# IOCCG-28 Committee Meeting

**Centro Espacial Teófilo Tabanera (CETT), Córdoba (Hybrid), 24-26 April 2024**

# MINUTES

## 1. Welcome and Opening Session

### 1.1. Opening of meeting, adoption of the agenda

The IOCCG chair, Shubha Sathyendranath, opened the meeting and welcomed all participants. She thanked Carolina Tauro and the team at CONAE for being such wonderful hosts; the participants for being present, especially those joining the meeting online. Shubha introduced the agenda and the changes implemented for the meeting to create more time for discussion, and thanked those who volunteered to be liaisons (the lead on review and discussion) for the working group and task force reports. The agenda was adopted. Following the welcome from CONAE, the group did a brief tour de table. Members present at the meeting are listed in Appendix I.

### 1.2. Welcome from CONAE

Laura Frulla, Manager of Earth Observations at CONAE, gave a warm welcome to the agency. She stressed how important it was for the IOCCG Committee to be convening at CETT, due to the high value of the interactions and collaborations that an in-person meeting can bring. She congratulated NASA for the launch of the PACE mission. As part of CEOS, Laura was happy to see the discussions of the Ocean Colour Radiometry Virtual Constellation (OCR-VC) and collaboration with other CEOS colleagues on the agenda, among many other important items for discussion during the week. She once again welcomed all the participants, and wished for the IOCCG a productive meeting.

### 1.3. Review of IOCCG-27 minutes, status of actions

The minutes for the IOCCG-27 meeting were approved, and the status of outstanding action items reviewed as follows:

- *Action 27/1: Ewa Kwiatkowska to organise with Maycira Costa a meeting with Arnold Dekker and/or others leading the Aquatic ARD effort to confirm the way forward, indicating that IOCCG wishes to contribute towards this document.* **CLOSED** – further follow-up in this agenda
- *Action 27/3: IOCCG Project Office to advertise the review process for IOCCG Reports to encourage uptake as a peer-review document.* **OPEN** – Raisha to follow-up.
- *Action 27/7: IOCCG Project Office to reach out in a joint email to those working on the topic of seasonal bias and give them the opportunity to form an informal group to share ideas and findings.* **CLOSED** – An IOCS session was dedicated to this and other items related to long-term time series.
- *Action 27/8: Marie-Hélène Rio, Laura Lorenzoni, Laurent Guigni, Hiroshi Murakami to go through the Previous IOCS BW Recommendations document and update the comments with whether the item has been included for agency funding.* **CLOSED** – Action completed prior to the IOCS meeting
- *Action 27/9 IOCCG Project Office to share the IOCS recommendation database on the IOCCG website when completed.* **CLOSED** – website link iocs.ioccg.org/iocs-recommendations.
- *Action 26/1: Cedric Jamet to finalise the report on atmospheric corrections over turbid waters as soon as possible and consider including some information on the performance of individual algorithms and approaches.* Update from IOCCG-27: First draft of the Report on Atmospheric Correction over optically complex waters is completed and a meeting to finalise

the report will occur at the end of March 2023. Will be updated in this meeting. Current Status: **OPEN** – will be discussed under working group reports.

- *Action 26/9 Vittorio Brando, Stewart Bernard & Cara Wilson to meet virtually and discuss user types and value chain and report back on any suggestions for the IOCCG.* Shubha recommended that this action be **CLOSED**. Sessions dedicated to users at the IOCS meeting, and recommendations emerging from these sessions, are on this agenda for discussion and would subsume this action.
- *Action 26/12: The education subcommittee to move forward with a proposal for an introductory ocean optics MOOC and follow up with suggestions, including with Paula Bontempi on possibly hosting at URI*. Update from IOCCG-27: Proposal for the MOOC is on-going. Paula Bontempi is drafting a first pass document to help with this task. Current Status: **OPEN** - Paula requested confirmation on whether this action was still required. Laura Lorenzoni suggested a market survey be done. Shubha indicated that the high subscriptions for MOOCs by ESA and EUMETSAT indicate the need. Paula to follow-up.
- *Action 26/15: Menghua Wang to investigate NOAA support for IOCS-2023 (transfer funds to USF)*. **CLOSED**
- *Action 26/16: IOCCG Project Office to submit a proposal to NASA for funding for the IOCS-2023 meeting*. **CLOSED**
- *Action 26/17: Cara Wilson to go through and synthesise previous recommendations from IOCS and report on their outcomes*. **CLOSED**

## 2. Agency Discussions

### 2.1. SABIA-Mar Mission Status

Carolina Tauro gave an overview of CETT, The space centre of CONAE. She then gave a brief update on the SABIA-Mar mission, which aims to measure ocean colour globally, but with focus in South America. There are two ground stations, one at CETT and another in the south of Argentina (La Estación Terrena de Tierra del Fuego). The satellite will have many cameras, the main being dedicated to ocean colour with spectral bands across two cameras: visible-NIR, and NIR-SWIR. A secondary instrument is a panchromatic high sensitivity camera, for night-time detection across the ocean. The expected resolution is 800 m globally, and 200 – 400 m in South America and Argentinian coastal waters. The mission passed critical design review last year and is now in the construction phase, and developing the prelaunch characterisation. CONAE has resumed collaboration with the Brazilian Space Agency (Agência Espacial Brasileira, AEB) which is great news for the region.

Launch Services are under public tender, and the updated launch date is perhaps early 2026. The main contract for building the satellite is in the south of Argentina. Characterisation tests are on-going (absolute gain, linearity, spectral response function, polarisation, stray light, temperature dependence, BRDF diffuser, etc.). The preliminary radiometric and spectral tests have been completed on one of three electro-optical modules. The others will be done this year.

Robert Frouin indicated that the camera is similar to that of MERIS/OLCI etc., and that ESA and EUMETSAT have a lot of experience with these systems. Robert wondered if IOCCG could facilitate a connection with engineers and those involved with the systems at ESA to help with characterisation tests at CONAE, and to pass on experience. Carolina indicated that they would greatly appreciate this.

Shubha also raised that the support for the mission through in situ observation/validation etc. are difficult for Argentina and South America in general. She suggests that IOCCG fully supports Argentina and neighbouring countries through collaboration, to make maximum use of the

satellite sensors. Carolina confirmed that data validation is a problem in the region because resources are low. Áurea Ciotti indicated that since the manufacturers are in the northern hemisphere, it is hard to get calibrated instruments. She asked whether agencies had calibrated instruments that could be donated or leased, as they do not necessarily need to own instruments, only use them.

Vivian Lutz asked whether there is going to be a call for projects related to SABIA-Mar to get funds for cruises. Carolina indicated that the idea is to have announcements to start moving the community forward, but there is no funding for these types of projects. Vivian suggested that making other governments aware of the importance of the mission might be a useful step. Ewa Kwiatkowska shared information about a program within EUMETSAT that is working towards providing the community with calibrated radiometers. Currently only 1-2 are available, but they are well characterised in the lab. A call for submission of proposals will open for the community who would like to rent/borrow such instruments. Another call is for free calibration of instruments, where all calibration will be done in a specific calibration lab in Europe. On Robert's point, Ewa expressed support for connecting the SABIA-Mar engineering team with those at EUMETSAT. Robert stressed the urgency and pressing nature of the support. Menghua supported this, indicating that the before-launch characterisation is very important, whereas post-launch issues can be solved later.

