

IOCCP Progress Report

(May 2006)

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I. Introduction

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

II. IOCCP Project Office Update

IOCCP hires new project coordinator - Following the July 2005 agreements to transition the IOCCP from a pilot project to a standing project of SCOR and IOC with a broader mandate, NSF has funded a second project coordinator to work at the IOCCP office. Roger Dargaville was chosen for the post from a pool of 40 candidates, and started work at the IOCCP project office at UNESCO-IOC in January 2006. Roger hails from Australia, and his expertise lies in the modelling of atmospheric transport of CO₂, and deducing CO₂ fluxes (both oceanic and terrestrial) by inverse methods. He has also studied physical chemistry and physical oceanography. Many years ago Roger assisted Bronte Tilbrook on two WOCE Southern Ocean cruises aboard the Aurora Australis, and worked as a post-doc with Scott Doney at NCAR before moving to France 3 years ago. During the past 12

months, he worked with Philippe Ciais and Berrien Moore as the coordinator of the Carbon theme of the Integrated Global Observing Strategy (IGOS), where the CO₂ Panel (and in the later stages, the IOCCP) provided the bulk of the input on ocean carbon observations.

Roger has rapidly taken on many project responsibilities, including activities of Repeat Hydrography, Surface CO₂, Time Series, Friends of Oxygen, the IOCCP-GCP virtual conference, web design and maintenance, and writing the quarterly news bulletins. He is also continuing some work with the IGOS Carbon Theme, as well as several IOCCP liaison activities with other groups such as OOPC and CLIVAR. Maria Hood will continue to oversee IOCCP activities in GlobColour, data set development and citations, developing a sensor catalog, and trying to deal with “lingering issues” of coastal ocean observations and coordination services for process studies; and of course, helping Roger. Maria is also spending increasing amounts of time on the ocean acidification issue, working on the development of a follow-up symposium to “The Ocean in a High CO₂ World”, and working within the UN system to investigate possibilities for funding for ocean acidification research and enhancing the visibility of this issue with the general public.

IOCCP Web Updates - Roger has renovated the Ocean Carbon Directory to better reflect the new range of activities of the IOCCP and to provide more introductory information about each activity. We strongly encourage everyone to review the site (www.ioccp.org) and provide us your comments. For the hydrography and underway pCO₂ system pages, we have established a collaboration with the CDIAC Ocean CO₂ Program (Alex Kozyr) to make a coordinated set of maps served from the CDIAC site that provide both the current and future plans (“IOCCP maps”) as well as past sites with publicly available data, directly linked to metadata and data pages (“CDIAC maps”). This has eliminated much duplication of effort as well as difficulties with having different map versions and displays between the two sites. We plan to use the same map system for the time series sites in the very near future.

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

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

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

Major activities for this period include:

- The International Ocean Carbon Research Program Stakeholders' Meeting (Paris, December 2004)
- The International Ocean Carbon Open House and First IOCCP SSG Meeting (Boulder, September / October 2005)
- The International Repeat Hydrography and Carbon Workshop (Shonan Village, Japan, November 2005)
- Carbon representatives to planning meetings (JCOMM SOT, OOPC, CLIVAR Basin Panels)
- The North Atlantic Carbon Synthesis Workshop and Friends of Oxygen on Argo Writing Team meeting (Iceland, June 2006)
- IOCCP representatives to the SIBER Indian Ocean Biogeochemistry Meeting (Goa, October 2006)

III. Observing Programs

A. Hydrography Update

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

What emerged was the need for a more coordinated ship-based hydrography program that focuses not only on monitoring decadal changes but also is capable of addressing new research issues, and to set up a system of regular data synthesis and interpretation activities that are driven by science questions. The participants recognized that any synthesis mechanism that will be developed for the future must address new realities of working within the framework of a sustained observation program. Working within a program with no sunset clause, for example, will require the regular production of scientific products on a timescale that is much shorter than the traditional 10-year approach carried out through global research programs. A sustained repeat hydrography program will need to continually justify its value through publications and data products, and a mechanism for science-driven data syntheses must be developed to address these needs. Participants outlined action items to develop a small advisory group to provide guidance on the development of a more coordinated ship-based hydrography program; to establish closer links with Argo and other ocean-interior observing programs; to improve data and information coordination of

existing systems; and to establish synthesis activities around science questions, beginning with the North Atlantic.

