IOCCG-25 Committee Meeting

Webex Online Meeting, 4, 5, 11, 13 May 2021

MINUTES

1.0 Welcome and Opening Session

1.1 Welcoming Address

The IOCCG Chair, Cara Wilson, opened the 25th IOCCG Committee meeting and welcomed all participants to the virtual meeting. The meeting started off with a moment of silence to remember Roland Doerffer and Oleg Kopelevich who had both made significant contributions to the IOCCG (see item 4.3). Participants then introduced themselves in a brief *tour de table* (a list of participants is provided in Appendix I).

1.2 Introduction of New IOCCG Scientific Officer

Raisha Lovindeer, the new IOCCG Scientific Officer, was warmly welcomed onto the IOCCG Committee. She gave a short presentation to introduce herself to Committee members, noting that she is a recent PhD graduate of the University of California Irvine where she has just completed her PhD looking at how cyanobacteria change their absorption based on light colour. She attended the 2018 IOCCG Summer Lecture Series followed by an internship with Mike Twardowski examining the detection of cyanobacteria blooms in estuarine waters. She is currently doing a one-year postdoc at the University of British Columbia modelling oil spills in the Salish Sea. In Jamaica, where she hails from, she was the music director for a Steel Orchestra where she gained a lot of experience managing a large non-profit group. She also worked in a business with her husband. She thanked the Committee for their warm welcome and is looking forward to meeting everyone in person.

1.3 Adoption of Agenda, Review of IOCCG-24 Minutes, Status of Actions

The agenda was adopted as written and the minutes of the IOCCG-24 Committee meeting were approved by consensus. The actions from the IOCCG 24th Committee meeting were reviewed by Venetia Stuart:

- *Action 24/1:* Closed - all Chapters of the modelling report were reviewed by various Committee members, and the report has been published.

- *Action 24/2:* Closed - the IOCCG report on harmful algal blooms has been published and will be discussed under agenda item 2.1.
- *Action 24/3:* Closed - guidelines for proposing a new IOCCG Task Force were circulated to the Committee for comment, and are now available on the IOCCG website at: https://ioccg.org/what-we-do/task-forces/.
- *Action 24/4:* Ongoing - the proposed IOCCG Hyperspectral Task Force will be discussed under agenda item 3.1
- *Action 24/5:* Closed - Mike Behrenfeld has been promoting ocean Lidar through town hall lectures. He and others are involved in discussions to include an ocean Lidar on an upcoming atmospheric satellite.
- *Action 24/6:* Closed - Cara Wilson conducted IOCCG Town Halls at the Fall AGU meeting (Dec 2019) and the 2020 Ocean Sciences meeting (Feb 2020).
- *Action 24/7:* Ongoing – dates for the 2023 IOCS meeting will be selected to avoid potential conflict/overlap with the 2022 and 2024 Ocean Optics meetings, scheduled for Vietnam and Australia respectively.
- *Action 24/8:* Closed - Cara Wilson contacted Shubha Sathyendranath regarding a possible update to IOCCG Report 3. She was interested in doing this if there was no urgent timeline.
- *Action 24/9:* Ongoing - a training roadmap for the IOCCG website will be discussed under agenda item 5.2.
- *Action 24/10:* Ongoing - Chuanmin Hu and Laura Lorenzoni have made plans for a journal special issue on *Aquatic Carbon from Space* which will be discussed under agenda item 6.1.
- *Action 24/11:* Closed - the byline on the IOCCG homepage has been changed to be more inclusive of the inland water community.

1.4 Remembering Trevor Platt and his Role in the Formation of the IOCCG

Robert Frouin gave a moving tribute to Trevor, who was a brilliant scientist with many concepts and ideas that seemed impossible to exploit. He was truly innovative in bringing elegant solutions to long standing problems such as modelling global primary production. In the early 1990's, the SIMBIOS Project was developed, and was aimed at merging satellite ocean colour data from multiple missions. An international body was needed to coordinate the activities of the Project so the IOCCG was established. Robert approached Trevor to act as Chair of the group. He immediately accepted the leadership role, and during his tenure as IOCCG Chair, Trevor emphasized capacity building and shared his knowledge with students from developing countries, as well as secured new funding sources. The IOCCG has endured and prospered because of his actions.

Jim Yoder, former NASA representative on the IOCCG Executive Committee and IOCCG Chair for 3 years, outlined the events of the first decade of the IOCCG. He noted that Trevor was truly the founding father of IOCCG. A person of such high scientific stature was absolutely essential to lead the first years of IOCCG and to develop it into a credible and successful international organization. Jim recalled four major contributions from Trevor: i) arranging for SCOR to act as host of the IOCCG; ii) recruiting new sponsors to sustain the organization; iii) creating the IOCCG scientific monograph series (20 monographs to date, an incredible resource for the international scientific community), and lastly iv) initiating the IOCCG training programmes. Trevor was always passionate about the need to train early career international scientists. Assisted by his equally brilliant partner, Dr. Shubha Sathyendranath, they led IOCCG-sponsored training programs throughout the developing world. Finally, another important contribution from Trevor was to choose Venetia Stuart as the Scientific Coordinator, and what a great choice and contribution that was, as she has been the glue for IOCCG for 25 years. In summary, Trevor was the right person at the right time to be the first leader of IOCCG, and he made many important and lasting contributions. IOCCG owes much of its success, in fact its very existence, to all that he did during the 10 years he led the organization.

2.0 Status of Current IOCCG Working Groups, Task Forces, Protocol Series

2.1 IOCCG/GEOHAB Harmful Algal Blooms Report

Stewart Bernard provided an update on the IOCCG harmful algal bloom report which was recently published thanks to the tremendous efforts of the co-editors Lisl Robinson Lain, Grant Pitcher and Raphael Kudela, as well as all the authors. This is a joint report with GEOHAB and GlobalHAB and thus reaches out to different communities. The report includes an introduction to HABs as well as several chapters broken down according to impact e.g., paralytic shellfish poisoning, with many case studies demonstrating different products and approaches. A chapter on "Going from HAB research to operational knowledge and action" demonstrates that a solid quantitative understanding of user needs and various development mechanisms are critical elements in the research-to-operational transition, and a very different approach is required. The report concludes with recommendations including multi scale observation systems, user needs, sensor requirements and a clear requirement for improved atmospheric corrections for optically complex waters.

2.2 Benthic Reflectance WG

Heidi Dierssen briefed the Committee on the new IOCCG Benthic Reflectance WG. She noted that benthic reflectance measurements are very important and are needed to characterize ocean habitats such as corals, seagrass and macroalgae, and are also used for biogeochemistry

and physiology. There are very few published datasets – most people use hydrolight (but only one coral spectrum). Benthic reflectance measurements can be done using many different instruments and techniques, but there are no recommendations for best practices for each method, metadata, or uncertainties inherent to the measurement. For example, soft corals have completely different spectral properties from hard corals, related to various factors including habitat, pigments, endosymbionts, morphology etc. This variability can lead to uncertainties in remote sensing of corals. She presented some chapter ideas for the IOCCG report including an overview of measurement theory and methods, sediments, hard substrates (corals, minerals), canopies and algal mats, environmental influences (glint, turbidity), representation of benthic reflectance in models, endmember libraries and a final chapter on new technology.

Referring to comments from the Committee, the report will not tackle inversion of the signal in shallow waters, but may work towards a library of quality controlled bottom reflectances. Furthermore, the report will not address flagging itself, but will include a section on how to differentiate between optically shallow and optically deep waters.

An online meeting will be held this fall to form subgroups and discuss the report outline, followed by a kickoff meeting in February 2022, in conjunction with the Ocean Sciences meeting in Hawaii, to identify chapter leads etc. Another group meeting could be held in conjunction with Ocean Optics (October 2022) to assess the progress of draft chapters. A full draft report could be ready for review by April 2023. The final deliverable could be an IOCCG Protocol or an IOCCG Report - some members preferred an IOCCG Report. The group may also publish a database paper of benthic reflectance libraries and come up with metadata.

