



# REPORT

## Eleventh Session of the Scientific Steering Group

20 February 2016  
New Orleans, LA, USA



United Nations  
Educational, Scientific and  
Cultural Organization



Intergovernmental  
Oceanographic  
Commission



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Support for this project is provided by the US National Science Foundation through a grant to the Scientific Committee on Oceanic Research (OCE - 1243377), and from the Intergovernmental Oceanographic Commission of UNESCO through the Global Ocean Observing System Project Office. Institute of Oceanology of Polish Academy of Sciences provided in kind support for the IOCCP Project Office.

# SSG for 2016 and Participants List

The composition of the IOCCP SSG in 2016 is shown in Table 1 below. This table also acts as a participants' list as far as SSG members are concerned. Contact details and full affiliations of listed SSG members can be found on the IOCCP website (Contacts' tab). Additional participants are listed in Table 2.

**Table 1. SSG members for 2016**

Name (Gender)	Home institution	Country of residence	Expertize	Participation in the Eleventh Session of the IOCCP SSG
Toste Tanhua (M, Chair)	GEOMAR	Germany	Framework for Ocean Observing	Attended
Michio Aoyama (M)	U. Fukushima	Japan	Nutrients	Attended
Richard Feely (M)	NOAA - PMEL	USA	Ocean Acidification	Attended
Masao Ishii (M)	JMA-MRI	Japan	Ocean Interior Observations	Did not attend
Björn Fiedler (M)	GEOMAR	Germany	Time Series	Attended
Douglas Connelly (M)	NOCS	UK	Instruments and Sensors	Attended
Are Olsen (M)	UiB	Norway	Ocean Interior Synthesis	Attended
Benjamin Pfeil (M)	UiB	Norway	Data Management	Attended
Rik Wanninkhof (M)	NOAA - AOML	USA	Underway CO <sub>2</sub> Observations	Attended
Kim Currie (F)	NIWA	New Zealand	Ocean Surface Synthesis	Attended
Cristian Vargas (M)	Uni Concepcion	Chile	Ocean Acidification	Did not attend
Siv Lauvset (F)	URC	Norway	Ocean Interior Synthesis	Did not attend

**Table 2. Project Office staff and additional meeting participants**

Name (Gender)	Home institution	Country of residence	Role	Participation in the Eighth Session of the IOCCP SSG
Maciej Telszewski (M)	IO PAN	Poland	IOCCP Director	Attended
Albert Fischer (M)	IOC-UNESCO	France	GOOS Director	Attended

# Report

## 1. Introduction

The Eleventh Session of the IOCCP Scientific Steering Group was held on 20 February 2016 in the Residence Inn Marriott in New Orleans, LA, USA. As customary, our meeting was held in conjunction with the Ocean Sciences Meeting (21-26 February 2016) attended by several SSG members hence reducing travel commitments and increasing cost-effectiveness. Following this bi-annual pattern additionally creates enormous networking possibilities with numerous panels also holding their meetings in conjunction with the OSM venue. IOCCP SSG members and Project Office staff attended at least 5 meetings of related panels (GOA-ON, GOOS EC, GOOS Bio/Eco Panel, SCOR WG's) and several informal planning meetings were held further increasing the time- and cost-effectiveness.

Toste Tanhua (Chair) was joined by eight members of the SSG, the Project Director and one guest representing IOC-UNESCO and GOOS (see Table 2). Two SSG members could not attend the meeting (see Table 1).

Toste welcomed the SSG members to the 2016 meeting and thanked the participants for the time and effort spent on preparations to the meeting. He then welcomed and introduced new SSG members, Douglas Connelly and Björn Fiedler. After a round of introductions, Toste asked the participants to engage actively in discussions and brainstorm each theme of IOCCP's activity. He applauded the efforts that led to the expansion of the Project Office giving the Project an opportunity to return to the intensity of activities from before 2012. With doubled support in the Project Office and stronger than before support from GOOS Project Office it's a great time to be involved in IOCCP activities.

Toste provided a brief overview of the many on-going activities that IOCCP was engaged in over the previous 10 months since the Tenth Session. He mentioned the SSG Quarterly Virtual Meetings (teleconferences) as important tool for the members to coordinate activities in short term and hinted that in-person meetings should concentrate primarily on long term planning and developing/shaping the long term strategy for the community.

This report summarizes the presentations and discussions held during the meeting. It does not necessarily follow the chronological order depicted in the meeting agenda but tries to divide the information provided during the meeting into subject-related chapters to enable a better implementation of the action items stemming from the meeting.

## 2. Update and Vision for Underway CO<sub>2</sub> Observations

### General update

Rik Wanninkhof presented this theme. He started by stating that the surface ocean carbon and biogeochemistry observing network is not on secure footing and far from operational. The vast majority of resources comes from national research funding and therefore is proposal-based and hypothesis-driven. It is not a sustained effort from a

funding perspective even though to a large extent it is a monitoring effort and the outcomes it produces support our understanding of long-term climate and ecosystem dynamics. On a global scale, there is currently no formal coordination of the different groups maintaining CO<sub>2</sub> systems on ships. We know that 123 ships provided data to SOCAT but we do not know which ones are operating at any given time i.e. we do not have an overview of the current status of this observing network. IOCCP activities focus on being a communication hub for general inquiries, capacity building and providing guidance on best practices. IOCCP also tries to maintain the map of the network status with varying success mainly due to limited man-power in the office in previous years. SOCAT effort takes care of data submission, quality control and publication but as these data streams are delayed mode (months to several months to years) they only give an indication of the status of the network with 12-24 months delay depending on the timeliness of data submission and the SOCAT publishing frequency.

Appreciable advances have been made through the Integrated Carbon Observation System, ICOS (an EU Strategic Research Infrastructure) to set up a systematic, sustained and coordinated surface pCO<sub>2</sub>-observing network in the Atlantic with 9 ships of opportunity lines. Note, there remain differences in nomenclature as ICOS lists as volunteer observing ship lines (Carbo-VOS lines) instead of the nomenclature used in JCOMM which refers to them as ships of opportunity (SOOP). Dr. Truls Johannessen is leading the ICOS-ocean effort. They plan to implement many practices developed in conjunction with NOAA and NIES SOOP-CO<sub>2</sub> effort and encouraged by IOCCP, including labeling ship lines based on the quality of data. Jessica Thorn (University of Exeter, UK) serves as a ship and planning coordinator for ICOS-ocean and is currently assembling SOOP-CO<sub>2</sub> ship line information from the international community. An ICOS Science conference will be held Sept 27-29 2016 in Helsinki.

Two documents are being prepared to facilitate underway CO<sub>2</sub> measurements:

1. A pCO<sub>2</sub> system installation guide on ships led by Tobias Steinhoff (GEOMAR, Germany) and Denis Pierrot (NOAA-AOML, USA) with target delivery date in boreal summer 2016. This document focuses on the considerable challenges of installation on ships and will provide guidance on do's and don'ts when installing. It will both cover installation on research ships and on commercial vessels.
2. A prospectus for ship's officers and crew, and ship owners led by Ute Shuster (Uni. Exeter, UK) with target delivery date in boreal summer 2016. This will serve as a "sales brochure" to inform on the reason for installation and overall scope. It will build on the efforts of several individual groups to provide this information in an appealing form to the prospective ships hosting underway systems.

### **NOAA operations workshop held in Miami, USA**

An operations workshop was held in Miami 21-22 January 2016 to discuss coordination and exchange of ideas in operation of underway CO<sub>2</sub> measurements of the NOAA funded SOOP-CO<sub>2</sub> effort, currently comprised of 13 ships (largest contributor to the global network). This workshop, of the investigators installing and operating the

systems, involved open exchanges of issues in operation of system were deemed highly beneficial and effective to all. Representatives of General Oceanics, commercial vendors of a system built to community standards, who provides the systems to the NOAA group were on hand the first day. Recommendations included mutual assistance in installing and operating other sensors, improved exchanges about failure modes of systems, improved documentation on system operation, including possible video instructions. D. Pierrot demonstrated improved data reduction software that is closely linked to the data and meta-data submission portal of SOCAT. He was encouraged to document the software and share with the community at large to increase uniformity and quality of data.

## **Joining JCOMMOPS**

Based on the current lack of formal coordination of the ever-changing existing fleet of SOOP-CO<sub>2</sub>, Rik proposes to benefit from the services provided by the WMO-IOC Joint Technical Commission on Oceanography and Marine Meteorology - Observing Platform Support Center (JCOMMOPS). JCOMMOPS provides technical metadata-based coordination at the international level for oceanographic and marine observations for the following global programs and networks:

- The Data Buoy Cooperation Panel (including drifting and moored buoys),
- The Ship Observations Team
  - Ship of Opportunity Program (SOOP) currently coordinating the collection of the upper ocean thermal oceanographic data collected by XBTs, XCTDs and TSGs.
  - ASAP&VOS – coordinating meteorological observations from commercial ships
- Global Sea Level Observing System (GLOSS)
- OceanSITES
- The Argo profiling float program.
- Global Ocean –Ship-based Hydrographic Investigations Panel (GO-SHIP)

Teaming up with the SOOP Implementation Panel and creating additional category: SOOP-CO<sub>2</sub> is proposed to optimize and harmonize coordination efforts related to surface ocean carbon observations. JCOMMOPS support after initial, to certain extent manual, stock-taking would allow constant, meta-data-based program planning and implementation and more effective operations. Specific benefits include but are not limited to:

- Pre-deployment interdisciplinary planning
- Deployment opportunities and advanced warning for network decreases
- Co-location with other observations under SOOP
- Observational meta-data requirements
- Constant operational status of observing network (e.g. identification of data sparse regions)

Services provided by JCOMMOPS require each participating program to contribute to their staffing cost in proportion equivalent to FTE required by each program. IOCCP would not be able to provide such support and as with other programs using JCOMMOPS' services, the service would have to be supported by national funding

agencies from participating countries. IOCCP would actively seek such support via its members and partner organizations.

## **Discussion and action items**

During the discussion following Rik's presentation, the proposed outline to become part of JCOMMOPS is deemed advantageous. Rik and Maciej Telszewski will attend the next JCOMM Observations Coordination Group meeting to outline IOCCP's proposal and draft the initial implementation strategy. Discussion also developed around the quality of air measurements from SOOP-CO<sub>2</sub> and efforts led by Colm Sweeney (NOAA/ESRL/GMD, Boulder USA) to homogenize and validate air sampling strategies across SOOP-CO<sub>2</sub> and provide advice leading to better precision and accuracy of air data. The Panel agreed that stronger collaboration with atmospheric chemists would be mutually beneficial.

