjusted accordingly to the results of the 2nd level QC. Additionally the merged data files contain interpolated missing data and calculated carbon parameters, if possible.

The CARINA data are publicly available at CDIAAC ([http://cdiac.ornl.gov/oceans/CARINA/Carina\\_inv.html](http://cdiac.ornl.gov/oceans/CARINA/Carina_inv.html)). In addition, a special issue in Earth System Science Data (ESSD, <http://www.earth-system-science-data.net/index.html>) in detail describing the CARINA data product and the secondary quality control is being prepared. As of today (August 25); 9 out of planned 20 publications are available on the

ESSD discussion forum. A few more are submitted and will be available within shortly, the resulting articles will be submitted during early fall / late summer of 2009.

#### Discussion and Action Items

Masao Ishii is leading an effort to synthesize and perform 2<sup>nd</sup> level QC on carbon data from the Pacific Ocean. This effort is coordinated through the PICES Carbon and Climate section with assistance from the IOCCP. To date nearly 200 cruises that were not part of the GLODAP synthesis have been compiled. A meeting of the PICES synthesis group is planned for October 23-24, 2009 in Jeju, South Korea. The IOCCP is working with the CARINA and PICES groups to ensure that the PICES effort takes advantage of the lessons learned from CARINA and that the final data sets are compatible so that all the data sets can be combined into a new global data set. It was suggested that the IOCCP co-sponsor a workshop in early 2010 for this purpose.

#### **Action Item 10**

Announce the release of the CARINA data base to the public. (*Responsible: Tedesco will publish an announcement in the IOCCP newsletter. Timeframe: Immediate. Financial Implications: None*).

#### **Action Item 11**

Work with PICES group to make sure the Pacific synthesis takes advantage of the recently completed CARINA effort and generates a data set that is compatible with the existing GLODAP and CARINA synthesis products. (*Responsible: Sabine. Timeframe: Ongoing. Financial Implications: None*)

#### **Action Item 12**

A Pacific synthesis meeting will be co-sponsored by IOCCP and held in early 2010. (*Responsible: Ishii. Timeframe: Immediate. Financial Implication: High*)

### **3.6 Methods Handbook**

The guide was originally prepared at the request, and with the active participation, of a science team formed by the U.S. Department of Energy (DOE) to carry out the first global survey of carbon dioxide in the oceans (DOE, 1994. Handbook of methods for the analysis of the various parameters of the carbon dioxide system in sea water; version 2, A.G. Dickson and C. Goyet, Eds. ORNL/CDIAC-74).

#### Status

The manual has been updated several times since, and the current version contains the most up-to-date information available on the chemistry of CO<sub>2</sub> in sea water and the methodology of determining carbon system parameters. This revision has been made possible by the generous support of the North Pacific Marine Science Organization (PICES), the Scientific Committee on Ocean Research (SCOR), the Intergovernmental Oceanographic Committee/UNESCO (IOC), and DOE through the Carbon Dioxide

Information and Analysis Center (CDIAC). Any errors in the text or corrections that arise as the methods evolve can be reported to Alex Kozyr at CDIAC (kozyra@ornl.gov).

The Guide to Best Practices for ocean CO<sub>2</sub> measurements. PICES Special Publication 3, 191 pp. is now available online from CDIAC:  
[http://cdiac.ornl.gov/oceans/Handbook\\_2007.html](http://cdiac.ornl.gov/oceans/Handbook_2007.html)

One thousand copies of the guide were printed and approximately half have already been distributed. To order hard copies please contact:

North and South America (except Canada) and Europe - Alex Kozyr at CDIAC

(kozyra@ornl.gov)

Canada - James Christian at Fisheries and Oceans Canada

(jim.christian@ec.gc.ca)

China - Prof. Liqi Chen at Third Institute of Oceanography, SOA

(lchen203@263.net)

Japan - Toru Suzuki at Marine Information Research Center (MIRC)

(suzuki@mirc.jha.jp)

Korea - Prof. Kitack Lee at Pohang University of Science and Technology

(ktl@postech.ac.kr)

Russia - Pavel Tishchenko at V.I. Il'ichev Pacific Oceanological Institute

(tpavel@poi.dvo.ru)

Alex Kozyr also noted that SPO-7 “Determinations of dissolved organic carbon and total dissolved nitrogen in seawater” has been translated into Spanish and we welcome others that may want to translate the chapters into other languages to share them with the community through the CDIAC Web-site.

