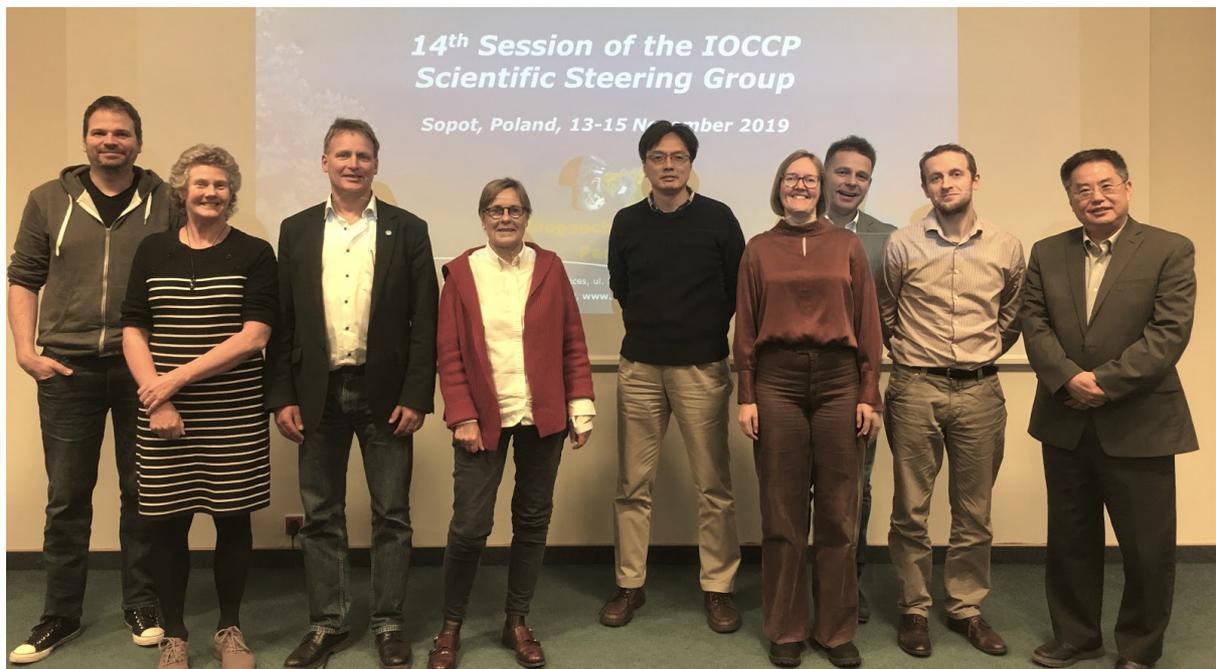




XIV Session of the International Ocean Carbon Coordination Project Scientific Steering Group & Global Ocean Observing System Biogeochemistry Panel of Experts (IOCCP-SSG-14)



Institute of Oceanology Polish Academy of Sciences (IO PAN), Sopot, Poland, 13-15 November 2019

REPORT



United Nations
Educational, Scientific and
Cultural Organization



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SSG for 2019 and Participants List

IOCCP SSG Co-Chairs Masao Ishii and Kim Currie extended their welcome to the SSG and guests, noting that several SSG members were unable to attend the meeting in person. The full list of attendees is provided in Tables 1 & 2 below.

Table 1. 2019 SSG member composition and annual meeting attendance

Name (Gender)	Home institution	Country of residence	Expertize (Role)	Attendance
Kim Currie (F)	NIWA	New Zealand	Ocean acidification (Co-Chair)	attended
Masao Ishii (M)	JMA-MRI	Japan	Ocean interior observations (Co-Chair)	attended
Veronique Garçon (F)	LEGOS	France	Oxygen	attended
Benjamin Pfeil (M)	UiB	Norway	Data & information access services	attended
Siv Lauvset (F)	NORCE	Norway	Synthesis activities	attended
Björn Fiedler (M)	GEOMAR	Germany	Time series efforts	parts attended remotely
Rik Wanninkhof (M)	NOAA-AOML	USA	Surface CO ₂ Observations	parts attended remotely
Cristian Vargas (M)	Univ. Concepcion	Chile	Ocean acidification	parts attended remotely
Douglas Connelly (M)	NOC	UK	Instruments and sensors	not attended

Table 2. Project Office staff and additional meeting participants

Name (gender)	Home institution	Country of residence	Role	Attendance
Maciej Telszewski (M)	IOCCP/IOPAN	Poland	Project Director	attended
Artur Palacz (M)	IOCCP/IOPAN	Poland	Project Officer	attended
Fei Chai (M)	Univ. Maine/SIO	USA/China	Invited expert	attended (1 st day)
Toste Tanhua (M)	GEOMAR	Germany	GOOS Co-Chair	attended (1 st day)

Meeting Report

The meeting took place over the course of 2.5 days from 13 to 15 November 2019, and was held at the Institute of Oceanology of the Polish Academy of Sciences (IO PAN) in Sopot, Poland. It is worth noting that the meeting was directly preceded by an Oxygen Data Portal Scoping Workshop - a direct execution of *Action Item #10* as agreed and detailed in the report from [IOCCP-SSG-13](#). Co-location of the two meetings led to a significant reduction of travel costs and allowed IOCCP to invite two experts external to SSG to attend relevant parts of the IOCCP SSG annual meeting.

On behalf of the IOCCP Executive, Kim Currie opened the meeting with an overview of the agenda, attached as [Appendix 1](#). Below is a report from items presented and discussed during the meeting, starting from summary of IOCCP accomplishments in 2018-2019, followed by IOCCP Themes and other business. The order of sections in the report does not necessarily reflect the order of the items shown in the meeting agenda.

IOCCP accomplishments in 2018-2019

Masao Ishii presented a summary of IOCCP accomplishments from 2018-2019, with a focus on key outcomes which had the biggest impact with respect to the [IOCCP Terms of Reference](#). Below is a list of selected accomplishments as presented by Masao. Each of these points was later elaborated on during sessions relevant to individual IOCCP themes.

IOCCP ToR #7: Training Activities / ToR#8,9: FAIR data

- IOCCP & BONUS INTEGRAL Training Course on a Suite of Biogeochemical Sensors
- AtlantOS workshop on Underway and Sensor CO₂ Data and Metadata QC Procedures
- Global Ocean Oxygen Network (GO₂NE) Summer School

IOCCP ToR #8,9: FAIR, open and quality controlled data

- Supporting data synthesis of Inorganic Carbon EOVS products through SOCAT and GLODAP
- Supporting the Global Ocean Acidification Observing Network Data Portal and phenomena-based products (ocean acidification)
- Developing a roadmap towards an Oxygen Data Portal and phenomena-based products (deoxygenation)
- Development of the Marine BGC Global Data Assembly Centre (GDAC)

IOCCP ToR #1.2: Observing system implementation

- Expansion of coordination activities onto new Biogeochemistry EOVS

IOCCP ToR #2.6: Fit-for-purpose BGC observing system

- IOCCP partnership with the modelling community
 - Surface Ocean pCO₂ Mapping intercomparison (SOCOM)
 - Towards ocean biogeochemistry data model assimilations

- Contribution to the synthesis and intercomparison of ocean carbon uptake in CMIP6 models
- IOC WG on Integrated Ocean Carbon Research (IOCR)
- Contribution to the Global Climate Observing System (GCOS)

IOCCP ToR #3.4: Goals, Metrics, Standards and Best Practices

- SDG Target 14.3: Minimize impacts of ocean acidification

Significant contribution to the OceanObs'19 Conference and Community White Papers - pertaining to virtually all IOCCP Terms of Reference.

During this session, IOCCP SSG briefly discussed several issues which were brought up in connection to activities attended to in the previous 12 months. Concluding and/or actionable remarks from these discussions are reported in thematically relevant sections of this report. A couple of programmatic issues were also discussed. Firstly, the SSG discussed the unsuccessful SCOR WG proposal “DiagnoSis of Carbon in the Ocean: Variability, unceRtainty and the Coasts” ([DISCOVER-C](#)) which was another attempt to expand the activities initiated through the [SOCOM project](#) with the goal of ultimately reducing the 5% imbalance in the carbon budget. Masao, who represented IOCCP at the [2019 SCOR Annual Meeting](#), informed the group that the proposal was evaluated positively but marginally missed the funding cut off. Siv Lauvset, a member of Discover-C, informed the SSG that the group will submit a proposal to become a [US OCB working group](#), benefiting from the rich feedback received from SCOR over the past 2 years. In January 2020, US OCB announced funding the new OCB WG “Filling the gaps in observation-based estimates of air–sea carbon fluxes.” The principle investigators of this group are: Galen McKinley, Jessica Cross, Tim DeVries, Peter Landschützer, Goulven G. Laruelle, Nicole Lovenduski, Pedro Monteiro, Ray Najjar, Laure Resplandy, Adrienne Sutton, Rik Wanninkhof, Nancy Williams). IOCCP will monitor further developments in that group through SSG member Rik Wanninkhof.

Secondly, the SSG discussed the current reorganization of the World Meteorological Organization (WMO), the future of the Global Climate Observing System (GCOS) and implications of these changes for IOCCP and GOOS as a whole. In discussion with Toste Tanhua as GOOS Co-Chair, the panel welcomed the prospect of receiving greater support from WMO in the future to improve the sustainability of some key elements of the ocean observing system. Such actions would result from the organization’s greater ambition to move towards seamless Earth System prediction which depends on sustained and high quality ocean data.

GOOS 2030 Strategy and Implementation Plan

Toste presented the [GOOS 2030 Strategy](#) document which was published and officially launched on several occasions in the second half of 2019. Apart from presenting the vision and mission statements, he described the 11 strategic objectives of GOOS, and addressed the priorities for meeting them over the next decade.

As GOOS aims to deliver against climate, operational services and ecosystem health, it is also likely that GOOS will consider formulating new Task Teams that would involve members from across all GOOS Expert Panels together with representatives from partner organizations such as WMO, UN Environment and many others. Such a view is in contrast to the current situation in which single panels are nominally responsible for each of these themes. GOOS recognizes that more and broader stakeholder discussions are needed to appropriately set and review the requirements for ocean observations. Delivering against ocean health might require temperature and salinity measurements on scales and levels of uncertainty different from climate requirements. Similarly, we need to be able to set adequate requirements for plankton measurements to better deliver against climate-related objectives. Initial GOOS-driven attempts towards a more multi-disciplinary requirement setting have been taken up, for example in the case of oxygen by [GO₂NE](#) and the [VOICE](#) initiative as described in their joint OceanObs'19 Community White Paper (CWP) by [Garçon et al. \(2019\)](#).

The importance of strengthening the existing (as well as building new) partnerships was presented as the key to successful realization of the very ambitious vision for an integrated ocean observing system which meets the needs of the society. For example, in the context of ensuring efficient, sufficient and adequate delivery of data for UN SDG indicators through National Oceanographic Data Centres (NODCs), a closer engagement with IODE and WMO and its WIS data system is paramount.

Toste also pointed towards the fact that GOOS has difficulties with reaching the end users and obtaining feedback from them. Strengthening the link between the observers and so-called superusers, e.g. EU Copernicus, is seen as a critical step towards providing more sustained funding for observations which underpin the products delivered to the end users. Coastal observing communities also need to be engaged much more strongly for that purpose.

With regard to monitoring human impacts in the ocean, Toste emphasized the importance of developing the so-called Human Impact/Pressure EOVs, and referred to EU H2020 [EuroSea project](#) which will initiate this effort for Marine (Plastics) Debris. GOOS acknowledges that Marine Plastics is not within the domain of expertise of IOCCP, but at the same time recognizes that IOCCP has a long and successful track record of building partnerships with expert working groups and dedicated institutions and organizations to initiate new elements of the observing system. Thus, GOOS hopes to build on this experience in its efforts to support the global coordination of an Integrated Marine Debris Observing System (IMDOS) as envisioned in the OceanObs'19 Community White paper by [Maximenko et al. \(2019\)](#). IOCCP project officer, funded through the EuroSea project, will support the establishment of a global coordination for IMDOS.

Much of the discussion following Toste's presentation focused on the intent of the GOOS Implementation Roadmap - which is meant to be co-developed with key strategic partners of GOOS, and how this differs from a GOOS Implementation Plan - which is meant as an internal document for GOOS structures only. In the context of mapping partners and stakeholders and engaging them for particular objectives, Masao asked for GOOS to put

forward a few success stories of such partnerships having been built in the past, to go in parallel with a more systematic partner mapping exercise currently pursued by GOOS Office.

When asked on how IOCCP could better contribute to GOOS activities, Toste suggested for the panel to focus primarily on EOV-based coordination and less on platform-based coordination, which is in good command of another GOOS structure, the Observations Coordination Group (OCG).

Sponsors' Review of IOCCP

During this session IOCCP SSG was asked to draft a response to a number of recommendations put forward for IOCCP by the Review Committee appointed by SCOR and IOC-UNESCO as IOCCP Sponsors. Maciej Telszewski, IOCCP Director, first described the origins and process leading up to the review of IOCCP. It was noted that while IOCCP SSG was so far only presented with a draft review obtained in August 2019, it is expected that the final review document will not vary in substance. The draft response to the recommendations from the review will be formulated in a separate document and sent to the sponsors and the review committee, but eventually will also be added as an appendix to this report.

Post OceanObs'19 Process

This session was an open discussion on what the process of implementing recommendations from OceanObs'19 might look like. IOCCP SSG members were significantly involved in writing a number of CWPs, and moderating breakout sessions during the Conference. The SSG also heard the perspectives from Toste Tanhua as GOOS Co-Chair, as well as from Fei Chai as member of the OceanObs'19 Programme Committee.

After releasing a summary of the Conference recommendations formulated in the context of GOOS Strategic Objectives, GOOS is currently working on a comprehensive synthesis of recommendations from the great number of CWPs. As expected, the Conference discussions could not capture all the community recommendations during the various breakout sessions, with many of the CWPs actually published only after the Conference. GOOS is keen to listen to the voice of the community and work with its partners to draft the GOOS Implementation Roadmap based on the OceanObs'19 recommendations.

At the same time, there are efforts from the Conference Organizers to prepare a living action plan which would focus on identifying 'big ideas' originating from the CWPs and the Conference itself. Fei stressed the fact that one must consider the different implementation pathways of individual countries, and not think only in terms of the mechanisms functioning in Europe and North America. This challenge requires a greater consideration of the global coastal ocean. OceanObs'19 was praised for strongly pronouncing the role of indigenous knowledge in sustained ocean observing, however, the focus should perhaps be expanded onto all local populations for which the issue of sustainability is relevant on a daily basis. These local coastal populations need to be considered both as providers and users of the ocean knowledge/information. Feedback from these local populations is currently not taken up well into the process of setting and/or revising requirements for ocean measurements.

Biogeochemical observations and models: needs, roles and responsibilities

In this session we invited Fei Chai, member of the OceanPredict Marine Ecosystem Analysis and Prediction Task Team ([MEAP-TT](#)) and Biogeochemical Argo SC member, to give his perspective on what biogeochemical observations are needed to support model development, and at the same time how models can be used to optimize the observing system design. During IOCCP-SSG-13 it was recognized that IOCCP would like to strengthen its dialogue with the modelling community and through partnership foster the delivery of observational data required for the development and evaluation of biogeochemical forecasts as a new frontier in oceanography.

One of the issues highlighted in the presentation was the challenge of accounting for multiple stressors in models, even when operating on a local scale. Phenomena such as hypoxia, ocean acidification, eutrophication, harmful algal blooms and others often control the marine environment. In that context Fei presented examples of successful forecasts of nutrients, pH, oxygen and other parameters, at sites where nested models and observational assets from multiple platforms were assimilated and used to constrain the models. These models provide information in response to ocean health applications, and so can be used to derive observing requirements for ocean health monitoring.