Hubert Loisel indicated that Robert can possibly help with putting the local engineers in contact with the right people, but detailing what is being requested and sharing it with the agencies is a first step. For calibration and validation based on in situ measurements, while CONAE can borrow instruments, it is very difficult to send and receive instruments due to high taxes and tariffs in Argentina. It may be better to send exact procedures to follow. Laura Lorenzoni seconded the list of needs. She also agreed that it was difficult to get instruments across borders, so knowing what is currently already available across the border is good. It is also unrealistic to get an instrument just once and send it back for calibration, so she asked what kind of robust instruments would be the best for long-term use to minimise the transport costs.

Ana Dogliotti agreed that validation can wait, but cautioned that things take much longer in the southern hemisphere, so the activities around validation are also urgent. She also raised the issue of where the instruments will go. Ships and ship-time can be expensive, and are often not accessible. Áurea volunteered to help with a census of available instruments in South America.

Jeremy Werdell suggested investment in AERONET-OC or WATERHYPERNET. Paula Bontempi agreed and inquired about the state of collaboration with private vessels for ship-time, and indicated that offshore wind turbines have become sites for moored instruments, and could be opportunities to build on.

**Action 28/1:** Carolina Tauro and Robert Frouin to create a specific list of items where help is required for SABIA-Mar and then send to IOCCG Project Office for distribution to the Sensor Calibration TF and IOCCG Committee members for assistance.

**Action 28/2:** Ana Dogliotti & Áurea Ciotti to create a census of the instruments already available in S. America

### 2.2. NASA PACE Mission Status

Jeremy Werdell gave an update on the PACE mission, which successfully launched on 8 February 2024. He shared a true colour and chlorophyll-a regional image of Argentina as taken by the Ocean Colour Instrument (OCI) aboard PACE. NASA released the radiometry publicly, along with a limited suite of data products from OCI. The validation science team is not yet in the field (they were starting now) and so most performance assessments are radiometric comparisons with VIIRS. With no calibration, remote sensing reflectance looked good. He indicated that the cost of having the data available now is that

people should publish at their peril, as it still needs to be vetted and reprocessed many times in the next few months. Only the second lunar calibration has been completed so far, and no system vicarious calibration yet. For the most part there is reasonable agreement with VIIRS right out of the box.

For products, chlorophyll coverage (compared to VIIRS) was looking good. The coverage was good because of the tilt from the OCI instrument. A number of aerosol products were being pursued because of the expended spectral range of OCI. Jeremy indicated that there is a common level-1C grid that all sensors on PACE are aligned (OCI, HARP2, SPEXone) and this allows for intercomparison of radiometry. He said there is a small bias in HARP2 that he was not worried about because it is still early days. Polarimetry from SPEXone is looking good, and Jeremy made a plea to the community to consider polarimetry for aquatic retrievals.

Data distribution is going through a unification of all its services. The L1 and L2 browser will not have PACE data, but will instead be available on the Earth Data Search platform (https://www.earthdata.nasa.gov/learn/earthdata-search). PACE data will be made available there, and all test products are currently on the website as provisional.

A panel was just completed for the third science and applications team. The validation science team has been assembled. A post-launch air-borne experiment will be conducted in September 2024, and the data will be publicly available by the end of the year. There is an ocean colour component of this experiment, courtesy of NOAA.

There are two systems vicarious calibration (SVC) teams. HyperNAV instruments have been deployed with two buoys in the field. The MarONet (Marine Optical Network) project is being supported but has not yet deployed in Perth, possibly no sooner than June/July 2024. There is also the PACE Early Adopter program. There is a table on the PACE website to track the data products and their release (https://pace.oceansciences.org/data_table.htm). Implementation of algorithms from the data is not specific to a science team, and there is an approach to bring in ideas from other communities. If this is of interest, contact Jeremy. A Hack-Week Sprint is planned for August at the University of Maryland, and anything produced there will be online for public access, along with tutorials on how to handle PACE's large datasets.

Shubha, on behalf of IOCCG, congratulated NASA and the entire PACE team for all the hard work and magnificent output. She indicated that PACE has been "a long time in the making and a long time in the waiting" and that we are all excited to see the output. Many other committee members agreed and joined the congratulations. Menghua appreciated the early release of the data, and was impressed that with no vicarious calibration, there was an exact match-up with VIIRS. He asked why they started reporting from 317 nm since there is no signal from 317-340 nm. Jeremy indicated that the aerosol community wanted the bands from 317 - 340 nm, but there is no heroic calibration of these bands. Marie-Helene asked whether there was any validation campaign in coastal areas, whether the data would be available, and whether there was any documentation listing which data might be made available. Jeremy indicated that there is a mix of coastal and open-ocean, and that yes, coastal validation is included. He indicated that teams have been requested to submit their data within 60-90 days of collection, and the data will be available on SeaBASS. There is no documentation yet for the measurements that will be made available, but they are building a website for this.

### 2.3. China's HY-1E Mission Status

Xianqiang He gave an update on China's ocean colour missions. HY-1 is the polar orbiting satellite series. HY-1A/B have ended, and HY-1C/D are still orbiting and acquire images twice daily. Xianqiang gave a brief overview of the products and data currently available from HY-1C/D. The L1 data from both of these sensors are available from the China Ocean Satellite Data Service Center (https://osdds.nsoas.org.cn/).

The HY-1E mission was successfully launched on 16 November 2023. HY-1E is an experimental ocean colour mission, with three new payloads: a new ocean colour and temperature scanner (COCTS2) with spatial resolution of 500 m, swath width of 3000 km, observing the globe daily; a programmable

moderate resolution imaging spectroradiometer (PMRIS) with spatial resolution of 100 – 200 m, and swath width of 950 km; and a new coastal zone imager (CZI2) with a narrow swath width of 60 km, and spatial resolution of 5 – 20 m for regional observations. Data is still in orbit testing, and so is not yet available.

He showed the first true colour image from the COCTS2 sensor, a beautiful image of a shelf region with high primary productivity, and some derived products. The orbit testing period was delayed to fix problems with the algorithms to reduce noise, especially near clouds. Remote sensing reflectance is almost consistent with that for Aqua/MODIS at typical wavebands, except for a bit of scatter. Validation is still on-going, with comparisons with AERONET-OC. He showed a false colour image of a small regional sea from PMRS, where sea ice was clearly visible in the winter season at 100m resolution. Other images included river plumes, coral reefs, and even lake water quality due to the high spatial resolution.

The operational mission, HY-1F, is planned for launch within the next 3 years.

The HY-3 series is the high spatial/temporal resolution satellite series, and HY-3C is a geostationary ocean colour satellite, which is now in the planning phase.

Shubha congratulated Xianqiang on the successful launch of the HY-1E satellite, and asked about the data policy. Xianqiang indicated that HY-1E data will also be distributed by the China Ocean Satellite Data Service Center (from L1B - L3), once available. Menghua indicated that the results looked impressive, and others agreed. He requested that Xianqiang could share the data link with IOCCG for posting on the website when the HY-1E data is available.

### 2.4. Review and updates to the past, present and scheduled ocean-colour sensor listing

Agency members submitted items to update the ocean colour sensors listing on the IOCCG website. Others submitted feedback on improvements to the sensor timeline graphic, including adding in the planned lifetime of the missions, and the date that the timeline was last generated. Chuanmin Hu suggested adding weblinks that provide data links from the existing sensors, but such links are already available for each mission on their detailed mission pages.