### **3.7 Ocean Carbon Sensor Directory**

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

In addition to the manuscript for oceanic carbon measurements, an internet-based directory of sensors and instruments has been developed by the IOCCP. The first version site can be viewed at: [www.ioccp.org](http://www.ioccp.org) >Sensors. The development of this directory stimulated great interest by the workshop participants, as it provides an overview of available technologies of interest to scientist aiming to start oceanic carbon measurements and to developers aiming to improve on technologies utilized. The issue of Technology Readiness Levels (TRLs, see e.g.

[http://en.wikipedia.org/wiki/Technology\\_Readiness\\_Level](http://en.wikipedia.org/wiki/Technology_Readiness_Level)), was also discussed. TRLs have been adapted for marine research, where the aim is to provide documentation (publications, cruise reports, laboratory reports, project reports, etc.) that describes the level of development for each sensor / instrument.

#### Discussion and Action Items

The IOCCP should continue to develop this directory and actively seek input and suggestions from the ocean carbon community. Web statistics show that this is the 2<sup>nd</sup> most often viewed page on the IOCCP site, with approximately 300 visits after the site was published, down to an average of 45 visits per month thereafter.

#### **4. Project Office Budget**

As of January 2008, the IOCCP director position is funded through a grant from NSF directly to UNESCO. This grant provides funds for a full time director and a part-time consultant to staff the IOCCP. This is a 3 year continuing grant with an end date of 31 December 2010.

Program support for the IOCCP is provided by NSF through a grant to SCOR. A new continuing grant was just approved beginning 1 October 2009 and provides \$40,000 per year to the program. The IOC also provides funding from its regular budget for the IOCCP project office and for ocean acidification activities. This money is received at the start of each year.

Given this level of available funding for 2009, it is proposed that Action Items be assigned a financial implication level based on “low” (<\$5,000), “medium” (<\$15,000), and “high” (>\$15,000).

#### **IV. Action Item List**

##### **Action Item 1**

SOCAT 2<sup>nd</sup> level QC recommended approaches will be developed (*Responsible: Olsen and Bakker. Timeframe: Immediate. Financial implications: None*)

##### **Action Item 2**

The IOCCP SSG recognized there is a lot of work involved in correcting the 1<sup>st</sup> level QC issues and addressing the 2<sup>nd</sup> level QC findings. The IOCCP will discuss with Pfeil and Olsen how best to assist with this workload. (*Responsible: Tedesco will work with IOC to determine if a contractor can be hired. Pfeil and Olsen will identify possible candidates. Timeframe: Immediate. Financial implications: Medium/High*).

##### **Action Item 3**

SOCAT Regional Meetings to be held in 2010, as needed. (*Responsible: Regional group chairs. Timeframe: Throughout 2010. Financial Implications: Medium*)

**Action Item 4**

Completion of the hydrographic methods manual. (*Responsible: Hood will continue to follow up with authors. Timeframe: Ongoing. Financial Implications: None*)

**Action Item 5**

GO-SHIP side meeting will be held during the Ocean Sciences Meeting in Portland, OR in early 2010 (*Responsible: Hood, Tanhua, and Fukasawa will develop the agenda, invite speakers, and reserve the meeting space. Timeframe: Immediate. Financial Implications: Low*)

**Action Item 6**

Contact Joellen Russell and Andrew Lenton to get an update on the status of the surface CO<sub>2</sub> network design. (*Responsible: Monteiro and Metzl will contact Russell and Lenton. Timeframe: early 2010. Financial Implications: None*)

**Action Item 7**

Recommendations based on the intercomparison experiment to be posted on the IOCCP website. (*Responsible: Nojiri will write up recommendations. Tedesco will post on the Web-site. Timeframe: By the end of 2009. Financial Implications: None*).