The Argo 2020 program, with a significant expansion of deep Argo and Biogeochemical Argo was used as an example of an essential source of oceanographic data describing multiple stressors in a given location, thus being useful for climate, operational and ocean health applications. However, there are still many issues with assimilating profiling float data. Currently oxygen is the most feasible. For example, the SSG cautioned against using Biogeochemical Argo alone to constrain carbon budgets (as obtaining $p\text{CO}_2$ from pH measurements might in fact increase rather than reduce the knowledge gap).

When reviewing the observing system requirements, there will be a strong need to engage various model developing communities as users of ocean data. There are multiple modelling communities operating on national and regional levels, as well as groups with truly global representation and focus (e.g. GODAE, CMIP). Several members of IOCCP SSG attended the US OCB CMIP6 workshop in December 2018 to contribute to the process of better constraining ocean carbon budgets in global climate models. A report from this workshop is available [online](#).

Addressing the issue of IOCCP's role in coordination with the modelling community, Fei indicated the need to promote the availability of metadata and quality control information to benefit modellers building or evaluating their ocean forecasts. On the other hand, there are examples of the modelling community successfully providing guidance to the observing networks/programs. For instance, the design of the [SOCCOM](#) array of profiling floats was based on the results of Observing System Simulation Experiments (OSSEs).

In early 2020, following the open call closed on 10 November, IOCCP will appoint a new SSG member who would be responsible for engaging with the modelling communities for the purpose of more efficient and authoritative EOVS-based process of setting requirements for the integrated ocean observing system.

Ocean Best Practices System

Maciej gave a brief summary of activities related to the Ocean Best Practices System (OBPS), including a workshop held in December 2018, and the approval of OBPS as an IOC Working Group.

In the last 2 years a number of key best practices have been compiled in one still-growing repository (<https://www.oceanbestpractices.org/>). These best practices have been developed through a formal and semi-formal community review process, and adopted as 'global' methods by the relevant ocean observing network or community. They can be viewed as globally recognised best practices that have undergone a rigorous process of community review and consensus building for the specified application, region, Essential Ocean Variable or Essential Climate Variable, and/or observing platform and sensor. The OBPS encourage these communities to develop best practices across the lifecycle of the observation, from mission design through to delayed mode quality control. These broadly adopted community best practices can be viewed as tested methods that are fit for the purpose defined and fully satisfy the definition of a best practice, as "a methodology that has repeatedly produced superior results relative to other methodologies with the same objective - to be fully elevated to a best practice, a promising method needs to be adopted and employed by multiple organizations."

The vision of the OBPS is to have agreed and broadly adopted methods for every activity in ocean observing from research to operations to applications. The OBPS supports the entire ocean community in sharing methods and facilitates the process of developing and improving best practices. The OBPS allows discovery and access to relevant and tested methods, from observations to applications and supports community building through peer review opportunities and training. Users of the OBPS have identified the importance of being able to discover best practices which are recommended and adopted by the GOOS/JCOMM OCG community. Thus, the GOOS, JCOMM OCG, OBPS collaboration aims to endorse and then highlight such best practices within the OBPS, for easier discovery and access to these key methods.

Maciej presented the proposal for GOOS Endorsement Process for best practices submitted to OBPS. As more best practices become available in the OBPS repository, there is a pressing need to help identify key community tested and adopted best practices across a wide range of application areas. The GOOS endorsement process will hopefully do this for best practices related to ocean observing. To be endorsed by GOOS, a best practice is expected to be beyond the « concept » maturity level, to be relevant to the ocean observing community, for example by covering survey design and/or planning a standardized method to acquire the data, and to be widely used and accepted. Once the Best Practice has been endorsed through this system, it will be tagged and searchable in the OBPS.

In order to ensure that the endorsement is consistent, reliable and efficient, a process is being developed. Once this process is approved, it will be implemented and most probably used by other organizations to endorse practices in their respective fields. A number of steps are suggested for the GOOS and JCOMM OCG ocean observing network communities to endorse what are considered the best practices for recommendation to the broader community via the OBPS repository. Once a best practice is created or identified, the focal point of the GOOS Endorsement Task Team (ETT) will liaise with the creator and provide instructions and the most recent best practice metadata sheet for completion. Once complete to satisfaction, the best practice will be sent to the ETT for distribution. After endorsement, information will be sent to the best practice creator who can then complete the GOOS endorsement sheet, which is checked by the ETT. The best practice is submitted to the repository by the creator and a DOI is issued. Automated information linked to the DOI is sent out and information is communicated via the best practice newsletter.

Finally Maciej asked the SSG to provide feedback on the current draft of the Best Practice Metadata Sheet. During the technical discussion around the metadata sheet, the SSG made the following comments and suggestions:

- Suggest adding another entry under “Best practice type” or clarify how to classify a resource such as GOA-ON in a Box.
- Code scripts (for example for QC routines) should be submitted but not as stand-alone resources but rather as part of a standard operating procedure or another type of best practice.
- Each piece of code should be annotated with relevant tags.
- It is unclear why a separate field for SDGs was needed.
- Dropdown menus are needed for most if not all fields.
- Replace sensors with Instruments/Sensors

Furthermore, the SSG recommended that there should only be one OBPS website (oceanbestpractices.net vs oceanbestpractices.org) thus avoiding confusion as to which one should be used. The Panel expressed their concern at who is going to be tasked with filling the BP Metadata Sheets for GOOS endorsement. The SSG decided that they will not be responsible for filling out the Data Sheets.

Action Item #1_SSG-14

Provide IOCCP SSG feedback to Ocean Best Practices System on the GOOS endorsement process and Document Data Sheet.

Responsible: Maciej Telszewski

Timeline: immediate

Financial implications: none

Status: Feedback was delivered during the OBPS workshop in December 2019.

IOCCP SSG rotations

Review of IOCCP SSG member applications

The SSG reviewed the applications submitted for two new SSG positions advertised through an open call, closed on 10 November. The SSG identified two outstanding candidates whom they would like to nominate to IOCCP sponsors. Upon their approval by the sponsors, they will take charge of among other things: (i) coordination of Particulate Matter EOVS observations, and (ii) coordination between marine biogeochemistry observationalist and modelling communities.

Action Item #2_SSG-14

Present nominations of two new SSG members to the sponsors of IOCCP, and request approval for their first terms to start in the first quarter of 2020.

Responsible: Maciej Telszewski

Timeline: immediate

Financial implications: none

Nutrients and Instruments and Sensors Themes

The SSG asked the IOCCP Exec to perform a thorough analysis of the IOCCP Skills, Roles and Responsibilities Matrix following the appointment of the two new members and provide recommendation(s) on IOCCP's approach to future curation of the Nutrients EOVS and general coordination of inorganic nutrients observations. This position remains vacant and related issues are tentatively a responsibility of IOCCP co-Chair, Masao Ishii.

Action Item #3_SSG-14

Develop a strategy for curation of the Nutrients EOVS and general coordination of inorganic nutrients observation.

Responsible: Step 1: IOCCP Exec, Step 2: IOCCP SSG

Timeline: 2nd quarter 2020

Financial implications: none

IOCCP SSG decided to strengthen its capacity to coordinate and communicate with users of biogeochemical Instruments and Sensors including technical capacity building through organizing next editions of a very successful bi-annual training course. The SSG decided to issue an open call in early 2020 and hopefully appoint a new SSG member in time for initial preparation for the 2021 Training Course (Action Item #6_SSG-14).

Changes to SSG Terms of Reference

The SSG discussed the fact that according to the current Terms of Reference for members of the IOCCP SSG, our co-Chair (Masao Ishii) should rotate off the group at the end of 2019. However, since Masao has only been the Co-Chair for the past 3 years, the SSG suggested that it would be more beneficial for IOCCP now and into the future, if Masao (and every new co-chair) had the choice of serving two terms on this position regardless of the duration of their earlier service as an IOCCP SSG member. The suggestion was grounded on the fact that it takes a considerable amount of time to acquire sufficient level of understanding and experience needed to efficiently steer the group. This effort, if made for a 3-year term, would not be seen worthwhile for either the prospective Co-Chair, or IOCCP for which leadership stability relies on infrequent co-chair rotations. Therefore, SSG approved the notion to change the SSG Terms of Reference to allow Co-Chair to serve for up to 6 years.

Action Item #4_SSG-14

Update the SSG Terms of Reference to allow IOCCP SSG Co-Chair to serve for up to 6 years and thus a maximum of 12 years on IOCCP SSG.

Responsible: Maciej Telszewski

Timeline: immediate

Financial implications: none

SSG member terms ending in 2019 and 2020

The SSG approved the IOCCP Executive proposal to extend by 1 year the second term of Benjamin Pfeil as SSG member. This decision was motivated by the fact that the work on creating the Biogeochemistry Global Data Assembly Centre (GDAC), initiated and coordinated by Benjamin for the past several years, is nearly complete and that it would be highly beneficial for both IOCCP and the GDAC effort to ensure Benjamin's position as IOCCP SSG member until the end of 2020.

Action Item #5_SSG-14

Extend the 2nd term of Benjamin Pfeil as IOCCP SSG member by 1 year, effectively until the end of 2020.

Responsible: Maciej Telszewski

Timeline: immediate

Financial implications: none

At the same time, the SSG had a comprehensive discussion on the roles and responsibilities that the new SSG responsible for Data and Information Access Services should have. It was

suggested that pending the establishment of the GDAC, IOCCP's future focus in this theme could be broadened onto many emerging issues related to global data management. The group decided to draw from the decadal visions and recommendations presented at the OceanObs'19 Conference and through many relevant CWPs, and hold additional consultations prior to releasing a call for applications for this position in late 2020.

It should also be noted that Rik Wanninkhof's second term as IOCCP SSG member also finishes in 2020, and that appropriate measures should be taken to ensure a new SSG member is appointed at the start of 2021.

Action Item #6_SSG-14

Release an open call for new SSG members who would replace those rotating off at the end of 2020 and also provide additional expertise where it is currently lacking (e.g. Nutrients observations including land-ocean and coastal zone issues, sensor technology, technical training).

Responsible: The IOCCP Office

Timeline: Jan-Mar and Oct-Nov 2020

Financial implications: none

Dissolving the original GOOS Biogeochemistry Panel formed in 2012

During 2019 it was brought to the attention of the Office that there was insufficient communication with some experts initially invited to join the GOOS Biogeochemistry Panel at its inception in 2012. Since IOCCP had formally assumed the role of GOOS Biogeochemistry Panel of Experts, the modus operandi has been to gradually invite members of that original panel to formally join the IOCCP SSG and take up responsibility for the non-carbon biogeochemistry EOVs. However, we have never officially dissolved that initial Panel (put together mainly to develop the biogeochemical EOVs and their specification sheets) leaving several international experts in an apparent limbo as to their role on the GOOS Biogeochemistry Panel. While acknowledging the experts' contributions in the early stages of the Panel formation, Maciej will inform those experts about the disbanding of that Panel.

Action Item #7_SSG14

Inform experts from the initial GOOS Biogeochemistry Panel set up in 2012 about the official disbandment of the panel, and its gradual incorporation into the IOCCP SSG.

Responsible: The Office

Timeline: Early 2020

Financial implications: none

Surface CO₂ Observations Theme

The international coordination of surface water CO₂ measurements from ships and moorings under auspices of IOCCP has made continued progress and advances during the intersessional period. Since at the 12th Session of IOCCP SSG the underway pCO₂ and mooring based activities were merged under a single theme of surface water measurements, the focus of the activity has evolved from platform- to variable-based. The groups performing high quality measurements continue to tighten their ties under the still semi-formal observing network, called SOCONET (Surface Ocean CO₂ reference Observing NETwork, www.soconet.info). The SOCAT effort remains the central focal point of data collation and quality control efforts for surface water CO₂ measurements and several augmentations are under discussion. As part of SOCONET effort, we have tested and are establishing protocols to quality control air XCO₂ measurements, and we are improving quality control procedures of temperature and conductivity/salinity measurements.

Below we provide an overview of action items that include new suggestions along with updates on the standing issues based on the report from [IOCCP-SSG-13](#).

Status of past action items

Action Item #19_SSG-13: Attend the Biennial WMO/IAEA meeting on Carbon Dioxide, other greenhouse gases and related tracer measurement techniques (GGMT-19), Korea, Jeju Island, 1-6 September 2019.

Rik Wanninkhof was not able to attend but the presentation, *Implementing Atmospheric CO₂ Measurements from Ships of Opportunity* by Rik Wanninkhof, David R. Munro, Colm Sweeney, Tim Newberger, Denis P. Pierrot and Kevin Sullivan was presented by Colm Sweeney (NOAA/ESRL, USA). The work describes the need for atmospheric CO₂ measurements for better air-sea flux estimates and inverse model constraints. The presentation showed the strategy to determine the quality of current shipboard measurements along with the first checks. The preliminary results show that with appropriate filtering and QC, air XCO₂ measurements from current underway pCO₂ systems are accurate to within 0.2 ppm. Presentations presented at the workshop will be posted at nims.go.kr/ggmt2019

Action Item #20_SSG-13: Support fundraising efforts to secure a part-time position of a SOCONET coordinator at JCOMMOPS.

SOCONET implementation is occurring in a phased approach at a longer timeline than originally planned. Funding has been secured from NOAA/OAR/CPO/OOBD to study and implement as a pilot the first phase of tracking all ships and platforms. Currently seven ships are [tracked](#).

We are currently reaching out to other SOCONET participants to share the position files from the ships and looking into using ship AIS for ships that do not relay information in real-time.

Once the acquisition and display software has been thoroughly tested, the site will be transitioned to JCOMMOPS.

Action Item #21_SSG-13: Organize a technical workshop to explore the utility of SOCONET data for surface water and profiling float pH measurements.

There has been limited interest in a narrowly scoped workshop as proposed. Several papers are being written (cf. Landshutzer, Fay, Gray and others) and the topic is actively being discussed in the SOCCOM community. It was mentioned that there is an ongoing Saildrone Inc. campaign which will shed more light on the uncertainty of Biogeochemical Argo data. The SSG agreed with the suggestion to table this action item. Reports from the Saildrone Inc. mission will be reported by Björn Fiedler and Benjamin Pfeil as both GEOMAR and ICOS-OTC are involved in this collaborative project.

Action Item #34_SSG-13: Organize a joint SOCAT-SOCONET community event (incl. technical workshop), attached to a larger conference/meeting). (Kim Currie, Siv Lauvset, Rik Wanninkhof)

Holding this workshop in conjunction with OceanObs'19 Conference was not practical because of the number of competing workshops held before and after the meeting. As there is currently no explicit interest in organizing a SOCAT community event, a possibility of organizing a SOCONET technical workshop in conjunction with an ICOS event was discussed at IOCCP-SSG-14, but with no action determined.

Action Item #24_SSG-13: Organize a workshop on the procedure for discerning anthropogenic signal in time series data, organized by NOAA by inviting the international community and link to ICOS efforts. [Possibly to be combined with Action Item 26.] Rik Wanninkhof, Kim Currie, Cristian Vargas in close collaboration with GOA-ON.

A workshop under this theme was to be carried out by NOAA-PMEL (Jan Newton, Adrienne Sutton) at the start of 2020, with the goal to develop a common set of approaches for analysing data from long term OA time series. IOCCP was not involved in the organisation. Kim Currie was invited to attend but declined due to other commitments.

Other activities

OceanObs'19 CWPs

Several OceanObs'19 CWPs ([Steinhoff et al.](#); [Tilbrook et al.](#); [Wanninkhof et al.](#)) related to surface CO₂ networks were published in 2019. Many other references in the CWPs list the need for such networks. IOCCP remains critical in coordinating and connecting the different components of the surface CO₂ network.

Continued development of SOCONET

The SOCONET website is accessible at <https://www.aoml.noaa.gov/ocd/gcc/SOCONET/>.