### **ACTION ITEM 1**

Continue promoting the use of SOOP-CO<sub>2</sub> vs Carbo-VOS to align with WMO terminology. *(Responsible: Wanninkhof, Telszewski. Timeframe: Ongoing. Financial Implications (to IOCCP Project Office): None)*

### **ACTION ITEM 2**

Write two advisory documents (installation guide for underway systems and prospectus for commercial partners) and publish on the IOCCP website and share with the community through other channels. *(Responsible: Tobias Steinhoff (GEOMAR, Germany), Denis Pierrot (NOAA-AOML, USA), Ute Schuster (U.Exeter, UK), coordinator: Wanninkhof. Timeframe: Drafts for consultations ready by boreal Summer 2016. Financial Implications: None).*

### **ACTION ITEM 3**

Attend the ICOS Science Conference to improve international coordination and exchange of best practices. *(Responsible: Telszewski, Wanninkhof. Timeframe: September 2016. Financial Implications: Low).*

### **ACTION ITEM 4**

Publish the detailed outcomes of the operations workshop in Miami in IOCCP Conveyor. *(Responsible: Wanninkhof. Timeframe: Boreal summer 2016. Financial Implications: None).*

### **ACTION ITEM 5**

Coordinate the efforts to write and make publicly available the data-reduction software developed and improved by Dennis Pierrot. *(Responsible: Telszewski, Wanninkhof. Timeframe: As soon as available. Financial Implications: None).*

### **ACTION ITEM 6**

Collect and publish on IOCCP website best practices documents for auxiliary measurements made on SOOP-CO<sub>2</sub>. *(Responsible: IOCCP Project Office, Wanninkhof. Timeframe: As soon as available. Financial Implications: None).*

### **ACTION ITEM 7**

Attend the JCOMM OCG meeting on 4-6 April in Mallorca, Spain to outline IOCCP's proposal related to SOOP-CO<sub>2</sub> and draft the initial implementation strategy.

*(Responsible: Wanninkhof, Telszewski. Timeframe: April - June 2016. Financial Implications: Low).*

### **ACTION ITEM 8**

Support development of auto-sampling technology and best practices (for auxiliary measurements) as well as sample preservation strategies for underway system. *(Responsible: Wanninkhof. Timeframe: Ongoing. Financial Implications: Low).*

### **ACTION ITEM 9**

Support developments (inter-comparison experiment, workshop) leading to higher quality atmospheric observations from SOOP-CO<sub>2</sub> *(Responsible: Wanninkhof. Timeframe: Ongoing. Financial Implications: Low).*

### **ACTION ITEM 10**

Update the relevant page on the IOCCP website including careful analysis of existing and missing content as well as connections to resources available elsewhere. *(Responsible: Wanninkhof, Palacz) Timeframe: Before next SSG meeting. Financial Implications: None).*

## **3. Update and Vision for Synthesis Activities: Surface Ocean**

Kim Currie presented this theme. SOCAT Version 3 was launched at a workshop held prior to the SOLAS Open Science Conference in Kiel in September 2015. Version 3 contains an additional 4.4 million data points and extends the time span of the data included in SOCAT to 1957 – 2014. Version 3 includes individual data sets, synthesis and gridded data products.

A revamped upload dashboard which integrates data upload, data submission and subsequent quality control on a single platform is currently being used for SOCAT Version 4. Data submission for version 4 closed at the end of January 2016 (1171 new and updated datasets submitted), the QC process is underway, and the release is scheduled for June 2016. The data submission, QC and release of subsequent versions will become an annual activity.

SOCAT has been used in more than 100 peer reviewed publications, 7 international reports and many PhD theses. The Global Carbon Project, and the CMIP project used data from the SOCAT data base. However, it is still necessary to promote SOCAT to ensure ongoing support, use and recognition, at both national and international levels.

Several strategic issues were discussed at the Kiel workshop, and the following decisions made:

**Inclusion of other parameters**, these are currently accepted but not QC'ed

- **Decision:** Convene a working group of MEMENTO scientists, SOCAT data providers and SOCAT data managers to discuss these issues further, starting with N<sub>2</sub>O and CH<sub>4</sub> surface water data.

### **Fair Data Use Statement**

- **Decision:** Working Group will consider if the wording of the SOCAT data policy can be improved and whether data providers can be made more visible.



- This action is complete, available on website

A full report, plus a summary report, on the SOCAT workshop in Kiel is available on the SOCAT website. It is important to acknowledge the large community that is involved in the SOCAT effort, data providers, QCers, IT managers, funders and SOCAT users. 53 organisations from 18 countries contribute either explicitly, or with in-kind support. Dorothee Bakker (Chair of SOCAT Global group; UEA, UK) received an award at the SOLAS conference for her ongoing lead and coordination of this project.

The workshop in Kiel included a SOCOM (Surface Ocean  $p\text{CO}_2$  Mapping intercomparison, <http://www.bgc-jena.mpg.de/SOCOM/>) session where the results from the mapping intercomparison were presented. The first SOCOM results, and the methodology was published in Biogeosciences (C. Rödenbeck et al. (2015) [Biogeosciences 12, 7251-7278](#) doi:10.5194/bg-12-7251-2015).

The long term funding and viability of SOCAT continues to be an issue. ICOS is preparing a proposal to the EU (INFRADEV), which may include an activity for ICOS to become the European pillar of SOCAT, and a proposal has been put forward for post-doc time for SOCAT assistance for Dorothee Bakker.

Kim requested unspecified support for SOCAT annual meeting/community event/launch of SOCAT v4.

## **Discussion and action items**

IOCCP SSG continues to support SOCAT and approves IOCCP support for SOCAT technical and community meetings at a level similar to previous years. During discussion it was stated that of high-importance is promoting recognition of SOCAT and GLODAP (see below) as global infrastructure. It is an optimal way for national funding agencies to be able to contribute to these efforts at global, long-term level. Panelists suggested that a small meeting should be organized focused on promoting SOCAT and GLODAP as global infrastructure. Funding agencies representatives should be included and SOCAT Implementation Plan (technical and science-related) should be developed in order to aid fund-rising initiatives.

### **ACTION ITEM 11**

Co-organize and co-sponsor the SOCATv4 release event/workshop. (*Responsible: Telszewski, Currie, Pfeil, Dorothee Bakker (UEA, UK). Timeframe: Late 2016. Financial Implications: Low*)

### **ACTION ITEM 12**

Coordinate with SOCAT and GLODAP teams to develop an Implementation Plan for both activities. (*Responsible: Currie, Pfeil, Olsen, Lauvset, Telszewski, Dorothee Bakker (UEA,UK). Timeframe: not specified. Financial Implications: Low*).

### **ACTION ITEM 13**

Update the relevant page on the IOCCP website including careful analysis of existing and missing content as well as connections to resources available elsewhere. (*Responsible: Currie, Palacz*) *Timeframe: Before next SSG meeting. Financial Implications: None*).

## 4. Update and Vision for Ocean Interior Observations

In absence of Masao Ishii, Rik Wanninkhof presented this theme with most input from Masao.

### 5<sup>th</sup> session of GO-SHIP Committee

The 5<sup>th</sup> session of GO-SHIP Committee was held in Galway, Ireland, on 14 September 2015. Meeting minutes and presented documents are available at [www.jcomm.info/go-ship5](http://www.jcomm.info/go-ship5).

- The meeting agreed on defining a new criterion of “associated GO-SHIP” section. It is defined as:
  1. High quality – some full depth stations below 2000m (at least every 240 nm)
  2. Repeated on decadal frequency or more often, on GO-SHIP line or not
  3. Not necessarily coast to coast
  4. 60 nm resolution minimum
  5. At least once per decade full Level 1 parameters (see go-ship.org for parameter description)
  6. Comply with data access policy
- GO-SHIP cruise plan was updated (<http://www.go-ship.org/CruisePlans.html>) by Martin Kramp (JCOMMOPS) based on the information provided by national representatives. The map of GO-SHIP sections was also updated accordingly (November 2015). It now includes several proposed “associated GO-SHIP” lines as well as reference sections and high-frequency sections. In 2016, cruises are planned for seven reference sections (A12, A28, I08S, I09N, P09, P15S, SR04) in addition to several high-frequency sections. JCOMMOPS maintains and serves an up-to-date listing of proposed and completed GO-SHIP cruises

### GO-SHIP review paper published

A review paper on GO-SHIP efforts by Talley et al., “Change in Ocean Heat, Carbon Content, and Ventilation: A Review of the First Decade of GO-SHIP Global Repeat Hydrography” was published in Annual Review of Marine Science in 2016 (8:19.1-19.31, doi: 10.1146/annurev-marine-052915-100829).

- Scientific outcomes from international GO-SHIP have been reviewed for anthropogenic climate change, ocean temperature change, salinity change, ocean carbon cycle, ocean oxygen and nutrients, ocean chlorofluorocarbons, ocean circulation change, ocean mixing.
- Preliminary results by Clement and Gruber on the global anthropogenic CO<sub>2</sub> inventory change over the last decade based on the second repeat occupation of reference lines yield an uptake of  $2.6 \pm 0.5$  PgC yr<sup>-1</sup> on average for years 1994-2006.

## Planning of global Biogeochemical Argo network

“Planning a global BioGeoChemical-Argo network” meeting, organized by Hervé. Claustre (LOV, France) and Ken Johnson (MBARI, USA) was held on January 11-13, 2016, in Villefranche-sur-mer. 30 persons, including Argo/BGC-float experts, ocean biogeochemists, modelers etc. from 9 countries attended the meeting.

- The goal for the meeting was to create a Science and Implementation plan for a global BGC float array. The Plan will include:
  - Major science questions revolving around ocean carbon cycle, ocean carbon uptake, ocean acidification, ocean deoxygenation and ecosystem processes.
  - Major societal applications such as carbon treaty verification, ecosystem modeling and link to management.
  - Formalization, to the extent necessary and possible, of the relationship with other major programs such as GO-SHIP, IOCCP, Satellite Ocean Color and more.
  - Conceptualization of the required system design for an array size, sensor array needed to meet the mission, integration with models, international structure for operations, implementation strategy allowing to build the array, plan for global capacity building to deal with BGC sensors data.
  - Reliable estimates of cost
- Draft of “The Rationale, Design and Implementation Plan for Biogeochemical-Argo” is under review by the meeting participants in May 2016. It is to be sent to the Argo Steering Team in June for comments and will go out to the ocean science community for further comments.

## Discussion and action items

### ACTION ITEM 14

Update the relevant page on the IOCCP website including careful analysis of existing and missing content as well as connections to resources available elsewhere. Also consider creating additional sub-page for BGC floats and gliders. (*Responsible: Ishii, Connelly, IOCCP Office, BGC Argo community*) *Timeframe: Before next SSG meeting. Financial Implications: None*).