2.3 Atmospheric Correction in Coastal Waters WG

Cedric Jamet briefed the Committee on the status of the working group on "Atmospheric correction over turbid waters". The report from this WG aims to provide guidance to end-users on the advantages and limitations of various atmospheric correction algorithms in turbid waters. A total of 9 different algorithms were evaluated using MODIS-A data, although the report is not necessarily sensor specific. A dedicated chapter will examine adjacency effects as well as other issues such as absorbing aerosols and CDOM. To evaluate the atmospheric correction algorithms, the group performed classic match-up analysis using AERONET-OC data, while a simulated dataset was used for sensitivity studies. Results for match-ups obtained by each AC algorithm were presented and discussed. The evaluations are almost complete and the results are currently being checked with the algorithm providers. An outline of the Table of Contents of the report was presented – most chapters were nearing completion, apart from the chapter on adjacency effects and absorbing aerosols. Some limitations of the study are that it

only examines moderately turbid waters, there is no spectral band response for MODIS-A, no evaluation for optical water types and no vicarious calibration for most algorithms. The report will be published as an IOCCG Technical Report.

2.4 Task Force on Remote Sensing of Marine Litter and Debris

Shungu Garaba provided an overview of the Task Force on remote sensing of marine litter and debris. The primary goal of the TF is to coordinate the advancement of remote sensing technologies that have potential to detect, identify, quantify and track floating plastic litter over all aquatic environments. One of the biggest challenges is the lack of *in situ* data to validate the RS data. Currently the group has 37 members from agencies, industry and institutes, with 5 co-chairs and 4 Core Team coordinators. A website has been created for the group in conjunction with the IOCCG website, and includes a bibliography, a list of online repositories and databases, as well as ongoing research projects. The TF is tackling four different core topics: technologies, datasets, interdisciplinary aspects and algorithms & applications. It is anticipated that the TF knowledge base can be used to identify research and technology gaps, and promote the exploration of new initiatives e.g., airborne monitoring in synergy with other technologies. The first TF workshop is planned for 7 – 9 July 2021.

2.5 Task Force on Satellite Sensor Calibration

Ewa Kwiatkowska updated the Committee on the Task Force on Satellite Sensor Calibration, co-chaired by herself and Gerhard Meister from NASA. The initial motivation for the Task Force was that it is one of the recommendations from the INSITU-OCR White Paper. The group typically meets during the IOCS meetings, but they have not held a meeting over the last two years. Nevertheless, there are still many successful inter-agency collaborations and exchanges (e.g., strategy and requirements for the PACE OCI Solar Calibration). A dedicated workshop for the Task Force is planned for the next IOCS meeting.

2.6 New Task Force on Ocean Colour System Vicarious Calibration

Ewa Kwiatkowska noted that ocean colour system vicarious calibration (OC-SVC) is a fundamental requirement for all ocean colour missions, and allows the missions to meet the stringent requirements. Initially, an IOCCG working group addressed this topic but they made little progress since there were so many disparate activities across agencies. It is very important to have a continuous OC-SVC activity, so the IOCCG recommended that this working group be transformed into an IOCCG Task Force. Currently there are many activities across the agencies to establish or maintain OC-SVC infrastructure e.g., MOBY, BOUSSOLE, planning for PACE, Copernicus OC-SVC activity etc. These are highly specialized and very expensive, and the

OC-SVC methodologies are also highly specialized, so it is important to ensure cooperation and coordination across the agencies.   The new Task Force will be co-chaired by Ewa Kwiatkowska and Carol Johnson (NIST) and agencies are welcome to nominate new members, if desired**.**

Action 25/1: *Agency members to nominate new members for the OC-SVC Task Force, if desired.*

At the recent CEOS SIT-36 meeting, OCR-VC received a request to develop a White Paper describing strategic planning for global OC-SVC infrastructures. This will be the first major activity undertaken by the new OC-SVC Task Force. They plan to hold their first meeting this summer to propose the structure of the document, address the main concepts and requirements and allocate writers, and intend to follow the template of the INSITU-OCR White Paper. The group requested advice and input from the IOCCG Committee.

Action 25/2: IOCCG members requested to provide input and advice on the proposed White Paper for the new OC-SVC Task Force.

2.7 Nomenclature Activity

Robert Frouin noted that there was nothing new to report on this activity. The consensus after the last Committee meeting was that this group should not evolve into an IOCCG working group on this topic because of the potential repercussions of name changes/definitions with the agencies. The Committee recognised that there was nevertheless a need to have clear and concise definitions on IOCCG websites as a resource, and Robert was willing to help out with this initiative. Inconsistencies in terminology could be noted, with suggestions offered on how to state differently, but nothing prescriptive. The PACE science team has also expressed an interest in establishing WG on nomenclature, which could be linked to the IOCCG activity, but this has not taken off yet.   It is difficult to motivate people without the publication of a report/document on the topic.

3.0 Establishing New IOCCG Working Groups and Task Forces

3.1 Progress with Establishing an IOCCG Hyperspectral Task Force

Stewart Bernard summarized discussions on the formation of the Hyperspectral Task Force (action item 24/4 at the last IOCCG meeting in Vietnam). He presented comments on the task force that yielded a focus on creating a quantitative guide to the pros and cons of hyperspectral radiometry as compared to multispectral, and looking at the science application and mission development of hyperspectral radiometry.

Stewart showed the initial scope and framing questions and key comments pertaining to each. The scope involved identifying phytoplankton functional types, substrates, and floating particles

(macrophytes, plastics). He presented a 6-step general approach from the first step of using synthetic datasets, validated with *in situ* measurements for select target variables, to the final step of comparing advantages of hyperspectral to multispectral. He illustrated an example of this approach using optical properties of phytoplankton functional types. He indicated that the task force requires significant resources across expertise and agencies and that he feels strongly that the chair of the task force should be affiliated with a space agency, such as NASA. He recommended Wesley Moses.

Jeremy Werdell volunteered to help with the task force – specifically in grounding the theoretical analysis in the reality of what is possible from space-based instruments and resources. Stewart agreed to the importance of this point, especially as he prepares to work with hyperspectral data from cubesats, and in light of potentially large expectations from data users.

Chuanmin Hu asked how agencies would support the task force. Stewart indicated that, for example, under both PACE and SBG, there could be a collaborative modeling effort to understand the limitations of hyperspectral. He suggested there be close collaboration and communication with these agencies to understand what explicitly they would want from the task force, and to look at their on-going science plans and projects for best fit.

Heidi Dierssen indicated that an on-going task force with experts discussing their models, datasets, and papers, was initially proposed, and questioned whether Stewart's approach appeared more in line with the report format of a working group. Stewart indicated that he hoped the output would be more of a special issue or extended publication. Ewa Kwiatkowska expressed that an IOCCG report would be welcome and very helpful across agencies, as many agencies get inspired by the reports for planning of future missions and development purposes, suggesting more for a working group than a task force. Stewart indicated that he envisions an analogue of Report 13 (Mission Requirements for Ocean Colour Remote Sensing) that would be used for the next 5 - 10 years by those needing to understand the best applications and limitations of a hyperspectral mission for water. Heidi expressed that The Alliance for Coastal Technology, an international body, has a coastal hyperspectral best practices workshop that encompasses many of the people proposed for the IOCCG task force. She indicated that they are already meeting and discussing hyperspectral applications at an international level, so parallel efforts exist. She expressed her preference for a discussion board and hyperspectral clearing house concept from IOCCG, because if reports were generated, they may become outdated too rapidly since this area of research is very active, with groups funded to produce algorithms for many of the applicable areas of focus, though she expressed that the underlying physics would be useful to discuss. Stewart expressed that if the focus of a report takes a physics-based, systematic perspective, it will likely stay applicable for an extended period of time. He expressed that the clearing house idea was a good one, but it does not provide a

definitive, quantitative guide for approaching hyperspectral missions and data analysis. Marie-Hélène Rio expressed that she is in strong support, but that further discussion is needed to focus the objectives of the task force. She agrees that a report would be very interesting, generated after brainstorming and discussion with the community, preferably as a guide for use and application of hyperspectral data. She emphasized the need for more discussion, and expressed her interest to take part in those discussions.