And contains links to the:

- Prospectus
- PowerPoint Presentation

- Platform Inventory (Updated 10/24/2019)
- Community White Paper Ocean Obs19
- Poster OceanObs19
- Picture Gallery

Coordination with JCOMM-SOT-SOOP-CO₂

As part of the Ships Observations Team (JCOMM-SOT), key performance indicators (KPIs) and specification sheets have been completed for SOOP-CO₂ and a template is in place for SOOP-BGC. Efforts are underway with JCOMMOPS to list all platforms in their appropriate program. At the [9th JCOMM OCG](#) meeting it was decided that the SOCONET development should remain under IOCCP rather than included in the JCOMM structure. SOCONET is an EOVS-based approach while OCG is a platform-based structure. SOCONET pCO₂ sensors will be listed in OCG under its relevant platform-based program (e.g. mooring under OceanSites and DBCP; SOOP-CO₂ under SOOP-SOT). With the restructuring of JCOMM, the OCG felt it was prudent at this time not to change the programmatic aspects of the constituent programs.

Interior Ocean Observations Theme

Masao Ishii reported on the status of GO-SHIP and Biogeochemical Argo activities as two established observing networks providing the core of routine biogeochemical measurements in the ocean interior. The SSG briefly discussed whether it was still relevant to maintain Ocean Interior Observations as a standalone theme considering that IOCCP might just be an observer to the actions planned and undertaken by the two networks. While coordination of platform-based networks is done in GOOS through OCG, IOCCP still takes part in guiding network developments (e.g. addition of biological variables onto GO-SHIP), producing and distributing network outputs (e.g. hydrographic manual for nutrient sampling and analysis) which can thus reach far beyond just the network community; and technical capacity development (e.g. strong focus on Biogeochemical Argo-type sensors during the IOCCP-BONUS INTEGRAL Sensors Training Course in 2019). It was concluded that IOCCP has a coordination role to play in this theme, especially since there is no sustainable model of funding for any of hydrographic observations.

The SSG did not identify any specific action items for the coming 12-month cycle. The detailed report below summarizes the current status and near-term plans of biogeochemical ocean interior observations performed by GO-SHIP and Biogeochemical Argo.

GO-SHIP

The latest GO-SHIP Cruises and cruise plans

Information on recent and planned GO-SHIP cruises has been gathered by ship coordinator Martin Kramp in JCOMMOPS and GO-SHIP Committee members. It was updated in September 2019 prior to the 6th meeting of the GO-SHIP Scientific Committee held on 15 September 2019 in Honolulu, and are available at <http://www.go-ship.org/CruisePlans.html>

In 2018-2019, nine reference sections (1 in the Atlantic, 2 in the Southern Ocean, 2 in the Pacific, 3 in the Indian, and 1 in the Mediterranean Sea) have been completed in addition to

the total of ten high-frequency and associated sections. For the years 2020-2021, thirteen cruises have been planned (eleven funded) for reference sections (8 in the Atlantic, 2 in the Indian, and 3 in the Pacific) but no cruises has been planned in the Southern Ocean.

Table 1. GO-SHIP cruises and cruise plans (September 2019)

Year	Line	Segment	Nation	Status
Annual	AR07	West	Canada	next 2020
Annual	SR01		UK	next 2020
Annual	ARC02		Canada	next 2019
Annual	A23		UK	2019 cancelled; next 2020
Annual	GSA-Radprof		Spain	next 2019
Annual	GSA-Samba		South Africa	next 2019
Annual	GSA-Line P		Canada	next 2020
Biennial	A25		France-Spain	next 2021
Biennial	75	North	Norway	next cruise not planned yet
Biennial	GSA-Arctic		Sweden	Next / where?
Biennial	GSA-EAC		Australia	next 2019
Biennial	Davis		Canada	next 2020
2018	P13		Japan	completed
2018	SR03		Australia	completed
2018	S4P		USA	completed
2018	A9.5		UK	completed
2018	I7	North	USA	completed
2018	MED01		Germany	completed
2019	I08	North	Japan	funded
2019	I06	South	USA	completed
2019	40N		Japan	completed
2019	A17		Spain	completed
2020	I05		USA	funded
2020	I07	South	Japan	funded
2020	P3	West	Japan	funded
2020	A10.5		Spain	funded
2020	A5		UK	funded
2020	A13.5		USA	funded
2021	P4	West	Japan	funded
2021	P1		Japan	funded
2021	A7	West	UK	funded
2021	A7	East	UK	funded
2021	AR28		UK	funded
2021	A16		USA	planned
2021	A20/A22		USA	planned
2022	I09	South	Australia	planned
2022	A10		USA	planned
2023	P15	South	Australia	planned
2027	SR3		Australia	planned

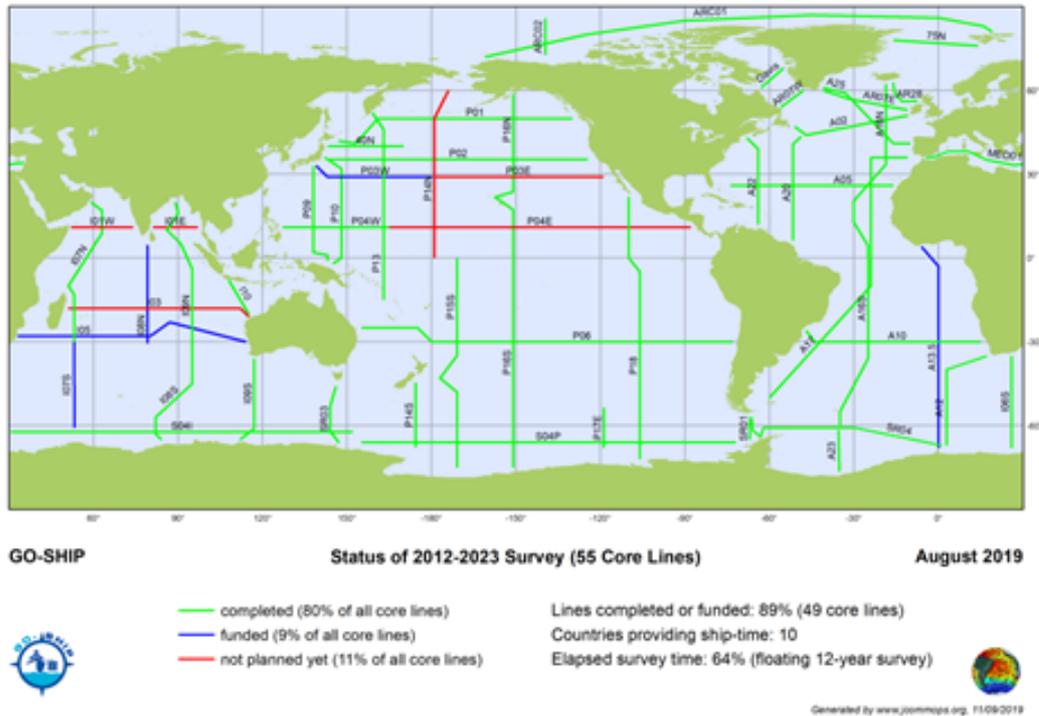


Figure 1. Status of GO-SHIP 2012-2023 survey.

GO-SHIP Community White Paper for OceanObs'19

A GO-SHIP CWP for OceanObs'19, Sloyan et al., [“The Global Ocean Ship-Based Hydrographic Investigations Program \(GO-SHIP\): A Platform for Integrated Multidisciplinary Ocean Science”](#) was published on 7 August 2019 in *Frontiers in Marine Science*. Among the total of 27 co-authors, 7 biogeochemists contributed to the article. The CWP will serve as a reference for the future of GO-SHIP. Important points are a central data management, central tracking/coordination by JCOMMOPS, an overall project site and bibliography, more international integration, regular science/logistics workshops, incorporation of new measurements, and expanded relationship with Biogeochemical and Deep Argo.

GO-SHIP will continue to build the time-series of full-depth repeat ocean measurements capable of resolving decadal and longer time scale changes in the circulation and storages of heat, freshwater, oxygen, and carbon, etc. of the global ocean, and will also contribute substantially to autonomous ocean observing such as core-, BGC-, and Deep-Argo, gliders, and marine mammal tag CTDs providing a variety of high-quality ocean reference data required for calibration and validation of their sensors. For these, GO-SHIP must develop data assemblages (by section or decade) to increase the accessibility of the data to the wider community and use of all of its Level 1 observations.

Future developments of GO-SHIP will include additional biogeochemistry and biology measurements to enable GO-SHIP to determine trends and variability in marine biogeochemistry and ocean health. In order to facilitate incorporation of new variables in the sampling suite, GO-SHIP must develop guidelines to evaluate requests for additional variables included in the program.

A serious impediment for continuation of GO-SHIP is that they currently depend mostly on project funds from individual countries that are proposal-driven and of finite duration. New models of funding based on multi-nation voyages and/or increased participation of the private sector need to be actively investigated as a means to sustainability. The questions of how to secure sustainable funding for GO-SHIP need to be addressed together with the ocean observation community as a whole, policy makers and national funders to guarantee the existing ocean observing systems and provide investment to expand the ocean observing systems where required.

Hydro Manual Updates

The update of the nutrient manual, “GO-SHIP Repeat Hydrography Nutrient Manual: The precise and accurate determination of dissolved inorganic nutrients in seawater, using Continuous Flow Analysis methods” by S. Becker, M. Aoyama, E. Malcolm, S. Woodward, K. Bakker, S. Coverly, C. Mahaffey, and T. Tanhua was published on 12 August 2019. This is available on-line from IOCCP:

http://www.ioccp.org/images/06Nutrients/GO-SHIPRepeatHydrographyNutrientManual_August2019_Finalv2.pdf

and/or OceanBestPractices: <https://www.oceanbestpractices.net/handle/11329/1023>

Regarding the update of the manual on dissolved organic matter (DOM) measurements, Rik Wanninkhof was in communication with Dennis Hansell and Craig Carlson and a best practices manual is expected shortly as a contribution from US GO-SHIP, which unlike the international GO-SHIP, includes DOM as a Level 1 measurement.

6th GO-SHIP Science Committee Meeting

The [meeting](#) was held on 15 September 2019, just prior to OceanObs’19 in Honolulu, Hawaii, USA. It was hosted by US GO-SHIP and sponsored by NOAA and saw a total of 40 participants including Science Committee members and invited experts.

Among 23 agenda items, there was an overview of the new GOOS 2030 strategy presented by Toste Tanhua, who among other things reminded the attendants how GO-SHIP is positioned in the overall GOOS structure and functioning. Strong connection to the OCG and the oversight for the observing networks that that group provides was also mentioned by David Legler. Questions were asked about the way to acknowledge the contribution to data products from individual nations and groups. A short discussion followed where the importance of this issue was acknowledged, but no direct solutions were presented.

J. Gum reported about CTD/O₂ operations and standardization Working Group. CTD working groups were proposed to review and update current sections of the GO-SHIP manual. Current thought is to form a single working group under “CTD/Rosette Operations” and apply for funding from the International Association for the Physical Sciences of the Oceans ([IAPSO](#)). Preliminary discussions for members of the working group have started with B. King and K. Katsumata.

In the discussion on the issues with consistency of GO-SHIP reference lines (level 1 measurements, # of samples taken) led by M. Ishii, each of the national delegates reported their situations. Some admitted to the absence of Level 1 transient tracer measurements because of the lack of expertise and paucity of resources, or difficulty in the high-quality nutrients measurements. Others stated the problems in keeping the high-density station spacing due to the limited ship-time. To fulfill the gaps in the expertise, it is necessary for GO-SHIP SC to continue efforts to coordinate the measurements within the international framework as had already been done successfully for some past cruises. For better quality control of nutrients analyses, IOCCP SSG members recommended using a hydro-manual and reference materials. The station-spacing issue needs further discussion and consultation with SC members.

A complete meeting report is available from <http://www.jcomm.info/go-ship6>.

Rotation of SC members

With Elaine McDonagh moving to Norway (but keeping her role as Co-Chair) and Toste and Leif stepping down from the committee, the SC endorsed three new members to join the SC: Mario Hoppema (AWI) for Germany, Penny Holliday (NOC) for the UK, and Are Olsen (UiB) as an additional member from a Nordic country.

Biogeochemical Argo

A global status map of BGC-Argo is reported at:

<http://biogeochemical-argo.org/float-map-network-status-maps.php>

The number of BGC-Argo floats in operation increased from 329 in September 2018 to 366 in September 2019. This is approximately one-third of the targeted number, and the number of those installed with a full suite of six sensors [oxygen, nitrate, pH, chlorophyll a, suspended particles (back scattering) and downwelling irradiance] is still very limited. Oxygen sensor is the most matured sensor on BGC-Argo floats. It has been installed on most (355) BGC-Argo floats currently in operation. On the other hand, numbers of floats installed with nitrate sensors (148) and pH sensors (136) remain less than half of that with oxygen sensor. The majority of BGC-Argo floats with nitrate and/or pH sensors have been in operation in the Southern Ocean for the [SOCCOM](#) (Southern Ocean Carbon and Climate Observations and Modeling) project.

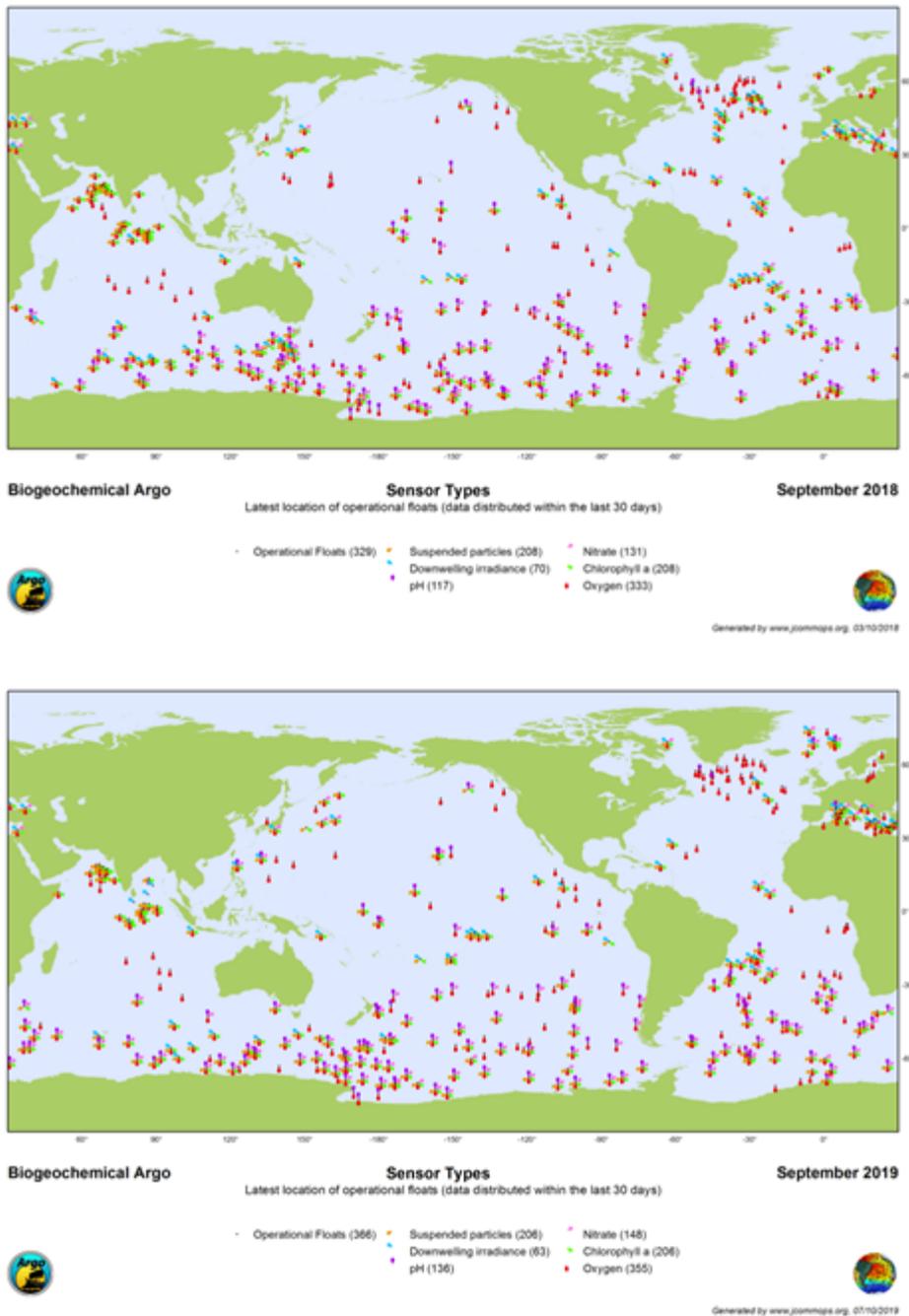


Figure 2. Status of BGC-Argo in September 2018 (top) and in September 2019 (bottom).

