

4.0 OCEAN CARBON AND OTHER ACTIVITIES

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4.1 IOC/SCOR International Ocean Carbon Coordination Project (IOCCP) *Fennel***International Ocean Carbon Coordination Project
Progress Report for SCOR, September 2013**

The complexity of the marine carbon cycle and its numerous connections to carbon's atmospheric and terrestrial pathways means that a wide range of approaches have to be used in order to establish carbon's qualitative and quantitative role in the global climate system. The International Ocean Carbon Coordination Project coordinates this highly diverse set of activities and facilitates the development of globally acceptable strategies, methodologies, practices and standards, homogenizing efforts of the research community and scientific advisory groups, as well as integrating the ocean carbon science into globally integrated earth system observing networks. This report highlights the main activities of the IOCCP between September 2012 and August 2013.

Project Highlights**The Surface Ocean CO₂ Atlas (SOCAT) Project**

The Surface Ocean CO₂ Atlas (SOCAT, <http://www.socat.info/>) was initiated by the International Ocean Carbon Coordination Project, SOLAS and IMBER in April 2007 (IOCCP, 2007). SOCAT version 1 was made public in September 2011 and contains 6.3 million surface water fCO₂ data from the global oceans and coastal seas originating from 1,851 cruises between 1968 and 2007.

SOCAT version 2 was released on 4 June 2013 during a lunch-time side event at the 9th International Carbon Dioxide Conference in Beijing, China. SOCAT version 2 contains 10.1 million fCO₂ data from 2,660 cruises and extends the data set to December 2011. New data in version 2 are mainly from the years 2006 to 2011. The data are available as recalculated fCO₂ in individual cruise files and concatenated synthesis files, and as gridded fCO₂ means. In addition to

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the recalculated $f\text{CO}_2$ data, the original CO_2 data, as reported by the data provider, are available in the individual cruise files. All data products are citable using DOIs (digital object identifiers). Interactive, online data viewers (via a Live Access Server) enable easy interrogation and visualization of the SOCAT products. The SOCAT products can be downloaded in a variety of formats, including in Ocean Data View format. The SOCAT website provides access to all version 2 (as well as version 1) products and tools as downloadable files and interactive data viewers.

The methods followed for creating version 2 closely follow those for version 1. Improvements include more consistent quality control and better documentation. The capabilities of the gridded data viewer have been expanded and include the SOCAT coastal mask. A manuscript, describing version 2, was recently submitted to *Earth System Science Data* (Bakker et al., 2013).

The SOCAT Automation team continues to work with strong IOCCP support, on implementing an automated data submission and data quality control system. The aim is to reduce the effort required for data providers to submit data and more importantly for the SOCAT team to quality control and flag the data in order to make SOCAT sustainable. At present, much manual effort is needed to organize and reformat the data before it is even considered for quality control. The automated system will provide:

- Automated data submission;
- Tools for initial quality control by data provider;
- An option to make original data public via CDIAC prior to SOCAT release. □

Tools and functions in the automated system will include the following: Metadata entry and edit; Metadata checker (e.g. spelling); File upload with version tracking; Identification of columns; A range checker for data values; Computation of recommended $f\text{CO}_2$; Preliminary WOCE flagging; Visualization and analysis; and Cross-over detection.

The aim is to have the automated system ready by January 2014 and to have it fully operational for version 4. Initially large data providers will be invited to submit data via the automated system.

The GLObal Ocean Data Analysis Product version 2 (GLODAPv2)

The Global Ocean Data Analysis Product version 2 (GLODAPv2) is currently being assembled by some of the key members (~10) of the international marine CO_2 community. With substantial help from IOCCP, the group met a couple of times over the past 12 months. This new global carbon data product aims at assembling all the existing interior ocean carbon data synthesis products into one harmonized data package. Specifically, the group is including the data from CARINA, GLODAP v1.1 and PACIFICA, and they will also add data from about one hundred "new" cruises to this collection.

The key step in the approach is an extensive analysis of the quality and consistency of the available data. Among other things, this requires reassessing the adjustments derived for the GLODAPv1.1 product, primarily in order to harmonize conventions for bias correction of nutrients and oxygen,

but also performing more effective crossover identification following the development of the necessary software. In addition, consistency analysis of CFC data from the Atlantic and Indian Oceans included in GLODAPv1.1 was required. The majority of this work had been carried out during the two workshops. The time at the workshop was also dedicated to agreeing to or discarding suggested bias adjustments, settling on the final format of the product and planning the details of the GLODAPv2 schedule. GLODAPv2 will likely be ready late in 2013 and it's foreseen that it will evolve into a routine effort, with regular releases of updated versions in the future.

Once released the GLODAPv2 will strongly improve data access for scientists interested in the ocean interior carbon variables. Potential applications include carbon budgets, studies of seasonal, inter-annual and decadal variations in ocean interior carbon variables and of the processes driving these.