- Responds to SSG 1/Action item 7: Implementation of the International Repeat Hydrography Meeting, November 14-16, Shonan Village, Japan.
- Further Reading: International Repeat Hydrography and Carbon Workshop Report.

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

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

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

Some of the tasks that need immediate attention include:

- i. the development of a single-site, comprehensive information and data center for all ship-based hydrography (encompassing more than just the official CLIVAR cruises, and combining / coordinating the information, data services, and “community bulletin board” outreach and communication services currently provided by CCHDO, NODC-A, CDIAC, IOCCP, and CLIVAR IPO);
- ii. providing input to the “Friends of Oxygen on Argo” activities;
- iii. providing input to the North Atlantic synthesis, with its first meeting of carbon scientists scheduled for late June 2006, and (d) making plans to update the hydrographic program manual as needed.

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

- Responds to SSG 1 / Action Item 8: Based on outcomes of the November hydrography meeting, the IOCCP will begin investigating the interest and feasibility of establishing a sustained international project office for repeat hydrography in collaboration with the S.I.C.,

CLIVAR, and the GCOS-GOOS-WCRP Ocean Observations Panel for Climate. Continue supporting carbon representatives to CLIVAR basin panels for 1 more year.

- Responds to SSG 1 / Action Item 21: After the November workshop, discuss with CDIAC the needs for more or additional types of information and data links for hydrography and other platforms

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

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

Friends of Oxygen on Argo

Following the IRHC Workshop, a small group (the "Friends of Oxygen on Argo", FOA) was established to develop plans and proposals for a large-scale extension of the current small-scale deployments of Argo floats instrumented with O₂ sensors. It was agreed that the IOCCP should facilitate the work of this group.

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

B. Underway / Surface pCO₂ Update

The IOCCP and the S.I.C. Group are developing plans for an international workshop on Surface CO₂. The workshop will be held at UNESCO in Paris from April 11-13, 2007. These dates were chosen to correspond with the EGU general assembly in Vienna the following week. An organizing committee has been formed, consisting of:

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

The overall goals are to:

- Review the current knowledge base of the magnitude, variability and processes governing ocean sources and sinks of carbon: from observations, process based models and atmospheric and oceanic inversions
- Review the current network of underway pCO₂ and future plans, and the current understanding of network design for underway pCO₂ measurements
- Develop firm plans for an internationally distributed network
- Develop firm plans for an internationally supported data synthesis effort

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

Associated with this activity, a working group on the feasibility of installing high precision continuous atmospheric sensors on VOS in conjunction with the underway pCO₂ system has been established. Working with Britt Stephens, Roger Dargaville (IOCCP) has assembled a group of experts on the technical aspects of taking high precision measurements of atmospheric CO₂ and modellers with expertise in the field of interpreting such data. The group comprises Peter Rayner (LSCE), Rachel Law (CSIRO), Britt Stephens (NCAR), Andy Watt (NCAR), Bronte Tilbrook (CSIRO), Marcel van der Schoot (CSIRO), David Baker (NCAR), Rik Wannikhof (NOAA) and Frederic Chevallier (LSCE). Email discussions have produced a short report on the current status of the measurement technology and the options for modelling studies to assimilate and interpret the data. Options for instruments currently include the CSIRO LoFlo and the NCAR AIRCOA instruments. Each has various accuracy and cost benefits – the modelling groups (NCAR and LSCE) will plan and run synthetic data experiments to estimate to optimal network of onboard and land based continuous instruments and flask samples, with a focus on the Southern Ocean, reporting the results at the surface pCO₂ meeting in April 2007 in Paris.