Nutrients Theme

The Panel has discussed the current gap in Nutrient EOV expertise and whether there is a need to nominate another SSG member who would fill this gap. On one hand, it should be considered that the SCOR Working Group 147: *Towards comparability of global oceanic nutrient data* ([COMPONUT](#)) has already been dissolved and that there is currently no group conducting work related to coordinating nutrient observations. It was mentioned that there are a lot of issues with nutrient observations at the land-ocean interface and in the coastal zone. These would require application of sensors which were not considered by

COMPONUT at all. Moreover, one might foresee a need to organize a nutrient data workshop similar to one organized for oxygen data (described in the following section).

Consequently, the panel agreed that IOCCP should provide international coordination of activities related to observing nutrients in seawater. However, in line with IOCCP-SSG-13 analysis of skills, roles and responsibilities, a new SSG member should provide nutrient expertise combined with some other expertise currently missing from the panel.

Oxygen Theme

Véronique Garçon reported on actions carried out in relation to oxygen observations over the past 12 months. The report focuses on coordination, communication and capacity building activities, also mentioning relevant publications and outreach initiatives.

4th GO₂NE Annual Meeting, Paris, France, 13-14 June 2019

During this workshop, Hernan Garcia from NOAA (USA) presented the World Ocean Data Atlas and World Ocean Database. He invited GO₂NE members to assist with the quality control of data sets to obtain relevant data products and facilitate access to data. In addition, the map and data collection produced by Bob Diaz (VIMS, USA) focusing on hypoxic coastal zones was discussed. The group explored the possibility of a small international workshop, including interested GO₂NE members, ocean data experts, and experts focusing on second level data quality control for ocean oxygen measurements. Ultimately the workshop took place just prior to IOCCP-SSG-14 (see below).

VOICE (Variability of the oxycline and its impact on the ecosystem)

The revised draft of the Community White Paper for OceanObs'19 Special Issue was submitted to *Frontiers in Marine Science* and published in December 2019. VOICE (<http://www.ioccp.org/voice>) is an initiative, supported by IOCCP since its beginning in 2017, which aims to demonstrate how societal benefits drive the need for integration and optimization of biological, biogeochemical, and physical components of regional ocean observing related to eastern boundary systems (EBSs). VOICE chose to focus on the upper oxycline (transition between high and low oxygen waters) which is fundamentally important for the ecosystem structure and can be a useful proxy for multiple observing objectives connected to EBSs that neighbour oxygen minimum zones. In this paper, we present a first readiness level assessment for ocean observing of the oxycline in EBS around the globe. The paper can be accessed openly and freely at: <https://www.frontiersin.org/articles/10.3389/fmars.2019.00722/full>

Oxygen data platform scoping Workshop 11-12 November 2019, Sopot, Poland

This workshop was supported by IOCCP, IOC-UNESCO, GO₂NE, NOAA and the German project [SFB754](#). Maciej Telszewski, Benjamin Pfeil, Masao Ishii, Kim Currie, Siv Lauvset and Véronique Garçon from the present IOCCP SSG participated in the meeting. The overarching goal of this 2-day scoping workshop was to develop a roadmap among the community interested in the issue of ocean deoxygenation towards an open access oxygen data platform for the world ocean. By this, it is meant a quality controlled (data quality flags

assigned based on consensus reached by data contributors and users) data synthesis product, with underlying raw data available in one place, or if impossible, then distributed but available, with metadata clearly defined and available for each data and with a DOI assigned to each data set. A detailed report from this workshop will soon be available.

Capacity building efforts related to oxygen observations

Veronique participated as a lecturer in the IOCCP & BONUS INTEGRAL Training Course on a Suite of Biogeochemical Sensors (see [section below](#)).

She was also the co-Director (organizer and lecturer) of the GO₂NE Summer School which took place on 2-8 September 2019 in Xiamen, China (please see website at <http://mel.xmu.edu.cn/summerschool/go2ne>, for programme and lecturers). Proceedings from the Summer School were described in [SOLAS Event Report N°15](#)- November 2019.

Proposed actions for 2020

Veronique requested support (5,000 USD) to organize the second oxygen data workshop, following the success of the first one held in November 2019 in Sopot, Poland. Significant work is foreseen to take place in the interim period, primarily around publishing the paper presenting the roadmap towards developing an open access oxygen data platform inspired by SOCAT and as discussed at the Sopot workshop. The second workshop in 2020 would enable making further progress towards implementing the roadmap.

Action Item #8_SSG-14

Publish the roadmap towards an oxygen data portal and data synthesis products as an outcome of the first scoping workshop on oxygen data.

Responsible: Véronique Garçon

Timeline: by the end of 2020

Financial implications: none

Action Item #9_SSG-14:

Organize a follow up oxygen data workshop.

Responsible: Véronique Garçon

Timeline: Second half of 2020

Financial implications: low-medium

Veronique also mentioned the SOLAS co-sponsored SCOR Working Group on Eastern Boundary Upwelling Systems (EBUS) 155 [Summer School "Changes in coastal upwelling systems and their impact on marine resources"](#) which will take place 4-12 May 2020 at the

Ecole Supérieure Polytechnique (ESP), University Cheikh Anta Diop (UCAD), Dakar, Senegal. The Summer School will bring together 40 attendees (Master/PhD students, postdoctoral scientists, and early career scientists/professionals from around the world) with the objective to provide an international training program and joint research opportunity for the next generation of ocean scientists focused on EBUS. Applications for the Summer School closed on 15 November 2019. More information can be found at: <https://sites.google.com/view/scor-wg-ebus-ss-2020/home>

IOCCP was approached by the Summer School organizers with a request for co-sponsorship. However, it was decided that this summer school goes beyond the IOCCP focus on technical capacity development, and thus IOCCP will not contribute as a co-sponsor.

Ocean Acidification Theme

Regional coordination (Latin America)

During 2018-2019 we have continued to focus on formalizing agreements and defining protocols for pCO₂ measurements in Latin-American countries in the framework of the Latin-American Ocean Acidification Network (LAOCA).

New platforms for pH monitoring were deployed in the framework of an international program led by The Ocean Foundation (TOF). Between 28th January and 1st February 2019, TOF organized an Advanced Training Workshop at the Instituto de Investigaciones Marinas y Costeras (INVEMAR), in Santa Marta, Colombia. This workshop was part of a series of capacity building trainings organized by TOF and its partners, including the Global Ocean Acidification Observing Network (GOA-ON), the International Atomic Energy Agency's Ocean Acidification International Coordination Centre (IAEA OA-ICC), and supported by multiple funding partners, including the U.S. Department of State and the Swedish International Development Agency. This workshop was co-organized by LAOCA.

The training focused on the use of the GOA-ON in a Box monitoring kit – a suite of equipment developed by Drs. Christopher Sabine and Andrew Dickson, The Ocean Foundation, The IAEA OA-ICC, GOA-ON, and Sunburst Sensors. This kit provided all hardware (sensors, lab-ware) and software (QC programs, SOPs) required to collect weather-quality carbonate chemistry data. Specifically, it included:

- Sunburst Sensor's iSAMI pH sensor
- Bottle sample and preservation materials for the collection of discrete samples
- A manual titration set up for determination of the alkalinity of discrete samples
- A spectrophotometer for manual determination of pH of discrete samples
- A computer loaded with sensor and QC software and SOPs
- Ad hoc equipment to support the collection and analysis of samples on an institution-by-institution basis

iSAMI pH sensor and the Van Essen CTD Diver will be deployed in specific locations at Jamaica, Panamá, Ecuador (Galápagos), Argentina (Patagonia), México, and Colombia

(Gorgona Island). It seems that most of the instruments are not being deployed yet for different administrative reasons, including those being deployed in the Colombian Pacific (Gorgona Island, Colombia), Galapagos Island (Ecuador), México and Argentina. Deployment of the sensors in Gorgona Island as well as the calibration of equipment in a facility at the Universidad Javeriana, Colombia, will be supported by Cristian Vargas through the GOA-ON Pier2Peer programme.



Figure 3. Monitoring of different parameters of the carbonate system at specific locations (red dots, buoys, continuous measures), or covering large coastal and oceanic areas (blue, oceanographic cruises, seasonal).

Data visibility in Latin America for Global Observing Networks, GOA-ON (2018-2019)

The first near-real-time time-series data streams integrated from platforms in South America are now available on the GOA-ON Data Portal. Located off the coast of central and southern Chile, the two stations are the Tongoy Balsa mooring in the Coquimbo region (30°S), managed by the Center for Advanced Studies in Arid Zones (CEAZA); and the Seno del Reloncaví mooring in northern Patagonia near Puerto Montt (41°S), managed by the University of Los Lagos i-mar Center. Data access was facilitated by the CEAZA-Met regional system, and the support of Dr. Luis Antonio Cuevas from the Center for the Study of Multiple-Drivers on Marine Socio-Ecological Systems (MUSELS). GOA-ON is working with Chilean partners to integrate data from other stations in the upcoming months. One of the stations to be online on the GOA-ON website is the Hualaihue Station from MUSELS Center in Southern Chile (Director: Cristian A. Vargas).

Regional capacities for development of new sensors

It is still recognized for the Latin-American region that one of the main limitations at a regional level is precisely the calibration and maintenance of pH and pCO₂ sensors that have been acquired through different initiatives (e.g., institutional projects, The Ocean Foundation, IAEA, etc.)

Dr. Martín Hernández-Ayón at Universidad Autónoma de Baja California (UABC), México, has been working on developing a new sensor for pH and alkalinity measurements. The design of this sensor is relatively similar to Satlantic's SeaFET, but with other electronics and associated software. This technological challenge arises as a good possibility to use lower cost equipment, ensure good quality information, and ensure its maintenance over time, through calibration and maintenance of this equipment. The sensor has already been tested during different conditions at sea.

Proposed action items for 2020

Action Item #25_SSG-13 was postponed from 2019 to 2020. Cristian proposed to partially fund and organize a regional workshop on data quality control and data management for ocean acidification research in Latin America and other regions. In order to avoid conflict with the Ocean in a High CO₂ World Symposium held in Lima, Peru, in September, the workshop could instead be organized in December 2020 in Concepcion, Chile. Cristian requested co-sponsorship from IOCCP and mentioned the possibility of additional funding to be requested from the International Atomic Energy Agency's Ocean Acidification International Coordination Centre (IAEA OA-ICC), and multiple local funding partners, such as the Millennium Institute of Oceanography (IMO), in Chile. The workshop would give us the opportunity to incorporate a community of new ocean observers from Colombia, Costa Rica, Mexico, and Ecuador, which were funded by TOF for implementing carbon chemistry (pH mostly) monitoring in their respective countries, and whose instruments will have been deployed by the time of the workshop.

Another relevant issue is the interest of the regional community for organizing inter-laboratory comparison exercises of carbonate chemistry measurements, including countries such as Colombia, Chile, Ecuador, Peru, Argentina, Brazil, and Mexico. During the last Latin-American Marine Science Meeting in Buenos Aires, Argentina, during a specific session focused on LAOCA Network, scientists from different Latin-American countries suggested this exercise should be led by an independent institution, and suggested IOCCP could support this activity as an outcome of the Technical Course in Carbonate Chemistry organized by IOCCP in Ensenada, Mexico in 2016.

IOCCP SSG discussed the two proposed action items and decided that:

- 1) Pending further information on the workshop scope and agenda, IOCCP will help organize and co-sponsor a regional workshop on carbonate chemistry data QC and submission into SOCAT. This workshop should not be limited to participants from Latin-America but rather be open to other practitioners from developing countries. The workshop format could be based on the prototype [AtlantOS workshop](#) led by Siv and Maciej in April 2019 in Sopot.
- 2) An inter-laboratory comparison of carbonate chemistry measurements done by LAOCA members could be part of a larger international effort as led in the past by Scripps. The SSG recommended that Cristian contact Emily Bockmon and Andrew Dickson (Scripps, USA) to inquire about plans for the next edition of a global comparison study. IOCCP would be willing to provide financial support for a selected number of participants.

The SSG further discussed the fact that currently we have little understanding of regional developments outside of those GOA-ON regional hubs represented on the Panel. Currently it is LAOCA (Cristian Vargas) and PI-TOA (Kim Currie). In the recent past Richard Feely provided annual updates on the North American OAN. A dedicated discussion on this subject will be held in the near future aimed at finding an optimal and realistic solution allowing the Panel to provide our services to regional communities regardless of the Panel composition. These discussions will be held within IOCCP SSG but we will also reach out to GOA-ON Executive Council. An ideal opportunity to consult our concerns with leaders of GOA-ON Regional Hubs will be at a GOA-ON Regional Hub Meeting to be held in September 2020 in Lima prior to the 5th International Symposium on the Ocean in a High CO₂ World. This meeting is quite distant in time but that time will allow us to prepare a solid contribution to the meeting, highlighting potential roles that IOCCP/GOOS Biogeochemistry Panel could play for regional OA communities and defining potential communication channels which would be efficient and mutually beneficial.

Action Item #10_SSG-14

Pending further information on the workshop scope and agenda, organize and co-sponsor a regional workshop for Latin America and other developing countries on carbonate chemistry data QC and submission into SOCAT.

Responsible: Cristian Vargas

Timeline: Late 2020

Financial implications: low to medium?

Action Item #11_SSG-14

Contact Emily Bockmon (Scripps, USA) to inquire about the next edition of the inter-laboratory comparison assessing the quality of seawater carbon dioxide measurements, and if relevant support the participation of LAOCA members.

Responsible: Cristian Vargas, Office

Timeline: 2020

Financial implications: low

Ocean acidification: global coordination

The membership of GOA-ON continues to grow, particularly as a result of training and capacity building. 680 scientists from 98 countries are now members, though not all of these members are actively engaged in OA monitoring or research.

The website (www.goa-on.org) was revamped during the year, and is actively managed with regular news updates. The website is also the primary link to the data portal

(<http://portal.goa-on.org/Explorer>), which has also been revamped, with multiple search and visualisation options, and links to data and data synthesis products. The GOA-ON Data Portal is not a data archive, but collates metadata on observing platforms with links to data repositories. Over 580 data assets measuring carbonate chemistry data are registered. Real time data from several platforms are available, and more are currently being added, including from South American moorings. A link is also provided to the OA-ICC biological response database.

The Regional Hub programme coordinates geographical groupings which enhances collaboration and the sharing of OA monitoring expertise and resources. There are now 7 active hubs – North America, NE Atlantic, Mediterranean, PI-TOA, LAOCA, OA-Africa and Westpac. A representative from each Regional Hub serves on the GOA-ON Executive Committee, and a Regional Hub meeting is planned in conjunction with the up-coming Oceans in a High CO₂ World Symposium.

Capacity Building and Training

The need to understand OA conditions globally requires the expansion of OA monitoring into regions where there is currently limited expertise and infrastructure. There are two main approaches to this: mentoring, and direct training and equipment provision. The Pier2Peer mentorship programme assists with knowledge exchange and collaborations, with the opportunity for scholarships and financial assistance. Training workshops and the GOA-ON-in-a-Box programme are financially supported by a number of institutions including NOAA, IAEA, IOC and The Ocean Foundation.

Sustainable Development Goal 14, Life Below Water

The UN SDG Target 14.3 is to “Minimize and address the impacts of ocean acidification, including through enhanced scientific cooperation at all levels”. The methodology associated with the SDG Indicator 14.3.1 has been developed, providing guidance on how to measure ocean acidity and how to report the collated information. The methodology has been upgraded to Tier II, and is available on the [GOA-ON webpage](#), including the associated data and metadata files.