## 5. Update and Vision for Synthesis Activities: Ocean Interior

Are Olsen presented this theme. The interior ocean data synthesis product, GLODAPv2 (Global Ocean Data Analysis Project version 2), which has been the main focus of the IOCCP interior ocean synthesis activity for the past few years, was released on January 19<sup>th</sup> 2016. Key data in GLODAPv2 are the ones produced during the WOCE and GO-SHIP hydrographic surveys, but the product also includes data from a multitude of regional surveys conducted nationally and regionally. Altogether, GLODAPv2 collates data from 724 ocean biogeochemical cruises into:

- a data base with uniformly formatted original data and metadata,
- merged global and regional data product files corrected for systematic biases, and
- a mapped 3D climatology of ocean nutrients, dissolved inorganic carbon, total alkalinity, pH and calcium carbonate mineral saturation states.

The GLODAPv2 includes all the data previously included in GLODAPv1, CARINA, PACIFICA as well as data from 168 cruises new to data synthesis efforts. The GLODAPv2 is openly available at a dedicated web page at CDIAC (<http://cdiac.ornl.gov/oceans/GLODAPv2/>). Two journal articles describing the construction of the data product (Olsen et al., 2016) and its mapping (Lauvset et al., 2016) are in review with Earth System Science Data as of February 2016. The distribution of data included in GLODAPv2 is presented in figure below.

Following the completion of GLODAPv2, the team has been making plans for a more regular (annual to bi-annual) and systematic release schedule preceded by a secondary quality control process. GLODAPv1 was released 12 years ago (in 2004), and for many purposes it's obvious that slightly more frequent updates of interior ocean data synthesis are needed. For future regular updates the GLODAP team intend to quality control newly available data using GLODAPv2 as a reference, and add these to GLODAPv2 and assemble updates. These will be named GLODAPv2.yyyy, where yyyy is year of release. This versioning enables distinguishing between updates prepared by adding data using GLODAPv2 as the QC reference vs. updates prepared through a full reanalysis of all data included, as was the case for GLODAPv1 and GLODAPv2. Eventually this will be carried out, resulting in Gv3, but this is not planned for until after the third global repeat survey is completed, around 2025.

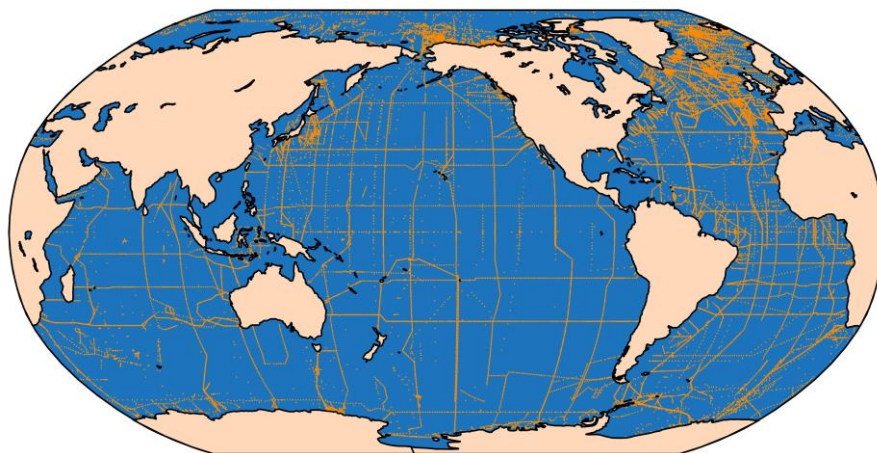


Figure: Locations of stations included in the GLODAPv2 data product

For IOCCP in particular the focus related to the interior ocean synthesis effort should be to support the transition towards regular releases of these GLODAP updates. Are has specifically expressed a request for support to establish a GLODAP International Reference Group (IRG). The composition and terms of reference for such group are to be established but general mandate of this group will be to (i) ensure that data are

submitted to GLODAP; (ii) carry out secondary QC and (iii) vouch adjustments that are recommended following the secondary QC.

## Discussion and action items

During the short discussion that developed after the presentation, the Panel congratulated the GLODAP team on the completion of such a tremendous task. GLODAPv2 is one of the two major products that the entire community worked for and even though the actual synthesis product was put together by a smaller group, the ownership is very wide. The IOCCP SSG has responded positively to Are's request and approved IOCCP's leading role in establishing and supporting the IRG.

## REFERENCES

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### **ACTION ITEM 15**

Coordinate and support the activities of soon-to-be-formed GLODAP International Reference Group. Initial tasks are composition and terms of reference for this group. (*Responsible: Olsen, Lauvset, Tanhua, IOCCP Office. Timeframe: ongoing. Financial Implications: None to Low*).

### **ACTION ITEM 16**

Facilitate activities increasing ocean interior data consistency and improved data quality. (*Responsible: Olsen, Lauvset, Steven van Heuven (NIOZ, Netherlands), IOCCP Office. Timeframe: ongoing. Financial Implications: None to Low*).

### **ACTION ITEM 17**

Update the relevant page on the IOCCP website including careful analysis of existing and missing content as well as connections to resources available elsewhere. (*Responsible: Lauvset, Palacz) Timeframe: Before next SSG meeting. Financial Implications: None*).

## **6. Update and Vision for Time Series Efforts**

Björn Fiedler presented this item with significant input from Laura Lorenzoni (USF, USA, former IOCCP SSG) and Toste Tanhua. As a new SSG member Björn initially focused on introducing his area of expertise and described his past, current and planned activities in the context of his role in the IOCCP. A summary of that part of Björn's presentation is captured in the form of a bio sketch on IOCCP website in the Contacts tab. Björn then moved onto presenting what he proposes as his initial tasks within the IOCCP.

## **Assessment of time series observing biogeochemical EOVs**

Björn proposed to intensify communication and coordination within the time-series community which has been initiated during the IOCCP/OCB time-series workshop in 2012 in Bermuda. Focusing strictly on time-series taking biogeochemistry measurements (based on GOOS Biogeochemistry Essential Ocean Variables) and including all types of Eulerian observatories. This work has to be based on the effort initiated in Bermuda and continued by IGMETS, but will aim at documenting the distribution of time series taking biogeochemical measurements (based on BGC EOVs). Time-series are a crucial element of the global ocean biogeochemistry observing system, and better understanding of its current status with regards to each BGC EOv will significantly contribute to the development of the global ocean biogeochemistry observing system design, a task that IOCCP has been asked to pursue by the Global Climate Observing System Panel. A better distribution of time-series-relevant information among member sites will also benefit the sites themselves by increasing their sense of community and also by creating a potential for international and multidisciplinary collaboration.

### **Future activities to be pursued by IOCCP**

Further, Björn presented three topics which encompass his current vision for IOCCP's involvement in time-series-related tasks. The approach might be different for each of the tasks and could vary from a white paper, through organizing a relevant survey, to organizing a focused workshop or a science meeting to multi-year community-driven data-related effort. Most probably a combination of the above would have to be utilized for each topic. The following topics were proposed:

- Creating a strategy for future ocean time series observatories by strengthening the connection between time-series science and socio-economic aspects and including the use of novel cost-effective technologies. This task could be presented as a white paper submitted for the next OceanObs Conference (to be held in 2019)
- Co-organizing (jointly with the instruments and sensors panel) next edition(s) of the IOCCP Sensor Summer Course (held in summer 2015) within the context of time-series observations, educating the next generation of operators fluent in autonomous sensors technology operations and maintenance
- Working towards a time-series data synthesis product (similar to or combined with SOCAT and/or GLODAP).

### **Capacity Building:**

Finally Björn moved to his last point, where he suggested that time-series related capacity building in Africa is an obvious gap that needs to be filled and IOCCP together with its relevant partners (SCOR, IOC-UNESCO, US OCB, OA-ICC (of IAEA), IGMETS, GOA-ON) is perfectly placed to develop and implement a suitable strategy. A striking lack of observations along most of the African coast (figure below) emerges from an analysis of the metadata compilation of global ship-based time series stations assembled for the Bermuda workshop in 2013. Two reasons might cause this deficit: A lack of observational as well as knowledge capacity and an insufficient integration of the African scientific community with the international time-series community. Synergies with the GOA-ON initiative as well as with POGO could be used to better integrate this region into international ocean carbon research.

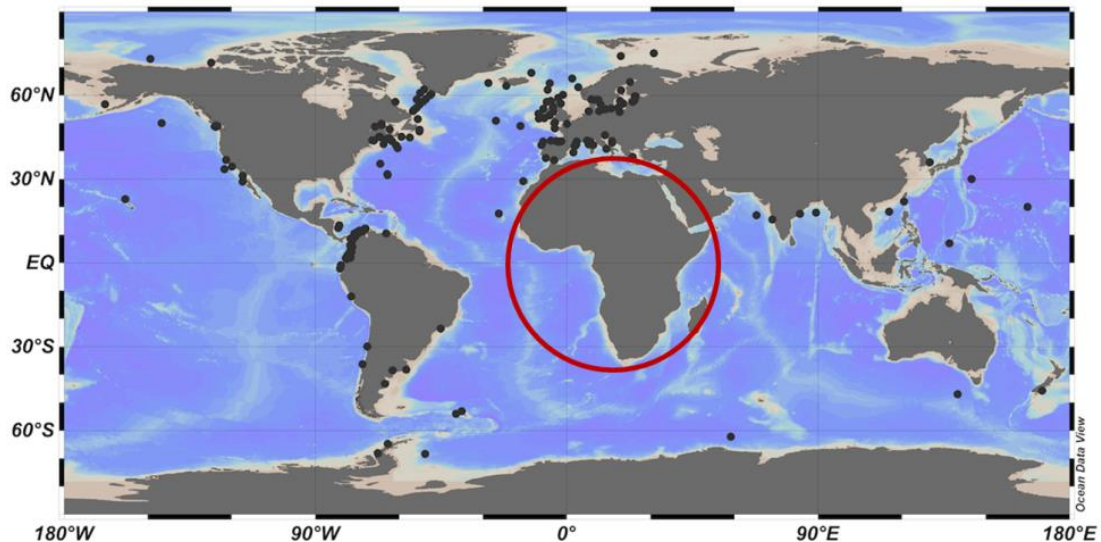


Figure: Global distribution of shipboard time series stations. Meta-information was gathered within the framework of the IOCCP/OCB time series workshop in 2012 in Bermuda.

### Discussion and action items

Discussion developed around the assessment of time series observing biogeochemical EOVs with regards to enhancing the global observing system design. Maciej summarized a recent request from OceanSITES seeking advice on location(s) of potential new sites globally in relation to the existing network and scientific and societal needs for time series observations. IOCCP's response was based on brief analysis of existing OceanSITES locations with biogeochemistry observations and initial and regionally limited gap analysis performed by Henson et al 2016. The former proved to be very difficult and un-earthed rather surprising lack of knowledge even within OceanSITES technical team about types of measurements taken at particular sites, details of data flow and other aspects crucial for informed and efficient observing system design. The latter, even though very informative in terms of the approach, proved to be limited in scope and not adequate to provide global, multi-platform based analysis.