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

A global reoccupation of the GO-SHIP hydrographic sections was recently completed. The global reoccupation was completed in a 10-year timeframe beginning in the Atlantic Ocean in 2003 and finishing in 2013 with the completion of the high latitude Southern Ocean Indian sections (S04I and P14S). With that, the international community is now planning the next decade of global repeat surveys. The IOCCP SSG and the GO-SHIP panel agreed that IOCCP should stay involved in coordination of global repeat hydrography at a planning and negotiating level. The IOCCP and the GO-SHIP panel have jointly submitted a town-hall session proposal for the Ocean Sciences Meeting in 2014 to discuss the future of global repeat hydrography with the community.

Also, with the completion of the global survey, the GO-SHIP committee is now working with CCHDO to undertake an audit of repeat sections completed and data availability at CCHDO. This is coordinated by Bernadette Sloyan (IOCCP) and Steve Diggs (CCHDO).

The GO-SHIP committee held several teleconference meetings in 2012 and 2013, mainly organized by Maciej Telszewski. Much of these discussions centered on completion of the program plan and defining the role of and funding sources for a GO-SHIP-dedicated coordinator. Over the past 3 years, GO-SHIP has demonstrated that without global coordination for planning and implementation of sections, significant gaps and duplications arise, and most sections do not measure the full suite of core variables. A program coordinator is needed to provide international coordination and implementation. Working with an international scientific steering committee, the program coordinator would be responsible for facilitating data release and sharing, and data management; facilitating collaborations to ensure that the full suite of core variables are measured on each cruise; providing technical support for meetings of the scientific steering committee; working with the other observing system components to harmonize and integrate observations and data streams; and serving as a central communications and information forum for the hydrographic community.

In parallel to the above discussions, Matthieu Belbeoch (JCOMMOPS) was actively pursuing the JCOMMOPS's Ship Coordinator position. The GO-SHIP committee met in late 2012 to discuss

the option of the JCOMMOPS Ship Coordinator filling some GO-SHIP coordinator goals based on partial financial support for this position provided from the GO-SHIP community. This process was concluded with Martin Kramp taking up the position in the first quarter of 2013.

The Global Ocean Acidification Observing Network (GOA-ON)

The foundations for a worldwide initiative to collect, collate and interpret information on ocean acidification and its effects were established at the first Global Ocean Acidification Observing Network (GOA-ON) workshop held in June 2012 at the University of Washington, Seattle (described in last year's report). The fundamental premise of GOA-ON is that management requires measurement: assessment of the biogeochemical, ecological and societal importance of ocean acidification needs field data on relevant chemical and biological variables at local, regional and global levels, with associated capacity building. To ensure data quality and comparability, a structured system based on common standards is required. An equally important need is for subsequent information synthesis, to assist policy-making through research products and model-based projections of future potential impacts.

The second international workshop of the GOA-ON (described in more detail in the *Workshops and Meetings* section) amongst other things aimed at drafting the Global Ocean Acidification Observing Plan and developing a governance structure to achieve the implementation of this plan. The IOCCP, due to its long experience in coordinating the global ocean carbon observations was asked to lead these two efforts. Five members of the IOCCP were heavily involved in the meeting and are active members of the network. The Observing Plan will be distributed in its draft form before the end of 2013. It will also include a governance structure based on discussions at two workshops held to date, as well as numerous electronic exchanges and virtual meetings amongst workshops' organizers and participants.

The Integrated Framework for Sustained Ocean Observing

A key recommendation from the OceanObs'09 Conference held in Venice in September 2009 (www.oceanobs09.net) was for international integration and coordination of interdisciplinary ocean observations. The Conference was sponsored by many international and national ocean agencies, and attended by representatives of ocean observation programs worldwide. Based on impressive agreement among the many groups at the Conference and their strong desire to work collectively, the sponsors commissioned a Task Team to develop an Integrated Framework for Sustained Ocean Observing (hereafter referred to as the FOO).

The FOO structure is such that the three Ocean Observing System Panels (Physics, Biology/Ecology and Carbon/Biogeochemistry) interact through virtual and in-person meetings to establish a set of Essential Ocean Variables (EOVs) which would then be promoted as fundamental measurements needed to address the current scientific and societal ocean/climate-related issues and enable funding of the interdisciplinary, integrated global ocean observing network (the improved, multidisciplinary GOOS). Each panel has a leader organization, which is tentatively tasked to consult the community and create a loose consortium of relevant and interested

organizations, helping to justify and negotiate the inclusion of certain parameters in the final list of EOVs.

The IOCCP was asked by the Task Team to lead the Biogeochemistry Panel very early on in the Framework drafting process. The IOCCP SSG replied positively to this request but requested separate funding from GOOS/IOC for staff support and related activities. The seed money for limited staff support and activities (\$13.5k and \$16.5k respectively) in 2013 was received from GOOS in January 2013. Longer term and more substantial support is under negotiations. With that in mind the IOCCP SSG agreed to take on some coordination tasks for a wider range of biogeochemical parameters beyond inorganic carbon (coordination of designing and implementation of a large-scale observing network), in particular oxygen and nutrients, in order to play its role in the FOO.