Claudia Giardino raised that the sensor list does not currently include sensors used for in-land waters and perhaps it should. For example, Vittorio Brando and others indicated that Sentinel-2 was listed, but not Landsat sensors. There was a discussion on this. Paula Bontempi gave the history of similar discussions on this topic, indicating that the list historically was of missions with dedicated ocean colour sensors. There was a discussion around creating a separate list for non-OC sensors that are used to derive ocean colour data, but with clear wording to not confuse readers, while leaving the current graphic only listing missions with dedicated OC sensors.

**Action 28/3:** IOCCG Project Office to create a new page of sensors leveraged for ocean colour with support from space agencies who should send the information on sensors that should be included.

### 2.5. What agencies expect to get from IOCCG

Shubha opened the floor for feedback from the space agencies on what they hope to gain from involvement within the IOCCG. The benefits of the group were highlighted, including coordination across the space agencies, fostering collaboration, promoting ocean colour data across the scientific community, information exchange, helping to shape the future direction of space missions, providing guidance to agencies and the scientific community through IOCCG reports and protocols, and conducting and supporting training and capacity building.

The following areas were listed as possible improvements so that IOCCG can better serve the agencies and the community

- NOAA (Menghua Wang) wishes IOCCG to put more effort into users and applications

- JAXA (Hiroshi Murakami) indicated more input and cross-linkages with CEOS. Example - this month the CEOS Annual meeting was in Japan and there was a connection to the Global stocktake with invited contributors to the IPCC. It would be good for IOCCG to have a stronger connection there.
- NASA (Laura Lorenzoni) indicated that better execution on our ideas and plans could be helpful. In connection with CEOS, IOCCG agencies are represented there, but perhaps we could, as a group, be more active rather than passive in areas of connection and overlap with CEOS priorities.
- CONAE (Caroline Tauro) raised that, judging from the experience with the training session, the region could benefit from more **in-person training courses that advance the users and the community** in South America, and increase the connection with the international community.
- JRC (Fréd Mélin) indicated that IOCCG has already evolved, with many more agencies, satellites, and users, and the importance of the data is more visible. Institutions are also using the data for policy decisions, etc., so the coordination should continue to keep the community in the right direction.

- EUMETSAT (Ewa Kwiatkowska) indicated the following to help IOCCG meet expectations:

    - Better promotion of information, tools, and resources contributed by agencies and members

    - Identification of shared agency needs and establishing activities to meet these needs.

    - Emphasising all aquatic environments, especially within CEOS as a schism is developing between ocean, coastal, and in-land waters. The OCR-VC is perceived as ocean only which would be good to change.

    - Promotion and lobbying for ocean colour as essential. Many operational agencies focus on parameters that go into numerical weather predictions (SST, waves, winds) but ocean colour is omitted.

    - Identification of applications, services, data, and development needs of users: we need to identify and document our users and their applications, and the development of the next generation of services. Also documenting why we need products with the user requirements.

    - Valuation of ocean colour, which follows on the previous points, and helps with promotion and lobbying.

- ESA (Marie-Hélène Rio) also recommended improving the link and coordination between IOCCG and CEOS. Also added was that we need to dive more into the science that can be achieved with very accurate long time series ocean colour products, which is the future direction and is requested from users.

- CNES (Aurelien Carbonniere) added that synergies with the many in situ networks - calibration and validation of missions for the coastal area is very important. CNES + NASA + NOAA is co-leading the CEOS coast working group and are very involved in this coastal dimension.

Shubha summarised and then opened the floor. Fréd added that there is a lot happening outside of the institutional space agencies, and also within the private sector, and we could possibly get involved to aid in its direction. Robert added that IOCCG needs to continue to address emerging research challenges.

**Action 28/4:** Raisha Lovindeer & Shubha Sathyendranath to go through the list of expectations made by the space agencies and implement follow-up actions.

## 3. IOCS-2023 Review, Recommendations, and Topics Emerging

### 3.1. New recommendations from IOCS-2023

Shubha led the discussion on the new recommendations proposed by the breakout workshops at the last IOCS meeting, held in November 2023, and hosted at the University of South Florida. Community recommendations emerged from 8 of the 9 breakout workshops. One breakout session was a meeting of the Task Force of Remote Sensing of Marine Litter and Debris, and the recommendations made therein were specific to the task force.

Each recommendation was reviewed for its clarity, and then possible action determined when the executor was the space agencies or the IOCCG. The following actions were determined on select recommendations

- ***2023.01.1 - Space agencies*** *should develop a strategy for remote sensing of optically complex waters in dialogue with the scientific community within the next two years.*
    - Marie-Hélène Rio indicated that the ESA strategy includes CHIME and Sentinel next generation. **Claudia indicated that these missions still do not meet the resolution that is required for coastal waters, because 30 m spatial resolution is still too coarse.** She agreed that future Sentinels will set the scene, along with PACE, but that the spatial resolution needs to be addressed for applicability to most of the lakes, rivers, and in-land waters.
    - AquaWatch Australia is also looking at this.
    - Aurelien Carbonniere indicated that the KRISHNA mission is focused on coastal waters, with plans to address spatial resolution issues. This is at the preliminary stage: mission development, rational, consolidation of scientific input, etc.
    - Laura Lorenzoni indicated that SBG is specific for coastal waters, but maybe there is still an issue of scale. Small pixel size equates to lower coverage, and may lean more into commercial data. **Perhaps there is something that space agencies can do with commercial companies to help to develop this strategy.**
    - Menghua Wang indicated CoastWatch and GEOXO have strategies towards coastal waters.
    - Paula Bontempi indicated that documents developed by Steve Grebb may be helpful. Perhaps white papers can be identified that are already written on this topic, to help remind ourselves of the additional requirements to meet these needs.
    - Strategies for remote sensing of optically complex waters might be addressed by the CEOS COAST VC.

- ***2023.01.2 - Community organisations*** *(like IOCCG or GEO Aquawatch) should focus more strongly on the science policy interface, than on research and technology, to help improve the integration of remote sensing in traditional lake monitoring.*
    - Shubha indicated that agencies have different foci, and perhaps we can first ask GEOAqua watch if there is room for collaboration. We could also go back to the co-chairs to ask for more detail on specific actions around this recommendation.

- ***2023.01.3 - Space agencies*** *are requested to review and expand the use of FAIR and open source standards in their commissioning processes to promote more open data and software*
    - Many space agencies already emphasise traceability and FAIR (findability, accessibility, interoperability, and reusability) practices in their products. In some cases, the commissioning process to derive products (the source code) has proprietary rights associated with it and legal teams determine their availability. Code that can be made available, is usually made available.

- ***2023.03.1 - IOCCG*** *should maintain a living inventory of validation activities, and create an accompanying webtool that seamlessly allows the community to submit their information. This*

*should be accompanied by a data catalogue that indicates where agencies/countries keep their data and how to access it (12 months)*

- Jeremy clarified that this was about sharing who is going into the field, where, and with what equipment, and plans for what will be measured, particularly regarding post-launch validation activities. A living document with self-reporting by the community is desired. Jeremy agreed to begin to collate items under this activity.

**Action 28/5**: Jeremy Werdell to begin to collate the inventory of validation activities in a document with the help of the IOCCG Project Office.