This state of knowledge triggered the IOCCP SSG to express support for what Björn has proposed and get involved in all-biogeochemistry-time-series “stock taking” in order to be able to fully include time-series observations in observing system design. Future activities proposed were also considered very attractive and useful, however all three need further discussions and coordination and were proposed to become action items with the initial emphasis on developing a deeper description of rationale, targets and outcomes as well as a timeline and budgetary requirements. Finally, the form, extent and specific targets of proposed capacity building in Africa will have to be considered with relevant partners (GOA-ON, IGMETS, GOOS) and discussed in more detail amongst the SSG during one of the quarterly teleconferences.

The Panel congratulated Björn on his ambitious approach and expressed their support for proposed activities.

### REFERENCES

Henson, S., A, C. Beaulieu and R. Lampit (2016). Observing climate change trends in ocean biogeochemistry: when and where, *Global Change Biology*, 22: 1561–1571. doi:10.1111/gcb.13152.

### **ACTION ITEM 18**

Collate, and process for basic visualization, metadata information about biogeochemical (based on BGC EOVs) time-series measurements done across programs and projects. *(Responsible: Fiedler, Palacz. Timeframe: ongoing. Financial Implications: None)*

### **ACTION ITEM 19**

In collaboration with major related programs and projects draft a (10-year) strategy for ocean time series observatories including strong emphasis on socio-economic aspects and based on the use of novel, cost-effective technologies wherever appropriate. *(Responsible: Fiedler, Connelly, Telszewski and Palacz, with input from SSG. Timeframe: outline ready for 2017 SSG meeting. Financial Implications: None).*

### **ACTION ITEM 20**

Continue discussions with the relevant data management community and existing observations coordinators leading towards a time-series data synthesis product (similar to or combined with SOCAT and/or GLODAP). *(Responsible: Fiedler, Pfeil, Currie, Lauvset, Telszewski. Timeframe: Ongoing. Financial Implications: None)*

### **ACTION ITEM 21**

Investigate how IOCCP could complement existing capacity building activities in Africa aimed at increasing the observational coverage around the continent. *(Responsible: Fiedler, Telszewski, Palacz) Timeframe: ongoing. Financial Implications: None).*

### **ACTION ITEM 22**

Update the relevant page on the IOCCP website including careful analysis of existing and missing content as well as connections to resources available elsewhere. *(Responsible: Fiedler, Palacz) Timeframe: Before next SSG meeting. Financial Implications: None).*

## **7. Update and Vision for Ocean Acidification**

Richard Feely reported on ocean acidification (OA) activities related to IOCCP followed by a presentation provided by Cristian Vargas who could not attend the meeting. The major focus for IOCCP continues to be the coordination of biogeochemistry observations-related activities of the Global Ocean Acidification Observing Network. During the past 10 months the GOA-ON focused on the following efforts (only activities with active IOCCP engagement are discussed):

### **Creating a joint portal for access to global ocean acidification data**

GOA-ON organized two expert meetings to advance the development of data portals for easy access to ocean acidification data. Both meetings were hosted and coordinated by the Ocean Acidification-International Coordination Center (OAICC). The first meeting (Monaco, 1-2 June 2015) focused on ocean acidification biogeochemical data, whereas the second (Monaco, 17-18 November 2015) focused on experimental data on the biological response to ocean acidification. Both meetings brought together scientific and technical experts actively involved in the use or archiving of ocean acidification data. These two expert meetings explored possibilities to create a joint portal for access to global ocean acidification data within the GOA-ON framework. Invited experts discussed the way forward to (1) extend and update the



current GOA-ON inventory and (2) propose a web portal interface for ocean acidification metadata retrieval. Both groups discussed the advantages and shortcomings of existing data portal systems, the use of common controlled vocabularies, useful search filters, metadata standards and interoperability between different data providers. The longer-term goal of creating a one-stop portal to ocean acidification data with adequate search facilities was also discussed.

### **Development of a set of global ocean acidification synthesis products**

With the above developments in mind the GOA-ON Executive Council during an extended working meeting in Monaco, (19-20 November 2015) agreed on developing a central site for products of the variability in ocean acidification (primarily carbonate mineral saturation states and pH) across a range of temporal and spatial scales, including: (1) decadal trends in pH and aragonite saturation state from long-term time series sites, (2) seasonal changes in pH and aragonite saturation state at the growing number of observing sites in recent years (moored and ship-based time series), and (3) global distributions focused initially on aragonite saturation state of the kind produced by [Jiang et al \(2015\)](#).

### **Organizing the 3rd GOA-ON Science Workshop**

The 3<sup>rd</sup> Science Workshop to be held in Hobart, Australia (8-10 May 2016), following the 4th International Symposium on the Oceans in a High CO<sub>2</sub> World (3-6 May 2016), aims to further the development of the network. Issues to be covered include:

- Update the GOA-ON community on GOA-ON status and linkages to other global programs
- Build communities to develop regional hubs that will facilitate capacity building
- Update requirements for biology and ecosystem response measurements
- Discuss modeling connections, observational challenges and opportunities
- Present advances in technologies, data management and products
- Gain input on data products and information needs
- Gain input on regional implementation needs
- Launch the GOA-ON Mentorship Program

IOCCP is actively involved in the organization of this activity at all levels.

### **Launch of the Latin American Ocean Acidification Network (LAOCA)**

Richard's presentation was followed by that provided by Cristian Vargas where primary focus was on the activities of ocean acidification observing community in Latin America. The major accomplishment was the launch of the Latin American Ocean Acidification Network (LAOCA Network) - a regional counterpart of GOA-ON. On December 15th, 2015, a group of 24 scientists from seven Latin-American countries, including Argentina, Brazil, Chile, Colombia, Ecuador, Mexico and Peru, met in Concepcion, Chile to establish the LAOCA.

This regional workshop was co-funded by the International Atomic Energy Agency (IAEA) through OA-ICC, the Intergovernmental Oceanographic Commission (IOC-UNESCO), the Center for the Study of Multiple-Drivers on Marine Socio-Ecological Systems (MUSELS), and the Millennium Institute of Oceanography (IMO) from Chile. During two days the group of scientists discussed the strengths and weaknesses of

each country in relation to ocean acidification research, and also defined the mission and goals of the LAOCA Network:

- to synthesize the information about ocean acidification impacts in Latin-America,
- to encourage the implementation, maintenance, and calibration of long-term data-sets of carbonate chemistry in Latin-America,
- training of LAOCA members in various aspects of research (e.g. observation, experimentation, and modelling),
- to standardize chemical analytical techniques and protocols for experimentation in order to enhance data quality and homogeneity,
- to establish a regional node for the articulation and communication amongst local, regional, and global research and coordination programs (e.g. Brazilian Ocean Acidification Network, IMO, GOA-ON and IOCCP),
- to determine and evaluate local and regional scenarios of Ocean Acidification for different types of marine ecosystems (e.g. estuaries, coastal area, open ocean, etc.),
- to enhance student exchange and to facilitate access to infrastructure and equipment among institutions and LAOCA member countries,
- to design an outreach strategy for communicating ocean acidification-related issues to various audiences,
- to promote the development of cooperation projects between member countries of LAOCA, and,
- to promote the inclusion of Ocean Acidification to the political agendas of member countries, and even through the pursuit of cooperation agreements among LAOCA member countries.

Meeting participants developed an organizational structure with the LAOCA Executive Council on top. The first EC is co-chaired by Leticia da Cunha, (Universidade do Estado do Rio de Janeiro – [UERJ](#), Brazil; Co-leader of BrOA); Nelson A. Lagos (Centro de Investigación e Innovación para el Cambio Climático ([CiiCC](#)), Universidad Santo Tomás, Chile; Member of the OA-ICC advisory board and SOLAS-IMBER WG in Ocean Acidification, [SIOA](#)) and Cristian A. Vargas ([Universidad de Concepción](#), Chile; Member of the GOA-ON Executive Council and IOCCP SSG).

### **Capacity in carbonate chemistry observations in Latin America**

Cristian's presentation also included an analysis of the current capacity in carbonate chemistry observations in Latin America. During and following the above mentioned LAOCA kick-off meeting, a sub-group of researchers from seven countries in Latin America compiled an assessment of the current state of capacity for carbonate chemistry measurements in both coastal and open ocean in the region.

Their analysis (summarized in figure below) showed that most countries in the region carry out pH measurements at least at *weather* quality (defined by the GOA-ON as measurements of quality sufficient to identify relative spatial patterns and short-term variation, and to support mechanistic interpretation of the ecosystem response).

However, most countries recognized their capacities for measurements of Total Alkalinity (AT) at *climate* quality level, as being limited ('climate level' being defined as measurements of quality sufficient for assessing long-term trends with a defined level of confidence). Some of the  $p\text{CO}_2$  data (from Argentinian cruises) are included in SOCAT but further work and coordination is needed in order to increase the data

submission rate from the region. Most carbonate chemistry data in the region is derived from: (i) research cruises on continental shelves and offshore (Chile, Brazil, México, Argentina, and Peru), (ii) coastal monitoring (Chile, Colombia, México, Brazil and Peru), and (iii) coastal buoys (Brazil and Chile), including the use of pH and  $p\text{CO}_2$  autonomous sensors. There are no observation programs in Ecuador and Galapagos Island, which points towards an urgent need for implementing the capacity building activities encompassing both personnel training as well as technical capacity.

Finally an initial and basic data policy was developed stating that after 1-year of collection and certification of data quality, carbonate chemistry data should be released for data sharing through LAOCA Network portal, and their subsequent connection with other international programs, such as IOCCP and GOA-ON.

COUNTRY	COLOMBIA	ARGENTINA	BRASIL	MEXICO	ECUADOR	PERU	CHILE
pH	X	X	X	X		X	X
Alkalinity (AT)	X	X	X	X		X	X
DIC		X		X			X
$p\text{CO}_2$	X	X	X	X			
CRM	X	X	X	X		X	X
Buoys/Sensors	X ( $p\text{CO}_2$ )	X	X	X		X	X
Data quality		Weather Climate ( $p\text{CO}_2$ , AT)	Weather Climate $p\text{CO}_2$ , AT)	Weather Climate AT		Weather	Weather Climate AT
Needs	Capacitation	Capacitation	Capacitation	Capacitation	Human resources (chemistry)	Human resources (chemistry)	Capacitation

Figure: State of carbonate chemistry observations in seven Latin American countries including information on measured parameters, use of Certified Reference Material, data quality assessment and needs.