- Responds to SSG 1 / Action Item 2: Both the SSG and the S.I.C. recognize the importance of having joint meetings, and agreed to try to co-locate / co-host the meetings of these two groups whenever possible.
- Responds to SSG 1 / Action Item 5: The S.I.C. Working Group on the Surface Ocean will take the lead on determining how best to establish a closer link to the atmospheric CO₂ community for measurements from underway ships.
- Responds to SSG 1 / Action Item 9: Begin plans for an international workshop on developing the scientific basis for VOS Network Design and Data Synthesis efforts, joint with the S.I.C. group.
- Responds to SSG 1 / Action Item 10: Establish a partnership with the JCOMM SOT and work with this group to develop an informational document on how the carbon community can use this group for on-going and future negotiations with shipping companies. [Note: JCOMM SOT has been contacted and will develop a short informational brochure to describe their services for assisting scientists in setting up observing systems on commercial ships. This may be introduced as an informational item at the workshop.]
- Responds to SSG 1 / Action Item 11: Continue developing the draft document, Underway pCO₂ Systems, with a goal of developing a generic document describing underway pCO₂ systems and ship requirements for use with the JCOMM SOT group. [This action may be folded into follow-up activities of this workshop with the same goal.]
- Responds to SSG 1 / Action Item 17: Continue work on getting surface pCO₂ data holdings at CDIAC into a common format, and encouraging the public release of existing datasets to CDIAC for incorporation in the dataset. (Note: CarboOcean's Benjamin Pfeil reports that this dataset should be completed and publicly available by mid-2006).
- Further Reading: http://ioc.unesco.org/ioccp/pco2_2007.htm

C. Time Series Stations Update

Based on the compilation developed by Nick Bates for SSG 1 and subsequent inputs from the community, a table of currently active time series stations measuring ocean carbon has been developed and put on the web. The table provides information on ship-based stations, permanent moorings, and coastal moorings. This information will be used to develop a map in partnership with CDIAC. 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. Discussions are underway with OceanSITES to determine how best to harmonize these projections.

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

D. Ocean Colour Update

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

The European Space Agency (ESA) has launched a project called GlobColour, which aims to develop and demonstrate a service supporting global ocean carbon-cycle research. An understanding of the cycling of carbon by the ocean biosphere is critical for developing scientifically based response to the sequestration of anthropogenic carbon emissions. ESA has one mission aboard ENVISAT: the Medium Resolution Imaging Spectrometer Instrument (MERIS), NASA has three missions in orbit to assess ocean biological processes by measuring the colour of the sea, the Sea-viewing Wide Field of view Sensor (SeaWiFS) and two flight models of the Moderate Imaging Spectrometer (MODIS) on the Terra and Aqua Earth Observing System (EOS) missions and CNES has now launched a new POLDER on board Parasol. In the coming years, the VIIRS, on the NPOESS Preparatory Project (NPP) will be deployed while ESA will deploy the Sentinel GMES-1 mission. In addition to ESA and NASA, several international space agencies have planned and deployed satellite ocean colour missions. As of today, there are 12 moderate resolution ocean colour imagers in orbit (www.ioccg.org/sensors/500m.html) 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 CO₂) influence the ocean biosphere and can these changes be detected? It seems obvious that better ocean colour data products will come from the merging of different data sets:

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

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

The project will provide scientists with a long time-series of consistently calibrated global ocean colour information, according to requirements specified by the global ocean colour user community, as represented by the user group. GLOBCOLOUR will also put in place the capacity to continue the ocean colour service in the future. The IOCCP, working with the International Ocean-Colour Coordinating Group, will serve as links between the ocean carbon community and this project, to provide input into the development of the data products to ensure they are useful for the ocean carbon community.

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

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

E. Ocean Climate System Update

Ocean Observations Panel for Climate - The IOCCP provides advice on ocean carbon observations to the OOPC for use in development of the Global Climate Observing System implementation plan in support of the UNFCCC. In addition, the IOCCP and OOPC have a number of common interests and possibilities for collaborations. Roger Dargaville will be attending the 12th Session of the OOPC in Tokyo from May 17-20, and will discuss, *inter alia*:

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

You can find information on all these issues in this report.

Joint IOC-WMO Technical Commission on Oceanography and Marine Meteorology (JCOMM) Observations Coordination Group Review – The IOCCP is considered a “dotted line” program of JCOMM, meaning that we provide input on ocean carbon observations, but are not officially part of the operational system. The IOCCP has two main interactions with JCOMM – sending representatives to the Ship Observations Team (JCOMM SOT) to discuss underway CO₂ systems and lines, to ensure compatibility and information exchange with other underway programs; and sending representatives to the JCOMM system overview meetings, held jointly with the NOAA Office of Climate Observation annual system review. From May 9-12, Maria Hood will attend a JCOMM Operational Center System review, and Roger Dargaville and Chris Sabine will attend the Climate Observing System review. Chris will provide a 20 minute overview on ocean carbon observations.