➢ ***2023.04.1 - The community*** *should develop an open-access database of POC and DOC for inland and coastal waters*

- There was a discussion around whether a separate database for coastal and in-land waters was needed, or whether data could be combined with existing databases (e.g. SeaBASS). Jeremy indicated to add products to GLORIA, if available. Claudia indicated that there is an opportunity here to add data in a continuum way. Many field activities are on-going, but collating data from the freshwater community is not as organised, nor is the information about field campaigns etc. It was agreed that the data could be pooled into existing databases, and suggested to **let the community know that if they have data that is not already in the commonly used databases, to please submit data**.
- Menghua suggested that distribution through GeoAquaWatch may be helpful, and possibly contacting Steve Grebb for any lists he has compiled might also help with distribution.

**Action 28/6:** IOCCG Project Office to alert the community about the idea for collating and adding POC and DOC data for inland and coastal waters to existing community databases such as SeaBASS and GLORIA.

➢ *2023.05 - IOCCG should formally endorse and helps to promote the Fourth International Operational Satellite Oceanography Symposium (OSOS-4) to be hosted by EUMETSAT in 2025 and consider providing international travel support funding for Lower-Middle Income Country (LMIC) scientists to attend as was done for the OSOS-3.*

- This recommendation was not accepted as IOCCG does not endorse particular events, but will advertise meetings to the community and provide support where possible.

➢ ***2023.05.1 - IOCCG*** *should form a User Engagement Task Force or Working Group to oversee at least these three things to be accomplished <u>in the next 2 to 3 years</u>:*

1. In 2024, draft a list of suggested ocean colour-related topic areas suitable for public-private partnership engagement to bridge the service gaps between space agencies and end-users. Communicate this list to space agencies for them to consider addressing when releasing calls for proposals.
2. By 2025, create on the IOCCG website a *quick start guide* for ocean colour data access to complement and better highlight the existing resource links. Use this opportunity to update the existing resource link content.
3. During 2024 through 2026, develop ocean colour data use-case stories that would enable the novice ocean colour data user to see the value in ocean colour data products for their research or application. Post these stories on the IOCCG website. Do at least 3 (representing different agencies and missions) in 2024 and add at least 4 more by 2026. (A total of 7 in 3 years, which should then be updated and rotated in future years to keep them relevant to the times. These are short, plain language intended to be demonstrative, ideally representative of a variety of sectors.

- Shubha indicated that she supports the idea of submitting a proposal for a task force on User Engagement, and requests for proposals can be included in the next IOCCG

news bulletin. There was agreement on this. The following other recommendations made by the same breakout workshop were considered to fall within the scope of the potential User Engagement TF:

4. Build community confidence and enhance user knowledge of the relative performance of ocean colour models. Building upon previous IOCCG reports, this might entail hosting an Assessment Workshop in 2024/25. Workshop participants would develop criteria and then identify models appropriate for inclusion. A "host" organisation would be sought for routine ensemble processing. The Assessment workshop should result in a report or other documentation for the IOCCG community, but also be incorporated into user-actionable information on the IOCCG website. See GHRSST for example: GMPE GHRSST mean p ensemble https://ghrsst-pp.metoffice.gov.uk/ostia-website/gmpe-monitoring.html
    - The recommendation initially called for IOCCG to form an Ensemble of Models Task Force or Working Group, however members indicated that IOCCG Report 7 (*Why Ocean Colour? The Societal Benefits of Ocean Colour Technology*) had dedicated chapters related to modelling, the value of each mission and why people should care, so another group on this may not be necessary given the current documents. This was agreed, though there is still room to improve engagement.
5. The community, spearheaded by the IOCCG in collaboration with representative data users and social scientists, should develop plain language and recommended standards for reporting uncertainties for ocean colour. This is envisioned as a multi-year exercise with intermediate reporting at the next IOCS meeting. Depending on the application, different ocean colour data users need different levels of detail in uncertainty reporting, thus some customization is needed. The ocean colour community should start by reviewing recommendations in Chapter 7 of IOCCG Report 18 (*Uncertainties in Ocean Colour Remote Sensing*) and participating work by other relevant groups (Analysis Ready Data; CEOS CARD4L, GEO AquaWatch, MBON, etc.) for relevance and gaps. The final deliverables could include publishing a recommended standards template. It should include members of the user community as well as ocean colour data providers - perhaps co-chairs from each. Here is one example publication on ways to communicate scientific uncertainties (there are many others and others could be more relevant) https://www.pnas.org/doi/10.1073/pnas.1317504111.

➢ ***2023.05.02 - IOCCG*** *should write an open letter to space agencies or publish a policy brief requesting agencies to acknowledge in their mid-to-long range planning that consistent (across sensors and missions) long-term time series (LTTS) are needed in response to user requirements, and for agencies to fund efforts for development, production, performance evaluation, validation, monitoring, and reprocessing for operational LTTS data products in the next 2-7 years.*
    - Discussed under agenda item 6.2

➢ ***2023.05.03*** *- In response to conversations during the session (and elsewhere) regarding the needs/uses for optical observations in waters with areas smaller than those covered by current sensors with the full suite of ocean colour bands, the moderators suggest that the IOCCG consider how to treat high resolution optical sensors for water applications (e.g. Sentinel-2 or commercial high-res platforms). IOCCG Report 17 on Water Quality covers this topic extensively. Clearly, many of the scientists engaged in coastal and inland water use of optics are also members of the ocean colour community and are already producing work. Should, and if so how*

*should, the IOCCG formally recognize this territory within its objectives and terms of reference documentation, (etc.)?*
    - IOCCG already recognizes all water types in its terms of reference, and already has a report on the topic. Clarification was needed from the chairs about who the target for this recommendation should be. Shubha recommended that the space agencies should review the report recommendations.

- ***2023.06.01 - all missions*** *should clearly identify which solar irradiance spectrum they are using to produce their science products*
    - Agencies accepted this action, to add the solar irradiance spectrum to the metadata of their products

- **2023.07 - 1) The IOCCG** should develop a biodiversity position paper for CEOS that focuses on remote sensing of ocean biodiversity over the next year, to expand the focus of CEOS biodiversity from terrestrial. **2) The community should** summarise priorities (low hanging fruit) over the next year into a paper (derived from the IOCS session and relevant projects) for space agencies to support over the next 5 years. **3) Space agencies should** support cross-agency work to engage with stakeholders to refine needs/requirements for essential biodiversity variables (EBV) and essential ocean variables (EOV). **4) Space agencies and the community need to** ensure mission continuity and climate relevant datasets for biodiversity
    - It was raised whether there should be a working group on biodiversity. Paula indicated that many existing reports address biodiversity in the oceans. There was agreement with this, and also uncertainty about what the breakout workshop thought was missing, since all ocean colour is biology-related. Shubha indicated that not all reports deal with satellite-based biodiversity, but the chairs of the breakout workshop are best to detail what they believe is missing.

The following recommendations from the breakout workshop on *Achieving long-term consistency in cross-sensor ocean color data products* are related to the long-term time series discussion in 6.2.