GOA-ON has committed to expand the spatial and temporal coverage of ocean acidification observations around the world (Voluntary Commitment #OceanAction16542) in support of the Target 14.3. The UN Community of Action now has 267 OA relevant commitments.

OA Partners and Resources

GOA-ON is an international partnership facilitating the documentation of the status and progress of OA, the understanding of the impacts and the forecasting of OA conditions. National, institutional and individual partners in many countries participate and contribute financially and with human and asset resources. There are several key international partners: The Ocean Foundation is particularly involved with capacity building and awareness raising. The OA-ICC, hosted by the IAEA, provides coordination, training, databases and a news feed. UNESCO -IOC is the custodian agency for the SDG14.3, and also facilitates training, resource development and meetings. The OA information Exchange is hosted by the US Interagency Working Group on Ocean Acidification. The distributed

Secretariat is hosted at IOC (Paris, France), IAEA (Monaco) and NOAA (Washington DC, USA).

4th GOA-ON International Workshop

The workshop was held in Hangzhou, China on 14-17 April 2019, with over 250 scientists from more than 60 countries participating. The main themes of the workshop were focused on monitoring OA in multi-stressor environments, studying biological responses, advancing OA modeling, and ways to meet the needs of stakeholders. There were two special events on (i) using satellite remote sensing software (SATCO₂), (ii) creating a dialogue between scientists and the aquaculture industry. Further details and a workshop summary report are available from: <http://goa-on.org/workshops/hangzhou2019/workshop.php>

GOA-ON Implementation Strategy

The [GOA-ON Implementation Strategy](#) was officially launched at the 4th GOA-ON International Workshop. The document outlines how to implement the GOA-ON Requirements and Governance Plan, including expanding ocean acidification observations, closing human and technology capacity gaps, and informing about the impacts of ocean acidification.

OceanObs'19 – Framing Ocean Observations for the Next Decade

An OceanObs'19 CWP was published in advance of the OceanObs'19 Conference:

Tilbrook B, Jewett EB, DeGrandpre MD, Hernandez-Ayon JM, Feely RA, Gledhill DK, Hansson L, Isensee K, Kurz ML, Newton JA, Siedlecki SA, Chai F, Dupont S, Graco M, Calvo E, Greeley D, Kapsenberg L, Lebrech M, Pelejero C, Schoo KL and Telszewski M (2019) An Enhanced Ocean Acidification Observing Network: From People to Technology to Data Synthesis and Information Exchange. *Front. Mar. Sci.* 6:337. doi: [10.3389/fmars.2019.00337](https://doi.org/10.3389/fmars.2019.00337)

Ocean Acidification in the WMO Report on the Global Climate in 2015–2019

In 2018, the WMO established ocean acidification as a Global Climate Indicator. The [WMO Report on the Global Climate in 2015–2019](#), with input from scientists, GOA-ON, IOC-UNESCO and other UN agencies, shows that ocean acidification continues to increase, with observed pH values at open ocean observing stations steadily decreasing.

Commonwealth Blue Charter - OA Action Group

New Zealand took up the position of a champion for the newly formed Commonwealth Blue Charter Ocean Acidification Action Group. The objective of this group is to improve the capacity of Commonwealth countries to address the impact of ocean acidification, particularly in small-island developing states. Report from the first workshop is available from <https://bluecharter.thecommonwealth.org/action-groups/ocean-acidification/>.

5th International Symposium on the Ocean in a High-CO₂ World

The Symposium will be held in Lima, Peru during 7-10 September 2020. The lead organizers are from the Pedro Ruiz Gallo National University and Institute of the Sea of Peru (IMARPE). There are currently plans for associated GOA-ON Regional Hub meeting and GOA-ON EC meeting. More information on the Symposium programme, abstract submission and other topics can be found at the website: <http://www.highco2-lima.org/index.htm>

GOA-ON Executive Council update

Currently, there are three IOCCP SSG members sitting on the GOA-ON Executive Council: Kim Currie as IOCCP Programme representative, Maciej Telszewski as GOOS Programme representative, and Benjamin Pfeil providing data management expertise.

Synthesis Activities Theme

Siv Lauvset presented the status of action items from IOCCP-SSG-13, summarized other activities which took place in the interim period, and proposed new action items for approval by the SSG. It should be noted action items from this theme are of direct relevance to the successful coordination within the Surface CO₂ Observations theme as well.

Status of Action Items from IOCCP-SSG-13

Action Item #29_SSG-13: Publicize GLODAPv2.2018 through IOCCP channels, in collaboration with the GLODAP Reference Group.

This action was completed. Released (as GLODAPv2.2019) on March 26, 2019 during the AtlantOS meeting and publicized through several email lists and the IOCCP website.

Action Item #30_SSG-13: Organize a GLODAP reference group meeting in 2019.

There has been no reference group meeting in 2019. GLODAP work in 2019 has been focused on (i) finalizing and releasing the update, and (ii) updating and publishing the ESSD paper describing GLODAPv2.

Action Item #31_SSG-13: Write a short commentary (published e.g. in Nature Commentary) on the lack of sustained funding for ocean data synthesis efforts.

Both GLODAP and SOCAT are community efforts that have become “brand names”. Both data products are much used and well cited in literature. Both efforts are great successes and show the dedication of the ocean carbon cycle community to produce high-quality data. This part of the story is well communicated and part of the “branding”. However, both efforts are basically unfunded, and it is mostly a volunteer effort. That part of the story, including the weakness inherent in the lack of funding, is not communicated as well.

Siv has been discussing the issue and proposed action with Are Olsen and Dorothee Bakker at a couple of occasions in 2019. Both agreed that the effort to write such a commentary would be worthwhile, but also warn not to come off as only complaining about lack of funds. Instead, we need to portray a story that celebrates the success while highlighting the vulnerabilities. No lead author has so far been identified.

Please see below for a summary of the SSG discussion on the matter and a resulting modification of this overdue action item.

Action Item #32_SSG-13: Update the SOCAT QC cookbook.

This action was completed through the new cookbook made available on the [SOCAT website](#). The new cookbook was distributed to the QC-ers prior to the 2019 QC effort (in Jan-Mar) and to the IOCCP community through the website and newsletter.

Action Item #33_SSG-13: Update the 2016 ESSD article on SOCAT

This action is not completed. The work is led by Dorothee Bakker and the delay is primarily due to lack of time and funding. There would be a benefit in having the publication updated annually along with the SOCAT product update, therefore it might be worthwhile for IOCCP to discuss/brainstorm possible new solutions.

Synthesis Activities in 2019

SOCAT

Work on updating the SOCAT cookbook commenced in late 2018 and was completed in early January 2019. The new version was communicated to the QC community and the 2019 QC effort used the new cookbook.

In spring 2019 it was decided by the SOCAT global group to change the naming scheme for future SOCAT versions. Beginning in 2019 the version will be denoted by the year of release. We therefore went from SOCATv6 (released in 2018) to SOCATv2019 (released in 2019).

In spring 2019 the various groups organizing the SOCAT effort were reorganized and some people rotated off. All group members for v2019 and forward are listed in [Appendix 2](#). Composition of past groups can be found on the SOCAT website (<https://www.socat.info/index.php/regional-groups/>).

SOCAT QC for v2019 was completed on March 29th. For the first time the QC was formally closed before the deadline (March 31st). 478 new data sets were QC-ed for v2019.

SOCATv2019 release took place on June 18th, 2019. A release poster was presented at OceanObs'19 in September 2019. SOCATv2019 has 25.7 million fCO₂ data points between 1957 and 2019.

Dorothee Bakker has been responsible for communicating on SOCAT through various channels, including, but not limited to, a presentation at the 2019 Challenger Advances in Marine Biogeochemistry meeting and a webinar to the Community of Ocean Action on Ocean Acidification.

GLODAP

GLODAPv2019 was released in March 2019. Updated paper describing GLODAPv2019 was published in ESSD. This is now a “living data” paper to be updated on the same schedule as the data product. I.e., every data product release will have an associated publication.

In 2019, there have been some changes in the reference group. Dorothee Bakker has rotated off and been replaced by Peter J Brown from NOC, Southampton. Ryan Woosley was officially announced as a new reference group member in November 2019 .

In preparation for GLODAPv2.2020, Nico Lange (GEOMAR, Germany) is working on QC for the new cruises. The list of new cruises to be added is available [here](#). Deadline for submitting new cruises to GLODAP is January 2020.

A GLODAP meeting will be held on 16 February 2020 ahead of the 2020 Ocean Sciences Meeting in San Diego, CA, USA. The meeting will help address issues to do with the long-term functioning of the activity (such as data submission and acquisition, automation, key people, funding).

There will also be a GLODAP reference group meeting in late March – early April 2020 to discuss the results of the crossover analysis and prepare GLODAPv2.2020.

Other synthesis activities

Recent literature has highlighted several ongoing challenges regarding the consistency of seawater CO₂ measurements with estimates from alternate input pairs. These gaps in our knowledge of the ocean carbonate system are probably related to carbonate constant uncertainties, frequently-unknown concentrations of organic bases in seawater, and unrecognized measurement uncertainties. CO₂ measurement inter-comparability is also challenged by the large and growing variety of instruments and approaches used for measurements and the lack of robust assessments or certified reference materials for some methods.

In an attempt to address these challenges funding has been obtained for a US OCB Working Group “Ocean Carbonate System Intercomparison Forum.” This is a forum between experts in carbonate system parameter measurements, data documentation, and interconversion to debate the nature of the problems, advocate for needed research to resolve these problems, and provide guidance for data product assembly and documentation. The group is led by Brendan Carter (NOAA, USA). You can find more information on the group and their outputs from here: <https://www.us-ocb.org/ocean-carbonate-system-intercomparison-forum/>

There are currently no synthesis activities supported by IOCCP other than SOCAT and GLODAP. However, the planned ocean oxygen synthesis is likely to receive IOCCP support from both the Oxygen and the Synthesis Activities responsible SSG members.

Proposed Action Items for 2020

Support for GLODAP and SOCAT events

Siv made a request on behalf of Are Olsen as GLODAP RG Co-Chair for IOCCP to support the organization of the meeting at a level of 5,000 USD. The SSG approved the support.

The SSG discussed the anticipated implications of Bob Key’s retirement in 2020. This issue will be discussed at length during the GLODAP meeting on 16 February 2020. There is a proposal for how to efficiently transition from a single person’s expertise (e.g. in reformatting

files) to a semi-automated system implemented jointly by CCHDO and NOAA PMEL. The plan is to perform primary QC online and submit data for secondary QC as mimicked from SOCAT. It is clear that there should only be a single submission of metadata to be then exchanged between CCHDO and GLODAP.

It was also noted that an in-person meeting of the GLODAP RG should not take place annually. Once the automation process is set-up and working, most meetings will occur via teleconference.

Action Item #12_SSG-14

Support the organization of 2020 GLODAP Reference Group meeting.

Responsible: Maciej Telszewski

Timeline: Jan-Feb 2020

Financial implications: low

According to Dorothee Bakker (SOCAT leader), there are no SOCAT events planned for 2020. The need for a joint SOCONET-SOCAT technical workshop might potentially be discussed at the SOCAT Global Group meeting planned towards the end of 2019.

Sustainable funding for SOCAT

It is suggested that IOCCP takes steps in coordinating and galvanizing the community to assure stronger financial footing for global synthesis efforts such as SOCAT and GLODAP. A first step will be to provide a clear picture of the elements and resources needed for robust operations. This could be done through a report outlining the scope of the efforts, voluntary contributions to the SOCAT enterprise, and required resources for the core effort. It could include a view of the evolution of SOCAT to include more parameters, linking to other datasets and improved automation and visualization, and the resources needed for this. This report would provide a holistic view and offer funding agencies a clear picture of how they could contribute to the sustainability of the effort. There is ongoing discussion on whether the EU H2020 EuroSea project could provide a similarly scoped report for GLODAP.

The SSG recognized the fact that such a report is warranted and suggested committing adequate resources to realizing this proposed action. Based on the discussions and suggestions from Are Olsen and Dorothee Bakker, the SSG recommended that the report should have a form of a business plan that could be used to successfully communicate both the value and needs of SOCAT and GLODAP efforts. There should be a common template to use for SOCAT, GLODAP and future data synthesis initiatives such as the one initiated for oxygen. The SSG recommended IOCCP to coordinate this activity.

Action Item #13_SSG-14

Write and publicize a business plan for SOCAT and GLODAP.

Responsible: Siv Lauvset

Timeline: end of 2020

Financial implications: none to low

SOCAT uncertainties

To aid in its utility, particularly for inverse modeling and data assimilation, all observations in SOCAT should include an uncertainty estimate rather than the current approach of using a QC flag. IOCCP should aid in determining a strategy to implement this change including the interest, feasibility, and resources required, and report to SOCAT global team and IOCCP SC at 15th Session of the IOCCP SSG.

Action Item #14_SSG-14

Determine a strategy to include an uncertainty estimate in place for the QC flag approach in SOCAT. The strategy should include the interest, feasibility and resources required, and be reported to SOCAT Global Team and IOCCP SSG at IOCCP-SSG-15.

Responsible: Rik Wanninkhof, Siv Lauvset

Timeline: November 2020

Financial implications: none

Reporting errors in SOCAT products

There was a question from the SSG on the procedure for reporting errors in the data released through SOCAT updates. While the SOCAT website has a contact form designed for this purpose, there was confusion as to whether online website-related errors should be reported this way. Benjamin will approach Steve Jones to clarify this information on the website and attach a suitable note with every new SOCAT release published as a news item.

Action Item #15_SSG-14

Provide clear guidance on the procedure for reporting errors in data published in consecutive SOCAT products. Adequate information should be communicated on the SOCAT website and along with every product release.

Responsible: Benjamin Pfeil

Timeline: immediate

Financial implications: none

Framework for Ocean Observing

Following *Action Item #14_SSG-13* the Office has taken up the responsibility for the Framework for Ocean Observing Theme. Artur Palacz presented a summary of activities and proposed actions for 2020 related to this theme.

Status of 2018-2019 Action Items

Action Item #1_SSG-13: Decide on which EOVs from among Nitrous Oxide, Dissolved Organic Carbon and Particulate Matter, will be added to the IOCCP portfolio of activities in 2019, in what sequence and on what time scale.

This action was completed by the IOCCP Executive which decided that Particulate Matter EOV will be the next one added to the IOCCP portfolio.

With respect to the other EOVs, the Exec agreed that the potential impact of increasing the readiness level was greater for Nitrous Oxide EOV than for the Dissolved Organic Carbon EOV. Arguments for each of the EOVs are described in the report from the 2018 SSG in-person meeting.

Action Item #2_SSG-13: Issue an open call invitation for a new SSG expert to assume responsibility for the new EOV theme.

An [open call for the new SSG person](#) responsible was drafted and released to the public in October 2019 via several communication channels. The news was shared widely through our partner organization newsletters, Twitter channels, and even through the [ECO Magazine](#). Based on the submitted applications, during IOCCP-SSG-14 the SSG selected one candidate to be nominated for approval by IOCCP sponsors. It is anticipated that the new theme will be added to the IOCCP portfolio around February-March 2020.

Action Item #3_SSG-13: Scope the needs for marine plastics monitoring through consultation with relevant organizations and expert working groups (UN Environment, GESAMP, SCOR and others) and to report back to GOOS SC with recommendations.

Results of scoping activities and recommendations from IOCCP were reported at the 8th Session of the GOOS Steering Committee (GOOS-SC-8). Kim Currie and Artur Palacz represented IOCCP/GOOS Biogeochemistry Panel at the meeting, thus also fulfilling *Action Item #16_SSG-13*. Details of the report on plastics can be found in the [GOOS Biogeochemistry status report](#) submitted by IOCCP Executive to GOOS.