The Carbon Office of the IGOS Partners

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

The IOCCP (and as it's predecessor, the CO₂ panel) has strong links to the Carbon theme of IGOS-P, having provided the bulk of the input on the strategy for global carbon observations in the ocean for the theme report which was published in 2004. In 2005 the Implementation Plan for the theme was compiled, again with the bulk of the input coming from the IOCCP. The next step in the theme's progress is to oversee the coordination of the Implementation Plan, and to do so will require an official office to be established. With the Carbon theme coordinator (Roger Dargaville, providing oceanography and atmospheric expertise) now at the IOCCP, and the potential for strong links between UNESCO/IOC and other IGOS partners such as FAO, it appears that UNESCO is the ideal IGOS partner to host the Carbon Theme Office. FAO has indicated willingness to provide expertise in the terrestrial domain, perhaps by sending a terrestrial carbon scientist to work at the carbon office at UNESCO. Thus the office could be established with relatively little expense. A UNSECO proposal will be submitted to IGOS-P plenary in May in Geneva to have the Carbon Theme Office at UNESCO approved.

For the IOCCP, this means the potential to become the “ocean pillar” of the Carbon Office, where coordination services similar to those of the IOCCP would be developed for atmospheric CO₂ and terrestrial carbon observations, and the activities and services of the three domains would come together to contribute to an integrated overview of global carbon observations. In practical terms, little would change for the IOCCP except the eventual development of a common integrated web-site and database portal with the other domains. Benefits might include increased funds and staff to share common technical tasks, the possibility for users of the system to look at either the full carbon observing system or just a zoom into the ocean observing system, and integrated technical coordination activities to move forward the development of fully integrated information and data systems for carbon cycle observations and research. In addition, this broader connection to other domains and

the wider IGOS partnership will provide increased visibility for ocean carbon observations required to address climate research.

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

IV. Standards and Methods

Ocean CO₂ Guide of Best Practices - At the kickoff meeting of the IOCCP in January 2003, the IOCCP set an action item to standardize measurement and data reporting techniques, starting with the publication of an updated Guide of Best Practices for Oceanic CO₂ Measurement and Data Reporting. The update of the Guide had been initiated by the North Pacific Marine Science Organization (PICES) Working Group 17, and the IOCCP co-sponsored this activity. The Guide was originally to be published in mid-2004. As of May 2006, the Guide has not been completed, and the PICES Working Group has disbanded.

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

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

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

V. Data and Products

Digital Object Identifiers for Datasets - In order to encourage rapid data release and appropriate acknowledgement for data contributions, data centers are exploring the options for identifying data sets with Digital Object Identifiers. Nicolas Dittert, WDC-MARE described their system, and the IOCCP has agreed to work with Nicolas and with the WDC

and IODE systems to explore how to make this practice widely used. For more information, please see the “Pilot Projects” section of this report.

WAVES System at CDIAC – The IOCCP has several action items dealing with making datasets at CDIAC available through Live Access Server or a similar visualization and extraction capability. The following “community letter” submitted by Alex Kozyr provides and update on those activities and a request for the community to provide feedback on the system that has been developed. It is anticipated that the surface pCO₂ data holdings at CDIAC will also use this system once the data are compiled in a common format (Benjamin Pfeil of CarboOcean is working on this and anticipates it will be completed by mid-2006).

Dear Carbon Scientists,

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

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

VI. Synthesis Activities

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

The IOCCP is hosting the Friends of Oxygen on Argo working group meeting during this event.