- ***2023.08.01 - The community*** *needs to conduct more research to identify all sources of discrepancies in merged datasets (beyond time and space, including geometry and other factors) and to quantify and correct them.*
- ***2023.08.02 - The community*** *needs to improve description of continuity metrics including reporting of possible extremes (tails), possibly using Probability Density Functions.*
- ***2023.08.03 - Space agencies*** *and distribution services (in collaboration with the ocean colour and metrology communities) need to prioritise calculating and distributing uncertainties associated with all products (pixel-based and composite), and including propagation through AC and algorithms following metrological practices.*
- ***2023.08.04 - The community and IOCCG*** *need to consider revising/updating the 2006 IOCCG report on data merging.*
- ***2023.08.05 - Space agencies*** *should advocate for mission design to ensure backwards compatibility to improve confidence in derived trends and ensure overlap between missions.*

It was suggested that the following recommendations on LIDAR could be tackled by a working group that could produce a white paper, which is quick action and very specific. It was suggested that we could raise this with the working group chairs, and ask them what kind of document would constitute the endorsement requested in ***2023.09.09.*** The need for LIDAR can be added to the discussion on the US decadal survey (the following item 3.2).

- ***2023.09.01 - The community*** *should to develop coupled atmosphere-ocean simulators for lidar propagation (Hydrolight-like) freely available*
- ***2023.09.02 - The community*** *should make open-source tools or codes for processing L1 and L2 CALIOP and ATLAS data freely available*

- ***2023.09.03 - Space agencies*** *need to make daily Ocean L1 and L2 CALIOP and ATLAS archives available, with a portal to easily view and download the data (such as oceancolor.gsfc.nasa.gov) as soon as possible.*
    - A question was raised on whether CALIOP and ATLAS archive data are already available.

- ***2023.09.04 - The community*** *needs to share current and past in-situ (shipborne, airborne, fixed platforms) lidar measurements*
- ***2023.09.05 - Space agencies*** *should fund, and the community should develop, in-situ oceanic profiling lidar (measurements up to the euphotic depth, Instruments to measure the back-scattering coefficient at 180°, Multi-wavelength : 355, 470, 532, 560 nm, Fluorescence profiles, Vertical resolution: ≤1 m, Temperature profiles)*
    - There were questions raised around whether there was a mandate for space agencies to develop this type in situ equipment. Vittorio indicated that it might be synonymous with AERONET-OC or WaterHypernets, but for Lidar.
- ***2023.09.06 - The community*** *should develop a ground-based network of profiling sensors to validate future ocean spaceborne lidar and passive OC missions*
- ***2023.09.07 - The community*** *needs to have better coordination with the atmospheric community for lidar development, scientific objectives and field campaigns*
- ***2023.09.08 - The community*** *should ensure better training on lidar, e.g. session at conferences (Ocean Optics), lectures at the IOCCG Lectures Series and Maine Summer School on fundamentals of lidar: principles, data processing, practical exercises to process the lidar data, courses on the components of a lidar: optics, electronics.*
- ***2023.09.09 -*** *There needs to be an endorsement from the OC Community (agencies, IOCCG, scientists, etc.) on space-borne oceanic profiling lidar (ocean capabilities of CALIGOLA space mission*
    - Shubha indicated that the Lecture Series for 2024 is already set. A LIDAR training course is needed, but who would take charge? It was indicated that the Ocean Optics course in Maine (USA) has lectures on LIDAR. This could be expanded.

Shubha indicated that there are 110 previous recommendations in addition to the new ones, so actions are accumulating faster than they can be tackled. She asked whether we should accept new recommendations at the next IOCS meeting, or spend time discussing actions to move the existing recommendations forward, and only entertain a very small number of additional ones. Robert agreed that we should leave room for new recommendations to be added.

**Action 28/7:** IOCCG Project Office to communicate any relevant feedback from the meeting about the new IOCS recommendations to the breakout workshop co-chairs.

### 3.2. IOCCG's role in the US decadal survey

Emerging from discussions at the IOCS-2023 meeting were questions about the role of IOCCG in the US Decadal Survey. Laura gave an overview of the role of the US Decadal Survey. It helps to inform the US government and agencies of research and funding priorities for the future in remote sensing. With the survey, stakeholders have an opportunity to provide input into the next decade of satellite observations. It is also used as the roadmap for space agencies to draft their missions. The first decadal survey resulted in the PACE mission. The second survey, released in 2017, had a shortage of ocean observations for biodiversity, ocean ecology etc. Although it is a US-based tool, the survey gives an opportunity to document needs, and request the satellite and sensor-capabilities that are of most benefit to the entire community.

Cara Wilson gave detail on how to contribute to the survey, which is via white papers that indicate why we need products or services. The next decadal survey will be in 2027, and she asked whether IOCCG could play a role in coordinating the white papers that would be used for the survey. Having IOCCG as a clearing house for these white papers also ensures that the white papers can be used, not just for the

decadal survey, but for other space agency needs, internationally. There was agreement that IOCCG could play this role, and that having white papers drafted in a coordinated fashion could indeed allow all space agencies to understand the high priority needs of the community. Also, as this is a decadal survey, we need long-term needs, thoughts, gaps, and priorities. Paula indicated that IOCCG should also consider the role that satellites play in the next decade. Laura added that the short timeframe helps to drive the need for people to self assemble to draft these papers.

Ewa raised the question about the format of the white paper, are they similar to those done by IOCCG in the past, such as IN-SITU OCR. Laura indicated yes, although specifics on the format that will be requested are not yet known.

There was agreement that IOCCG could issue an open call to the community for interest, with an eye to including existing IOCS recommendations and IOCCG reports. Cara agreed to put together a list of emerging topics from the community based on IOCS recommendations, recommendations made in IOCCG reports, and topics covered by IOCCG task forces. She also indicated that a group working on SAFARI-3 (Societal Applications in Fisheries & Aquaculture using Remotely Sensed Imagery) could contribute a white paper as an output, which could be helpful.

Shubha asked about coordination with CEOS, and there was agreement that IOCCG and the ocean colour community should have their priorities and needs documented first, and then use CEOS as a venue for vetting once we agree.

Jeremy cautioned that the surveys tend to focus on the newest things, but we also need to have continuity, and this should be highlighted and included. Shubha indicated that Sentinel next generation could go hyperspectral to help with continuity. Paula raised that new science questions require continuity of missions, so raising some of those pressing science questions may require us to document continuity and maintenance.

**Action 28/8**: Cara Wilson to put together the first draft list of items (based on IOCS recommendations) that could be collated for the US Decadal Survey white papers, and work backwards from the timeline of the white paper submissions to set some deadlines by June 2024.

### 3.3. Review of previous recommendations from IOCS meetings and gaps

All previous IOCS recommendations for which the IOCCG or the space agencies are executors were reviewed in the meeting, and accepted for further action. These included:

- ***2015.02.1 Resolution*** – *Form a new IOCCG Geostationary WG*
  Shubha asked whether agencies interested in geostationary missions wished to come together to form a geostationary ring or ad hoc group for geostationary. There was interest among agencies. Jeremy volunteered NASA (Antonio Mannino). Ewa Kwiatkowska volunteered for EUMETSAT. Wonkook Kim/Jongkuk Choi for KIOST (already has a geostationary satellite). Marie-Helene will check with ESA for interest and the right person. NOAA suggests Ryan Vandermeulen.
- ***2019.01.3 Data & Datasets*** – *Establish a code repository to exists as a live IOCCG report*
  Paula indicated that it was heavily referenced in the OC-SVC white paper that we need to share code. Vittorio indicated that we were in a pre-git world, and now we have open science tools for code, so maybe a listing of where codes are posted may be good. Ewa indicated that, with every new algorithm development, the code is open to the community and it would be easy to surface the links on the IOCCG website.

**Action 28/9:** IOCCG Project Office to publish links to open access code for algorithm development in the software tab on the IOCCG website

- ***2019.06.3*** – *IOCCG could extend its tasks to coordinate user engagement*
  Some action has already been taken, but this can be further actioned under a task force on user engagement.