Heidi indicated that she submitted the original proposal for the hyperspectral task force in collaboration with Astrid Bracher and Emanuele Organelli, but the proposal was turned down by the IOCCG committee. She said that at the hyperspectral best practices workshop, Ana Dogliotti and Emanuele Organelli volunteered to pursue a hyperspectral task force. Heidi was therefore interested to know the differences between what was initially proposed and this new call for a task force. Ana indicated that she, Astrid and Emanuele are still interested, and are awaiting a decision/reply from the IOCCG regarding this topic. Stewart indicated that the email chain he used to compile his presentation came from the feedback to that initial proposal, which incorporates some of the initial ideas. He indicated the need for forward-looking, quantitative analyses that were missing from the initial proposal, but valuable from the IOCCG's perspective. He said the committee could revisit the team's willingness, and emphasized the importance of understanding what we hope to achieve with this task.

Lastly, Robert Frouin indicated that thoughts about hyperspectral remote sensing must also include a balance with spatial resolution, as it is possible to get much more data with higher spatial resolution even while having low spectral resolution. The two work in tandem and need to be discussed together. Stewart agreed, and emphasized that space, time, and the quality of information all need to be balanced.

Action 25/3: *IOCCG Project Office to schedule a side meeting to discuss the formation and scope of an IOCCG Hyperspectral Task Force/WG and to identify a possible Chair.*

3.2 Open Call for New IOCCG Working Groups or Task Forces?

Venetia Stuart indicated that Ewa Kwiatkowska, Marie-Hélène Rio, and Paula Bontempi (in her presentation) had previously expressed support for the call for new working groups and task forces. Chaunmin Hu indicated that he supports an open call to the entire community for their input. Stewart Bernard expressed support for an open call, and indicated that the wording for the call needs to clearly express IOCCG's expectations, whether a technical review, best practices, etc. Chaunmin agreed and suggested we share links to past working groups and task forces in the call. Venetia indicated that all proposals will be reviewed by the committee and then selected to move forward, which is another means of constraining the topics.

Stewart indicated that feedback to proposers from the committee on proposals that are interesting but could be expanded/contracted would be useful. Ewa suggested communicating key priority areas for the advancement of ocean colour that result directly from the high priority areas decided within the IOCCG, especially in light of Paula Bontempi's presentation on where we go next. Stewart agreed with this approach.

Robert Frouin indicated that there are existing working groups that could easily be leveraged to evolve into IOCCG working groups. He gave the example of the SBG working group on sun glint that reviews techniques to manage sun glint in ocean colour remote sensing. Such a group could evolve into an IOCCG working group and would be uniquely prepared to write an IOCCG report on the topic in a relatively short time frame.

In agreement and response to comments and questions from Cédric Jamet and Heidi Dierssen in the chat, Venetia reminded the committee of funding considerations in their deliberations. The IOCCG usually provides funds for the convening of working groups and pays to have the reports generated. Generally, only one working group meeting can be funded per year.

Stewart concluded that a hybrid of the suggestions made could be useful. The IOCCG Project Office could indicate key areas of priority in the call, and still request proposals that are open (do not align with any of these key areas) for consideration by the committee, in order to not stifle creativity and input from the community. Venetia agreed, and asked for consideration of the time frame. Venetia indicated that Heidi's working group (on benthic reflectance) is active this year, so a call for additional working groups could go out for next year. She stressed that it is good to always have working groups in the pipeline for continuity of the report series. Stewart suggested that the importance of the report series could be used as a selling point for specific agency funding so that more than one working group may exist at a time. Lastly, Heidi suggested, in the chat, that moving reports more towards peer-reviewed publications should be considered in the future.

4.0 Agency Updates: New and Emerging Initiatives

4.1 EUMETSAT Ocean Colour Update

Ewa Kwiatkowska presented the EUMETSAT update, focusing on L2 ocean colour activities. The Sentinel-3 OLCI operational processor - Collection 3 - is due to be completed by Summer 2021. There will be new L2 system vicarious calibration (SVC) gains as well as updated L2 marine algorithms (including atmospheric correction) and updated/new flags. Collection 3 demonstrates: high consistency between OLCI-A and OLCI-B, open water chlorophyll within mission requirements, improved coastal retrievals/ reduced noise, and compares well against MODIS-A. Collection 3.1 was released on 28 April 2021. New OLCI L2 marine test products and

tools are also available for user validation, in source code, as SNAP toolboxes, and via EUMETSAT on demand processing (IOPs, fluorescence, BRDF clear water). EUMETSAT would like to get community feedback on the IOP and fluorescence products so they can be put into the operational processing with Collection 4 of OLCI data (Collection 4, timeframe 2023). There are also plans for an OC day-2 processor (timeframe 2024/25).

Many activities are underway regarding Copernicus OC-SVC infrastructure development - a roadmap is being accomplished, and EUMETSAT is currently investigating five sites in European waters for infrastructure placement. In response to a question from Robert Frouin regarding the BOUSSOLE site, Ewa noted that one of the two preliminary designs aimed to expand BOUSSOLE into a fully operational infrastructure.

A third EUMETSAT activity involves Fiducial Reference Measurements for Satellite Ocean Colour (FRM4SOC-2), which started at the beginning of April 2021, and will provide confidence in satellite data products through FRM-quality validation results and satellite product uncertainty estimates. Collaborations are invited and welcome for FRM4SOC-2 field experiments (at AAOT July 2022), laboratory characterisation/ calibration exercises and workshops.

EUMETSAT also has a broad interest in geostationary ocean colour products, as an emerging activity for EUMETSAT's Ocean and Sea Ice Satellite Application Facility. Further development of extended geostationary capabilities from EUMETSAT's missions will be pursued towards the end of 2021.

4.2 NASA Updates on PACE and GLIMR Missions

Bryan Franz presented the status of IOCCG protocols currently in development. Protocols on CDOM absorption and particulate organic carbon are in revision for publication later this year. Protocols on aquatic primary productivity and scattering are in advanced draft. An OCB publication on data standards and taxonomy of phytoplankton is currently in progress, with expected publication by June 2021. Protocols that are in the planning stages include a supplemental to topics on ocean colour radiometry, phytoplankton carbon, and phytoplankton community composition.

NASA's Ocean Biology Processing Group (OBPG) is continuing to produce and distribute data from MODIS Aqua and Terra and VIIRS JPSS-1 and SNPP. There is drift in the SNPP late stage remote sensing reflectance data but can be corrected in reprocessing. Multi-mission reprocessing was delayed but should occur within the next 6 months. Major focus is updating instrument calibration, including MERIS level 1-B. Currently, level 1-B products from OLCI are mirrored from ESA, and level 2 and 3 products will be added for the first time, starting with OLCI level 3A. The main challenge has been consistent time series data from OLCI with minimum bias

with other sensors, specifically because of instability with MOBI-derived water-leaving radiance and deviations from 2017 data. Model-based vicarious calibration has resolved much (though not all) of these biases giving the team confidence to move forward with data processing from OLCI/S3A. GOCI-I has stopped producing data, and on-going data mirroring and processing from GOCI-II is not confirmed. There is upcoming data from HawkEye on the SeaHawk cubesat, which is an incredible cost-effective mission and a great demonstration of inexpensive data acquisition for ocean colour. Data will be available on the Ocean Colour Web once SeaHawk is fully operational (expected in June 2021). Preliminary data on chlorophyll-a shows good agreement and higher resolution than MODIS Terra.

In collaboration with ESA, SeaDAS 8.0 was released in February 2021 on the Sentinel Applications Platform (SNAP). It includes a SeaDAS toolbox as a plug-in to SNAP as well as other SNAP toolboxes. The SeaDAS toolbox includes all the processing codes from NASA (standard products along with high resolution instruments). The addition of MERIS and OLCI data is in support of the Cyanobacteria Assessment Network (CYAN) project that makes use of red wavelength bands not available in other sensors. The CYAN Project provides a means for water quality managers to get earlier warnings of HABS for the continental US and Alaska. Upcoming releases include in-land water body datasets and time series for the continental US and Alaska.