### **Workshop on carbonate chemistry measurements for Latin American community**

The last part of Cristian's presentation focused on a request to IOCCP for helping to organize and fund a small, focused workshop for leading PI's in Latin American community concentrating on specific, hands-on activities such as: sensor calibration, data sharing, manual and autonomous measurements methodology and best practice.

Initial discussions within LAOCA indicate that about 15 participants would be interested in attending such a workshop and they are keen to have it as soon as possible, perhaps in September-October 2016 in Concepcion, Chile (location dictated by the fact that the group there owns several instruments and sensors critical for running an efficient hands-on workshop).

### **Discussion and action items**

The discussion initially developed around the activities related to GOA-ON. Both, the

data portal and a set of synthesis products should be connected to existing activities like SOCAT and GLODAP. IOCCP and GOOS data management teams should be involved to avoid duplication and allow future convergence of existing data products for marine biogeochemistry regardless of the EOVS covered or main platform used. The GOA-ON Science Workshop will be attended by many SSG members as will the Ocean in a High CO<sub>2</sub> Symposium. SSG members strongly supported IOCCP's involvement in the GOA-ON activities in general and in organizing and co-sponsoring of the Science Workshop in particular. Olsen asked for a clarification of the target user groups for the OA synthesis products. Such information would allow better tailoring of the products as well as their presentation. Feely suggested that these products will have numerous user groups (scientific, policy making, local management, local industry) and that the information should be available in "layers" depending on the intended use.

Discussion moved to subjects related to developments in Latin America. The SSG applauded the Latin American community on their coordination success and strong will to become a significant part of the global ocean observing system. The obvious need for building stronger capacity in the region was confirmed and the SSG agreed that IOCCP has an important role to play there. Questions were raised on whether a workshop is the best mode for IOCCP's involvement. Perhaps a few "placements" in more developed labs would be more efficient. More specific description of the workshop will be requested and discussed to establish the most efficient modus operandi but IOCCP is no doubt interested in closer work with and support for the Latin American community. Finally, the SSG stated that complete open data-sharing policy needs to be adopted by LAOCA in order for the international community to benefit from IOCCP's efforts.

#### **ACTION ITEM 23**

Co-organize, co-sponsor and participate in the 3<sup>rd</sup> GOA-ON Science Workshop in Hobart, Australia. *(Responsible: Feely, Vargas, Pfeil, Currie and Telszewski. Timeframe: May 2016. Financial Implications: Medium to High)*

#### **ACTION ITEM 24**

Continue support for efforts related to the creation of the OA data portal and OA synthesis products *(Responsible: Pfeil, Feely, Telszewski, Palacz. Timeframe: Ongoing. Financial Implications: Low to Medium)*.

#### **ACTION ITEM 25**

Work closely with GOOS, OA-ICC and GOA-ON to actively support the Latin American capacity in OA observations. Specifically focus on requested activity allowing for knowledge transfer on specific technical aspects. Request a more substantial description of current needs from LAOCA and decide on mutually acceptable form of support. *(Responsible: Vargas, SSG, Project Office. Timeframe: ongoing. Financial Implications: Low to Medium)*.

#### **ACTION ITEM 26**

Update the relevant page on the IOCCP website including careful analysis of existing and missing content as well as connections to resources available elsewhere. *(Responsible: Vargas, Feely, Palacz) Timeframe: Before next SSG meeting. Financial Implications: None)*.

## 8. Update and Vision for Nutrients

Michio Aoyama presented this theme.

### **Certified Reference Materials for nutrients in seawater**

The National Meteorology Institute of Japan (NMIJ) started to provide three lots (batches) of nutrients Certified Reference Material (CRM) in March 2014 for nitrate and silicate. NMIJ are currently working on certification of phosphate concentrations. KANSO-produced CRMs were certified for nitrate, nitrite, phosphate and silicate by joint analysis performed simultaneously by JAMSTEC and KANSO and since April 2015 are 100% SI traceable. Seven lots of KANSO-produced CRMs have already been certified. The Korea Institute of Ocean Science and Technology (KIOST) Nutrient Reference Materials for Seawater (KNRMS) were also recently produced and they were evaluated during the 2014/15 inter-comparison experiment. Phosphate and nitrate concentrations in Seawater Certified Reference Materials for Nutrients (MOOS-3) produced by the National Research Council Canada showed lower and unstable values when they were measured during certification process at JAMSTEC and KANSO in 2015. JAMSTEC will start to provide CRMs to the global community under SCOR-JAMSTEC umbrella in April 2016. Special consideration was given to affordability of these CRMs and cost reduction strategies were implemented.

### **Results of the 2014/2015 intercomparison experiment**

In 2014, IOCCP and JAMSTEC co-organized an inter-laboratory comparison study of nutrients in seawater using:

- four lots of recently certified RM by KANSO,
- former RMNS produced by KANSO, which has already shown an excellent homogeneity of within 0.2% and long shelf-life of 6 years (Aoyama et al., 2012), and
- three CRMs by National Metrology Institute of Japan, which were certified in March 2014 .

Additionally, the Korean Institute of Standards offered to provide their recently developed RMs to be utilized in the inter-laboratory comparison study and the Royal Netherlands Institute for Sea Research (NIOZ) offered to provide a silicate stock solution to contribute to the overall assessment of results.

Based on that, a set of four samples of CRMs was distributed to all 71 participating laboratories around the globe (28 countries) free of charge, and NMIJ CRMs were sent to the laboratories who agreed to pay for them. Korean RMs were also distributed to laboratories who agreed to analyze them. NIOZ stock solutions were sent to selected laboratories focused on open ocean deep waters which agreed to perform the analysis. Results were received from 58 participating laboratories, which included partial reporting from some laboratories. 24 laboratories reported results from analysis of Korean RMs.

Early analysis of obtained results compared with the results obtained previously (i.e. 2012) makes it clear that the level of internal consistency is high for laboratories participating in both inter-comparison experiments. However, poor inter-laboratory

comparability emerged from the same analysis and still significant discrepancies between results from different laboratories exist, at least for some of the participants.

Standard deviations of determinants are one order of magnitude larger than homogeneity of the samples distributed. One major conclusion from this analysis is that the use of CRMs will greatly improve comparability of nutrient data among the laboratories in the world. Another positive conclusion is that although standard deviations are relatively large, median/mean of each sample for all groups showed good agreement with certified values of the samples within their SDs. This implies that majority of the participating laboratories have good capability to measure nutrients concentration in seawater, and using CRMs will further improve the consistency of obtained data of different groups worldwide and will allow for the results to be SI traceable.

Michio stated that despite the positive outcome of the recent inter-comparison study, there is more progress to be made to ensure comparability of oceanic nutrients data in the world. Therefore, he proposes that IOCCP in collaboration with JAMSTEC will co-organize another inter-comparison study using SCOR-JAMSTEC CRMs. Proposed timeframe would be late 2016 – early 2017 and organizational structure would mimic that employed in the 2014/2015 inter-comparison study.

### **GO-SHIP manual re-write by SCOR WG 147**

One of full members of the SCOR WG147 (COMPONUT) is leading a re-write of GO-SHIP nutrients manual published by Hydes et al. in 2010. An outline was already accepted by the SCOR WG 147 and draft of the manual will be prepared before October 2016. The main updates will be presented at the CLIVAR Open Science Conference in Qingdao, China in September 2016 and will be discussed during an annual meeting of SCOR WG147 taking place during the CLIVAR meeting.

### **Discussion and action items**

The Panel congratulated the nutrients group for their continuing efforts towards increasing the quality of nutrients measurements and inter comparability of the data. Based on the report, which will be published in the first half of 2016, it was suggested that participating labs be contacted for feedback on the inter-comparison experiment. Perhaps a short questionnaire should be developed where participating labs could (perhaps anonymously) provide feedback on the usefulness of the exercise, suggest improvements, comment on the logistics etc. IOCCP SSG also agreed to support the organization of and contribute financially to the follow-up inter-comparison activity to be performed about 1 year after publication of the report from the 2014 inter-comparison. Finally the discussion turned to the fact that a rather sudden rise in the number of available CRMs for nutrients might cause confusion amongst users. Also the quality of some materials is not very well verified. There might be more interest in developing CRMs in the future and the community might end up with a whole suite of nationally developed materials and no way to compare them or cross-reference them. A discussion within the COMPONUT was proposed and a joint activity between interested organizations might have to be developed in order to ensure consistency and clarity.

### **ACTION ITEM 27**

Publish the 2014 Nutrient Inter-comparison study report. (*Responsible: Aoyama, IOCCP Office. Timeframe: June 2016. Financial Implications: None*)

### **ACTION ITEM 28**

Develop and distribute a questionnaire asking laboratories participating in the two most recent inter-comparison studies for feedback on various aspects of the exercise. (*Responsible: Aoyama, Tanhua, IOCCP Office. Timeframe: Receive feedback within 6 months after publication of the 2014 Inter-comparison report. Financial Implications: None*)

### **ACTION ITEM 29**

Support the organization of and contribute financially to the follow-up inter-comparison activity to be performed about 1 year after publication of the report from 2014 inter-comparison (*Responsible: Aoyama, IOCCP Office. Timeframe: June 2017. Financial Implications: Low to Medium*)

### **ACTION ITEM 30**

Update the relevant page on the IOCCP website including careful analysis of existing and missing content as well as connections to resources available elsewhere. (*Responsible: Aoyama, Tanhua, Palacz) Timeframe: Before next SSG meeting. Financial Implications: None*).

## **9. Update and Vision for Instruments and Sensors**

Douglas Connelly presented this item, with input from Maciej Telszewski on the IOCCP Sensors Summer Course. As a new SSG member Doug initially focused on introducing his area of expertise and described his past, current and planned activities in the context of his role in the IOCCP. A summary of that part of Doug's presentation is captured in the form of a bio sketch on IOCCP website in the Contacts tab. Doug then moved onto presenting what he proposes as his initial task within the IOCCP.

There have been exciting developments in the field of sensors and technology over the last 12 months. The Wendy Schmidt Ocean Health XPRIZE to develop a durable in situ sensor for ocean pH was awarded to Sunburst Sensors. Their commercially available SAMI-pH demonstrated accuracy in measurement during a series of tests and also won the award for affordability. The newly launched Shell ocean discovery XPRIZE competition is aimed at the development of new rapid unmanned ocean exploration tools, the prize has been augmented by a \$1 million bonus from NOAA for systems that can 'sniff out' a target using biological or chemical sensors.

There are a large number of existing and upcoming EC funded collaborative projects in the field of marine technology that are aiming to develop the next generation of marine sensors. These projects are not limited just to pH and the other carbon system parameters but nutrients, contaminants and optical properties. These projects are either specifically aimed at sensor development; such as those funded under the 'Oceans of Tomorrow' call, or projects with a high level of technology development in them e.g. AtlantOS and the upcoming STEMM-CCS project. A review of the projects below highlights some of the aims of the projects.