As a first step in this process, IOCCP decided to extend the SSG with two new members, each with an expertise in nutrient and oxygen observations, respectively. Michio Aoyama agreed to lead IOCCP's efforts in nutrients coordination and joined the IOCCP SSG on 1 January 2013. IOCCP is still searching for an appropriate researcher to lead IOCCP's oxygen efforts.

Further to expanding the SSG, the IOCCP has been discussing (internally and externally) the details of its role in the FOO for the past two years. During the 8th Session, the first executive decisions on Framework implementation were finally taken. First, the panel approved the Terms of Reference (ToR) for the FOO's Biogeochemistry Panel drafted during the Second Meeting of the GOOS Steering Committee (Tanhua and Telszewski attended) that took place on 25-27 March 2013 in Qingdao, China. IOCCP SSG members also agreed to join the FOO Panel.

In the short term, the IOCCP SSG agreed to follow a 4-step work plan leading to the initial assessment of the existing observing network. The IOCCP will compile the available information on societal and scientific requirements regarding the marine biogeochemistry parameters necessary for inclusion into the FOO as EOVs. The IOCCP will then consult with programmatic and institutional partners on their requirements for the multidimensional feasibility assessment of the proposed parameters. It is important that observing, modeling and sensor/instrument developing communities are involved. The IOCCP will then lead the multidimensional feasibility assessment of the proposed parameters built on the FOO recommendations and summarize the results for inclusion into the Global Climate Observing System. Finally, the IOCCP will produce a summary publication of the multidimensional feasibility assessment of the marine biogeochemistry parameters necessary for inclusion into the FOO as EOVs.

Workshops and Meetings

Coastal and Arctic Surface Ocean CO₂ Atlas (SOCAT) Quality Control Workshop, Seattle, USA, 2-4 October 2012.

The need for a dedicated Coastal Group was recognized early in the formation of SOCAT, and a meeting was held in Kiel, Germany, in February 2009 (prior to the release of the LAS) to engage the coastal CO₂ community. Results of that meeting are summarized in the [report](#) available from the SOCAT website. Since that time, coastal data QC was erratic, with some coastal sub-regions receiving more thorough attention than others.

Select members of the SOCAT Coastal Regional Group met at the NOAA Pacific Marine Environmental Laboratory in Seattle, USA, 2-4 October 2012. The workshop was chaired by Maciej Telszewski (IOCCP) and Simone Alin (NOAA-PMEL) and attended by eighteen scientists from four countries. The Coastal group met with the developers of the Live-Access Server (LAS) tools to learn how LAS can be used in the quality control (QC) effort for SOCAT. The participants accessed the tools and software on the LAS via their own computers, downloaded data files for their regions, set up the shared QC environment, and worked through several exercises to demonstrate the system. The groups began working through the data sets for their region (flagging, determining which 2nd level QC tests may be applied, testing those, etc.). Significant progress was made in the QC of new submissions to the SOCAT database for the coastal region.

Prior to the October 2012 meeting in Seattle, organizers identified nearly 900 cruises in the SOCAT database as at least partially coastal and in need of QC. This was attributed to the geographically scattered distribution of coastal carbon cycle scientists, and the SOCAT community felt that a meeting of the coastal working group, with active training in the SOCAT LAS and data QC procedures, would be a useful framework for engaging new participants with the SOCAT Coastal Group. The Seattle meeting was the first meeting of the Coastal Group since 2009, and the first since Simone Alin, Wei-Jun Cai, and Burke Hales were introduced as new co-leaders of the SOCAT Coastal Group.

Early plans for this meeting called for joint gathering of Arctic and Coastal groups; however, the small number of Arctic datasets and unavailability of SOCAT Arctic researchers at that particular time led organizers to focus on the Coastal Group. All new Arctic data sets (~20) were considered in the QC sessions.

The meeting followed a pattern of plenary sessions interspersed with QC performed by meeting participants. The meeting was mainly intended to 1) familiarize the coastal QC group with the QC criteria; 2) provide hands-on training with the SOCAT LAS for contributors performing data QC; 3) define QC responsibilities; and 4) complete as much of the unfinished coastal data QC as possible during the meeting.

In addition, the group discussed several possibilities for creating synthesis products, including simple bin-averaging of the coastal data, following the Chavez et al. (2007) effort for North American coastal waters. Hales presented results of the recent Hales et al. (2012) satellite

map/meta-model approach applied to North American Pacific coastal waters. Participants suggested that it made sense to proceed using the above approaches to estimating air-sea CO₂ flux in coastal oceans first on a regional basis, to be followed by a subsequent global synthesis. There were informal agreements made to move forward with these efforts after the release of SOCAT v2, with the SOCAT Coastal Group leads (Hales, Alin, Cai) providing leadership in soliciting participation from scientists within sub-regions of the global coastal oceans and suggesting consistent spatial and temporal resolution to be applied across all regions to facilitate a later global synthesis. The NOAA-PMEL TMAP group agreed to provide support for this effort by testing different gridding approaches within the LAS system.