Jeremy Werdell gave an update on NASA's Plankton, Aerosol, Cloud, ocean Ecosystem (PACE) mission. The PACE launch has been delayed by ~9 months, due to the pandemic, and will be no earlier than November 2023. The official launch date will be announced later. On-going programs in relation to community engagement include a science and applications team, formed in June 2020 for 3 years. There are two system vicarious calibration teams that started in June 2020 with a plan to down-select to one team after year two. There are currently >20 early adopter projects in an Early Adopters Program, and NASA PACE is still accepting applications from others who wish to be a part of this program, including international partners.

The Ocean Colour Instrument (OCI) was moving on schedule prior to the pandemic shut down. Work has restarted and delivery of instruments for testing and integration will commence next year, with total delivery of all instruments and systems by mid to late 2022. A simulated dataset with 5 full global days of level 1-B top of atmosphere radiances generated using radiative transfer models, MODIS, and VIIRS is available at oceancolor.gsfc.nasa.gov/data/pace. The observatory will include two multi-angled polarimeters that are in flight build development and will be ready in the first quarter of 2022. There is the potential for simulated data from these instruments available to the community in the coming month or two.

A PACE validation science team (PVST) will be created 6 months prior to launch in mid 2023. Primary focus is the validation of threshold products, but will evolve over time. This mission is keen to collaborate and create synergies with international partners.

Lastly, Jeremy highlighted key pages on the NASA PACE website that can be useful to the ocean colour community, including technical memos and documentation, as well as simulated data and data product descriptions. He also introduced a fun collaboration between NASA and ESA happening with the public on social media (see #NASAESABakeoff on Twitter).

Laura Lorenzoni presented focal points for NASA related to ocean colour missions. This included a decadal survey which was started in 2017 and is currently underway within an integrated Earth System Observatory concept. The concept includes five key areas: surface biology and geology (SBG), surface deformation and change (SDC), mass change (MC), aerosols, and cloud convection and precipitation (CCP). SBG is the first to be launched (anticipated after 2027) and is highly relevant to the IOCCG as it will address science questions concerning coastal areas, water quality, and water resource management. Included in the SBG observatory are the VSWIR platform, and the TIR platform in collaboration with the Italian Space Agency. A strong international collaboration is the aim, as leveraging other instruments in a constellation (e.g. CHIME from ESA, TRISHNA from CNES/SRO) increases coverage, reduces revisit times, and creates opportunities for data harmonization across platforms. Aerosol and/or Cloud Convection and Precipitation (ACCP) is the designated observable that is slated to be launched after SBG. That mission is considering 3 satellites in 2 orbits, including a high spectral resolution ocean-capable LIDAR in polar orbit with wavelengths in the green and infrared, and multiple polarizations—highly relevant to ocean colour science.

Regarding geosynchronous instruments, NASA has been developing the Geosynchronous Littoral Imagine and Monitoring Radiometer (GLIMR) slated to launch between 2026 – 2027. It is expected to provide data from the Gulf of Mexico, Southern United States and the Amazon river plume. It is anticipated to possess a hyperspectral ocean colour sensor with 300 m resolution at nadir. The focus for the instrument will be on the coastal zone and fluxes of organic matter and phytoplankton growth. There is anticipated to be high synergy between instruments to adequately capture land and ocean.

Another focus for NASA is adequate calibration for satellites with reference to the moon through the Air-LUSI project. This project is on-going over the next few years until full lunar calibration is achieved, and will benefit calibration of multiple Earth observing satellites including commercial satellites. Laura welcomes inter-agency collaboration as this project has a broad reach for many.

Regarding *in situ* field validation, the second field campaign for EXPORTS is currently underway in the North Atlantic Ocean to understand the export and fate of organic matter. The campaign is slated to return to port on 1 June 2021. Additionally, the Southern Ocean Carbon and Climate Observations and Monitoring (SOCCOM) has floats that include bio-optical measurement capability. The project has been renewed for another 4 years and NASA is invested in adding more optical sensors to Argo floats for *in situ* validation. The National Science Foundation has also recently funded the Global Biogeochemical-Argo (GO-BGC) project that will deploy 500 floats with optical sensors across the globe over the next few years. There is currently an on-going meeting for GO-BGC every Tuesday that will end on 1 June 2021, which is the kick-off date for the UN Decade of the Ocean for Sustainable Development.

Lastly, Dirk Aurin gave an introduction to HyperInSpace (hyperspectral *in situ* support for PACE), a community processor for *in situ* radiometry. This project came out of a need for match-ups between satellite imagery and *in situ* biogeochemical properties for ocean colour validation. Current *in situ* validation platforms are legacy, multispectral and not well/equally distributed. Autonomous radiometric data is currently collected but proper quality control and corrections to ensure data are comparable is difficult. HyperInSpace helps to solve this problem by having community processors with on-going peer review for the data. The aim is to increase the quality of data going into SeaBASS. In order for HyperInSpace to be successful, it needs community buy-in and participation. Currently the processors are only capable of working with data from Seabird-type radiometers, with a planned update for Trios sensor. Dirk requests community help to develop new sensor packages, and to develop smaller packages and modules. See more information at http://github.com/nasa/hyperinspace.

4.3 ESA Updates: New and Emerging Initiatives

Marie-Hélène Rio opened her presentation with a few words about Roland Doerffer. He was one of the pioneers in ocean colour radiometry, providing expert scientific advice, developing algorithms and carrying out validation on the MERIS OC sensor as well as OLCI. He was part of ESA's Science Advisory Group, Quality Working Group and Validation group, and ran several ESA training courses. On top of that, he was a very nice person, always willing to help and mentor the students. ESA and the entire OC community will miss him and are grateful for all his contributions.

ESA's Sentinel-2 mission is mostly focussed on land but ESA has been mandated to generate dedicated L-2 aquatic reflectance products for coastal and in-land waters. From mid-2021, ESA is aiming to generate S2-Collection-1 – a reprocessing of the full S2 archive which will include both Level-1 and Level-2A products. ESA has a number of on-going and planned OC related projects including the BICEP Project (Biological Pump and Carbon Exchange Processes), to better characterise the different components of the biological carbon pump and compute carbon pools

and fluxes from space. Global products under development include POC, PIC, DOC, phytoplankton carbon and primary production. The project is also organizing the "Aquatic Carbon from Space" workshop In February 2022.

Other OC related projects include exploitation of Aeolus data (carrying a Lidar payload) to retrieve ocean particle optical properties and biogeochemical parameters, and the Sentinel-5P innovation OC project to retrieve products such as Kd and PFTs (cyanobacteria, diatoms, coccolithophores). Other projects include the Rapid Action on Coronavirus and EO (RACE) project and the trilateral NASA/JAXA/ESA dashboard to examine the use of EO data to shed light on environmental and economic changes resulting from the coronavirus pandemic (reduction of anthropic forcing on the environment, water quality parameters etc.). Other planned projects include the Biodiversity + Precursors activity (2020-2022) and the Ocean Health Project (2021-2023).

4.4 JAXA Update

Hiroshi Murakami started with a brief update on JAXA's Earth observing missions in development. The ALOS-3 high resolution optical sensor will be launched in 2021, and though not developed for the ocean, some band channels are applicable to coastal operations. However, ALOS-3 is a commercial satellite so the data needs to be purchased from the company. Launches in 2022 include ALOS-4 and EarthCARE/CPR which are not ocean colour missions, but JAXA is trying to collaborate with NASA on their A-CCP mission (presented by Laura Lorenzoni in the NASA update).

The Global Change Observation Mission-Climate (GCOM-C)/SGLI was launched in December 2017 with data available from 1 Jan 2018 with 250 m resolution in the visible, near UV, and NIR, and 2 polarization channels. Though it was designed for atmospheric application, it has many ocean applications. Data is freely available from JAXA's G-Portal (gportal.jaxa.jp/gpr), with other products available on the JASMES web portal. Data validation is on-going with updated information posted to the portal. SGLI has monthly lunar calibration using the GIRO model. Corrections for 2% per year degradation in the blue channels are included in the processing of level-1B data. Vicarious calibration is based on MOBY and BOUSSOLE and validated using Aeronet-OC sites. Results are also validated using Aeronet-OC sites along with in situ ocean colour data from GCOM-C Pis and SST validated by NOAA iQuam data. The team has applied for funding to continue data processing to level 2 and 3, with a target release for November 2021.