## Oceans of Tomorrow

([http://ec.europa.eu/research/bioeconomy/pdf/ocean-of-tomorrow-2014\\_en.pdf](http://ec.europa.eu/research/bioeconomy/pdf/ocean-of-tomorrow-2014_en.pdf))

Whilst the projects funded under the OoT are broad ranging there is one topic that is specifically directed towards marine sensing technology. From this topic four projects: Common Sense, NEXOS, SCHeMA and SenseOCEAN, are developing sensors for the carbon system. The overall aim of each project is to produce sensors that have been demonstrated in 'real-life' environments by the end of the project, and have a clear path to commercial production.

SenseOCEAN : <http://www.senseocean.eu>

Common Sense: <http://www.commonsenseproject.eu>

NEXOS: <http://www.nexosproject.eu>

SCHeMA: <http://www.schema-ocean.eu>

## AtlantOS

As part of the AtlantOS project (<https://www.atlant-os-h2020.eu>) there is a dedicated Work Package on cross-cutting issues and emerging networks. Some of the tasks identified are relevant to the work of the IOCCP; in particular, there is a task on developing a Sensor and Instrumentation Roadmap. This is described as a report that includes a ten-year roadmap for strategic development of sensor and instrument technology. This task is led by the National Oceanography Centre in the UK (NOC) and clearly identifies technology related to ocean carbon observations. A second task, also led by the NOC, will coordinate the development of new and emerging observational activities based on horizon scanning, relevant to IOCCP is the requirement to develop roadmaps for biogeochemical networks.

## STEMM-CCS.

The "Strategies for the environmental monitoring and measurement of marine carbon capture and storage" project (<http://www.stemm-ccs.eu/>) is a recently awarded H2020 project. The project has a large component of technology development around sensors for carbon system parameters and nutrients. The project starts on 1<sup>st</sup> March 2016 and runs for 4 years.

## First International IOCCP Sensors Summer Course

The IOCCP has completed its First International Summer Course on Best Practices for Selected Biogeochemical Sensors (oxygen, pH, pCO<sub>2</sub>, nitrate). The course titled *Instrumenting our oceans for better observation: a training course on biogeochemical sensors* was held at the Sven Lovén Center for Marine Sciences in Kristineberg, Sweden, June 22-July 1, 2015.

In early 2014 the IOCCP decided to start a series of summer courses with the main aim to develop proficiency in the use of a suite of biogeochemical sensors world-wide and to improve the quality of the data currently generated by autonomous biogeochemical sensors. This first 10-day summer course provided 27 trainees from 14 countries with lectures, hands-on in-situ and laboratory experiences, and informal interactions to improve their knowledge on instrument know-how, troubleshooting, data management, data reduction and quality control.

For 8 months between November 2014 and June 2015, the IOCCP Project Office (1 person at that time) as well as 2 designated IOCCP SSG members were strongly



engaged in number of activities leading-up to the course. The intensity of activities increased significantly in March 2015 when participants' selection started and most of the activities listed below entered their final phase. These activities included:

- fundraising (approximately 80% of costs were covered from outside the regular IOCCP budget);
- selection of Scientific Advisory Committee (SAC) and monthly SAC meetings
- selection of specific sensor types
- development of participants selection criteria
- development of the course agenda
- advanced course logistics related to hardware shipments (biogeochemical sensors, auxiliary sensors, supporting hardware, etc.)
- local logistics at the Station (accommodation arrangements, local transportation arrangements, laboratories, meals, lecture halls)
- participants' selection process
- travel arrangements for lecturers, participants and organizers
- dealing with a large number of individual questions and requests

These activities and the Course itself consumed a significant portion of Project Office's time during March-June 2015, therefore no other activities are going to be planned around the dates chosen for the second edition of the course (at the moment proposed for June 2018). Despite this significant workload, it is clear that this activity is in high demand within our community. IOCCP received an enormous amount of outstanding applications (almost 100!) and following relatively strict evaluation process, this first course brought together a group of 27 participants from 14 countries. Many of the rejected applicants will re-apply in 2018 (based on their communication) and new applicants are already keen to ask questions related to the application process.

We were also very lucky to attract 13 excellent lecturers and 4 manufacturers, who through their dedication, hard work and unwavering enthusiasm made this course an unforgettable experience for everyone involved. Most of them have expressed their interest in teaching this course again in the future. The agenda was developed with plenaries, practical sessions, informal presentations and social time allowing our participants not only to improve their knowledge in many aspects of biogeochemical sensors observations but also to walk away from Kristineberg with an expanded network of collaborators and friends. An analysis of individual evaluation forms from lecturers and participants suggested that the course as a whole was a great experience for most of the participants, with too high intensity (most often 8am-10pm agenda) given as the only negative aspect. All the individual evaluations will be taken into account during planning of the second edition of the Course.

A more formal report based on the extensive input received during the course from lecturers, participants and manufacturers will be finalized over the coming months. We hope to turn it into a field manual for novice sensor users worldwide.

### **Discussion and action items**

Doug states that we are clearly entering an exciting time for sensors and technology that is particularly relevant to the work of the IOCCP. The group agrees that IOCCP activities related to coordination of relevant developments are highly needed. Specifically aspects like data quality protocols, observing system design, metrology and incorporating of the sensors data into already established data streams should be considered. The Panel also agreed that training of the next generation of users of

biogeochemical sensors is worth the effort invested. The Instruments and Sensors group in the IOCCP is to continue to report on existing technologies currently on the market and endeavour to link to the newly developing technologies in sensors, platforms and observing systems.

### **ACTION ITEM 31**

Finalize and publish a Sensors User Guide based on the input compiled during and after the First Sensor Summer Course. (*Responsible: Telszewski, Tanhua, Palacz. Timeframe: Boreal Fall 2016. Financial Implications: None*).

### **ACTION ITEM 32**

Prepare a proposal for the 2<sup>nd</sup> edition of the IOCCP Sensor Summer Course to be held in summer 2018. Scope, general agenda, planned outcomes and logistics and initial description of partners need to be included. It's proposed that also oceanographic platforms utilizing autonomous sensors (fixed-point vs. mobile platforms) would become part of the scope so that a system design becomes part of the skill-set in the next generation of autonomous sensors' operators. (*Responsible: Connelly, Fiedler, Tanhua, Telszewski, Palacz. Timeframe: Proposal ready for IOCCP SSG meeting 2017. Financial Implications: Low*).

### **ACTION ITEM 33**

Develop an engagement strategy for IOCCP focusing on connections between sensors developers' and sensors users' communities. Specifically, aspects like data quality protocols, observing system design, metrology and incorporating of the sensors data into already established data streams should be considered (*Responsible: Connelly, Telszewski, Palacz. Timeframe: ongoing. Financial Implications: None*)

### **ACTION ITEM 34**

Extend the functionality and content of the Instruments and Sensors' page on IOCCP website to better cater the community needs (*Responsible: Connelly, Palacz. Timeframe: On-going. Financial Implications: None*)

## **10. Update and Vision for Data and Information Access Services**

Benjamin Pfeil provided this theme, with input from Toste Tanhua on the IOCCP Position Statement on Global Ocean Biogeochemistry Data Management.

The period since the previous IOCCP SSG meeting has been very active for data managers in marine biogeochemistry. Many major achievements can be mentioned. In September 2015 SOCAT Version 3 was published in Kiel, Germany during the SOLAS OSC. Data for SOCAT Version 4 have been assembled and are being quality controlled. The SOCAT automation was very successful and essential for the data integration. GLODAP Version 2 was successfully published by the GLODAP group also with strong input from the data management team.

In January 2016 funding for the European infrastructure project ICOS (Integrated Carbon Observing System) Ocean Thematic Centre (OTC) was approved – the OTC is a joined effort between Norway and the UK, and the ICOS OTC head office is located in Bergen, Norway. This activity will change the field of data management in our

community and will lead to easier and faster access to quality controlled data by allowing for much more flexibility in staff employment and dedicating funds for infrastructure. Version tracking, implementation of controlled vocabulary, detailed documentation of quality control, NRT data visualization are just some parts that will become the norm and European developments will effect and feedback to the global marine carbon community. Additional data management personnel will be hired in Bergen and will continue to work towards global data synthesis efforts in our field.

During this reporting period many communities have been approached (GOA-ON, EMODNET, SeaDataNet and more) for cross-fertilizing and coordination. These connections will allow for harmonization and convergence of efforts leading to data interoperability of marine biogeochemistry data in the foreseeable future.

Triggered by adverse developments in the DOE/USA related to funding of data management activities lying in the center of global ocean marine biogeochemistry observing community and based on the long-lasting need to update several protocols and procedures utilized by data management system, a Position Statement was written by members of the IOCCP SSG and the former IOCCP SSG Chair, Dr. Christopher Sabine. Some emphasis in this document is placed on our current situation but the major focus is on providing the initial direction for the way forward into the future. Benjamin and Toste presented the document and asked the Panel for comments and ideally approval so that IOCCP would act on it in the coming years:

*The international ocean biogeochemistry community is mainly using and depending upon one global data center, the Carbon Dioxide Information Analysis Center ocean trace gases section (CDIAC-Oceans) at the U.S. Department of Energy's Oak Ridge National Laboratory, USA. CDIAC-Oceans provides data management support for ocean carbon measurements from Repeat Section cruises, VOS/SOOP lines, time series and moorings data, has accommodated most community requests for data archival and data access and has also actively engaged with the science community, supporting large synthesis projects like SOCAT, the LDEO Database, GLODAP, CARINA, PACIFICA and GLODAPv2. The cut of funding support for the ocean trace gases section of CDIAC puts in jeopardy the uninterrupted data management that the ocean biogeochemical data community has come to rely upon as well as the trust and recognition from the scientific community that CDIAC-Oceans has built though decades of interactions. The loss of CDIAC-Oceans will have a negative impact on ocean carbon data submissions and reduction in value added products.*

*The uncertainty of funding for CDIAC highlights the vulnerability of a system that relies too heavily on individual data managers or institutions. At the same time, it provides an opportunity to review the requirements for modern data access and data management systems that have evolved significantly during the last decades and which currently are not being met through the CDIAC infrastructure. Operational data management systems that (a) provide automated data ingestion, (b) conform to modern standards for data and metadata, (c) utilize standard vocabularies, (d) have easy-to-use data access tools, and (e) provide stable data citations are driven not only by user requirements, but also by funding and government agencies as they promote open access to data. In the discussion of CDIAC funding and the vulnerability of ocean biogeochemistry data, we see a strong opportunity to implement a data management infrastructure that can thrive in the modern world of integrated science data.*

*A modern data management infrastructure needs to be established in which existing*