Following the recommendations made by IOCCP, GOOS will support the establishment of the global coordination of the Integrated Marine Debris Observing System as envisioned in the OceanObs'19 Community White Paper by [Maximenko et al. \(2019\)](#). Financial support for this activity comes from [EU H20202 EuroSea Project](#), coordinated by Toste Tanhua (GOOS Co-Chair). As part of the task devoted to marine plastics monitoring, EuroSea will develop Marine Plastics Debris as a new class of Human Impact EOVs, with a first version of EOVS Specification Sheet anticipated in early 2022. As in the case of Ocean Colour EOVS, this effort will be coordinated by GOOS Biogeochemistry Project Officer whose position is funded through the EuroSea project.

Action Item #6_SSG-13: Issue an open call invitation for a new SSG expert to primarily act as a GCOS liaison.

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Action Item #7_SSG-13: Request a permanent seat for GOOS Biogeochemistry Panel representative at GCOS meetings as a long-term solution to an efficient GOOS-GCOS interactions. As a short-term solution, IOCCP representative(s) will join the OOPC delegation to the GCOS All Panels Summit.

IOCCP delegation (Masao Ishii, Maciej Telszewski) attended the [GCOS Joint Panels meeting](#) in Marrakesh in Morocco on 18-22 March 2019. Following the meeting, IOCCP Executive decided not to invite a new SSG member who would be solely responsible for liaising with GCOS, but instead, seek a person who would strengthen the link to the modelling community and at the same time take charge of providing support for the GCOS processes as needed.

A revised [call for a suitable SSG candidate](#) was released by IOCCP in October, along with the call for a new SSG member responsible for Particulate Matter EOVS coordination. IOCCP SSG selected one name which was then nominated for approval by IOCCP Sponsors. The new SSG person is expected to be appointed in February-March 2020.

Regarding the permanent seat on GCOS, status quo will be maintained in that IOCCP will continue to provide input via OOPC (joint GOOS/GCOS Panel for Physics and Climate). However, a more direct link has been established between GCOS and IOCCP Secretariats following Artur's visit to WMO in July 2019.

Action Item #8_SSG-13: Propose to the IOC-UNESCO Working Group on Integrated Ocean Carbon Research (IOCR) that one of their activities could be the participation in OOPC-led observing system reviews of storage and air-sea fluxes, both of which would benefit from including the ocean carbon components.

The activity was suggested as one of several topics that IOCCP would like to see on the IOCR WG agenda. The topics were ultimately discussed at the scoping meeting of IOCR WG in Paris in October 2019.

Action Item #13: Update Biogeochemistry EOVS Specification Sheets according to the new curation procedure and timeline.

This action was postponed till 2020. Due to the ongoing process of revising EOVS requirements in order to match with the ECV requirements, the updated EOVS Specification Sheets will not be released until late 2020 or early 2021. It is anticipated that all EOVS Spec Sheets across the three Panels of GOOS will be updated at that time, following a common template.

In the meantime, the Office is working with individual experts to collate information on what needs to be updated in the EOVS Specification Sheets. Due to rapid developments in some observing networks, as well as data management streams, information is becoming outdated.

During IOCCP-SSG-14 we discussed some new developments which should be reflected in the documents. For instance, Saildrone Inc. has greatly increased the readiness level of the autonomous surface vehicles (ASVs) as an observing approach. A new model of data collection and dissemination, based on private-public partnerships (see OceanObs'19 CWP by [Meinig et al., 2019](#)), is opening up new opportunities for sustained marine biogeochemistry, not only in terms of coverage and resolution but also cross-platform data validation and multidisciplinary information product creation. It was also suggested that a person familiar with running an ASV fleet sampling campaign be potentially invited to the IOCCP-SSG-15 meeting.

Action Item #16_SSG-14

Publish a revised version of GOOS Biogeochemistry EOVS Specification Sheets, taking into account among other things recent developments in observing approaches and networks (e.g. Biogeochemical Argo, Autonomous Surface Vehicles)

Responsible: Office

Timeline: End of 2020

Financial implications: none

Action Item #15_SSG-13: Provide input into the GOOS Implementation Plan.

IOCCP Exec is responding to any queries from GOOS regarding drafting the Implementation Plan. The short version of the document was distributed prior to OceanObs'19 Conference. For more information please see the summary and discussion after [Toste's presentation on GOOS Strategy and Implementation Roadmap](#).

Harmonization of requirements for EOV and ECV observations

In July 2019, Artur travelled to WMO Headquarters in Geneva to work with Katy Hill (WMO, Switzerland - until December 2019) on improving how GOOS articulates requirements and to meet our various reporting responsibilities. Bernadette Sloyan (CSIRO, Australia) as OOPC Co-Chair and Patricia Miloslavich (UTAS, Australia) as GOOS BioEco Project Manager attended the meeting remotely.

The concept of setting requirements for EOVs has been evolving since their first drafting in 2013. More recent developments; particularly, clear articulation from GCOS of their reporting needs (see [GCOS Workplan and guidelines](#)), and the move towards strengthened engagement with WMO (which also means engaging in the [Rolling Review of Requirements](#)) meant it was timely to take a good look at the Specification Sheet approach. Our goal was to harmonize the GOOS EOV and GCOS ECV approach to setting requirements for what essentially is the same observing system. Recognizing discrepancies in definitions and formats used by GOOS and GCOS and lack of flexibility from GCOS to better adapt to the needs of the ocean community, we opted to further modify the table of requirements for EOVs to make it a source of all requirements information to be used for various reporting needs as the most efficient and consistent way to advocate for observation requirements.

In the GOOS approach, characteristic scales of phenomena provide the framework for articulating what the observing requirements are for EOVs, and provide authoritative guidance for the design of an integrated multi-scale, multi-disciplinary, multi-platform observing system. The phenomena based approach to setting EOV requirements has the following benefits:

- It provides a useful framework for evaluating the observing system in an integrated way (e.g. how well are we able to capture ocean heat storage?)
- We can consider phenomena and hence scales and sampling strategies in an integrated way across the 3 disciplines: e.g. stratification, mixed layer and deoxygenation; upwelling, ocean acidification and productivity.
- It provides a scientifically defensible approach to determining requirements for different applications (what phenomena are important for climate, or for weather prediction, or for water quality monitoring?)

The reporting pathways both GCOS and WMO consider requirements for each ECV by sub-variables, or products, which has its own merits:

- The identification of ‘threshold, (breakthrough) and goal’ requirements for spatial and temporal sampling resolution and uncertainty of measurements enables us to provide stretch goals for advancing the observing system.
- GCOS curates the ‘Climate Monitoring’ application area which is only one of many that are relevant to GOOS and which are also articulated by WMO. Currently, it is not clear for which application the GOOS EOV requirements are specified.

As an outcome of the work done by GOOS Secretariat members in Geneva, it was recommended a two-step process be employed. The process would (i) determine the phenomena in the ocean we need to capture, and the scales (and regions) which they operate, and (ii) then use this information to determine the relevant requirements for individual sub-variables/products depending on the particular observing objective/application (e.g. climate vs operation services).

The first step is largely completed and requires only an incremental update to the information already provided in Table 2 of the current version of [EOV Specification Sheets](#). The second step means that for every EOV a new table needs to be produced which encompasses the resolution and uncertainty requirements for EOV sub-variables taken into account the need for potentially distinct requirements depending on the coverage (global vs coastal, surface vs interior vs deep ocean) and application if relevant. The second step requires that an additional table with sub-variable requirements be specified.

The recommendations were presented to GOOS Executive and later presented to all three Panels of GOOS during respective panel meetings, including IOCCP-SSG-14. The new table with sub-variable requirements was initially filled out by Artur and a few experts, based on the information provided in 2015 for the previous GCOS Implementation Plan, using information from existing EOV Specification Sheet, and other available documents (e.g. GOA-ON Implementation Plan, Biogeochemical Argo Implementation Plan, [GO-SHIP data requirements](#)). However, due to the ambiguity in translating phenomena characteristics into specific observing targets, many fields had to be left blank or might have been interpreted incorrectly when filled out. Therefore, the information provided in the tables requires a broader expert and/or community review.

By the time of writing this report, GCOS will have initiated its public review of ECV requirements. Although the information on requirements comes from GOOS, the format used to present and request feedback is significantly different from the one that GOOS community is familiar with. In order to avoid overburdening the GOOS Expert Panel members with the need to report to multiple and often inconsistent requests for review of requirements, GOOS does not require that the Panel members review these requirements as part of the GCOS public review.

The rationale for refining existing EOV requirements, the motivation for working with GCOS and the recommended process as outlined above was discussed at length with IOCCP SSG. The SSG decided that refining the requirements to the level of setting goals for coverage, resolution, uncertainty and timeliness of EOV sub-variable observations would be a worthwhile exercise. However, the SSG was strongly insistent on such refinement taking

place through dedicated workshops engaging an adequate pool of experts. It was suggested that throughout 2020 we plan for one or two such type workshops, starting with EOVs on highest overall readiness level: inorganic carbon and oxygen. It was tentatively proposed that a workshop on Inorganic Carbon EOV requirements could take place in conjunction with the 15th Session of IOCCP SSG, while the workshop on oxygen EOV requirements be combined with the already planned oxygen data workshop (see action item in the [Oxygen theme](#) section of this report).

At the same time, as GOOS Biogeochemistry Panel we are requested to support in OOPC in their obligation to provide input into the GCOS processes. In order to meet the GCOS deadlines, OOPC has asked IOCCP to provide the following input by mid March 2020:

- Review GCOS IP Actions Progress (relevant actions as excerpt from GCOS IP 2016 are listed in [Appendix 3](#))
- Review any public comments on ECV requirements as received by GCOS and forwarded to GOOS via OOPC
- Agree on a common GOOS approach to drafting the GCOS Status Report

All these points will be presented and discussed during the 23rd Session of GOOS Physics and Climate (OOPC-23) meeting, in Cape Town, South Africa, on 10-13 March 2020. In the aftermath of IOCCP-SSG-14, IOCCP Executive decided that Maciej Telszewski will represent IOCCP in person during OOPC meeting. Input from GOOS Biogeochemistry Panel should be collated in due time to be presented at the OOPC meeting.

Time Series Efforts Theme

Björn Fiedler gave a summary of activities related to Time Series Efforts over the past 12 month cycle.

NSF EarthCube Workshop for Ocean Time Series Data (13.-15. Sept. 2019, Hawaii, USA)

Björn reported on the EarthCube time series workshop he attended and which took place in Hawaii just prior to OceanObs'19 Conference. Kim Currie and Benjamin Pfeil also attended from IOCCP SSG.

The rationale for the workshop stated that data synthesis and modeling efforts across ocean time-series represent an important and necessary step forward in broadening our view of a changing ocean and improving our return on investment in ocean time-series. Despite the advances achieved over the past decade, significant barriers remain that hinder work across time-series, including issues related to data access, discoverability, and metadata reporting. Furthermore, incorporation of ocean time series data into ocean and earth system models is currently limited due to the lack of a standardized data format and user interface. More details can be found at: <https://www.us-ocb.org/earthcube-workshop-ocean-time-series-data/>

Outcomes of the workshop were: (i) developing a pilot data product test case, (ii) develop an international time series working group to implement best practices and (iii) work on high-profile briefs and visualizations to increase awareness of time series stations. OCB will look into opportunities to raise dedicated funds for (ii) and (iii), potentially via NSF RCN, SCOR or NCEAS WG proposals. Outcome (i) is already being addressed through the EU H2020 project EuroSea (WP4) in which a PhD student already started working on a pilot product. This task within EuroSea was developed by IOCCP SSG members Benjamin Pfeil and Björn Fiedler and will be closely linked with coordination activities of IOCCP.

OceanObs'19 Community White Paper on Time Series

Björn contributed on behalf of IOCCP to the OceanObs'19 Community White Paper "[Ocean Time Series Observations of Changing Marine Ecosystems: An Era of Integration, Synthesis, and Societal Applications](#)" led by Heather Benway. The paper outlines a vision for time series over the next decade. This document outlines "near-term observing priorities and technology needs; explores potential mechanisms to broaden ocean time series data applications and end-user communities; and describes current tools and future requirements for managing increasingly complex multi-platform data streams and developing synthesis products that support science and society." This review article also lists actionable recommendations which would help develop "a robust, sustainable, fit-for-purpose time series network that will foster a predictive understanding of changing ocean systems for the benefit of society." The publication of this paper fulfills the action item from 12th Session of IOCCP SSG which called for a 10-year strategy for internationally coordinated biogeochemistry time series observations.

Björn also informed about near-term plans of IGMETS which plans to release its second report in 2020. This will be an update on the data described in the first report in 2019. Unfortunately, IGMETS does not plan on filling in the gaps in coverage of biogeochemical data. Instead, an even greater focus will be placed on ecological data available from time series sites globally.

Proposed actions in 2020

The IOCCP SSG was informed about the planned contribution of the EU H2020 EuroSea project into further development of multi-platform time series observations in the Atlantic Ocean and a demonstration of a first time series based data synthesis product (see above). Björn requested financial support for a workshop which would accompany the development of such a product and strengthened coordination of global biogeochemistry time series observations under the joint auspices of US OCB and IOCCP. Partial funding for this workshop has been secured through the EuroSea project. Remaining 50% of the budget could come from IOCCP (12,500 USD).

Björn explained that the workshop would discuss procedures for quality control of bottle data and not be occupied with sensor data at all. Therefore, there seems to be complementarity with the oxygen data workshop held in Sopot prior to the SSG meeting where a task team was created to deal with mooring and other sensor oxygen data for the purpose of data management and synthesis product development.

The proposed time series workshop dates remain to be set (ideally second half of 2020, depending on progress of the PhD work in EuroSea), ideally in conjunction with another IOCCP-related event.

Action Item #17_SSG-14

Organize a workshop on time series biogeochemical data product, following up from the Earth Cube workshop in 2019 and building upon the proposed demonstrator in the EU H2020 EuroSea project.

Responsible: Björn Fiedler

Timeline: by end of 2020

Financial implications: medium

Instruments and Sensors Theme

1st ICOS OTC pCO₂ instrument inter-comparison, 24 Aug - 4 Sep 2020, Oostende, Belgium

As announced by IOCCP through the communication channels, the 1st ICOS OTC pCO₂ instrument inter-comparison exercise will take place on 24 Aug - 4 Sep 2020, at VLIZ in Oostende, Belgium. Tobias Steinhoff (GEOMAR, Germany) and Thanos Gritzalis (VLIZ, Belgium) are leading the effort. IOCCP was invited to join the Organizing Committee and provide know-how and experience related to organizing similar scale events. Organizers are committed to making this intercomparison global and to invite explicitly those colleagues who work at laboratories submitting their data to SOCAT.

The SSG approved the request to support travel for participants from developing countries, with a total contribution of 5,000 USD. The organizers ensured that there will be a final report with the results of the intercomparison published under the IOCCP umbrella. Maciej met the organizers at VLIZ in December 2019, a few weeks after the IOCCP SSG meeting in Sopot, to discuss the details and agree on IOCCP commitments as co-organizers of the event.

Action Item #18_SSG-14

Support the organization and sponsorship of the 1st ICOS OTC pCO₂ instrument intercomparison.

Responsible: Maciej Telszewski

Timeline: January - September 2020

Financial implications: low

2019 IOCCP Sensors Training Course

The Office presented a summary of the [2019 IOCCP - BONUS INTEGRAL Training Course on a Suite of Biogeochemical Sensors](#) - a 10-day event held at the Sven Lovén Centre for Marine Sciences in Kristineberg, Sweden, in June 2019. The workshop was attended by 27 outstanding early-career scientists, including 18 women scientists, selected from almost 140 applicants. The attendees were joined by 20 dedicated instructors, who shared their practical expertise with a variety of sensors:

- Multiple optode-type optical oxygen sensors
- Chlorophyll fluorescence and backscatter/turbidity sensors for bio-optical measurements
- Ion-sensitive field-effect transistor (ISFET)- and spectrophotometry-based pH sensors
- Membrane-based sensors and an underway system for measuring partial pressure of carbon dioxide (pCO₂)

This intensive course provided trainees with lectures and hands-on experience across the whole spectrum of operations—from deployment and interfacing, through troubleshooting and calibration, to data reduction, quality control, and data management. More information about the course goals, agenda, instructors and materials can be found on the course website: <http://www.ioccp.org/2019-training-course>

Based on the course proceedings, and in collaboration with IOC-UNESCO IODE's Ocean Teacher Global Academy (OTGA), we have prepared an online version of this course in an attempt to meet the overwhelming demand for such training opportunities. Here we provide a comprehensive set of training materials divided into a number of topics. The course materials include video recorded lectures and/or lecture slideshows in PDF supplemented with links and references to various materials such as manuals, guides and best practices. The online course materials are open to all and are meant to expand the impact of the sensors training beyond the initial group of 28 that we could invite to Kristineberg in June 2019.