The GLObal Ocean Data Analysis Product version 2 workshop, Bergen, Norway, 12-14 November 2012.

The GLODAPv2 workshop took place at the Institute of Marine Research, Bergen, Norway, 12-14 November 2012. The workshop was sponsored by the IOCCP, the Fram – High North Research Centre for Climate and the Environment and the Bjerknes Centre for Climate Research, University of Bergen.

Specific aims of the workshop and issues discussed were described earlier in this report, in the section dedicated to GLODAP version 2.

Global Intercomparability in a Changing Ocean: An International Time-Series Methods Workshop, St. George's, Bermuda, 28-30 November 2012.

With representation from 17 countries and 33 time series around the globe, the workshop brought together participants who had both an understanding of the scientific goals of their time series and ample hands-on experience with sample collection and analysis. The workshop opened with plenary talks that highlighted scientific insights derived from shipboard and fixed-point time series, as well as the logistical challenges of maintaining time series, particularly in developing countries. Participants then broke into nine smaller groups to discuss sampling and analytical protocols. Each working group comprised representatives from multiple time series and focused on a different set of biogeochemical parameters, including pigments; in-line (bow intake) measurements; conductivity, temperature, and depth parameters; inorganic macro- and micronutrients; biomass; carbonate system; primary and bacterial production rates; sediment trap fluxes; and organic matter.

With a focus on sampling, standardization, nomenclature and data reporting, and quality assurance and control protocols, the working groups compared established methods and developed a consensus ranking of methods (optimal/good/acceptable) for each parameter. With the recognition that not all time series can easily adopt the optimal method for each parameter, working groups identified metadata (method details and descriptors) that would facilitate comparison of data derived from different methods. Working groups also discussed newly emerging technology that might improve data precision and accuracy in the future.

In the interest of improving internal consistency within individual time series as well as data intercomparability across multiple time series, working groups highlighted ongoing community

intercomparison activities and devised simple, low-cost experiments to assess the efficacy of current sampling and analytical protocols. Suggested experiments and community intercomparison activities included seawater sample collection with repeat particulate sampling at regular time intervals to quantify the effects of particle settling and revisit sample extraction order if necessary, quantitative comparisons of chlorophyll extraction using different solvents, primary productivity incubation time (e.g., 12 versus 24 hours) comparisons, laser-based (flow cytometry) bacteria and phytoplankton cell count intercomparisons, nutrient intercomparison using both commercially available and secondary (internally calibrated) standards, and comparison of a suite of coulometric titration models being used for measuring dissolved inorganic carbon.

More information (including the full workshop report) is available on the workshop Web portal (<http://www.who.edu/website/TS-workshop/>), which will be gradually transformed into a Web-based global network of shipboard biogeochemical time series that will include detailed information about parameters being measured and methods being used for each time series.

Surface Ocean CO₂ Atlas (SOCAT) side event: Release of Version 2 and Science Highlights, Beijing, China, 4 June 2013.

The IOCCP organized a lunch-time side event at the 9th International Carbon Dioxide Conference ([ICDC9](#)) on 4 June 2013 to make SOCAT version 2 public. Around 60 participants joined the SOCAT team for this 2-hour session. Three SOCAT talks (SOCAT history, SOCAT version 2 release and SOCAT Future) were followed by three science talks on SOCAT applications. These concentrated mainly on global distribution of the ocean carbon sink and ocean-atmosphere CO₂ flux.

The session was concluded with an open discussion which concentrated on potential future additions to SOCAT. Sensor CO₂ data, additional oceanic parameters, atmospheric parameters were of most interest to participants. SOCAT team will consider these suggestions in our future work.

The Second International Workshop of the Global Ocean Acidification Observing Network, St. Andrews, Scotland, 24-26 July 2013.

The second international workshop of the Global Ocean Acidification Observing Network (GOA-ON) was convened in St. Andrews, Scotland, UK on 24-26 July 2013 with support from the IOCCP, the UK Ocean Acidification research programme (co-funded by NERC, Defra and DECC), the Ocean Acidification International Coordination Centre of the International Atomic Energy Agency, the UK Science & Innovation Network (co-funded by BIS and FCO), the UK Natural Environment Research Council, the US NOAA Ocean Acidification Program, the Global Ocean Observing System, the Integrated Ocean Observing System, the Intergovernmental Oceanographic Commission (IOC) of UNESCO, the University of Washington and others.

This international workshop continued to build and document an integrated global observing network for both carbon and ocean acidification that addresses the requirements of nations affected by this emerging environmental problem in response to societal needs. Participants from all over the world convened to discuss the vision and directions forward for the GOA-ON. Scientists from

the following countries participated: Australia, Brazil, Canada, Chile, China, France, Germany, Iceland, Ireland, India, Israel, Italy, Japan, Korea, Malaysia, Mexico, New Zealand, Norway, Philippines, South Africa, Spain, Sweden, Taiwan, Thailand, UK, and the USA.