VII. Pilot Projects

Friends of Oxygen on Argo - Following the IRHC Workshop, a small group (the "Friends of Oxygen on Argo", FOA) was established to develop plans and proposals for a large-scale extension of the current small-scale deployments of Argo floats instrumented with O₂ sensors. It was agreed that the IOCCP should facilitate the work of this group. For more information, see the "Pilot Projects" section of this report. Polarographic oxygen sensors have been deployed on Argo floats since at least as early as 2002. Published studies (Körtzinger et al., 2004, 2005) have also demonstrated the feasibility of a new instrument technology, the optode, which takes advantage of dynamic luminescence of luminophores, which fluoresce with a dependence on the O₂ concentration. For example, two prototype oxygen optode instruments were deployed on autonomous floats in the Labrador Sea in September 2003 and data collected over the following year showed very promising results demonstrating the required accuracy and stability (Körtzinger et al., 2004). In fact, several groups have successfully deployed Argo float with both types of O₂-sensors, bringing the total number of O₂ sensors on floats to over 60. The plan is to build on these small pilot projects and scale them up to a large internationally coordinated project for the benefit of the physical and biogeochemical communities alike.

Led by Nicolas Gruber (UCLA), FOA will produce a white paper to present the utility and practicality of adding O₂ sensors to a portion of the Argo array as a pilot project. Issues such as the number of sensors required, interpretation of the resulting data, and technical issues including the sensor design, calibration accuracy and stability, power usage, satellite communication requirements, and additional cost will be addressed. The Argo Chair and Project Coordinator welcome and support this initiative.

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

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

At the meeting, Nicolas Dittert described a system currently being used by WDC-MARE that involves identifying data sets with DOIs (Digital Object Identifiers). The DOI system provides a framework for identification and management of intellectual content across all forms of electronic media (e.g., electronic publications as well as data sets). Once a data set has been given a DOI, it can be referenced in the same manner as a publication in a journal article. Each dataset is linked to a URL where the data are available at the data center, and these URLs are associated with the DOIs. For example, an article would cite and reference the data set in the following way:

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

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

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

- Responds to SSG 1 / Action Item 17: Continue work on getting surface pCO₂ data holdings at CDIAC into a common format, and encouraging the public release of existing datasets to CDIAC for incorporation in the dataset.
- Responds to SSG 1 / Action Item 19: Encourage CDIAC to provide clear instructions on each dataset about how to acknowledge the data contributors. Provide information and instructions in a visible place on the IOCCP web-site.

Virtual Conferencing – through the encouragement of the Global Carbon Project, the IOCCP is investigating methods of virtual conferencing that could be tested through several small pilot-project type workshops or meetings in order to introduce the ocean carbon community to video and/or web-conferencing with the goals of eventually reducing our own CO₂ emissions and travel time, as well as encouraging the participation of more young scientists and a wider range of scientists who may not otherwise attend a conference on ocean carbon. The IOCCP project office at UNESCO will investigate options for both video conferencing and web-based conferencing and rely on the SSG for input and participation in these tests. Stay tuned !

VIII. Sensors

At the first meeting of the S.I.C. group, the group outlined the need for a central information source on sensor / instrument development for carbon and biogeochemical

variables, and decided that this was an appropriate task for the IOCCP to undertake as a service for all the research programs. During the IOCCP SSG meeting, this was discussed further, and the group decided that the web-based inventory of sensors should be developed using a standard template of information that would include information on the sensor's development status, with additional information about the sensor's success and failure rates, and detailed contact information.

In early March, the IOCCP sent out an email to approximately 20 members of the community who work directly with the development of sensors to get their input on this activity. The purpose of this catalogue would be to inform the ocean carbon and biogeochemistry community, observing system developers, and program managers about instruments that are either available commercially, available through a research lab, or are under development. It could also serve as a community bulletin board and forum to highlight the contributions of instrument developers and the exciting possibilities of new devices. The IOCCP proposed that the scope be restricted to instruments that are in situ, autonomous instruments (or quasi-autonomous in the case of underway pCO₂ systems), suitable for open ocean measurements, and have a minimum operational lifetime or deployment time of at least 6 months. Primary interest is for instruments measuring one or more of the following: DIC, pCO₂, Alkalinity, pH, POC, PIC, DOC, O₂, and major nutrients. The IOCCP also developed an initial template of information to collect for the catalogue :