**Action Item 8**

Provide information and feedback as requested to assist the SOLAS/IMBER sub-groups as they prepare their terms of reference. (*Responsible: Urban, Metzl, Gruber, Sabine. Time frame: Ongoing. Financial Implications: None*)

**Action Item 9**

Assist SOLAS/IMBER sub-groups in planning for the Surface and Interior Ocean meeting to be held at UNESCO in early 2011. (*Responsible: Gruber and Metzl will organize meeting. Tedesco will reserve space at UNESCO for 100 people. Timeframe: Begin organizing in early 2010. Financial Implications: None*)

**Action Item 10**

Announce the release of the CARINA data base to the public. (*Responsible: Tedesco will publish an announcement in the IOCCP newsletter. Timeframe: Immediate. Financial Implications: None*).

**Action Item 11**

Work with PICES group to make sure the Pacific synthesis takes advantage of the recently completed CARINA effort and generates a data set that is compatible with the existing GLODAP and CARINA synthesis products. (*Responsible: Sabine. Timeframe: Ongoing. Financial Implications: None*)

**Action Item 12**

A Pacific synthesis meeting will be co-sponsored by IOCCP and held in early 2010. (*Responsible: Ishii. Timeframe: Immediate. Financial Implication: High*)

## APPENDIX I

### **EU Partner Programs**

The IOC has agreed to be a no-cost partner in 2 EU framework 7 projects dealing with ocean carbon and ocean acidification. These activities are carried out through the IOCCP. The EU scientists developing these projects have requested IOC partnership in order to assist with coordinating their activities with similar activities carried out by non-EU partners. IOC contributions to these EU projects do not represent new activities, but rather are activities already programmed for the IOCCP that involve EU scientists in technical coordination activities these areas.

### European Project on Ocean Acidification (EPOCA)

#### Background

The EU FP7 Integrated Project EPOCA (European Project on Ocean Acidification) was launched in June 2008 for 4 years. The overall goal is to advance our understanding of the biological, ecological, biogeochemical, and societal implications of ocean acidification. EPOCA aims to document the changes in ocean chemistry and biogeography across space and time; determine the sensitivity of marine organisms, communities and ecosystems to ocean acidification; integrate results on the impact of ocean acidification on marine ecosystems in biogeochemical, sediment, and coupled ocean-climate models to better understand and predict the responses of the Earth system to ocean acidification; and assess uncertainties, risks and thresholds ("tipping points") related to ocean acidification at scales ranging from subcellular to ecosystem and local to global.

The EPOCA consortium brings together more than 100 researchers from 27 institutes and 9 European countries (Belgium, France, Germany, Iceland, The Netherlands, Norway, Sweden, Switzerland, United Kingdom).

#### Status

The IOCCP is a no-cost partner in EPOCA to facilitate links between EPOCA activities and non-EU projects and scientists. The IOCCP has specifically committed to 2 activities: providing support for a training program "Fundamentals of Marine Carbon Biogeochemistry" under the leadership of Richard Bellerby (Univ. Bergen, Norway), and co-sponsoring a workshop to reach agreements on best practices for ocean acidification research and data reporting.

### **Ocean Acidification Best Practices Meeting**

The European Project on Ocean Acidification, the IOCCP, the US Ocean Carbon and Biogeochemistry Program, and the Kiel Excellence Cluster the "Future Ocean" are co-

sponsored a workshop to develop a guide of best practices and data reporting for ocean acidification research. The workshop was held from 19-21 November 2008 at the Leibniz Institute of Marine Sciences (IFM-GEOMAR) in Kiel, and brought together approximately 40 scientists from the EU, US, Japan, Korea, China and Australia. Sessions included carbonate chemistry, experimental design of perturbation experiments, measurements of CO<sub>2</sub>-sensitive processes, and data reporting and usage. Break-out and writing groups focused on 3 major issues: Carbonate system measurements, manipulations and experimental CO<sub>2</sub> / Ω levels; Measurement of calcification processes, data normalization, reporting and archiving; and Measurement of CO<sub>2</sub>-sensitive processes (other than calcification), data normalization, reporting and archiving.

The workshop will produce several short technical reports on perturbation and calcification experiments, as well as a Guide to Best Practices for Ocean Acidification Research and Data Reporting. It is anticipated that the draft guide will be made available on-line for an open 3 month community review period before publication.