The workshop built upon progress made during the first [international workshop](#) to document the status and progress of ocean acidification in open-ocean and coastal environments, and to understand its drivers and impacts on marine ecosystems. A coordinated multidisciplinary multinational approach for observations and modeling is fundamental to establishing a successful research strategy for ocean acidification. This will hopefully facilitate the development of our capability to predict present-day and future responses of marine biota, ecosystem processes, biogeochemistry, and climate change feedbacks. Required research elements include regional and global networks of observations collected in concert with process studies, manipulative experiments, field studies, and modeling, to be carried out with close linkages to other global observing activities. Global and regional observation networks will provide the necessary data required to firmly establish impacts attributable to ocean acidification.

The overarching goal of the meeting was to further refine the vision for the structure and evolution of the GOA-ON in shelf seas and coastal waters. The expected meeting outcomes included:

- a more comprehensive vision of a global coastal and open ocean OA network,
- conceptualization of the ideal fixed observing node that contains chemical, physical and biologically relevant observations,
- ensuring that data from observing systems are relevant to modeling needs,
- creating a near-term priority list of geographic areas that are both “hot spots” for OA and are also under-observed, with an intention to create a plan to cover them,
- an international data sharing plan for OA observing data,
- development of a governance structure for GOA-ON,
- update of the draft Global OA Observing Plan developed as a result of the June 2012 Seattle workshop

The agenda covered such topics as the physical, chemical and biological variability of OA in different shelf seas and coastal waters (such as shelf seas, intertidal waters and estuaries, polar and tropical zones), and how to observe ocean acidification and its impacts in these very different zones. The meeting was a mixture of informational plenary talks to help frame the dialogue and breakout discussions designed to flesh out the specific details. The information shared in this workshop will be brought together with the report arising from the Seattle 2012 workshop, “Toward a Global Ocean Acidification Observing Network”, to provide a comprehensive Global OA Observing Plan, for wider sharing.

Project Office

IOCCP Scientific Steering Group Meeting

The **Eighth** IOCCP Scientific Steering Group meeting was held on 22-23 April 2013 at the University of East Anglia in Norwich, UK. Toste Tanhua (Chair, GEOMAR, Germany) was joined by members Are Olsen (UB, Norway), Alex Kozyr (CDIAC, USA), Richard Feely (NOAA, USA), Laura Lorenzoni (USF, USA), Ute Schuster (UEA, UK), Benjamin Pfeil (UB, Norway), and Michio Aoyama (JMA-MRI, Japan). Corinne Le Quere (Tyndall-UEA, UK) attended as a representative of the Global Carbon Project. Ed Urban (SCOR), Bernadette Sloyan (CSIRO, Australia), Masao Ishii (JMA-MRI, Japan), and Todd Martz (SIO, USA) were unable to attend. The full meeting report with specific action items stemming from presentations and discussions is available at <http://www.ioccp.org/documents/meeting-reports>.

New IOCCP website

Early in 2013, the IOCCP launched its new, completely re-designed website. In addition to updating the design, a complete technical change to incorporate the Content Management System (CMS) was implemented. This allows user-friendly administration of content by non-experts, including layout, volume and order of elements of the website. The CMS also allows for administrative access to analytical statistics allowing for assessment of usefulness of each element of the website. Aesthetic re-design of the IOCCP website brought it up to date with other research project's websites. IOCCP's outreach activities are not plentiful and the website should play an outreach role in the most effective way possible. Additional functionalities like a Jobs section, downloadable Calendar and a slider highlighting the most important events and actions should help IOCCP's website become an information hub for international activities in marine biogeochemistry.

Future Directions

IOCCP will execute specific actions (42 in total) developed during the Eighth Session of the Scientific Steering Group (22-23 April 2012, Norwich, UK, report available from IOCCP website: <http://www.ioccp.org/documents/meeting-reports>). In addition, more general actions will be taken to meet new challenges dictated by changing needs of marine biogeochemistry community. During the course of the next year IOCCP priorities will include the following.

A Framework for Ocean Observing and the First Technical Workshop for Biology and Ecosystem and Biogeochemistry Panels, Townsville, Australia, 13-15 November 2013.

The ocean observing community realized that quantifying the simultaneous impacts of multiple stressors on ocean ecosystems cannot be achieved without a truly multidisciplinary approach to observing. This requires re-thinking of many observing strategies and no doubt some compromises (within and across- disciplines) will have to be made in order to achieve a fit-for-purpose global ocean observing system. IOCCP with its mandate to coordinate ocean carbon and

biogeochemistry observations plans to play an active role in these discussions so that “our” future observing strategies are aligned with those proposed by colleagues concerned with physics and biology.

Organized and funded by GOOS through its various funding pathways, the First Technical Workshop for Biology and Ecosystem and Biogeochemistry Panels, Townsville, Australia 13-15 November 2013 will aim at establishing an enhanced information base across the multidisciplinary (biology, biogeochemistry and physics) range of ocean system components, which is an essential contribution towards critical policy development and management decisions on ocean and coastal resource sustainability.