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

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

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

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

IX. Technical Coordination for Research

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

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

I. Arctic

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

II. Antarctic

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

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

X. Summary

Progress against Action Items from SSG-1

1. SSG members thought it would be useful to have a short mission statement prominently placed on the web-site to describe more clearly the IOCCP functions. [*Responsible member: MH. Timeframe: immediate. Cost Implications: 0.*]
Status: Completed. See Section II.
2. Both the SSG and the S.I.C. recognize the importance of having joint meetings, and agreed to try to co-locate / co-host the meetings of these two groups whenever possible. [*Responsible members: Hood, Sabine, Johannessen, Koertzing. Timeframe: 1 year. Cost Implications: 0.*]
Status: Completed / On-going. SSG-2 is tentatively scheduled to meet with SOLAs/IMBER carbon group in April 2007.
3. The IOCCP will assist S.I.C. Working Group on Climate Sensitivities and Feedbacks to develop guidelines and protocols for mesocosm experiments. [*Responsible members: K. Lee, C. Lee, Hood, Riebesell. Timeframe: email discussion group to begin within the month. Cost implications: up to \$10k for 1 meeting + publication.*]
Status: Postponed. See Section IV.
4. The IOCCP will develop an on-line inventory of autonomous sensors available or under development. [*Responsible members: Hood, Sabine, Koertzing. Timeframe: email discussion group to begin within the month. Cost Implications: 0.*]
Status: On-going. Activity is developing via large-scale / large scope collaborations with ORION, OceanSITES, and Eur-Oceans. See Section VIII.
5. The S.I.C. Working Group on the Surface Ocean will take the lead on determining how best to establish a closer link to the atmospheric CO₂ community for measurements from underway ships. [*Responsible members: Britt Stephens and Roger Dargaville. Timeframe: email discussion group to begin within the month. Cost implications: 0.*]
Status: On-going. See Section III.B.
6. The S.I.C. agreed to review the proposal to co-sponsor a meeting on climate-relevant carbon and biogeochemical processes in the Indian Ocean. [*Responsible members: Hood to send proposal to Hare and Roy for follow up. Timeframe: immediate. Cost Implications: 0 for IOCCP.*]
Status: Completed. IOCCP is providing funding to support the participation of Chris Sabine and Tommy Dickey.
7. Implementation of the International Repeat Hydrography Meeting, November 14-16, Shonan Village, Japan. [*Responsible members: Fukasawa, Sabine, Hood, Tilbrook. Timeframe: November 2005, with on-line report of meeting available by early 2006. Cost Implications: \$40-50k.*]
Status: Completed. See Section III.A.

8. Based on outcomes of the November hydrography meeting, the IOCCP will begin investigating the interest and feasibility of establishing a sustained international project office for repeat hydrography in collaboration with the S.I.C., CLIVAR, and the GCOS-GOOS-WCRP Ocean Observations Panel for Climate. Continue supporting carbon representatives to CLIVAR basin panels for 1 more year. [Responsible members: Hood, Sabine. Timeframe: Late 2005 / early 2006 with report to interested groups on feasibility and necessary steps. Cost Implications: \$8k for Basin Panel Rep Travel.]
Status: On-going through development of an Advisory Group. See Section III.A.
9. Begin plans for an international workshop on developing the scientific basis for VOS Network Design and Data Synthesis efforts, joint with the S.I.C. group. [Responsible members: Tilbrook, Sabine (Feeby), Hood, Johannessen, Koertzing. Timeframe: begin email discussion group by the end of the month, with a major effort beginning after November workshop. Cost Implications: \$50k IOCCP.]
Status: On-going. See Section III.B.
10. Establish a partnership with the JCOMM SOT and work with this group to develop an informational document on how the carbon community can use this group for on-going and future negotiations with shipping companies. [Responsible member: Hood, Sabine. Timeframe: begin email discussions by the end of the month. Cost Implications: 0.]
Status: On-going. See Section III.B and III.E.
11. Continue developing the draft document, Underway pCO₂ Systems, with a goal of developing a generic document describing underway pCO₂ systems and ship requirements for use with the JCOMM SOT group. [Responsible members: Tilbrook, Hood, with open community participation. Timeframe: begin circulating a new draft document by end November 2005 and/ or after further discussions with JCOMM SOT to optimise needs for the document. Cost Implications: 0]
Status: Postponed. To be re-addressed as part of Surface pCO₂ Workshop in April 2007. See Section III.B.
12. Moulin will attend the first GlobColour Meeting in early 2006 and report back to the IOCCP on how the carbon community can assist this project. [Cost Implications: \$1.5k.]
Status: Completed / On-going with follow-up meetings.
13. Finalize the inventory of information on current and planned time-series stations with carbon measurements. [Responsible members: Bates, Sabine, Hood. Timeframe: end of the month. Cost Implications: 0.]
Status: Completed. See Section III.C.
14. Determine an initial map / table display for the time-series information, and work with CDIAC to determine need and feasibility to develop a more sophisticated database for all information displays. [Responsible members: Hood, Sabine, Kozyr. Timeframe: initial maps and table to be added to the site by end of 2005; plans for new information display tools should begin soon, with a decision on how to implement a new system by