JAXA collaborates with many institutes in Japan that use the data, for example, to detect red tides. Other collaborations include the NASA/ESA/JAXA Earth Observing Dashboard (eodashboard.org) on a land-water budget project, and their membership in the OCR-VC. JAXA

is also involved in a collaborative project to monitor eutrophication using Google Earth Engine under the Northwest Pacific Action Plan (NOWPAP, unep.org/nowpap), as part of the 2030 UN Sustainable Development Agenda. The project is in its second and final year.

The next research announcement will open in the summer-autumn of 2021 for a start in April 2022.

4.5 ISRO: GISAT-1

Prakash Chauhan reported on ISRO's GEO Imaging Satellite-(GISAT-1) which will provide NRT imaging for the Indian sub-continent and parts of eastern Asian from a geostationary orbit (ideal for observing disasters and other episodic events). The satellite will carry three sensors including a multispectral VIS-NIR imager and two hyperspectral instruments to provide simultaneous and integrated observations of the land, ocean and atmosphere at a relatively high spatial resolution (42 – 318 m). Satellite ocean data will be used for multiple applications including fishery forecast, coastal zone management and carbon cycling. Launch has been impacted by the pandemic and is now scheduled for June/July 2021. ISRO's Oceansat-3 satellite, carrying the OCM ocean colour monitor, has also been delayed and is now scheduled for launch in December 2021. Committee members were very impressed by the specifications of the instruments, including the SNR and the spatial resolution.

4.6 CSA WaterSat Mission

Laurent Giugni reiterated that CSA is supportive of the IOCCG activities and updated the meeting on OC activities in Canada from 2018. The needs of the community for understanding, monitoring and protecting aquatic environments, as well as bridging gaps between users and satellite agencies, were detailed in a report by the NetCOLOR Community on Canadian priorities, and the 2017 IOCCG Report. The proposed mission to monitor the health of inland and coastal waters, WaterSat, was meant to complement PACE's global 1 km resolution, but global and regional opportunities to launch this project failed for various reasons.

Since 2018, prototypes were selected for investment, including WaterSat Imaging Spectrometer Experiment (WISE), COCI which is now in development, and new collaborations with Environment & Climate Change Canada (ECCC via Caren Binding) and CSIRO. New collaborations and investments are still being explored to move the project to Phase 0 in 2022 and then onward.

Laurent gave various examples of ocean colour activities in Canada, including the 3rd National NetCOLOR Meeting with over 80 participants in March 2021. Other major projects he

highlighted included EOLakeWatch (led by Caren Binding at ECCC); macroalgae monitoring via Sentinel-3 by Maycira Costa at University of Victoria; LakePulse.ca national assessment of lake health; Watershed 4 Health (W4H); and smartEarth, CSA's initiative to foster the use of satellite data for Earth system application; and the Atlantis Science Enterprise Center (ASEC) which CSA has invested to continue to pursue research in ocean science.

4.7 Italian Space Agency PRISMA Mission

Claudia Giardino gave an overview of the PRIMA mission, which is the Italian Space Agency's mission on hyperspectral data with aquatic application, launched in March 2019. Spectral range of PRISMA goes from visible to SWIR. Ground spatial resolution is 30 m for the hyperspectral camera and 5 m for the panchromatic camera. PRISMA covers the globe and has the ability to capture data from all of the oceans and data is comparable to existing satellite products. A data portal (prisma.asi.it) allows data acquisition from level-1 to level-2d. Claudia presented comparisons of L1 and L2 data with hyperspectral in situ data as well as simulated data for L1 and Sentinel-2/3 data for L2. She also presented application of PRISMA data to detection of seagrass, distinction of estuarine waters, water quality characterization, and phycocyanin concentrations.

PRISMA and in situ data are currently being used to help advise the next generation of Sentinel-2 at ESA and to support the CHIME-SBG missions. Matchups with PRISMA, in situ, and AVIRIS data will be available after AVIRIS flights in May – June 2021 and this data will be available to the public.

The follow-on mission, a second generation of PRISMA, will be launched in 2025.

4.8 CMEMS / EU HYPERNET Project

Vittorio Brando presented the current state of the ocean colour data streams in the Copernicus Marine Service. Ocean Colour Thematic Assembly Center (OCTAC) processes data for regional application, with the idea that regional algorithms will be superior to global standard products for regional application. Vittorio gave a historical overview of the product evolution from 2015 to 2021. The Sentinel 3-OLCI data stream was introduced in 2018 with 1-km resolution, and was replaced with S3A/3B at 300 m last week. A new product at 100 m resolution for the coastal area based on Sentinel 2A/B was also introduced last week. New products for phytoplankton functional types and pigments were introduced last year.

Full product reprocessing advanced from once per year to twice per year. Vittorio showed examples of the higher resolution products generated from OLCI at 300 m for coastal areas. He

indicated there is almost full data coverage above 40°N between S3A and S3B, and gave examples of regional applications (e.g. Black Sea, where there is seamless data from S3A+B). With the use of multi-sensors, there is much larger coverage for regional applications, such as the Mediterranean. Merged case 1 and case 2 algorithms are used in these regional seas, and there is little decrease in retrieval accuracy between Level-3 and Level-4 data.

Phytoplankton functional types have been introduced in all the regional seas as regional products, as well as a global product from merged S3A/B. Vittorio gave additional examples of regional application using blended algorithms via neural networks (e.g. Black Sea and Baltic sea) and there is room for improvement in these areas.

Future products between 2021 – 2024 include S2C, S3C and VIIRS as soon as they are launched and system vicarious calibration is available. Also planned is to increase current spatial resolution from 1-km using the higher resolution of VIIRS and OLCI, and resolve the spectral bands between them. There will be an effort to improve the accuracy of existing oceanographic variables, and spatial and temporal resolution across the range from open ocean to coastal waters.

Vittorio also gave an introduction to the EU H2020 HYPERNETS project which is developing a new hyperspectral radiometer integrated into automated networks for water and land used for satellite validation. Systems would be deployed across 24 sites for the collection of data. Vittorio gave a breakdown of the progress of the project to date. Since January 2021, there are 7 working prototypes, and 4 have been deployed to test sites in Italy, France, Belgium, and Estonia. The research project ends in October 2022, and collaboration (especially with space agencies) is required to take the project from research to continuous operation. The aim is to have a commercial product available for sale to the community by 2023.

A paper was published earlier this year (Concha et al., 2021, *Remote Sensing of Environment*) comparing validation protocols to select the most suitable for application to HYPERNETS. Vittorio highlighted 3 questions that he thought the IOCCG should help to anwer in their activities: "1) what are the most relevant criteria for validation protocols 2) is it better to have more match-ups (relaxed filtering criteria) or to select the best-case scenario (fewer match-ups), and 3) are we introducing biases by showing the best results and hiding inferior results?"

4.9 NOAA: GEO XO

Menghua Wang gave an update on the next generation geostationary satellite mission, GEO-XO. He gave the history of GOES, which started in 1975 with GOES 1-3 and will extend to GEO-XO in 2032, with XO representing extended observation. GEO-XO will include ocean colour and

atmospheric composition capabilities, which are new, and will keep capabilities of previous GOES missions. Menghua reiterated that user-engagement for GOES and other future missions is very important within NOAA, and is used to inform future missions. Application of ocean colour information emerged as a top priority within user surveys.

Mission concept review will take place in June 2021, and by 2022, more firm decisions will be made about the program.

4.10   Australian Ocean Colour Activities

Tim Malthus reported on Australian ocean colour activities including national perspectives as well as field activities and ongoing research projects. The Australian Space Agency was founded in 2018, Earth Observation for Australia (EOA; https://www.eoa.org.au) was incorporated in 2020 (a collaboration and coordination hub across research and education, government, private industry and non-government organisations), and the SMARTSAT cooperative research center was established in 2020 to push forward certain areas of technology. Many different activities are being carried out in the frame of the Australia Integrated Marine Observing System (IMOS). Field activities include participation in the Antarctic circumnavigation expedition (2016/17) and the 5-week SOLACE research voyage in the Southern Ocean (2021), the Inland Water Quality (IWQual) Project, the EU PrimeWater Project (using Sentinel-2, Landsat, PRISMA), Himawari-8 diurnal variability in concentrations of Total Suspended Solids and the oil spill detection system for the Great Barrier Reef marine park. The Australia Aquawatch mission concept was also discussed which includes three major components: satellite, *in situ* sensor, and data processing systems, with a dual focus on inland and coastal waters. The Phase 0 work packages are currently underway (user consultation, instrument specifications for a satellite constellation, in situ sensor network etc.). Lastly, the planned Polar POD 3-year expedition around the Southern Ocean will release an enormous floating tower to circulate around the Antarctic continent. A significant part of this programme, which is essentially driven from France but will include an Australian component, will support validation of satellite OCR (also satellite SST, salinity and waves) as well as research towards better interpretation of satellite ocean colour in the southern ocean.