During this workshop we will be seeking advice from technical experts to assist us with:

- identification of major scientific and societal challenges that require sustained ocean biology and biochemistry variable observations;
- identification of candidate ecosystem and biogeochemical Essential Ocean Variables (EOVs);
- clarification of the role of GOOS, IOCCP, OOPC and the biology panel in developing consensus requirements, coordinating observing networks, and promoting development of a data management system;
- monitoring activities and projects to practically implement the biological and biogeochemistry recommendations in the GOOS Framework for Ocean Observing (FOO), the Panel for Integrated Coastal Observation (PICO) Plan and the upcoming update of the Global Climate Observing System’s Implementation Plan.

IOCCP Vision 2019

Four years after OceanObs’09 and six years before OceanObs’19, the IOCCP composed this Vision 2019 and plans to work on it throughout the next 12 months and beyond so that it becomes a more firm, long-term action plan halfway through the inter-sessional period of the OceanObs series.

Vision 2019 is a result of a long brainstorming session lead by IOCCP Chair during the last SSG meeting. The session aimed at drafting a list of actions and activities that the community needs to take in order to progress with an overall goal of better understanding the recent and future changes in marine biogeochemistry.

At the moment our Vision consists of a “laundry list of general and specific recommendations for action divided in three categories: (i) deliverables needed for more complete understanding of marine biogeochemistry, (ii) data-related issues and (iii) specific activities in 2013-2014 and beyond that could address (i) and (ii).

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(i) IOCCP Vision 2019 deliverables

- Decadal rate of change in ocean acidification (regional and global)
- Trends in nutrient supply to the surface waters
- Ocean interior oxygen distribution
- Rates of deoxygenation
- Regional and global rates of carbon storage and uptake
- Rate of shallowing of carbonate (e.g. aragonite) saturation state depth
- Regional and global fluxes of carbon and their changes
- N₂O fluxes/concentration changes
- N-fixation (processes)
- Denitrification (processes)
- N/P ratio changes in deep water
- Particle flux/remineralization depths
- Improvement in the spatial resolution of observations
- Improvement in the temporal resolution of observations
- Improvement in the accuracy of measurements
- Better understanding of uncertainties
- Community debate on the use of proxy parameters

(ii) IOCCP Vision 2019 data needs

- Further streamlining data flows (formats, protocols)
- Relational database
- Early submission of encrypted data for quality control by community-agreed tools rather than submission several years after data collection
- Development of a worldwide requirement for addition of uncertainty estimate in data and data products
- Development of quality-control procedures for sensor data
- Development of calibration procedures for autonomous sensors
- Creation of an international ocean interior data quality assessment group
- Regular updates to data synthesis products

(iii) IOCCP Vision 2019 implementation plans

- 2nd GOA-ON workshop in St. Andrews, Scotland
- Fall 2013 EOJ/FOO/Vision'19 workshop in Townsville, Australia
- Sensors Workshop or Summer School in 2014
- Town-hall on repeat hydrography data and observations at the Ocean Sciences Meeting (OSM) 2014
- Town-hall on EOJs at the OSM 2014
- Time Series session at the OSM 2014

- SOCATv3 public release event in 2014
- 3rd GOA-ON workshop to be organized in 2014/2015
- Follow-up on the Time Series workshop held in late 2012, with specific focus on instruments and sensors

4.2 Symposia on The Ocean in a High-CO₂ World (SCOR/IOC/IGBP) *Volkman*

From the Third Symposium, a special issue of *Biogeosciences* is underway. Three papers have been published so far (see http://www.biogeosciences.net/special_issue129.html), with another 22 papers in some stage of review (see http://www.biogeosciences-discuss.net/special_issue104.html). The International Geosphere – Biosphere Programme is leading development of a Summary for Policymakers by the International Planning Committee for the symposium, which should be completed later this year. The following paper was published in *Oceanography* magazine in early 2013

[Urban, E.R. Jr., and R. Boscolo. 2013. Using scientific meetings to enhance the development of early career scientists. *Oceanography*, <http://dx.doi.org/10.5670/oceanog.2013.16>.](http://dx.doi.org/10.5670/oceanog.2013.16)

This paper suggests approaches that could be used in any scientific meeting to help early-career scientists. It is based on experiences from the symposium and from the 2011 Open Science Conference of the World Climate Research Programme.

The SCOR Executive Committee will make a final decision at the SCOR Executive Committee meeting regarding SCOR's potential role in a fourth symposium in 2016.

4.3 Other Activities

4.3.1 Data Publication Activity *Costello*

What was to become the SCOR/IODE initiative on data publication started in December 2006 at the Second SCOR Summit of International Marine Research Projects (see http://www.scor-int.org/Project_Summit_2/ProjCoord2.htm). The meeting brought together representatives of most large-scale international ocean research projects (e.g. SOLAS, GEOTRACES, IMBER, GLOBEC, etc.). The meeting considered what constituted the major barriers to data sharing and greater data submission to national and global databases, and identified a need to create better approaches to ensure that scientists get credit for releasing their data and increased credit for use of their data by others. To this aim, the meeting recommended that SCOR form a Panel on Ocean Data Publication and Incentives. SCOR and the International Oceanographic Data and Information Exchange (IODE) of the Intergovernmental Oceanographic Commission (IOC) formed an informal group to address this topic. The MBLWHOI Library, British Oceanographic Data Centre, the Biological and Chemical Oceanography Data Management Office (BCO-DMO), and U.S. National Oceanic and Atmospheric Administration also participate in the group, whose members meet annually.