early 2006. Cost Implications: possibly up to \$10k for database development.]

Status: On-going. See Section III.C.

15. Develop an email discussion list of coastal ocean carbon scientists and modelers to determine what is useful and feasible for information and coordination services for this community. [*Responsible members: Thomas, Sabine, Hood. Timeframe: try to establish a plan and initial inventory by mid-2006. Cost Implications: 0.*]

Status: No actions taken on email discussion. An initial inventory of ocean carbon modeling projects has been put on the web-site. See Section IX.

16. Initiate a discussion with SOLAS, IMBER, and POGO/SCOR about plans for an information database on biogeochemical process studies, cruises, etc. IOCCP should assist, but not take a leading role in this activity. [*Responsible members: Hare, Roy, Urban, Hood. Timeframe: begin email discussions as soon as possible, and provide input to Urban by Dec. 13. Cost Implications: 0.*]

Status: Completed. No immediate actions for IOCCP. IOCCP has taken the lead in developing a compilation of ocean carbon field programs in polar areas. See Section IX.

17. Continue work on getting surface pCO₂ data holdings at CDIAC into a common format, and encouraging the public release of existing datasets to CDIAC for incorporation in the dataset. [*Responsible members: Bakker, Pfeil, Kozyr. Timeframe: open-ended. Cost Implications: 0.*]

Status: On target for mid-2006 release (work undertaken by CarboOcean). No actions for IOCCP.

18. NOAA PMEL will continue its experiments with making CDIAC datasets available via Live Access Server. [*Responsible members: Sabine. Timeframe: open-ended. Cost Implications: 0.*]

Status: Completed through CDIAC WAVES system. See Section V.

19. Encourage CDIAC to provide clear instructions on each dataset about how to acknowledge the data contributors. Provide information and instructions in a visible place on the IOCCP web-site. [*Responsible members: Hood, Sabine, Kozyr. Timeframe: immediately. Cost Implications: 0.*]

Status: Completed through CDIAC WAVES system. See Section V. Also See Section VII on Digital Object Identifiers Pilot Project, On-going.

20. Continue the e-based newsletters on a quarterly basis and maintain the web-site structure as is for the present. Include updates on time-series inventories as discussed in section 7 above. [*Responsible member: Hood. Timeframe: on-going / open-ended. Cost Implications: 0.*]

Status: On-going quarterly.

21. After the November workshop, discuss with CDIAC the needs for more or additional types of information and data links for hydrography and other platforms. See also discussion / actions in section 7. [*Responsible members: Sabine, Hood, Fukasawa,*

Kozyr, all. Timeframe: December 2006 for initial discussions. Cost Implications: 0.]
Status: On-going via IRHC Advisory Group. See Section III.A.

Planned meetings and workshops:

JCOMM Observations Coordination Group Review

May 9-12, NOAA Office of Climate Observations

IOCCP Representatives: Chris Sabine, Maria Hood, Roger Dargaville

11th Session of the Ocean Observations Panel for Climate

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

IOCCP Representatives: Roger Dargaville

13th Session of the IGOS Partnership

May 22-24, WMO, Geneva

IOCCP Representatives: Roger Dargaville (Carbon Theme Coordinator)

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

June 28-30, Laugavartn, Iceland

IOCCP Representatives: Chris Sabine, Arne Koertzinger, Maria Hood

Global Carbon Project SSC-6

31 August – 2 September, Mexico City, Mexico

IOCCP Representatives: Chris Sabine

International Surface pCO₂ Workshop and SSG-2 Joint with SOLAS/IMBER Carbon Group

April 11-13, 2007 UNESCO, Paris

IOCCP Representatives: all SSG

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