4.11   China: HY-1D and GEO Mission

Xianqianq He reported on current and future Chinese ocean colour (OC) missions. The ocean satellite constellation, HY-1A and B were historic OC satellites and were experiments for local observation. HY-1C, launched in September 2018, and HY-1D, launched in June 2020, are successors to HY-1A/B. Three OC payloads are onboard HY-1C/D: global daily coverage from the China Ocean Color Temperature Scanner (COCTS) with 8 of 10 bands for OC; the Coastal Zone

Imager (CZI) with high spatial resolution at 50m and 4 bands in visible and NIR; and the Ultraviolet imager (UVI) with 2 UV bands and daily global observation at 550 m resolution. The next generation of satellites in this mission are HY-1E, scheduled for launch in 2023 and currently approved by the Chinese government, and HY-1F, planned for 2024 and awaiting government approval. These will have three major payloads: a new Ocean Color and Temperature Scanner with 18 bands from 350 nm – 12000 nm; Programmable Moderate Resolution Imaging Spectroradiometer with 100 m resolution and 16 bands from 375 – 2350 nm; and a Coastal Zone Imager with 20 m resolution and 9 bands from 400 – 800 nm. The HY-2 mission series is dedicated to ocean dynamics (sea surface wind, SSH, SST). HY-2D, the next in the series, will be launched next week.

The first geostationary OC mission is planned as part of the HY-3 series, and will launch in 2023. The HY-3 series is a high-resolution ocean monitoring mission that includes high resolution monitoring satellites GF-3 and HY-3A which were launched in 2020 and monitor disasters. HY-3B will launch this year, in 2021. The 2023 launch is HY-3C and will include three sensors for the ocean and coastal zone, with 25 – 200 m resolution in the visible and NIR. This includes the GEO Ocean & Coastal Zone Imager, with typical ocean colour bands from blue to NIR along with additional bands for coastal zone monitoring, as well as SWIR, MWIR and TIR. Spatial resolution for coastal bands will be 25 m, ocean colour bands at 100 or 200 m, SWIR/MWIR at 200 m, and TIR at 500 m spatial resolution. Temporal resolution is approximately one hour, but with irregular coverage and focused on the Chinese coastal zone. Other sensors will include a GEO Ultraviolet & Oil Spill monitor, and GEO Air pollution monitor for ships in large harbors.

4.12   CONAE: Sabia-Mar Mission Update

Carolina Tauro provided an update on the SABIA-Mar OC mission, developed in cooperation between CONAE and AEB. CONAE is developing the first of two planned satellites. SABIA-Mar will focus on the open ocean ($\pm$ 60° Lat, 800 m spatial resolution) as well as coastal waters of Argentina and South America (~650 km offshore, 200/400 m resolution). Standard products will include water leaving radiance, Chl-a, K_d(490), PAR, turbidity and SST. The sensors onboard will have a total of 16 VIS-NIR-SWIR bands (412-1610 nm) plus two TIR bands (10800 and 11800 nm). Level 1 A and B products will be available under agreement, while L2 and L3 products will be available free of charge on the website. Existing models and algorithms will be used to generate the L2 products. Currently, the SABIA-Mar science team is being formed and the OC community is invited to participate in its activities including development of AC algorithms, pre- and post-launch calibration, and product validation. The next milestone of SABIA-Mar is the Mission Critical Design Review, scheduled for September 2021. Mission launch is planned for 2023.

5.0 Training Initiatives

5.1 Plans for 2022 Summer Lecture Series

David Antoine outlined plans for the 5th edition of the IOCCG Summer Lecture Series (SLS), tentatively scheduled to take place in July 2022 in Villefranche-sur-mer (France). With an average of 20 students per course, a total of ~100 students would have been trained through the SLS by the end of 2022. If the course goes ahead in 2022, it will be almost fully supported by external sponsors with little impact on the IOCCG budget thanks to a €34,000 grant obtained from Copernicus, plus additional support from LOV, IMEV, CNES, OCB etc. Travel and accommodation for students for the first four editions accounted on average for 41% of the budget, lecturers accounted for 33% of the budget, while other expenses were related to video/audio recording, social events, consumables for practical sessions, management. The new student accommodation building has five floors with 44 rooms for students. A first announcement will be released in September 2021 and potential lecturers will be contacted at that time. Applications will open in January 2022 for a period of 6 weeks, and selected students will be notified by the end of March 2022. The likelihood of SLS taking place in 2022 is dependent upon the COVID situation which is very hard to predict, and also upon renewal of the informal agreement by LOV-IMEV to host the SLS (highly likely).

5.2 Other Plans for IOCCG Training

It was noted that the SLS is a great resource but there are still gaps in the IOCCG training programme, particularly at the introductory level. Venetia Stuart reported that there is a lot of material on the IOCCG website including books, links to online courses and training material from various agencies, as well as the lecture material from the SLS, but it would be good to have a roadmap for new OC users to link all these resources together. Heidi Dierssen pointed out that there is also a lot of online material on the EUMETSAT website including Jupiter notebooks with code, which should be incorporated into the IOCCG training roadmap. Prakash Chauhan noted that ISRO recently ran a Massive Open Online Courses (MOOC) on disaster risk management using EO data, in conjunction with the CEOS WG on Capacity Development and the United Nations Office for Outer Space Affairs (UNOOSA). If IOCCG decided to offer a MOOC on ocean colour (e.g., a compilation of lectures and practical aspects), the Indian Institute of Remote Sensing could provide support by hosting the platform and handling registration and certificates.

Cara suggested that it would be useful to form a sub-committee of people who are interested in advancing an IOCCG online introductory training course on ocean colour: Paula Bontempi, Heidi Dierssen, Aurea Ciotti, Prakash Chauhan, Emmanuel Devred and Raisha Lovindeer

volunteered to serve on this sub-committee. It was recommended that Hayley Evers-King (EUMETSAT) also be invited.

Action 25/4: IOCCG Project Office to confirm membership of the training sub-committee and move forward with an introductory OC training roadmap for the IOCCG website.

6.0 Other Ocean Colour Related Business

6.1 Journal Special Issue on Carbon

Chuanmin Hu gave an update on the special issue on carbon first presented at the IOCS meeting in 2019. An editorial board has formed and met several times to finalize the scope of the issue. Earth-Science Reviews is the journal of choice under the title *Aquatic carbon stocks and fluxes: the big picture from remote sensing*. Though the invitation for papers includes other supporting methods for determining aquatic carbon stocks, the focus on remote sensing is specially highlighted in this issue because carbon from space is currently under-represented in the literature. The editorial board has decided that review papers are best for meeting the needs of the special issue.

The editorial board is managed by Laura Lorenzoni with representatives from Australia, China, USA and the UK. Chuanmin expressed that more representation from EU and African countries would have been good but that the current composition is the best they have at the moment, while covering many different topics by the editorial board. Chuanmin Hu is not included in the editorial board listing as the journal had a cap on the number of editors, though he will be actively involved in the administrative process.

The journal is ready to accept papers. The editorial board still needs to select and contact people for invited reviews. Contributed papers are also welcome. For contributed papers, a letter of intent is required with the title, abstract, and author listing. Editors will decide which papers fit within the scope of the special issue. The submission deadline for papers is 1 March 2022, with the final deadline for acceptance in December 2022. Chuanmin asked and received feedback that the names of the editorial board members should be included in the announcement. Laura Lorenzoni confirmed that the official announcement with IOCCG is ready to be made, as final approval from the journal was received late last week.