**For more information:** visit the EPOCA web-site at: <http://epoca-project.eu/>

### **The Fundamentals of Carbon Biogeochemistry: A Training Workshop**

A training workshop, sponsored by the EU projects EPOCA and CARBOOCEAN, and the IOCCP, was held at the Bjerknes Centre for Climate Research, University of Bergen, Norway from February 24-26 2009 for Ph.D. students and early-stage post-docs. The workshop brought together 52 Ph.D. students and early-stage post-docs to review the PICES-IOCCP “Guide of Best Practices for Oceanic CO<sub>2</sub> Measurement and Data Reporting” (A. Dickson, C. Sabine, and J. Christian, 2008) and hear lectures on:

- The marine carbon cycle - past, present, and future
- pH scales and dissociation constants
- Instrumentation for measurement of the marine CO<sub>2</sub> system
- Ecosystem carbon biogeochemistry – sensitivity and feedbacks to ocean acidification
- Data transfer and communication of results, and
- CO<sub>2</sub> system calculations.

Lecturers included Richard Bellerby (Chair), Toby Tyrell, Ingunn Skjelvan, Jim Orr, Bjorn Rost, Markus Weinbauer, Fred Gazeau, Anne-Marin Nisumaa, and Mike DeGrandpre. The meeting also includes 2 substantial poster sessions for students to present their own research. The IOCCP will provide financial support for 3 instructors and provide guidance on the agenda and workshop plans.

### Coordination Action Carbon Observing System (COCOS)

#### Background

The EU project “Coordinated Action Carbon Observing System” (or COCOS), coordinated by Han Dolman at Vrije Universiteit, Amsterdam, aims to develop common methodologies, standards, data management systems and protocols to increase the cost-

efficiency of European (and global) carbon observations by avoiding duplication and facilitating data sharing. This will be achieved by working towards a coordinated system of integrated global carbon cycle observations, encompassing the ocean, the land and the atmosphere, and including in situ as well as, to a lesser extent, remotely-sensed observations. It will improve the interoperability of existing and new datasets.

Interoperability is defined ([www.ieee.org](http://www.ieee.org)) as “the ability of two or more systems or components to exchange information and to use the information that has been exchanged”; hence the coordination action is organized around two main lines: (1) improving the exchange of datasets between projects, and (2) facilitating the use datasets between different continental and basin scale projects and programs. The coordination activities of COCOS will contribute to an effective monitoring of the carbon cycle at the global level as recommended by GEO and GCOS in supporting the European participation to an international CO<sub>2</sub> research monitoring project. The research and harmonization work developed in this proposal will contribute significantly to building an integrated global approach that promotes close collaboration with the international carbon cycle research community. This work builds on the Integrated Global Carbon Observing strategy developed by the IGOS Partners.

This project will specifically bring together the ocean and land components of carbon research to make sure that we “speak the same language” and that our data are in an interoperable format. For the ocean carbon community, the results from COCOS may affect the way we report carbon data and the way it is stored, including meta-data. It will also provide important links between the ocean and land communities in carbon research. The IOCCP is a partner in the COCOS project to facilitate broad input from the ocean carbon community and to coordinate these activities with non-EU initiatives. There are no specific commitments at this time.

COCOS will assess the status of harmonization of key carbon cycle variables with international partners. It will improve the interoperability of data sets that are used in global scale carbon cycle studies through joint activities between ecosystem, atmospheric and ocean bottom-up and top down observation communities. COCOS will also perform integrated regional-scale multiple constraint assessments of the land and ocean carbon balance through the use of harmonized data sets. It will identify, narrow down uncertainties and decrease differences in emerging global data sets that are aimed at providing constraints on the vulnerability of the global carbon cycle. COCOS will thus contribute to the implementation and improvement of global observing systems. These activities are consistent with IOCCP’s Terms of Reference and contributions listed below are activities planned by the IOCCP scientific steering group for 2008 – 2010.