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A series of workshop reports have been produced from the group's annual meetings:

- IOC Workshop Report No. 207: <http://www.iode.org/wr207>
- IOC Workshop Report No. 230: <http://www.scor-int.org/Publications/wr230.pdf>
- IOC Workshop Report No. 244: <http://www.scor-int.org/Publications/wr244.pdf>
- IOC Workshop Report No. 252: <http://www.scor-int.org/Publications/wr252.pdf>

Two pilot projects have been developed:

1. Creating data publications from existing and future holdings at national data centers.
2. Linking data to traditional journal publications.

The group continues to present updates of its work to meetings of oceanographers, data centers, and library specialists. The most recent article aimed at an oceanography audience was published in *Eos* around the time of last year's SCOR annual meeting:

[Urban, E., A. Leadbetter, G. Moncoiffe, P. Pissierssens, L. Raymond, and L. Pikula. 2012. Pilot Projects for Publishing and Citing Ocean Data. *Eos* 93:425-426.](#)

In 2013, the group published a “Cookbook” that presents information about how the approaches used by the pilot projects could be implemented more broadly by other institutions:

[Leadbetter, A., Raymond, L., Chandler, C., Pikula, L., Pissierssens, P., Urban, E. \(2013\) *Ocean Data Publication Cookbook*. Paris: UNESCO, 41 pp. & annexes. \(Manuals and Guides. Intergovernmental Oceanographic Commission, 64\), \(IOC/MG/64\)](#)

This document is intended to be updated as more experience is gained from implementing its recommendations. Future work of the group will focus on helping new data publication sites become established.

4.3.2 International Quiet Ocean Experiment

Feeley

The International Quiet Ocean Experiment (IQOE) workshop in October 2010 concluded that there was sufficient interest in this topic to hold an open science meeting (OSM) to gauge community interest. The OSM was held in late August/early September 2011 (see <http://www.iqoe-2011.org/>) and a related Web site has been developed as a portal to literature and other information about sound in the ocean (see <http://aquaticacousticarchive.com/>). A draft science plan has been developed and is in review. Scientists in several countries are developing activities to implement the science recommended in the IQOE Science Plan.

IQOE is co-sponsoring a workshop on “Predicting Soundfields—Global Soundscape Modeling to Inform Management of Cetaceans and Anthropogenic Noise”, which will be held in The Netherlands in early 2014. The purpose of the workshop will be to

- Exchange, evaluate, and analyse soundscape modelling methodologies with a view to optimizing techniques and their transferability in order to increase the accessibility of

these methodologies to a wider range of researchers, governments, industry, and organizations;

- Examine and assess priority regions and the important sound sources within those regions for soundscape characterization, including specifying the human use and sound source characterization data that are necessary to model anthropogenic noise.
- Develop scientific recommendations and a two-year work plan for consideration by the IWC, IQOE and others to continue to develop, improve and apply these sound mapping tools to more global locations.

SCOR and POGO will consider the IQOE Science Plan and reviews at their annual meetings to determine whether to accept IQOE as a SCOR- and/or POGO-sponsored project.

4.4.3 IAPWS/SCOR/IAPSO Joint Committee on Seawater

Morozov

SCOR and partners formed a Joint Subcommittee on Seawater with IAPSO and the International Association for the Properties of Water and Steam (IAPWS). This group is a follow-on to the SCOR/IAPSO Working Group 127 on the Thermodynamic Properties of Seawater. The Joint Subcommittee is a subgroup of the IAPWS Working Group Thermophysical Properties of Water and Steam. It was launched at the IAPWS annual meeting at the end of September 2012. SCOR and IAPSO have approved a three-person Executive for the group and SCOR has provided some support for members of the Executive to attend IAPWS meetings to serve as liaisons.

Report on activities at JCS workshops, Greenwich UK Sept 2-3, 2013

The IAPWS has been having discussions with the Bureau international des poids et mesures (BIPM; the “keepers” of the SI) about collaborating on standards. JCS (and IAPWS) member Rainer Feistel has in the past attended meetings of the Consultative Committees on Temperature (CCT) and Amount of Substance (CCQM, confusingly), which handle temperature and chemistry issues, respectively. In addition, a top-level meeting took place between several IAPWS and BIPM executives in 2012. At this time BIPM suggested some joint workshops. Since seawater issues seemed a good place to start, JCS took over the responsibility for organizing and coordinating these workshops, which took place during the 16th International Conference on the Properties of Water and Steam (ICPWS16) in Greenwich, UK. These combined workshops would be useful to JCS for several reasons, one of which is that we would like to make oceanographic standards traceable to the SI.