Action 25/5: Editorial Board and IOCCG Project Office to make an official announcement and call for paper submissions to the special issue on Aquatic carbon stocks and fluxes.

6.2 Building the Operational Component of OCR-VC

The co-chairs of OCR-VC, Ewa Kwiatkowska and Marie-Hélène Rio, were in regular communication with CEOS to ensure that OCR-VC has a clear and transparent message. OCR-VC activities focus on three major points: climate, carbon, and water quality. OCR is an essential climate variable (ECV) as defined by GCOS, and the OCR Climate Data Records contribute to the CEOS WG Climate ECV inventory. SVC infrastructure also applies to climate, as well as bio-optical measurement protocols to support climate quality OCR data. Contributions for carbon include the "Aquatic Carbon From Space" journal special issue and the ESA workshop on aquatic carbon. There are also many contributing IOCCG activities regarding water quality including IOCCG Report 17, the TF on plastic marine debris and the proposed hyperspectral TF.

OCR-VC ongoing contributions to CEOS by various agencies are related to implementation of the INSITU-OCR White Paper. CEOS has requested the development of another White Paper on planning for global OC-SVC infrastructures, which will be the first major activity undertaken by the new IOCCG Task Force on the topic. Many of IOCCG's ongoing activities feed into the CEOS work plan, including the AC algorithm WG, the uncertainties report, the HAB report, the protocol series and capacity building initiatives (Summer Lecture Series, Platt Scholarship etc.). Currently the OCR-VC is co-chaired by Ewa and Marie-Hélène but there should be a regular rotation of co-chairs. Also, the official list of IOCCG OCR-VC representatives from each space agency should be confirmed.

Action 25/6: IOCCG Project Office to confirm the official list of IOCCG Representatives for the CEOS OCR-VC.

6.3 Ocean Carbon from Space workshop in 2022

Marie-Hélène Rio gave the context of the Ocean Carbon from Space workshop, which emerged from 2 strategy papers (CEOS Carbon Strategy in 2010, and GEO carbon strategy in 2014), and the CEOS AC-VC greenhouse gas Whitepaper in 2018, presented at CEOS Plenary in October 2020. For IOCCG, it is important to highlight and push the aquatic portion of the carbon budget, resulting in two main items related to aquatic carbon: Ocean Carbon from Space workshop and ESA BICEP (Ocean biological carbon pump).

The workshop is planned for February 2022, and Marie-Hélène opened the invitation to the IOCCG for recommendations and ideas on the content, and volunteers to participate. The main focus of the workshop is the current state of knowledge of the role of the aquatic environment on the carbon cycle, using satellites, models, and *in situ* data. The outcome of the workshop could be synthesized into a whitepaper, and could contribute an Aquatic Carbon from Space section of the GHG from Space Roadmap.

There are also on-going discussions with Laura Lorenzoni, as the recommendations from the workshop could also be published in the Special Issue on Carbon. Marie-Hélène indicated that she thought the workshop would be a great opportunity to showcase the capabilities of satellite data for ocean and freshwater carbon.

Cara Wilson asked about the nature of the workshop (virtual / in-person) and the location. Marie-Hélène said the planning committee would meet next week to decide. In-person is preferred but may not be possible. A hybrid may emerge. No decision has been made yet, but one will be made very soon.

6.4 Future Directions in Ocean Colour Remote Sensing

Paula Bontempi gave an inspiring talk on the future directions of the IOCCG. She started with a bit of background and contrasted the output and involvement of the IOCCG between when she joined in 2003 and today: from 8 to 17 agency sponsors; 3 to 20 reports; working groups and task forces addressing priority science questions; and a wealth of data across missions and space agency partners, especially the application of time series. Paula broke down the question "where do we go from here?" to include a series of adjacent questions: How do we process all the data we have produced? Are we prepared for the data-rich future in Earth system science? What will be the role of the new space agencies from international partners that need to be invited to the table? Are we funding the right tools and research to enable us to answer global-scale questions about the Earth system on an international level?

As we have moved from basic to applied sciences, the tools we have created have been used by policy makers and the public, and we need to think about the next steps towards further development. The movement of marine species poleward due to changing climate leads to jurisdictional challenges. Satellite ocean colour data, on large temporal and spatial scales, will be important for addressing these challenges, but defense of the uncertainties surrounding that data will be called into question. Are we ready for this?

This year marks the 25th year of the IOCCG (and the start of the UN Decade of the Ocean) and though we were unable to celebrate in person because of the COVID-19 pandemic, the accomplishments of the IOCCG are worth celebrating. Paula made the following broad suggestions surrounding telling the IOCCG's story and directing our future focus.
- As a 25th anniversary celebration of IOCCG (also in Venetia Stuart's honor), a coordinated release of top 10 findings from the IOCCG on World Oceans Day on June 8 via social media;

- Continue the IOCCG summer lecture series and other training opportunities and continue to ensure the inclusiveness and equitability of all training programs;
- Creating an interdisciplinary, climate-literate, workforce;
- Investigating the economic value of an Earth ocean observing system;
- The inclusion of social and environmental justice in our long-term planning, as there is a disproportionate impact of climate change on indigenous populations and underprivileged groups;
- Examine if we have what we need for the Earth system science question we want to answer;
- Focus on our goals (not just the means);
- Find a balance between sustained observables by using collaborations and partnerships in new technologies;
- Continue to utilize sensors that are not dedicated to the ocean colour, but also push for ocean-dedicated sensors;
- Look into the resources required for having modeled, multiple representations of the Earth via high performance computing nationally and possible internationally, which requires collaboration;
- Take advantage of opportunities that look at oceans across our solar systems as comparisons to our systems on Earth.

Action 25/7: IOCCG Project Office to compile and disseminate top findings for the IOCCG over the past 25 years on social media as part of the 25th anniversary on 8 June 2021, World Oceans Day

6.5 Update on ESA Lakes ECV CCI

Stefan Simis provided an update on ESA's Lakes Essential Climate Variable (ECV) Climate Change Initiative (CCI). The objective is to provide a consistent, uninterrupted time-series of the largest possible number of lakes covering all variables under the Lakes ECV (e.g., ice cover, surface water reflectance etc.) using over 30 different instruments and sensors. ECV products are guided by GCOS as well as user requirements. Thematic datasets are produced then merged. The ECV output for lake colour includes water-leaving reflectance as well as derived products (optical water type, Chl-a, turbidity and uncertainties). Currently, product uncertainty does not meet GCOS requirements. There is also a systematic underestimation of lake water leaving reflectance, so they are exploiting the systematic bias to correct. Another challenge is product continuity, so sensors with different capabilities are being exploited to fill data gaps (e.g., MODIS, MERIS, OLCI-A/B). The large and ambitious V2.0 release is in preparation for September 2021 and will include over 2000 lakes for most variables (1992-2019). Collaborations are highly encouraged so they can continue to improve these products.

In response to a question regarding adjacency effects, two optical water types have just been introduced that are quite efficient at recognizing adjacent land pixels. They are not correcting for adjacency, just flagging it. Regarding the users of the lake ECV data, the main CCI project is focussed on climate modellers - ESA is very keen to see observation data used to evidence climate change, and thus to influence policy makers through the IPCC reports.

6.6 GO-BGC - the Global Ocean Biogeochemistry Array

Cara Wilson gave a brief update on the GO-BCG workshop occurring during the month of May. The kick-off for the workshop was on 4 May 2021 at 14:00/23:00 UTC. All workshop presentations are pre-recorded and available for view at [The Global Biogeochemical-Argo Fleet: Knowledge to Action Workshop](#). The United States has 500 BGC floats and welcomes the input of internationally-contributed floats to get the number to 1000 floats. The workshop includes data users as well as agencies, with topics that cover the carbon budget using GO-BGC (May 18) and data simulation and modeling (May 25). The workshop will wrap up on 1 June 2021.

7.0 Plans for Next IOCS Meeting (USA 2023)

7.1 Possible venues, format, breakout workshops, sponsorship

The next IOCS meeting should occur in the USA based on rotation. Preliminary venues were suggested. It was suggested and agreed that a smaller committee of people based in the US needed to meet and decide on options for cities, meeting places, sponsorship, and other logistics.