#### Status

IOC’s role:

Work Package 1: Enhancing interoperability of existing networks in land and ocean

*Task 1.1.* We will first define what carbon cycle variables will be considered: An actual updated list of essential carbon variables will be provided starting from the existing list in the IGCO documents and updated implementation plans (Table 1.3.2.b). (All partners)

*Task 1.2.* The data sources of the various networks and their quality check procedures will be assessed against common standards. Concrete steps towards a standardization of the reporting of data quality and accuracy will be defined. In case the quality assessment is not satisfactory, standardized corrections will be suggested to obtain data quality of a previously specified level or characteristic. (All partners)

*Task 1.3.* Binding formats for data reporting and exchange (physical units, errors, meta-information, digital data format, originators/users, access rights) will need to be agreed on and must become the standard approach for all networks. (All partners)

*Task 1.4.* Access rights to the data have to be agreed on through common data policies. Of particular importance is the timely publication of data. Intellectual Property Rights regulations have to be found which solve present data publication delays. We will propose an open data policy, in particular for the EU projects, in line with common international practice. (All partners)

- IOCCP Activities that contribute to these: IOCCP's regular review and update of essential climate variables for OOPC and GCOS, also used by IGCO; ongoing data qc, synthesis and data format and reporting activities, including the global surface ocean data set publication and the surface ocean CO<sub>2</sub> atlas (SOCAT) project; IOC work on international data policy.

Work Package 5. Filling in gaps in data of vulnerable global carbon pools and fluxes in the ocean.

*Task 5.1.* An inverse modeling approach combining SeaWiFs and MODIS products, in-situ production data, trap data, and large data sets on DIC, dissolved nutrients and O<sub>2</sub> (both from the subsurface and surface ocean) will be pursued (AWI), in order to achieve a more consistent view of biological carbon fluxes relevant to controls on atmospheric pCO<sub>2</sub>. We will improve linkages between the various groups involved in satellite ocean color data products, sediment trap data and collection and the collection and interpretation of ocean DIC, nutrient and O<sub>2</sub> data (UiB, IfM-GEOMAR, UEA and IOC-UNESCO). We will work on revised estimates of gross carbon export fluxes through application of inverse methods to the above mentioned data sets (AWI).

*Task 5.2.* Ocean carbon data (DIC, pCO<sub>2</sub>, anthropogenic carbon C<sub>ant</sub>) will be co-located with observations of ocean circulation and hydrography (T, S, indicators of meridional overturning strength, ocean volume transport data products) in order to enable a systematical evaluation of perturbations in the real world through integrative modeling (UiB). Evidence for synchronous changes in source/sink variations for anthropogenic carbon with ocean circulation variations will be summarized (UiB, UEA, IfM-GEOMAR). Recommendations for efficient linkages between data sets on ocean

circulation and carbon cycling will be given. (UiB, UEA, IfM-GEOMAR, AWI, and IOC-UNESCO)

- IOCCP Activities contributing to these: global surface ocean CO<sub>2</sub> data set publication and initiation of the SOCAT project to provide global data for the modeling approach. The IOCCP Global Oceanographic Ship-based Hydrographic Investigations Panel (GO\_SHIP) will begin developing joint physical and carbon hydrographic data bases and data management systems to assist with task 5.2.

Work Package 6. The European contribution to a global observing system for Carbon  
*Task 6.2.* The synthesis activities in the other work packages will be linked to the political processes under GEO and UNFCCC, by participation at meetings, presentations at GEOSS plenary sessions and UN Framework Convention on Climate Change (UNFCCC)-COPs, as well as via written contributions to updates of the GEO work plan. VUA and UiB will seek the endorsement of the project by the global observing systems (GEO, GCOS, GTOS, GOOS, see also Appendix 1). MPI-BGC will present the project and intermediate results at UNFCCC-COPs and to European policy makers.

*Task 6.3* .Through the involvement of GCOS and GTOS partners in COCOS and direct links with the GEO secretariat and the Commission, we will seek approval for our workshops and meetings to be recognized as European contributions to GEO. This will also be achieved by providing a regular annual update of the IGCO 2005 implementation plan (<http://ioc.unesco.org/ioccp/Newsletters/newsMay2004.htm#Article3>) to the GEO/GEOSS secretariat. We will supply the GEO secretariat on request updates of our work, and ensure that our results are known by the GEO partners, by inviting them to our meetings and workshops.

IOCCP Activities contributing to these: use of IOCCP's linkages with GOOS and GCOS to assist with GEO and UNFCCC; assisting COCOS in coordinating its EU contribution with those of other nations through IOCCP's networks.