Robert Weilgosz (executive director of CCQM) was invited to give a plenary talk at the conference. One interesting point is that environmental needs are now part of the BIPM's vision statement (rather than a focus on just industry and regulation). Following this plenary presentation, there were three workshops: one on pH, one on salinity/density issues, and one on relative humidity. Each workshop was co-chaired by two JCS members; one of whom was primarily a research oceanographer or atmospheric scientist (Dickson, Pawlowicz, Hellmuth), and the other of which was more metrology-oriented and a BIPM representative (Spitzer and Seitz for CCQM, and Lovell-Smith for CCT). In addition, Stephanie Bell (chair of CCT's Working Group 6 on relative humidity) and Marti Heinonen (CCT) also participated. All JCS members managed to travel to Greenwich (including both industry reps), with the exception of

4-16

McDougall and Barker, and there was much discussion about sections of the *Metrologia*¹ draft paper (which is now more than 100 pages in length), especially in pH and relative humidity (RH) where many issues are still being resolved.

Each workshop began with a series of short presentations, chosen by Pawlowicz, followed by open discussion with reference to the immediate aims of JCS in that area. A list of tasks were decided on, as well as someone in charge of these tasks; JCS will endeavour to make sure they are completed!

pH Workshop

About 30 people attended this workshop, including many members of the Euromet ENV05 metrology program that included pH and several IAPWS members from National Metrological Institutes. Tasks decided on were the following:

- (1) Define a plausible artificial seawater matrix (based on TEOS-10 Reference Composition) both with and without sulfate, for new measurements in a way that may relate more easily to Absolute Salinity. (Stoica)
- (2) Write a more cookbook-like document to detail the creation of TRIS buffers (needed for pH calibration in seawater), expanding on the recipe in SOP6a in the CO₂ Best Practices document (see [Dickson, A.G., Sabine, C.L. and Christian, J.R. \(Eds.\) 2007. *Guide to best practices for ocean CO₂ measurements*. PICES Special Publication 3, 191 pp.](#)). More widespread use of such buffers will make pH measurements more available to the wider community (NB – Dickson is currently able to provide small amounts of TRIS buffers on request). (Dickson and Stoica)
- (3) Investigate the possibility of tracing uncertainties in Pitzer-like models (required for full analysis of uncertainty if such models will be part of a pH definition) (Stoica)

NB: D. Stoica is a member of ENV05 working on pH, but not a member of JCS.

Salinity/Density Workshop

About 25 people attended this workshop. It was generally felt that different groups were having trouble replicating measurements of, for example, the density of Standard Seawater, and part of this was because the correct method of using a commercially available Anton Paar density meter for accuracies smaller than its specification was not obvious. Tasks decided on were the following:

- (1) Investigate the linearity of the Anton Paar (using heavy water or NaCl solutions). (Wolf)
- (2) Develop a best practices guide for high-precision density measurements (perhaps to go to *L&O: Methods* or JOAT) by pooling collective experience (Pawlowicz)
- (3) Although Standard Seawater is an amazingly successful Practical Salinity standard, its utility for other purposes is not as clear because of the way the chemical composition can change in the bottles. Collective experience should be pooled about the chemical composition of SSW and its changes with age (journal article?). (Pawlowicz)

¹ *Metrologia* is “the leading international journal in pure and applied metrology, published by IOP Publishing on behalf of [Bureau International des Poids et Mesures \(BIPM\)](#).” See <http://iopscience.iop.org/0026-1394>.

- (4) Perform some laboratory intercomparisons of density measurements. (Wolf)

NB: Wolf is not a member of JCS, but will likely replace Spitzer after Spitzer's retirement next spring; Wolf is leading the effort to get funding for a follow-on project.

Relative Humidity Workshop

The RH workshop had only 13 participants, but discussion was lively and technical. The RH section of the *Metrologia* draft in particular had not been progressing well, but these verbal discussions went a long way towards resolving several issues. Tasks decided on were the following:

- (1) Hold further meeting on the subject at BIPM
- (2) Write a technical report on the physical basis of RH to circulate among the members of CCT WG-6 to stimulate discussion (Hellmuth)
- (3) Develop software or at least a comprehensive set of equations to convert between the many different currently used definitions of RH (timelines and work packages by end of 2013, to lead to work to be presented at an MMC conference in Solvenia, Sept. 2014) (Hellmuth)

Future BIPM collaboration

Finally, there was a brief “general” meeting of JCS members and others at the end of the last workshop session. The tasks listed above were reviewed. In addition, discussion was held about how to continue. It was felt that IAPWS members (or effectively JCS members with IAPWS affiliations) should attend BIPM working group workshops next year (CCQM in April, CCT in June), and funding should be sought to facilitate such travel. Weilgosz is also keen on having an environmental focus to a CCQ conference in Nov 2014, but details of this are as yet unclear.

R. Pawlowicz
JCS chair, Sept 5, 2013