Action 25/8: *IOCCG Project Office along with Laura Lorenzoni, Menghua Wang and Cara Wilson to meet as soon as possible to select a venue and discuss logistics of the IOCS Meeting in 2023.*

8.0 Next IOCCG Committee Meeting

8.1 Proposal to host IOCCG-26 meeting at ESA in 2022

Marie-Hélène Rio expressed that the IOCCG-26 meeting can still occur in Rome in 2022. Availability of main meeting rooms are limited to the 1st week in Feb and 3rd week of March (Ocean Sciences Meeting is Feb 27 – March 4 2022). Later in the year was suggested because of the COVID-19 pandemic and the uncertainty of countries returning to normal by early 2022. A discussion led to a decision to have IOCCG-26 in April 2022.

Action 25/9: *Marie-Hélène to check for available dates in April for the IOCCG-26 meeting and get back to the IOCCG Project office and IOCCG Chair***.**

A poll will be circulated to select meeting dates based on room availability. Potential conflicts to keep in mind include the later Easter holiday in April 2022 (17th and 18th) which shortens two work weeks, and the Oceans from Space meeting that is not yet set, but would take place in Venice.

8.2 Proposals welcomed for hosting IOCCG-27 in 2023

Marie-Hélène Rio suggested that we should really aim at minimizing travel by having the IOCS meeting in 2023 co-located with the IOCCG-27 meeting. There was large support for this suggestion, which would mean the IOCCG-27 would be held in the USA.

Concerns were raised that two back-to-back meetings may lead people to be away from home for too long. A hybrid meeting model incorporating both in-person and remote options was suggested, to help alleviate this problem. Suggestions were made to compress the meetings to accomplish everything in a shorter space of time; to arrange both meetings to occur at the same venue; and to use adjacent days and weekends to keep the timeframe short. Concern for ample time to go through all topics on the agenda and for interaction among members should be considered.

8.3 Rotation of IOCCG Committee members

Cara Wilson and Venetia Stuart expressed that with the COVID-19 pandemic, it may be prudent to keep the committee as is, and not rotate any committee members this year. This would allow members who have missed in-person meetings to experience their quota before rotation. The actual term for committee members is 3 years with a member attending at least 3 in-person committee meetings. There were no objections.

Cara Wilson has been the committee chair for longer than her allotted time, but agreed to remain in the position for the change-over of the scientific officer, and again, during the pandemic, to ensure continuity. Menghua Wang agreed that replacing the chair after everything has settled with the pandemic is a good move, and others concurred. While Cara expressed that she was happy to continue in this role, she requested that we use this time to consider the new chair and reminded the meeting that the chair cannot concurrently be in an agency representative role. Venetia expressed that she already received some names and encouraged

the committee to continue to submit nominations for a new Chair or even volunteer for the position.

8.4 Closing Comments

The committee chair, Cara Wilson, thanked everyone for their commitment and persistence in attending the virtual meetings over the four days/nights. The meetings were well attended with fruitful discussions. Cara especially thanked the committee for using the chat services available, which kept discussion going and kept the meeting running more or less on time.

Committee members expressed their appreciation for the hosting and planning of the meeting, and their appreciation to Venetia Stuart for her dedication and support of the IOCCG over many years. There was a question about whether Venetia would attend the in-person committee meeting in Rome in 2022, as the meeting is scheduled for April and Raisha Lovindeer will take over the position in May. Cara reminded Venetia that she agreed to be present for that final meeting, and Venetia agreed. Laura Lorenzoni suggested (in the chat) that we celebrate Venetia's up-coming retirement.

Action 25/10: *IOCCG Project Office to incorporate electronic chat into in-person and/or hybrid meetings in the future (if possible).*

Appendix I: LIST OF PARTICIPANTS IOCCG-25

Online Meeting, 4, 5, 11, 13 May 2021

IOCCG Members		Affiliation
Bernard, Stewart (past-Chair)	-	SANSA, South Africa
Bontempi, Paula	-	University of Rhode Island, USA
Brando, Vittorio	-	CNR-ISMAR, Italy
Chauhan, Prakash	-	IIRS, ISRO, India
Ciotti, Aurea	-	Universidade de São Paulo, Brazil
Devred, Emmanuel	-	Bedford Institute of Oceanography, Canada
Dogliotti, Ana	-	IAFE/CONICET, Argentina
Franz, Bryan	-	NASA GSFC, USA
Giardino, Claudia	-	CNR-IREA, Italy
Giugni, Laurent	-	CSA, Canada
He, Xianqiang	-	Second Institute of Oceanography, China
Hu, Chuanmin	-	University of South Florida, USA
Kim, Wonkook	-	Pusan National University, South Korea
Kwiatkowska, Ewa	-	EUMETSAT, EU, Germany
Lifermann, Anne	-	CNES, France
Loisel, Hubert	-	Université du Littoral, France
Lorenzoni, Laura	-	NASA HQ, USA
Malthus, Tim	-	CSIRO, Australia
Mélin, Frédéric	-	EU Joint Research Center, Italy
Murakami, Hiroshi	-	JAXA EORC, Japan
Rio, Marie-Hélène	-	ESA/ESRIN, Italy
Wang, Menghua	-	NOAA/NESDIS/STAR, USA
Wilson, Cara (Chair)	-	NOAA/NMFS, USA

IOCCG Project Office

Lovindeer, Raisha	-	IOCCG Scientific Officer, Canada
Stuart, Venetia	-	IOCCG Scientific Coordinator, Canada

Invited Participants		Affiliation
Antoine, David (past-Chair)	-	Curtin University, Australia
Aurin, Dirk	-	NASA GSFC, USA
Corradi, Paolo	-	ESA ESTEC, The Netherlands
Dierssen, Heidi	-	University of Connecticut, USA
Frouin, Robert	-	SIO/UCSD, USA
Garaba, Shungu	-	University of Oldenburg, Germany

Jamet, Cédric   -   Université du Littoral Côte d'Opale, France
Scott, Joel   -   NASA GSFC, USA
Simis, Stefan   -   Plymouth Marine Laboratory, UK
Tauro, Carolina   -   CONAE, Argentina
Werdell, Jeremy   -   NASA GSFC, USA
Yoder, James (past-Chair)   -   Woods Hole Oceanographic Institution, USA

Apologies   **Affiliation**
Boss, Emmanuel   -   University of Maine, USA
Ryu, Joo-Hyung   -   KIOST, South Korea

Supporting Documentation:

https://ioccg.org/ioccg-25-supporting-documentation/

Appendix II: List of Actions: IOCCG-25 Committee Meeting

Online Meeting, 4, 5, 11, 13 May 2021

	Brief Description	Status
25/1	Agency members to nominate new members for the OC-SVC Task Force, if desired.	Closed
25/2	IOCCG members requested to provide input and advice on the proposed White Paper for the new OC-SVC Task Force.	On-going
25/3	IOCCG Project Office to schedule a side meeting to discuss the formation and scope of an IOCCG Hyperspectral Task Force/WG and to identify a possible Chair.	Open
25/4	IOCCG Project Office to confirm membership of the training sub-committee and move forward with an introductory OC training roadmap for the IOCCG website.	On-going
25/5	Editorial Board and IOCCG Project Office to make an official announcement and call for paper submissions to the special issue on Aquatic carbon stocks and fluxes.	Closed
25/6	IOCCG Project Office to confirm the official list of IOCCG Representatives for the CEOS OCR-VC.	Closed
25/7	IOCCG Project Office to compile and disseminate top findings for the IOCCG over the past 25 years on social media as part of the 25th anniversary on 8 June 2021, World Oceans Day.	Closed
25/8	IOCCG Project Office along with Laura Lorenzoni, Menghua Wang and Cara Wilson to meet as soon as possible to select a venue and discuss logistics of the IOCS Meeting in 2023.	Open
25/9	Marie-Hélène to check for available dates in April for the IOCCG-26 meeting and get back to the IOCCG Project office and IOCCG Chair.	Closed
25/10	IOCCG Project Office to incorporate electronic chat into in-person and/or hybrid meetings in the future (if possible).	Open