**Action 28/10:** Agencies should continue to review and update the existing recommendations from the IOCS meetings that are targeted at the space agencies.

### 3.4. Focus/theme & updates on hosting for IOCS-2025

Ewa Kwiatkowska and Marie-Hélène Rio indicated that EUMETSAT and ESA agreed and are excited to host the 2025 IOCS meeting in Darmstadt Germany, which is a 20 min drive from Frankfurt Airport. Darmstadt is home to ESA ESOC and EUMETSAT.

Dates are currently set for the week of 1-5 December 2025, during the Christmas Market in Germany. The meeting will take place at Darmstadtium, the venue of the 1st IOCS meeting. The local organisation committee is Marie-Helene, Ewa, and Sylwia Miechurska. There is a need to agree on the high level schedule of the meeting.

In the vein of discussions that we had previously, and agencies showing their needs and specific expectations regarding IOCCG, Ewa suggested it would be useful to have a survey across the agencies to find the 2-3 big issues that this kind of meeting or community could address or contribute towards (not funding, but science and application issues). Shubha agreed that this approach is good, and also wondered whether one of the themes could be related to aquatic carbon to support the CEOS roadmap. Ewa agreed that in addition to the common themes from the agencies, we could add sessions of interest for the IOCCG, such as aquatic carbon. The structure is up for agencies to define and then make up the nine themes for the breakout sessions. Robert suggested a possible overall theme of the impact of climate change on ocean colour.

**Action 28/11:** IOCCG Project Office to send a survey across the IOCCG agencies to find the 2-3 big issues that the IOCS-2025 meeting could address or contribute towards.

## 4. CEOS OCR-VC Discussions, Work Plan & Deliverables

### 4.1. OCR contributions to CEOS aquatic reflectance Analysis Ready Data (ARD)

Ewa Kwiatkowska gave a brief introduction of the CEOS analysis ready data (ARD) activity. Strong recommendations had emerged from IOCCG that there should not be separate recommendations for ARD for nearshore+inland waters and oceans, but one joint specification for all water types. There is a mature document from the team who developed the aquatic reflectance ARD specifications, and now is the time to examine that document to ensure it includes oceans.

#### 4.1.1. Presentation on CEOS Aquatic Reflectance ARD

Ewa introduced Matt Steventon, CEOS ARD representative, to give some context to the discussion. Matt gave an overview of CEOS ARD efforts, which started in 2016 when a team set out to define analysis ready data, that is, define the parameters that allow data to be in form that others can use fairly quickly and easily. The ARD effort provides the first step for interoperability and transparency for data providers. ARD is built around the concept of product family specifications and there are specifications for each measurement, e.g. surface reflectance, SST, radar, etc. Also defined are the thresholds, or minimum requirements needed to be CEOS ARD.

CEOS Virtual Constellations drive the specifications, which are written as a table on the CEOS website (ceos.org/ARD). The steps to creating an ARD are: Documentation completed and submitted to Matt (ARD Secretariat) for checks > CEOS working group on calibration/validation for peer review > CEOS ARD approval and posting on website > CEOS ARD dataset available for use. There are a few datasets already available on the website, and others in review. There is good interest from the commercial sector in these ARD datasets.

Why an ocean reflectance CEOS ARD? Matt explained that it can provide a minimum viable product for coastal and ocean waters, and improve intercomparison and interoperability between products. It can

also expand the user base to others outside of the ocean colour expert community, who can use the ARD for broader applications.

Matt posed the question of whether the ocean colour community thought this was a good idea, if it might indeed expand the user base, and if it would be helpful. He indicated that the CEOS oversight group concluded that it was better to have a coordinated response to have the aquatic ARD be for both in-land, coastal waters, and oceans. There was coordination with IOCCG through Maycira Costa (who was selected as the representative) and Ewa, and there were preliminary differences between the original aquatic reflectance ARD and that needed to have oceans be included, but the effort stalled. Currently, we need to judge appropriate demand, have a strong lead to push the effort forward, and have a team dedicated to writing the specifications for the ocean colour products.

#### 4.1.2. Discussion and editing of the ARD

Jeremy asked if the goal is to physically change the data files and metadata to reflect new information, because this would change the approach considerably. Matt indicated that typically it has required changes to the metadata, but since the aquatic PFS has not yet been written, it is difficult to say if that would be required in this case. He suggested that we take a look at the surface reflectance PFS for guidance on the sorts of changes that might need to be made to metadata. Ewa indicated that, looking into the details of the PFS, she did not see anything clashing with what is normally produced in the standard metadata for the different agencies. She also noted that there was no specification on the data format.

Marie-Hélène went back to the question of user demand as it seems the request for the ARD did not come from the users. Matt indicated that it is hard to measure which users might be enabled until the ARD exists. However he asked whether we had a sense of non-expert users, and what they might be looking for, and this data would help. He reiterated that implementation of the ARD, and deciding on applicability to users, was up to us.

Vittorio was involved in the definition of the aquatic reflectance PFS and the initial revising. He indicated that ocean colour already meets the requirement laid out in this PFS because it is such a mature and consistent product across the agencies and the IOCCG. It is well defined, well delivered, and well documented. It is very easy for any L2-4 ocean colour product to meet 90+% of the requirements listed. He raised that the real issue is for Sentinel-2, and other data streams used for aquatic reflectance, to come closer to what is already achieved with ocean colour. Sean Bailey agreed, indicating that the effort would largely be ensuring metadata consistency in terms of terminology. Chuanmin indicated in the chat that he was unclear about whether the objective was to create another set of ocean reflectance. Sean replied that the intent was not to duplicate the product, but to ensure consistency to an agreed, standard set of metadata, with possible additions of ancillary information.

Given Vittorio's point, Ewa raised that we need to review what is available and possibly only make minor edits, and then coordinate with the authors of the original document. There were no objections to the following ocean colour representatives reviewing the document: Sean Bailey (NASA), Hayley Evers King (EUMETSAT), Vittorio Brando (CMEMS).

**Action 28/12:** Vittorio Brando, along with agency volunteers Sean Bailey and Hayley Evers-King, to coordinate with Matt Steventon and the original authors of the Aquatic ARD to determine what changes and updates are needed to harmonise ocean requirements in the document.

### 4.2. CEOS OCR-VC Aquatic Carbon Roadmap

Marie-Hélène Rio shared slides presented at the last CEOS meeting to give context to the Aquatic Carbon Roadmap effort. The objective is to add the roadmap for aquatic carbon to the effort of the UNFCCC Global Carbon Stocktake. This is also following on a few activities on carbon:

- Aquatic carbon from space workshop - completed
- Aquatic carbon from space special issue - completed

- Development of the roadmap - due end of 2025
- Organization of the Blue Carbon workshop - planned for 14-17 May in Switzerland

Unlike the Greenhouse Gas (GHG) and Agriculture Forestry and Other Land Use (AFOLU) roadmaps that provide information on carbon emissions and removal, the Aquatic Carbon roadmap needs to communicate why aquatic carbon is important in the Global Stocktake. This includes the carbon sink, as well as the biological and solubility pumps.

The roadmap needs to characterise the needs, gaps, challenges, products, observation continuity, etc to quantify the carbon routes and carbon stock in the ocean. It is an ambitious task. Marie-Hélène has coordinated so far with Laura and Hiroshi, but a strong contribution is needed from the IOCCG space agencies and committee at large. She highlighted some of the needs from the current roadmap outline document, including leaders for certain sections. The CEOS technical workshop in September 2024, and we must be ready to present on the status of the roadmap.