*data centers (e.g. CDIAC, CCHDO, BCO-DMO, PANGAEA, NCEI) and data from various other networks (e.g. OceanSites, Argo) can be integrated through interoperable discovery and access services. This is essential for providing access to data, while at the same time ensuring that credit for data creation and data synthesis products is appropriately assigned. We propose to mimic the successful data management approach implemented for the Argo profiling float network (<http://www.argodatamgt.org>). The Argo network addresses national funding agency requirements of having data housed in specific locales by setting up two Global Data Assembly Centers (GDACs), one in the US and one in Europe. Data holdings are mirrored between the data centers and can be accessed through either one. This redundancy makes access to the data collection, by nature, more resilient.*

*We suggest establishing a system of Global Data Assembly Centers for ocean biogeochemistry (e.g. GDAC-OBGC) where two initial GDACs are established, each with specific roles and responsibilities. The two GDACS will be complementary systems that will leverage the unique capabilities of each, to provide a complete solution for data ingestion, data quality control, data access, data citation and data archival.*

*A strong focus will be on interoperable access of standards compliant carbonate system data and metadata, irrespective of where they are archived. In addition, it is paramount that support for automated data ingestion, both for real time and delayed mode sources, be integrated into the data management workflow. This is crucial to being able to keep pace with the higher volume of data now being generated by autonomous platforms. First order quality control checks built into the automated ingestion streams can further reduce the quality control burden. By providing interoperable access, and adhering to standards and conventions, this framework will make future data synthesis products and activities much more efficient than with the current non-centralized data management system.*

*Another important emphasis of the GDAC will be an external review process by ensuring that (a) data are being quality assured and controlled according to community agreed standards, (b) direct feedback is given to the data source, (c) duplicates are being identified and resulting issues are resolved, (d) metadata are complete according to community agreed best practices or existing standards, (e) data and metadata are available through interoperable services, (f) reports are made to IODE and JCOMM Committees on data management status and activities, (g) data citation practices as outlined by the Research Data Alliance (RDA) and DataCite are incorporated, (h) data requests and searches from users can be reproduced and (i) there is clear tracking of the complete data lifecycle for each dataset. The last three bullet points are often overlooked but are increasingly becoming more important to ensure that PIs get credit for data they create and that users/reviewers can reproduce the exact data requests for data that is referenced in scientific publications.*

*The implementation of the above framework will facilitate continuation of the data synthesis and assessment products such as GLODAP, SOCAT and create a foundation for additional data products, including the integration of data such as time series data and coastal data. In addition, the implementation of such a framework will support compatible efforts internationally, providing a cohesive process toward more uniform data management strategies within the ocean biogeochemistry community. In the long term, such efforts will provide a significant cost savings by reducing data management overhead as well reducing the data management burden on individual*

scientists.

## Discussion and action items

The Panel unanimously endorsed the Position Statement and supported the data and information team in their activities aimed at finding a short-term and long-term solutions so that no legacy is lost and the future data management system, while modernized, can benefit from the existing infrastructure and personnel.

### **ACTION ITEM 35**

Support and contribute to the development of activities aimed at implementing strategies described in the IOCCP Data Management Position Statement. (*Responsible: Pfeil, SSG, IOCCP Office. Timeframe: Ongoing. Financial Implications: Low to Medium*).

### **ACTION ITEM 36**

Update the relevant data and information access page on the IOCCP website including careful scrutiny of existing and missing content as well as connections to resources available elsewhere. (*Responsible: Pfeil, Palacz*) *Timeframe: Before next SSG meeting. Financial Implications: None*).

## **11. IOCCP's activities in leading GOOS Biogeochemistry Panel**

Toste Tanhua and Maciej Telszewski reported on this theme. Leadership in GOOS Biogeochemistry Panel gradually merges with the core IOCCP themes through integration of topics like development of EOVs and their Specification Sheets, strategic work on observing system design and development of targets and metrics for the observing system in relation to EOVs. All these become essential part of IOCCP's mission and each SSG member contributes to specific tasks. However, some activities require very wide overview in terms of EOVs, observing networks and observing requirements as well as good working understanding of activities undertaken by GOOS Physics Panel and GOOS Biology and Ecosystem Panel. Such activities are accomplished by calling on expertise from outside the SSG (modelling, experts on EOVs currently not "covered" by the SSG, communities of practice around certain observing network or platform and more) and include tasks which traditionally were not included in IOCCP's mission. These tasks are led by Toste and Maciej as integrators and moderators, and are logistically and financially supported by the GOOS Office.

### **Global Climate Observing System 2015 Status Report and 2016 Implementation Plan**

Toste reported on IOCCP's role in these tasks. During the past 12 months the IOCCP significantly contributed to the Status Report on the Global Observing System for Climate (available from <http://www.wmo.int/gcos>). Several IOCCP SSG members took the responsibility to lead individual sections of the Report. IOCCP's input is most significant in sections describing oceanic Essential Climate Variables (ECVs) related to biogeochemistry (nutrients, ocean acidity, carbon dioxide partial pressure, oxygen and tracers) and sections dealing with the observing networks that carry out biogeochemical observations (SOO network, GO-SHIP, biogeochemical floats, mooring arrays and ship-based time series). Additionally, IOCCP made important

contributions to an overall ocean observing section introduction and summary.

This Report tries to provide a full account of how well climate is currently being observed in support of IPCC and UNFCCC. It provides a basis for identifying the actions required to reduce gaps in knowledge (expression of which will be published as a GCOS Implementation Plan in 2016), and to assess where progress is being made, and where progress is lacking (progress against 2010 GCOS Implementation Plan is assessed). Since 2012, when the Framework for Ocean Observing identified the need for more integrated marine biogeochemistry observations, IOCCP was asked to lend its expertise and community-wide network to contribute to this multi-domain effort. Past year was when the actual report writing took place and the final product was presented during the COP 21 in Paris in December 2015.

Specific details on individual parameters and networks can be found in the Report but the very general conclusion is that observation of the ocean has progressed substantially through deployment of buoy networks, autonomous sub-surface measurement systems and space-based remote sensing, which complement longer-established and still-essential ship-based programs. It is now taking place under revised arrangements for scientific guidance and advice, provided by GOOS and its three panels, including one for biogeochemistry (led by IOCCP). The last few years have seen rapid development of chemical and bio-optical sensors, with increasing levels of readiness for deployment on Argo floats, gliders and moorings. Currently 7% of floats are equipped with oxygen sensors and a smaller number of floats measuring nitrate and pH.

Progress in recent years has also been made on data collection and support, for example through establishment of SOCAT and work towards GLODAPv2. Organization of observing activities has taken place through formation of the GOA-ON. The considerable progress made in establishing observational capabilities and systems provides a basis for reconsidering the specification of the related ECVs during preparation of the 2016 Implementation Plan (GCOS 2016 IP).

The GCOS 2016 IP is where the importance of this activity lies for biogeochemistry community. The Implementation Plan will be published in mid- to late 2016 and it is already clear that much stronger emphasis will be placed on marine biogeochemical observations for the system to be able to truly observe climate variability globally. IOCCP has a major role to play there as almost revolutionary progress was made in our observational capacity in terms of marine biogeochemistry, and a strategic utilization of these technological developments needs to be structured and aligned with the rest of global climate observing system.

The writing process has started with the first writing meeting which took place in Italy in February 2016. Toste and Bernadette Sloyan (CSIRO, Hobart, Australia) are leading the ocean part of the GCOS 2016 IP, with support from the OOPC Office and very soon from IOCCP SSG and other biogeochemistry experts. To further the development of a comprehensive GCOS IP an open conference *Global Climate Observation: the Road to the Future* was organized at the Royal Academy of Arts and Sciences, Amsterdam, Netherlands from 2-4 March 2016. It allowed producers and users of climate observations and other stakeholders the opportunity to discuss the current monitoring of the ECVs and to highlight possible new areas for ECVs. These discussions will provide a key input into the new GCOS IP. The second writing meeting is planned for May 2016.

An initial draft of the ocean biogeochemistry part of the 2016 GCOS IP has been circulated amongst the SSG members, with request for input. The GCOS 2016 IP will be published for open community review by the northern hemisphere summer 2016, and for solicited expert review before that.

### **Promoting Implementation of Multi-Disciplinary Sustained Ocean Observations based on Essential Ocean Variables**

Since the OceanObs'09 Conference, the ocean observing community has been improving coordination and collaboration amongst physical, biogeochemical and biology/ecosystem communities. Societal and scientific requirements for sustained observations have been captured in EOVs, many of which are also essential climate variables. IOCCP made significant progress in development of BGC EOVs, development of EOV Specification Sheets and made initial progress towards the development of targets and metrics for the BGC part of the observing system.

With advances in observing technology, and the definition of EOVs, clear opportunities exist to improve the coordinated planning and implementation of observing activities measuring EOVs across the three major disciplines (biogeochemistry, physics and biology). Working with GOOS Physics and Biology & Ecosystem Panels, JCOMM-OCG, GCOS, GOOS and NSF-RCN, we propose to hold a workshop in early 2017 (in Miami) where specific actions will be developed for implementation of a truly multidisciplinary observing system.

The workshop will identify priority steps forward by bringing together users of established observing networks and experts in EOVs and science in all three ocean observation disciplines.

#### Objectives of the Workshop

The major aims of the workshop are:

- Building on the established societal and scientific requirements expressed in EOVs, identify the key applications and phenomena that will benefit from co-located multi-disciplinary sustained observations
- Identify near-term innovation priorities for observing platforms and sensors to enable multi-disciplinary observations, and
- Identify programmatic and professional connections between existing and emerging observing networks that will increase multi-disciplinary observations

These will contribute to long-term objectives of improving the capability of GOOS to serve specific information needs, and to raise awareness of the foundational role of sustained ocean observations in delivering societal benefit.

#### Outcomes

Outcomes from the workshop, based on specific exemplars, will be a clear series of actions with related milestones and metrics for efforts of collaborations across disciplines and observation platforms. These will be focused through actions that fall within current funded activities or actions with clear paths for resources and consistent with identified EOVs. These will be documented in proceedings.

### Organizing Committee

Nic Bax (GOOS Bio-Eco Panel), Mark Bourassa (GOOS Physics Panel), Albert Fischer (GOOS Director), Katherine Hill (GOOS Physics panel, GCOS), Bob Houtman (NSF), David Legler (JCOMM-OCG, NOAA), Eric Lindstrom (GOOS Co-Chair, NASA), Jay Pearlman (NSF-RCN), Samantha Simmons (GOOS Bio-Eco Panel), Bernadette Sloyan (GOOS Physics Panel), Toste Tanhua (IOCCP), Maciej Telszewski (IOCCP).