You can access the online course materials freely and openly from here: <https://classroom.oceanteacher.org/course/view.php?id=394>. The course proceedings and outcomes were also described in an article in *Eos* published in November 2019: <https://eos.org/science-updates/training-the-next-generation-of-marine-biogeochemists>

Next edition(s) of the IOCCP Sensors Training Course

Based on the very successful two editions of the sensors training course in 2015 and 2019 and in response to a great demand for such technical capacity building, the SSG strongly supported organizing the sensors training course as a recurrent event. The SSG approved of the proposal to hold the course on a bi-annual basis, provided that we avoid overlap with other major international summer schools (IMBeR, SOLAS) with which we might compete for funding as well as participants.

Tentative plans have been made to organize the 3rd IOCCP Sensors Training Course in June 2021, also in Kristineberg, Sweden. The Office is tasked with inquiring about the exact plans for the next edition of the SOLAS Summer School which might be taking place in the summer of 2021 too.

IOCCP SSG recommended supporting the organization of the course at a level of ca. 30,000 USD. IOCCP Co-Chairs and the Office will start inquiring about funding opportunities with the goal of securing co-sponsorship by summer 2020.

The first preparatory meeting will take place during the 2020 Ocean Sciences Meeting in San Diego, CA, USA. Maciej Telszewski will meet with several course instructors and participants of the 2019 course to discuss the content and agenda outline for the 2021 course.

Action Item #19_SSG-14

Initiate the organisation of the 2021 Sensors Training Course by confirming the course dates, seeking funding, and holding a preparatory meeting for outlining the course agenda.

Responsible: The Office

Timeline: All throughout 2020

Financial implications: low

Workshop on Underway and sensor CO₂ data and metadata quality control procedures, 1-3 April, Sopot, Poland

The Workshop on Underway and sensor CO₂ data and metadata quality control procedures was held on 1-3 April 2019 at the Institute of Oceanology Polish Academy of Science in Sopot, Poland. The workshop was organized by IOCCP and sponsored by the EU project AtlantOS and EU BONUS INTEGRAL (Integrated carbon and trace gas monitoring for the Baltic Sea) project. The goal of this workshop was to teach/update the participants on the protocols enabling globally coherent quality control of surface ocean CO₂ data, using a series of lectures and practicals given in the context of the most comprehensive surface ocean CO₂ data set: SOCAT.

Siv Lauvset from IOCCP SSG was the main instructor for this practical course which attracted 10 participants from 5 European countries. Maciej Telszewski and Bernd Schneider (IOW, Germany) gave additional lectures during this course.

This course was a successful prototype for what could be considered a new type of technical capacity building activity exclusively offered by IOCCP. There is a clear demand for such training in Latin America as indicated by Cristian Vargas in his report from the past 2 years of activities. The level of potential interest in other continents remains to be estimated.

The IOCCP SSG discussed the agenda of this course in the context of maximizing its impact and at the same time increasing the feasibility for acquired regular funding. It was suggested

that such training does not only include data originating from instruments but also from sensors measuring pCO₂. The SSG members mentioned that ICOS would be potentially interested in supporting such workshops, and also recommended contacting General Oceanics who might be interested in obtaining access to a new market for their instrumentation in return for workshop co-sponsorship.

Action Item #20_SSG-14

Scope out the potential demand for organizing regional technical workshops providing practical training on data QC and submission into SOCAT.

Responsible: Office

Timeline: November 2020

Financial implications: none

Data and Information Access Services Theme

Benjamin Pfeil, SSG member responsible for the Data and Information Access Services theme, reported on the actions which took place in the interim period between IOCCP-SSG-13 and IOCCP-SSG-14, and laid out the proposed list of actions for 2020. Benjamin responded to questions from the SSG who approved the proposed near-term actions.

Operational data flow developments

While operational data flow including NRT (Near Real-Time data) data distribution has been established for decades for mainly physical oceanographic parameters like temperature and salinity – the entire field of operational data flow is relatively new to many of the parameters in the field of marine biogeochemistry. Data obtained from biogeochemical (BGC) sensors is often obtained in NRT mode (e.g. Biogeochemical Argo) made available to portals e.g. GOA-ON, but data is often not automatically quality controlled or integrated in global/regional NRT data products. There are many valid reasons, one major is the non-standardized system setups with a variety of measurement devices which makes it challenging to automate data flow and QC. Higher financial resources are needed to overcome this burden. At the same time data is often obtained in research projects with limited resources where the major focus is on science with and not on establishing an operational data flow. Activities in the US (e.g. IOOS, NOAA), Australia (e.g. IMOS) and in Europe (e.g. ICOS, EMODnet) are moving towards making the data flow for the EOVs that are of interest for IOCCP (e.g. Inorganic Carbon EOV) operational, and to speed up data availability.

In Europe the Research Infrastructure ICOS, one of the flagships on the European Strategy Forum on Research Infrastructures Roadmap of the European Commission, achieved an operational data flow including NRT data availability in 2019 including software development for automated data reduction and initial first level quality control procedures. The task has

been achieved by the Ocean Thematic Centre of ICOS where the data is being handled by the data group of the Bjerknes Climate Data Centre (BCDC) at the University of Bergen, Norway.

Established operational data flow for EOVI Inorganic Carbon from SOOP

In Europe Mercator Ocean offers customized operational oceanography services. It was decided to extend the portfolio to other EOVI which included the Inorganic Carbon EOVI (NRT distribution of quality control data plus delayed mode data products). In 2018 BCDC became the Thematic Assembly Centre for Carbon under Copernicus Marine Environmental Monitoring Services (CMEMS) and in spring 2019 an operational data flow including comprehensive documentation has been established for QCed NRT $f\text{CO}_2$ data of the RI ICOS (see below for details) and data is made available to CMEMS/Mercator Ocean.

Within the CMEMS In Situ Thematic Assembly Centre (INSTAC), BCDC provides inorganic carbon data in Near-Real Time (NRT) and the data products SOCAT and GLODAP since April 2019. This is the first time inorganic carbon observations are included in the CMEMS catalogue, one of the priorities in the CMEMS roadmap.

While the data products are and will continue to be available via their original channels ([ICOS Carbon Portal](#), www.socat.info, www.glodap.info, [NOAA NCEI](#), [PANGAEA](#)), now they are exposed to a wider audience of CMEMS INSTAC users which includes other components of Copernicus (Marine Forecasting Centres, Satellite component) that in turn report to the European Commission, and a variety of downstream service providers that rely on operational marine data. These users can now find carbon data ready to use and integrate into their workflow. The conversion to CMEMS INSTAC specifications requires substantial reformatting, reorganizing and annotation. Their format is based on OceanSITES NetCDF, uses the British Oceanographic Data Centre (BODC) standard vocabulary, and is distributed with a CC-BY license. In the reformatting process, special care is taken to ensure that proper credit is given to the original data providers/Pis.

NRT temperature, salinity and $f\text{CO}_2$ measurements from platforms of the ICOS network are updated daily. Currently, two vessels are providing data in NRT, but the expectation is that the number will increase when technical implementations are in place, to include non-ICOS platforms, e.g. data from the GOA-ON community, too. It is also planned to provide pH NRT in the near future. Raw data is sent daily from the ships to QuinCe, the automatic QC software that performs data reduction, automatic QC, reformats and adds the necessary metadata.

In delayed mode ("REP products" in CMEMS terms), BCDC provides SOCAT and GLODAP observation data in CMEMS INSTAC format. The gridded products (SOCAT 1-degree monthly, yearly and decadal, 1/4-degree coastal; GLODAP 1-degree climatology) are distributed almost as-is, with the addition of global attributes relevant to CMEMS. Considering the goals and end-users of CMEMS product, BCDC provides a selection of the variables available from each products: temperature, salinity and $f\text{CO}_2$ from SOCAT, temperature, salinity, chlorophyll a, oxygen, nitrate, nitrite, phosphate, dissolved organic carbon and nitrogen, silicate, organic carbon and alkalinity, DIC, pH (at in situ temperature

and 25 degrees). For each major CMEMS INSTAC release (every April during the current phase), BCDC will provide the latest version available of SOCAT and GLODAP.

Data availability for Mercator Ocean and CMEMS is a milestone for the marine biogeochemistry community highlighting its data products, data inventories moving towards big data, the overarching need for biogeochemical data availability and underlining the advancements in the field of operational data management.

The IOCCP SSG inquired about the users of inorganic carbon data made available in NRT mode, and cautioned against allocating too much effort into NRT data availability at the expense of providing second level quality controlled data in delayed mode.

FerryBox workshop, 24.-26. April 2019, Genoa, Italy

In relation to this topic, Benjamin also informed the SSG about a FerryBox workshop he attended in 2019. The main topics of the workshop were tackling environmental challenges using Ships of Opportunity and other underway measurements (e.g., eutrophication, ocean acidification, contamination, microplastics), the integration of Ships of Opportunity observations in physical and biogeochemical models, and plans for a joint ICOS/FB session on ship-based carbonate system observation. Another major focus was on data management including QA/QC procedures and data flow to ocean observation portals (e.g., CMEMS, EMODnet, SOCAT, etc.).

Automated data reduction and initial quality control software development

The main reason for establishing an operation data flow for marine carbon data is the development of QuinCe. QuinCe is developed within ICOS at BCDC and is an online based, automated data reduction and quality control software. QuinCe performs all necessary data reduction calculations according to internationally agreed standards ([Dickson et al., 2007](#); [Pierrot et al., 2009](#)), and performs automatic quality control checks to identify potential problems in the data.

QuinCe development has continued on a number of fronts in 2019. Support for self-contained pCO₂ instruments on SOOP platforms is in place and now operational. Two platforms have been introduced to the software and have begun integrating it into their data processing workflow. NRT data from both ships is received daily, and QuinCe ingests and processes the data, runs automatic QC checks, and publishes the results to the ICOS Carbon Portal and CMEMS INSTAC in a fully automated process. The scientists will begin transitioning their manual quality control workflow to the QuinCe software in early 2020, at which point the complete data workflow can be considered operational.

The main infrastructure for more complex SOOP platforms, fixed moorings, and support for additional sensor types (particularly pH sensors) has been completed during 2019. The final implementation details require consultation with the scientific community to ensure that QuinCe follows best practices in all arenas. A consultation session has been organised for November 2019, and this effort will continue into 2020. Full pCO₂ support for SOOPs and fixed moorings is scheduled for Spring 2020, along with preliminary support for the most commonly used pH sensors.

QuinCe was released in 2018 and will be continuously upgraded and maintained. Within the US and Australia similar approaches towards operational services are being developed e.g. metadata submission and activities are being aligned to ensure complementary efforts and reduce redundancies.

Metadata editor

Current metadata schemes for the Inorganic Carbon EOY which are used by the scientific community are also used for data products like GLODAP and SOCAT. This input was gathered at a workshop co-hosted by NIES, PICES, IOC, SCOR and IOCCP in 2004 (<https://tinyurl.com/yaxjnbhb>). This metadata form has been continuously improved especially by NOAA OAP and the latest version is used by the NOAA OAP, RI ICOS, SOCAT, GLODAP and is the baseline for the methodology for UN's Sustainable Development Goal target 14.3 'minimize and address the impacts of ocean acidification'. In order to ease metadata reporting, this form has been modernized and an online editor has been developed by NOAA PMEL. This editor has been further developed by IOC UNESCO Ocean Acidification Program and IODE (International Oceanographic Data and Information Exchange) including adding controlled vocabularies for certain fields (e.g. instruments). Limitations on the free text submission will make it easier to control received information which is essential for automatically handling received metadata. The scheme is available at IODE (<https://oa.iode.org/>) and will be distributed to data archives under IODE (National Oceanographic Data Centres and Associated Data Units) when finalised. This is expected to happen within 2019/2020.

GLODAP crossover QC routines – automation of GLODAP QC routines

Secondary quality control of GLODAP analysis has been performed by using MATLAB routines. More details can be found in the GLODAP documentation. The overall aim is to follow the SOCAT automation approach including ingestion and performance of QC procedures and being able to scale data submissions by the scientists, avoiding bottlenecks for data ingestion, applying basic primary QC, version control and finally to move towards annual releases. This activity is a collaboration between the data ingestion group at NOAA/PMEL and BCDC. While funding for the data ingestion and primary QC system has been requested by partner NOAA/PMEL in 2019 -the second level QC routines have been finalized by BCDC in 2019 and are ready to be implemented in the framework to be developed by NOAA/PMEL.

MATLAB routines were translated from MATLAB into Python and are available on an internet based platform. It allows users to register, and upload their own data in the WOCE exchange file format – flexible integration of data files including reformatting will be integrated in the framework that NOAA is developing. The functionality mimics the behaviour of the original scripts, implements functionality to merge CTD-parameters with bottle samples. The system allows export of maps, plots and results after analysis. QCers can choose preconditions for crossover calculations and plots which are just for merging and calculations. All basic features of the crossover QC routines are available from [here](#).

GLODAPv2020

BCDC hired (for a period of three months) one of the main scientists (Nico Lange) performing second level QC for GLODAPv2019. His tasks were to address and fix known issues in GLODAPv2019, perform second level QC for newly submitted data making it ready to be adjusted by the GLODAP QC groups in 2020, and test the GLODAP secondary quality control application developed by BCDC. His work gave the baseline for enabling the GLODAP group to release a GLODAPv2020 release.

Secured funding towards an initial ship-based time series product including development of QC routines

An EU H2020 project EuroSea, coordinated by Toste Tanhua, kicked off officially in November 2019. IOCCP SSG members Björn Fiedler (GEOMAR, Germany) and Benjamin Pfeil (BCDC/ University of Bergen, Norway) are members of the consortium. Within EuroSea existing EOv synthesis products from in situ biogeochemical observations and high quality and long-term ship-based time series data will be optimally fused to obtain optimal estimates of EOvs and derived quantities in support of ocean climate and ocean health monitoring. This task will focus on the Inorganic Carbon EOv with all four of its sub-variables (dissolved Inorganic Carbon (DIC), Total Alkalinity (TA), Partial pressure of carbon dioxide (pCO₂) and pH), including how to operationalise data flow and availability. Partner GEOMAR's main tasks will be to develop quality control procedures for data from certain platforms e.g. ship-based time series stations, while Partner University of Bergen will integrate those quality controlled data with data from the GLODAP data product. University of Bergen will operationalise European SOCAT and GLODAP quality control efforts and test the implementation of the quality control routines for ship-based time-series (TS) EOv data developed by GEOMAR.

Increasing the visibility of the community data products SOCAT and GLODAP under the GOOS BGC Panel /IOCCP

Many data networks need access to high quality biogeochemistry data (especially Inorganic Carbon EOv). In addition to the collaboration and data exchange with CMEMS described above, it should be noted that GLODAP and SOCAT groups agreed on sharing data inventories with EMODnet. SOCAT and GLODAP would not be EMODnet products but can be served through EMODnet based upon the license agreement and credit will be given at all stages (e.g. data providers, data products, agencies involved, etc.). This will happen in early 2020.

Global Data Assembly Centre (GDAC) for marine Biogeochemistry

Developments are ongoing and funding was secured in Europe and in the US for future GDAC partners. NOAA PMEL and BCDC at the University of Bergen signed a Memorandum of Understanding in 2018 and will apply to become IODE Associated Data Units (ADU). A formal GDAC application will follow in 2019 or 2020.