Hubert Loisel gave suggested names and topics. Due to the structure of the current outline, in discrete sections from land to open ocean, he asked about the continuum and how it would be incorporated. Marie-Hélène indicated that it would be good to have the link across the continuum as a separate section. Hubert indicated that a link with land experts would be needed. Claudia was pleased to see the inclusion of inland waters. She agreed that land experts would be needed for the continuum, and instead suggested writing that section into the conclusion, leaving the roadmap to focus on oceans and coastal and inland waters. She gave suggestions for in-land water experts.

Shubha asked about the consideration of the impact of anthropogenic carbon on aquatic life—not just how much carbon is mediated through the ocean but how the carbon is mediated through the various components of the ocean. Partition of carbon and inclusion of biodiversity could be interesting, especially as this is a document that sets out the vision for future years. Marie-Hélène indicated that this was already included within each of the sections, even though there was no individual section. She agreed with highlighting the impact of carbon on ocean life, and indicated that it was in the original pitch to CEOS but was not really in the outline and maybe should be added. However, we need to ensure we have all the contributors to write these sections. Laura raised that the point was to have a presence in the Global Stocktake, and so while ecosystems are included intrinsically, the roadmap ideally would take the perspective of tracking carbon. Ecosystems are involved but are examined through the lens of the movement of carbon and carbon sequestration. Shubha suggested that the importance of ecosystem structure be elevated rather than buried within the subsections. Marie-Hélène requested whether Shubha could add this section to the document.

Marie-Hélène requested further input for anything within the document that is still missing, or suggestions on the rearrangement of the outline. She also requested comments and feedback on the structure. Jamie Shutler agreed that the roadmap needs to cover carbon in relation to the climate, but also climate in relation to conservation and the natural system. He reiterated that the document is at the stage where details are starting to be added, and also welcomed comments directly in the document.

**Action 28/13:** Committee members to give their feedback directly on the Aquatic Carbon Roadmap Outline by 1 June 2024.

### 4.3. Agency contributions to the CEOS work plan

Ewa Kwiatkowska introduced the actions and deliverables that are currently within the CEOS work plan. She asked for feedback on whether the INSITU-OCR White Paper was still the approach for CEOS. Paula Bontempi indicated that most of the recommendations in the INSITU-OCR White paper were modular and fluid, so while milestones can be completed, the recommendations will likely always be ongoing. Since it's been 12 years, she suggested that IOCCG could re-examine the white paper for updates. Shubha suggested that the original authors of the white paper might be the best ones to advise if it needs updating. There was debate about the importance of having documented deliverables for CEOS,

and it was agreed that documents and activities generated by the virtual constellations (VCs) have more exposure and backing from CEOS.

Major items from the CEOS work plan include:

- Aquatic carbon
- SVC infrastructure and white paper
- Other white papers (e.g. that can be used for the US decadal survey)
- Additional Protocols

Marie-Helene and Ewa co-chair the OCR-VC and are open to additional chairs, especially to broaden the international spread of the chair team.

### 4.4. Synergies with CEOS Coast

Laura Lorenzoni introduced the CEOS COAST (Coastal Observation Application Services and Tools) virtual constellation (VC). COAST was originally an ad hoc team, led by Paul DiGiacomo and Merrie Beth Neely, and was recently endorsed by CEOS as a VC. This is unique because all other VCs have a specific product associated with them, but COAST is a mix-and-match of everything. COAST is specifically focussed on user needs and product applications. They had two work streams: 1) land to ocean (biology - PP, harmful algal blooms, etc), and 2) ocean to land (physical forcings - tides, storm surge) in which to develop specific user-defined products. When they were an ad hoc team they had 5 geographic regions (Bay of Bengal, West Coast of Africa, etc). They have plans to continue to be product-driven as a VC, and many of the focus areas overlap with that being addressed by other CEOS VC working groups. An *Applications Knowledge Hub* is hosted under CEOS and for their deliverables they plan to develop and codesign products for users.

Some background - in 2021 GOOS (Global Ocean Observing System) requested help from CEOS with satellite observations towards the Decade of the Ocean. A CEOS Decade Group was formed to understand how to better insert satellite observations into the plans, and an Ocean Coordination Group within it (Laura and Carolina represented IOCCG). The Ocean Coordination Group made recommendations on stakeholders and activities that CEOS could engage that were specific to the ocean, and the Ocean Coordination Group was sunset in 2023. There is now overlap and transfer of similar activities to CEOS Coast. Laura sits on CEOS Coast and serves as an interface. Since the COAST VC is new, there is still development occurring, and Laura suggested the Committee think of ways to synergise with COAST.

ISRO, NOAA and CNES are the current co-chairs. NASA has interest in co-chairing in the future, as it rotates across agencies.

Laura indicated that it was important for IOCCG to be represented within COAST, and for updates of the VC to be shared with the Committee. For example, discussions within IOCCG on gaps in observations for coastal and in-land waters is a specific focus that would interest the COAST VC. Perhaps we can use them to help to collaborate some of the overlapping interests within the community.

As COAST is focused on products and stakeholders, Laura made the following recommendations:

- That IOCCG attend/listen in to meetings of COAST and provide feedback, especially related to products developed by CEOS Coast. (They currently plan to meet monthly or bimonthly.
- It would be good to have a lengthy block of time for discussion within the IOCCG on activities that synergise with COAST.
- We should leverage the intersection with stakeholders that we are not already working closely with. For example, GCOS (Global Climate Observing System) has a mandate to develop certain products that are coastal. WMO (World Meteorological Organization) is also spinning a carbon working group that intersects with the aquatic carbon roadmap, and could feed directly into the roadmap.

There was mention about the creation of ecosystem silos (coastal versus in-land versus open ocean) within CEOS and how to avoid it. Hiroshi raised that COAST priorities include integration across current

VCs and working groups, and that CEOS also encourages collaboration across the community. Shubha indicated that recommendations from the IOCS meetings include strategies for COAST, so perhaps COAST could be an avenue to tackle some of the gaps. Laura mentioned that COAST is user-focused and IOCCG and the agencies are data-heavy, so another good synergy might be that we agree on the requirements for the basic data and then COAST can implement. Shubha raised that integration with COAST and GEO AquaWatch might be key, however Laura did not know how AquaWatch currently interacts with COAST. There was agreement with the collaboration between IOCCG and COAST, and consensus that inviting a lead member of COAST to sit on the IOCCG Committee as a scientific member might be helpful. Shubha also indicated that the Committee used to have that link in the membership in the past, and it would be good to reinstate.

Ewa asked about the data needed to produce the products being created, and where the products would be housed. Laura indicated that there is an Analytics Lab to evaluate the products, but going forward we can ensure quality as well.

**Action 28/14:** Laura Lorenzoni to invite a leader from CEOS Coast to the next IOCCG Committee Meeting to understand possible synergies.

**Action 28/15:** IOCCG to invite a leader from CEOS Coast / GEO AquaWatch to join the IOCCG Committee (after action 28/14)

## 5. IOCCG Report Series, Protocol Series, and Task Forces

### 5.1. Working group annual reports and progress of IOCCG Report Series

The annual reports from the IOCCG working groups were submitted and shared with the Committee members before the meeting. The progress of each working group towards their deliverable of an IOCCG Report was discussed.