### **Discussion and action items**

The Panel agreed that these two comprehensive presentations were very informative. The work that IOCCP does in its role in GOOS gives our efforts a clear path to implementation through input to formal conventions and strategies utilized by policy makers and decision makers globally. Our clearly beneficial strong connection with GOOS was supported and proposed activities accepted. It was noted that most probably several SSG members will attend the planned EOJ workshop and therefore it would make sense to organize the next SSG meeting at the same time.

#### **ACTION ITEM 37**

All SSG members to provide input to the GCOS 2016 IP when requested by the writing team. (*Responsible: Tanhua, IOCCP SSG. Timeframe: On-going. Financial Implications: None*)

#### **ACTION ITEM 38**

Co-organize and co-sponsor the multidisciplinary EOJ workshop planned for February 2017. (*Responsible: Telszewski, Palacz, Tanhua, SSG. Timeframe: On-going. Financial Implications: Low to Medium*)

#### **ACTION ITEM 39**

Plan for the next IOCCP SSG meeting to be held in conjunction with the GOOS EOJ workshop in February, 2017 in Miami. (*Responsible: Telszewski, Palacz, Wanninkhof. Timeframe: ongoing. Financial Implications: Medium to High*)

## **12. Project Office and general administration**

### **New Project Officer**

We are very pleased to announce that after more than three years of fundraising we have been able to appoint a new IOCCP Project Officer! We had announced the position in August 2015 and within a month of application period we received a somewhat surprisingly large number of outstanding applications. The final decision was made in early October 2015 and Dr Artur Palacz has been appointed effective 1 January 2016.

Artur holds a B.Sc. in Geosciences & Astrophysics from Jacobs University in Bremen, Germany (2006) and a Ph.D. in Oceanography from the University of Maine in Orono, Maine, USA (2011). He took advantage of this transdisciplinary education to explore innovative approaches to combining multi-platform ocean observations with ecosystem model results while contributing to numerous national and international, regional and global projects. His scientific interests and contributions range from cold-water coral biology and trace metal biogeochemistry, through ecosystem modeling, to the development of decision-support tools for marine resource management. As an



oceanographer he gained a broad perspective on a critical issue of data collection and synthesis, which often hinders the development of reliable biogeochemical and ecosystem model projections needed to provide scientific advice to local, regional and global ocean management – a perspective lacking so far from the IOCCP Project Office.

In his most recent employment as a researcher at the National Institute of Aquatic Resources, Technical University of Denmark (DTU-Aqua), Copenhagen, Denmark (2012-2015), Artur gained experience in coordinating international and cross-sector data synthesis efforts (EU VECTORS project) and designing decision-support tools (EU EURO-BASIN project for the North Atlantic). He has also been providing scientific advice to three working groups of the International Council for the Exploration of the Sea (ICES).

Very broadly, at IOCCP Artur will contribute to our mission of coordination and communication services for carbon and biogeochemistry observing community. You will hear from him via email ([a.palacz@ioccp.org](mailto:a.palacz@ioccp.org)) and over time via other means of communication.

### **Rotations of SSG members**

The following members rotated off at the end of 2015:

1. Laura Lorenzoni (Time Series)

*Decided to step down at the beginning of the second term due to over-commitment and change in employment status.*

2. Todd Martz (Instruments and Sensors)

*Decided to step down at the beginning of the second term due to over-commitment.*

The following colleagues accepted our invitation and joined the SSG in January 2016:

1. Dr Björn Fiedler (Kiel, Germany) assumed responsibilities related to Time Series Efforts.
2. Dr Douglas Patrick Connelly (Southampton, UK) assumed responsibilities related to Instruments and Sensors.
3. Dr Cristian A. Vargas (Concepcion, Chile) to strengthen IOCCP's coordination in Latin and South America through Ocean Acidification – related activities.
4. Dr Siv Kari Lauvset (Bergen, Norway) to strengthen IOCCP's coordination in Ocean Interior Synthesis Activities allowing for an overlap with Are Olsen who will rotate off at the end of 2016.

### **IOCCP ToR update**

In order to fulfil the mission of providing technical services to the community efficiently, the IOCCP needs to acknowledge the relevance multiple stressors on the marine environment, widely recognised by marine biogeochemists, especially those concerned with climate-related issues. For scientific and financial reasons observations become multidisciplinary, as do platforms. The current IOCCP Terms of Reference (ToR) need to be updated to reflect the expansion of IOCCP efforts beyond carbon to include biogeochemical parameters closely related to the carbon system like

nutrients and oxygen and, in time, IOCCP needs to connect to the rest of biogeochemical EOVs. This is also necessary to align the IOCCP ToRs with its leading role in the Framework for Ocean Observing.

Tanhua and Telszewski will draft and update the current ToRs. The SSG will be given adequate time to familiarize themselves with the updated document and the SSG will discuss it during one of the Virtual Meetings. The SSG will then submit the proposed changes for approval by IOCCP sponsors.

### **IOCCP Website**

The IOCCP Office asked the SSG members to try and make a stronger effort to take ownership of their dedicated thematic pages on IOCCP website. Individual teleconferences will be scheduled with each SSG member to discuss and update the relevant page on the IOCCP website including careful analysis of existing and missing content as well as connections to resources available elsewhere. Also all SSG members were asked to review the standards and methods page and provide input if the information provided is not up-to-date.

### **IOCCP annual cycle including publishing of IOCCP Conveyor**

The SSG was presented and approved the IOCCP annual cycle proposed by Telszewski. The cycle consists of 3 quarterly Virtual Meetings (focused on 1-3 specific tasks) and one in-person annual SSG meeting. The SSG and Project Office will produce material for 4 quarterly *IOCCP Conveyors* to be published during each inter-sessional period (around 2-4 weeks after each meeting). The IOCCP office will try to introduce a couple of thematic series in IOCCP Conveyor and one will include an overview of a selected IOCCP theme which in turn will require significant and coordinated input from the SSG.

Dates of an in-person meeting will continue to depend on SSG's participation in other thematic meetings to reduce travel time and costs, however it is recommended that the SSG meets at the end or at the beginning of a calendar year rather than in the middle of a calendar year.

### **Annual cycle for 2016-2017**

#### **Meetings**

VMQ2 – Doodle for 16-27 May  
VMQ3 – Doodle for 6-9 September  
VMQ4 – Doodle for 21 Nov. - 2 Dec.  
In-person meeting: 6-7 February 2017

#### **IOCCP Conveyor**

Conveyor out 6-10 June  
Conveyor out 12-16 Sep.  
Conveyor out 5-9 December  
Conveyor out 20-24 Feb 2017

*VMQ2 – Virtual Meeting in the second quarter of 2016*

### **Budget and fundraising activities**

The IOCCP Project Office support is provided by the US National Science Foundation (NSF) through a grant to SCOR, and by the European Commission through the Horizon 2020 project AtlantOS. A new 3-year grant from NSF was approved and started on 1 September 2015. AtlantOS funds for a Project Officer is available for 3

years starting on 1 January 2016. Generous in-kind support for the Project Office is provided by the Institute of Oceanology of Polish Academy of Sciences (IO PAN).

In 2015-2016 program support for IOCCP activities comes from three sources:

- NSF through a grant to SCOR
- IOC-UNESCO through GOOS Project Office.
- EU Horizon 2020 AtlantOS Project.

The IOCCP action items are assigned a financial implication level based on “low” (<\$5,000), “medium” (<\$10,000), and “high” (<\$15,000).

Fundraising activities continue to be important for the IOCCP Office and the SSG. SSG members agreed that a general draft IOCCP proposal should be prepared and available for editing to the SSG. The SSG is urged to actively look for potentially suitable calls for proposals and when a relevant one comes up an (a series of) ad-hoc virtual meeting(s) should be organized to compose a specific text bringing IOCCP’s expertise to a specific call. Also, fund-raising for specific activities (like the IOCCP Sensors Course) proves to be a very efficient way of forwarding program’s agenda.

#### **ACTION ITEM 40**

Draft a formal letter of gratitude for members rotating off. *(Responsible: Telszewski, Palacz. Timeframe: Mid-2016. Financial Implications: None)*

#### **ACTION ITEM 41**

Draft an update to the IOCCP ToRs. *(Responsible: Tanhua, Telszewski, Palacz. Timeframe: mid 2016. Financial Implications: None)*

#### **ACTION ITEM 42**

Submit the updated ToRs to IOCCP sponsors for approval. *(Responsible: SSG. Timeframe: End 2016. Financial Implications: None)*

#### **ACTION ITEM 43**

Enable website statistics software for each page of IOCCP website. *(Responsible: Telszewski. Timeframe: June 2016. Financial Implications: None)*

#### **ACTION ITEM 44**

Draft a generic IOCCP proposal. *(Responsible: Telszewski, Palacz, Tanhua. Timeframe: End of 2016. Financial Implications: None)*

#### **ACTION ITEM 45**

Continue active participation in proposal writing and fundraising for specific activities. *(Responsible: Telszewski, Palacz, Tanhua, SSG. Timeframe: Ongoing. Financial Implications: None to Low)*

# Meeting Agenda

## **8.30-9.00:**

### ***Arrival and Setup***

- 9.00-9.10: Opening and Welcome (Toste)
- 9.10-9.20: Introductions (Everybody)
- 9.20-9.30: Local Logistics (Maciej)
- 9.30-9.50: Underway CO<sub>2</sub> Observations (Rik)
- 9.50-10.10: Synthesis Activities: Surface Ocean (Kim)
- 10.10-10.30: Ocean Interior Observations (Rik for Masao)
- 10.30-11.00: Synthesis Activities: Ocean Interior (Are)

## **11.00-11.30:**

### ***Coffee Break***

- 11.30-12.00: Recap IOCCP/GOOS Biogeochemistry (Toste)
- 12.00-12.30: Current status of biogeochemical EOVs (Maciej)
- 12.30-13.30: Updates from programs:
  - TPOS (Dick)
  - AtlantOS (Maciej)
  - IMOS (Maciej)
  - IG3IS and GEO Carbon Flagship (Toste)

## **13.30-14.00:**

### ***Lunch Break***

- 14.00-14.30: Time Series Efforts
- 14.30-14.50: Ocean Acidification
- 14.50-15.10: Nutrients
- 15.10-15.30: Data and Information Management

## **15.30-16.00:**

### ***Coffee Break***

- 16.00-16.30: Instruments and Sensors
- 16.30-17.40: Update on Project Office and SSG developments 2015-2016
  - Activities funded and organized since April 2015
  - Current budget and actions for 2016-2017
  - Useful links to web-based tools etc.
  - Website activity
  - New staff in IOCCP Office
  - Rotations of SSG members and IOCCP themes
  - GOOS BGC Panel Composition
- 17.40-18.00: Summary of action items and closing remarks

## **~19.00:**

### ***IOCCP dinner***