BCDC at the University of Bergen made an assessment of related tasks for an operational GDAC, which is covered by current and future activities. TRLs for data management activities are continuously increasing, and becoming a formal part of IODE will help to increase the visibility and usability of biogeochemical data. BCDC representatives attended

several IOC UNESCO IODE meetings and will apply to become an official IODE GDAC in 2020. NOAA NCEI is interested in becoming a partner and will have visited BCDC in November 2019.

Prompted by several questions from the SSG, Benjamin further explained the overall concept of streaming data through the GDAC and how the effort relates to the needs for national data reporting and reporting into the UN system. While the GDAC is primarily funded from European sources, it is a global effort based on the existing national data management structures and regional hubs or assembly centres. In most countries, data can be submitted via a National Oceanographic Data Centre (NODC). If a country does not have an NODC, one can submit the data via a regional DAC or hub. For instance, NOAA NCEI would be considered a hub in North America, and ICOS in Europe. For scientists working e.g. in South America, the simplest way would be to put an ERDDAP on the datastream used, which would then get picked up by the GDAC. In some instances, data providers might prefer to bypass the NODC and still be able to deliver into the UN system. In response to IOC requests, they can submit their data directly through the regional DAC or the GDAC which has the status of an IODE unit. Regardless of how the data providers choose to submit the data, it must be clear that GDAC is only responsible for streaming data, and not for reporting the data. The actual reporting takes place through the national bureau of statistics, and this need not go through the GDAC.

Benjamin further clarified that there is no conceptual difference in how NRT and delayed mode data would be streamed in the GDAC structure.

Action Item #21_SSG-14

Submit a formal GDAC application to IODE after BCDC and NOAA PMEL become approved as IODE Associated Data Units.

Responsible: Benjamin Pfeil

Timeline: End of 2020

Financial implications: none

IOCCP budget status and anticipated expenses

IOCCP Project Director outlined the major budgetary issues for 2019 and 2020. Thanks to earlier savings and significant successful fundraising efforts, IOCCP has funded several significant activities in 2019. These included training courses, contribution to workshops and strategy meetings and capacity building as well as the usual contribution to fora such as GOA-ON, SOCAT, GLODAP, JCOMM OCG, Best Practices WG and others.

IOCCP Project Office has also managed to secure salary support for the Project Officer until the end of 2022, required tremendous effort in 2019, but will allow the Project Office to focus on implementing the Project ToRs in the next 3 years. The funding secured for the Project

Officer comes from the EU project EuroSea and our successful participation in the project consortium has been assured directly by the GOOS co-Chair and the GOOS Head Office.

Salary support for the Project Director is currently secured until August 2021.

Activities support from SCOR and GOOS (IOC) remain stable and will allow effective implementation of the action items in 2020.

IOCCP Communications Services

Artur presented an overview of IOCCP communication services from the past 12 months.

Twitter

During the 2019 Sensors Training Course in June 2019 IOCCP Project Office launched its Twitter account, thus fulfilling *Action Item #36* from IOCCP-SSG-13. You can now follow news relevant to marine biogeochemistry through [@ioccp_org](https://twitter.com/ioccp_org). This new communication service responds to the needs of the predominantly younger generation of marine biogeochemists who seem to prefer short and frequent updates to be distributed via social media. We do not only share but also receive important news through Twitter which is gradually replacing daily to weekly email communications used by other international projects of a similar profile, such as IMBeR, SOLAS, or US OCB.



The IOCCP Twitter account received plenty of attention right from the start thanks to an enthusiastic crowd of #2019SensorsTraining course attendees and course instructors, many of which are frequent Twitter users. By the end of 2020, after almost 6 months of Twitter activity, we have 195 followers. During this period we posted 80 tweets, many of which were re-tweeted by our followers, eventually reaching an estimated 2,000 - 8,800 users per tweet.

It is worth pointing out that daily news on job postings, training courses, workshop reports and scientific publications, are currently more easily (and often exclusively) available from Twitter. We perform daily filtering of information shared by individuals and organizations strategically “followed” by IOCCP, and often instantly share

with our followers (and their followers) any unique information acquired by the Project Office through more traditional communications means. We reckon that thanks to the new Twitter service we have greatly expanded our capability to timely and efficiently reach out to the global community of marine biogeochemistry observationalists and thus better serve as a communication hub.

Website and email newsletter

The Office is committed to using the IOCCP website and (sub-)weekly email newsletter as its primary means of communicating with the core of the marine biogeochemistry community, i.e. those who explicitly subscribe to our services (currently 600 subscribers). Over the past 12 months, we have distributed over 70 news pieces through our newsletter. We consider the new Twitter service as complementary to this core communication activity. Currently, we use Twitter for short, rapid and/or urgent communications, followed by or linked to a more extensive news article posted on the web and shared via the email newsletter.

The IOCCP Conveyor

The shift towards more frequent and short communications shed new light on our quarterly newsletter *The IOCCP Conveyor*. The Office ended up not publishing a single issue of the Conveyor in the past 12 months cycle. An internal analysis revealed several reasons to suggest that this particular communication service might be obsolete.

Firstly, there is a lack of input from the SSG or the wider community on what topics and articles that could be of interest to those on the receiving end of this service. Secondly, the majority of the articles written for the past issues heavily relied on news already communicated via website and email weeks or months prior to the publication of the Conveyor. Thirdly, the purposefulness of communicating on a quarterly to bi-annual time scale seems questionable considering the daily to weekly Twitter and email communication on one end, and the annual reporting from IOCCP SSG meetings on the other end. Fourth, it is difficult to estimate who reads the newsletter, or which sections of it. Finally, in an environment that is supersaturated with lengthy newsletters on one hand, and tweets designed for the new generation characterized by an average 8-second attention span (Microsoft Attention Span Report, 2015), IOCCP's strength and communication niche could be the weekly email newsletter.

After a short discussion, the SSG endorsed the suggestion from the Office to discontinue the quarterly newsletter service, to maintain the weekly to monthly website updates and email newsletters, and shift the efforts towards the shorter, frequent and up to date messages distributed via Twitter.

Action Item #22_SSG-14

Discontinue the publication of IOCCP quarterly newsletter *The Conveyor*, and refocus the communication activity onto frequent news and updates published via Twitter. Regular email and website communication is to be maintained as before.

Responsible: Artur Palacz

Timeline: immediate

Financial implications: none

Internal communication

The SSG discussed the need to further improve internal communication. To this end, the Office is tasked with a more rigorous execution of the following items:

- Delivery of quarterly updates on the status of Action Items by SSG members assigned as lead responsible for a given action.
- Requests for monthly checks on website update, if needed.

Monthly IOCCP Executive meetings have been deemed as extremely useful and will be maintained in their current frequency and structure.

In addition, as a new Action Item, the SSG have agreed to timely sharing of reports/notes from relevant meetings attended by IOCCP SSG members, using a shared online [“Meetings”](#) folder. The Office will send private invitations to access the folder.

Action Item #23_SSG-14

Share notes/reports from relevant meetings attended by IOCCP SSG members through a shared Google Drive “Meetings” folder set up by the Office.

Responsible: All SSG

Timeline: immediate

Financial implications: none

15th Session of IOCCP SSG and GOOS Biogeochemistry Panel of Experts

Kim Currie invited IOCCP SSG to hold the next annual meeting in Wellington, New Zealand. Exact time and venue will be determined based on SSG member availabilities and possibility of holding an adjacent event (e.g. one of the workshops presented in the approved Action Items). Tentatively, the meeting is to take place in the week of 16-20 November 2020.

Action Item #24_SSG-14

To confirm time and venue, and organize the 15th Session of IOCCP SSG / GOOS Biogeochemistry Panel of Experts (IOCCP-SSG-15). Tentatively, the meeting is to take place in Wellington, New Zealand, in the week of 16-20 November 2020.

Responsible: Office and Kim Currie

Timeline: Throughout 2020

Financial implications: medium to high

Appendix 1: Meeting Agenda



**14th Session of the
International Ocean Carbon Coordination Project
Scientific Steering Group /
GOOS Biogeochemistry Panel of Experts
13-15 November 2019, IO PAN, Sopot, Poland**

MEETING AGENDA

WEDNESDAY, 13 November 2019

08.30-09.00 *Arrival*

09.00-09.10 **Opening and welcome + local logistics** (*Maciej*)

09.10-09.20 **Overview of the meeting agenda** (*Kim/Masao*)

09.20-09.50 **Summary of IOCCP accomplishments over 2018-2019** (*Kim/Masao*)

09.50-10.30 **GOOS 2030 Strategy and Implementation Plan** (*Toste Tanhua*)

- Presentation (15 min) + discussion (25 min)

10.30-10.45 *Coffee break*

10.45-12.30 **Sponsors Review of IOCCP** (*Masao & Maciej*)

- Send draft review to SSG
- Prepare draft PPT with main points to address
- Decisions with implications for IOCCP SSG, to be discussed on Friday...?

12.30-13.30 *Lunch break*

13.30-14.15 **OceanObs'19 synthesis and implications** (*Maciej, Artur/IOCCP Exec*)

- Synthesis of CWPs with regard to recommendations for marine biogeochemistry observations as well as specific and relevant GOOS Strategic Objectives (15 min)

- NB: Need to refer back to the IOCCP Future Directions presented and agreed upon at the 13th session in Tokyo
- Discussion on what these recommendations mean for IOCCP near-term or long-term actions (30 min)

14.15-15.15 Biogeochemical observations and models: needs, roles and responsibilities

What are the requirements for marine BGC observations from the modelling perspective, and vice versa, how can BGC models optimize the design of the integrated ocean observing system?

- Intro and link to sponsors review recommendation on the connection with modelling community (**Maciej/Masao - 5 min**)
- Perspective from GODAE Ocean View (OceanPredict) Marine Ecosystem Analysis and Prediction Task Team - (**Fei Chai - 15 min**)
- IOCCP's involvement in RECCAP2 and GCOS activities with respect to modelling - (**Masao - 10 min**)
- Carbon in CMIP6 - (**Artur's summary from meeting report - 5 min**)
- Other?
- Open discussion - 25 min

15.15-15.45 Coffee break

15.45-16.30 Standards and best practices (Maciej)

- OBP Website - new version of repository
- Reminder of responsibility for all SSG and community
- IOC formal acceptance of OBP as a WG + small GOOS Task Team with Maciej as BGC member
- GOOS endorsement process
- Upcoming meeting

16.30-17.15 IOCCP Sensors Training Course(s) (Maciej & Artur)

Core IOCCP activity to fulfil the technical capacity development mandate

- Overview of work for the 2019 edition (**Maciej**)
- Overview of finance for the 2019 edition (**Maciej**)
- Sensors School proceedings + early impact assessment (**Artur**)
- Ocean Teacher Global Academy online product (**Artur**)
- Discussion: next edition: yes or no. If yes, scheme of early planning for 2021 edition
- ICOS OTC Intercomparison (**Maciej**)

18:30 or so: Group Dinner sponsored by IOCCP (<http://www.tawernaorlowska.pl/>)

THURSDAY, 14 November 2019

09.00-09.20 Roles and responsibilities of IOCCP SSG/ GOOS BGC Panel members (Kim)

- Reminder of the outcomes of the skills, roles and responsibilities

- Re-emphasis on the role of IOCCP SSG members as focal points for specific communities and representations of their views, responsible for two-way communication between IOCCP SSG and the community

09.20-10.30 IOCCP Themes: status of past and proposed new action items

- Ocean Acidification: Global (20 min)
- Ocean Acidification: Regional (20 min)
- Oxygen (30 min) Data and Information Access Services (10 min presentation + 20 min discussion)
- Synthesis Activities (30 min)
- Time Series Efforts (30 min)

10.30-11.00 Coffee break

11.00-12.30 IOCCP Themes: status of past and proposed new action items

-
- Data and Information Access Services (10 min presentation + 20 min discussion)
- Synthesis Activities (30 min)
- Time Series Efforts (30 min)

12.30-13.30 Lunch break

13.30-14.30 FOO Theme, EO/ECV Requirements, input into the GCOS process

- Framework for Ocean Observing (Artur)
- Reconciling EO/ECV requirements, update of EO/ECV Spec Sheets (Artur)
- Inputs into the GCOS process (Artur)
- Discussion (All)

14.30-15.30 IOCCP Themes: status of past and proposed new action items

- Ocean Interior Observations (30 min)
- Nutrients (30 min) - incl. Strategy on finding/identifying a responsible SSG member

15.30-16.00 Coffee break

16.00-16.30 IOCCP Themes: status of past and proposed new action items

- Surface CO₂ observations (30 min)

16.30-17.15 IOCR WG and RECCAP2 (Maciej, Masao, Fei)

- Update and results from IOCR scoping and RECCAP2 kick-off workshops
- IOCR WG on gaps in ocean carbon research and modelling - (Fei Chai - 10 min)
- Timeline for future activities and need for IOCCP input

FRIDAY, 15 November 2019

09.00-09.45 IOCCP Office: Communication, budget, etc.

- Budget status
- Website and other communication services
- Conveyor
- Project officer funding from EU H2020 EuroSea project
- Planned meetings calendar
- Next IOCCP SSG meeting in 2021: any opportunity for combining with other events?

09.45-10.45 SSG rotations and review of IOCCP SSG member applications

- Request to SCOR the extension of the Co-Chair term to 6 years
- Masao to continue as Co-Chair for another 3 years
- SSG rotations
- IOCCP SSG selects candidates to fill up two open positions and prepares nominations for SCOR
- Doug Connelly

10.45-11.15 *Coffee break*

11.15-12.45 IOCCP/GOOS BGC White Paper

- Discussion on the need to revise the scope of the paper, based on OceanObs'19 CWP synthesis among other things
- Review of existing contributions and identification of missing sections
- Timeline and writing champions

12.45-13.15 Summary of 2019-2020 Action Items & adjourned

Appendix 2: Groups for SOCAT version 2019

Coastal and Marginal Seas:	<ul style="list-style-type: none"> ● Simone Alin (NOAA/PMEL, USA) ● Thanos Gkritzalis (VLIZ, Belgium)
Arctic Ocean (incl. coastal waters):	<ul style="list-style-type: none"> ● Michael DeGrandpre (U. Montana, USA)
North Atlantic (30°N to Fram Strait):	<ul style="list-style-type: none"> ● Ute Schuster (U.Exeter, UK) ● Tobias Steinhoff (GEOMAR, Germany)
North Pacific (30°N):	<ul style="list-style-type: none"> ● Shin-Ichiro Nakaoka (NIES, Japan)
Tropical Atlantic (30°N to 30°S):	<ul style="list-style-type: none"> ● Nathalie Lefèvre (LOCEAN, France) ● J. Severino Ibánhez (U. Dublin, Ireland)
Tropical Pacific (30°N-30°S):	<ul style="list-style-type: none"> ● Cathy Cosca (NOAA/PMEL, USA)
Indian Ocean (north of 30°S):	<ul style="list-style-type: none"> ● Nicolas Metzl (LOCEAN/IPSL, France)
Southern Ocean (south of 30°S including coast):	<ul style="list-style-type: none"> ● Bronte Tilbrook (CSIRO, Australia) ● Nicolas Metzl (LOCEAN/IPSL, France)
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Appendix 3: GCOS 2016 IP Ocean Actions related to BGC ECVs

Action O18:	Surface ocean partial pressure of CO ₂ , moorings	Sustain the surface reference mooring pCO ₂ network and increase the number of sites to cover all major biogeochemical regions to resolve seasonal cycle
Action O19:	Building multidisciplinary time series	Add inorganic carbon and basic physical measurements to existing biological timeseries, considering particularly spatial gaps in current observing system, aiming for balanced representation of the full range of natural variability (benefit: regional effects of ocean acidification).
Action O20:	Nutrient observation standards and best practices	Increase the use of nutrient CRMs on ship-based hydrographic programmes
Action O21:	Sustaining tracer observations	Maintain capacity to measure transient tracers on the GO-SHIP network. Encourage technological development to encompass additional tracers that provide additional information on ventilation.
Action O22:	Develop sustained N ₂ O observations	Develop an observing network for ocean N ₂ O observations, with particular emphasis on regions with known high oceanic N ₂ O production/emission rates