#### 5.1.1. Atmospheric Correction Algorithms over Optically-Complex Waters WG

Chair: Cedric Jamet. Claudia gave the overview of the annual report. The working group is wrapping up and their scientific report is almost complete. They are organising the final sections and are expected to submit the draft by 2025.

Due to the length of time it has taken the report to be ready, there were concerns that it may be outdated before it is published. As no draft was submitted with the annual report, there were also questions about what was contained and addressed within the report. The Committee requested that an as-is draft be submitted within 2-months time, for the Committee to review.

**Action 28/16:** Cedric Jamet to submit the as-is draft of the Intercomparison of Atmospheric Correction Algorithms over Optically-Complex Waters in 2 months time so the Committee can see the progress.

#### 5.1.2. Conducting Benthic Reflectance Measurements WG

Chair: Heidi Dierssen. This annual report was very brief, and indicated that a completed draft of the scientific report was expected within this calendar year.

Robert Frouin suggested, for this other WG annual reports, that any draft material be submitted with the report so that the Committee can make better evaluations, as the annual report was not detailed enough.

#### 5.1.3. Ocean Primary Production WG

Chair Bob Brewin. Fréd Mélin gave the overview of the annual report. The working group was now around 20 members, and the kick-off meeting was held in Nov 2023. Discussed at this meeting were aspects of the content of the report—the domain would be open ocean, with no in-land waters

included in the report; the focus will be phytoplankton (gross and net PP); in situ measurements and uncertainties; future perspective, and values. The meeting agenda produced an outline for the report. The original terms of reference (TOR) mentioned compilation of match-up databases, and the group was unsure whether they would go in that direction. They instead intend to use students and a test, but note that the approach should not slow down the writing or completion of the report. Their next step is to draft the report outline. The WG is set to have quarterly online meetings.

Menghua asked whether the scientific report will indicate which models to use to estimate PP. The terms of reference indicate that the working group will summarise the advantages and limitations of the various PP algorithms, but perhaps will not make a recommendation on a particular model.

The progress of the group was noted and the Committee awaits the report outline.

#### 5.1.4. Optical Water Types WG

Chairs: Tom Jackson and Tim Moore. Emmanuel Devred gave the overview of the annual report. The working group was approved in Feb 2023 and had their kick-off meeting in Nov 2023 to organise how the report would be structured. Links to the minutes of the meeting were made available, along with a first layout of the report. The group plans to meet on a regular basis to ensure the written chapters are cohesive when placed together. They are hoping to have a draft by the end of 2024.

Emmanuel wondered if hyperspectral data could be included. Robert indicated that dimensions are not included in the outline. Fréd said this was partly discussed in the kick-off workshop, and the TOR is centred on optical classification. There was discussion on what should be included in the classes, and Fréd clarified that the framework of the group is optical (reflectance only) clustering.

There was a request to add the membership of this working group to their webpage on the IOCCG website.

### 5.2. Requests from IOCCG task force reports

Annual reports from all the IOCCG task forces were submitted and shared with the Committee beforehand, and only those who made requests of the IOCCG or warranted further discussion were tabled at the Committee Meeting.

#### 5.2.1. Updated Terms of Reference (TOR) for Hyperspectral TF

Co-Chairs: Astrid Bracher, Lisl Lain, Jeremy Werdell. Jeremy indicated that the TOR was updated after a leadership change that occurred last winter. Lisl and Jeremy W. were asked to support Astrid, after Jeremy Kravitz rotated away from chairing. This was used as an opportunity to restructure the direction of the TF for a meaningful series of deliverables. The kick-off meeting was held in November (prior to the chair change) and virtual meetings in March. The goals of the TF were re-cast, and the first output of the TF will catalogue what is available via instrumentation and resources, as well as identifying gaps and challenges to inform investment by others.

The plan is to spend the northern hemisphere summer writing, and the group will reconvene at the Ocean Optics meeting in October 2024. Shubha indicated that normally TFs have a fairly longer life-span and enquired what would occur after the document is completed. Jeremy indicated that he believes the document would be a living document that is maintained and revisited every 1-2 years to continue to be relevant. Chuanmin Hu added that the draft document that was developed in the kick-off meeting is actively being worked on by the members. The new TORs were approved by the Committee.

#### 5.2.2. Discussion on OC System Vicarious Calibration (SVC) TF White Paper

Co-Chairs: Carol Johnson and Giuseppe Zibordi. Paula Bontempi led the discussion on the annual report and deliverable from the OC-SVC TF. The annual report was succinct and clear about a deliverable of a white paper, and the OC-SVC White Paper Draft Version 3.2 was submitted to IOCCG for

review and feedback, and shared with the Committee before the meeting. Upon review, the white paper was also succinct, with clear descriptions and recommendations for paths forward. Paula then raised a number of points for discussion, including modularizing and harmonising of investments, and whether space agencies were prepared to tackle the implications of the recommendations.

Menghua indicated, as funding is not shared, it may not be easy to share infrastructure in a modular approach. Paula gave the example of AERONET-OC as a shared infrastructure and resource that was similar to what she described.

Robert wondered why the white paper had not mentioned the study by Bisson et al., (2021) which identifies a seasonal bias in ocean colour reflectance, as this is a pressing issue to address in regards to calibration. Ewa clarified that the paper focused on system vicarious calibration, which is both the quality of the in situ data as well as the algorithm used for processing. For example, at EUMETSAT when using data from MOBY and their algorithms, she did not see the seasonality in the data. Jeremy agreed, in that he did not think the instrumentation of SVC was the issue of the seasonal bias, and that this was an active area of investigation that was outside the scope of the SVC white paper.

Paula reminded the group that the white paper is available in editable format and indicated that she would add her comments to the document on the IOCCG Google Drive. Hiroshi had already commented directly on the document. Shubha asked others to also put their comments in the document within the next 2 weeks.

**Action 28/17:** IOCCG Committee to read and make comments on the draft OC-SVC White Paper within the next 2 weeks.

### 5.3. IOCCG Protocol Series

#### 5.3.1. Update on existing Protocol Series

Raisha Lovindeer gave the status update on the Protocol Series, a report for which was submitted to the IOCCG by Antonio Mannino. For the CDOM Absorption Protocol, currently in draft on the IOCCG website, there is a target of April-May 2024 for revisions to be sent to the peer reviewers for approval, before final edits, copy editing and publishing. The DOC Protocol will almost be ready for the start of peer and community review on the IOCCG website. This initiative was led by Chelsea Lopez. New protocols, Scattering Properties (led by Wayne Slade), Phytoplankton Carbon (led by Jason Graff) and Suspended Particulate Matter (Joaquin Chaves), are in the works.

Cara raised whether there could be a way to have a comment on the protocols after they are published. Vivian Luz agreed, indicating that publicly available questions and their answers would be beneficial for those trying to implement protocols. Raisha indicated that she would investigate what resources would be required to add this functionality to the website.

**Action 28/18:** IOCCG Project Office to investigate the resources to implement a forum or mechanism for information sharing on protocol documents on the IOCCG website.

Robert asked whether there were protocols missing. He indicated that Kevin Ruddick has published protocols on water reflectance and solar irradiance, and should we duplicate these or simply make them available from the IOCCG website. There was no objection to linking additional protocols to the IOCCG website, once these protocols were approved by the IOCCG.

**Action 28/19:** IOCCG Project Office to link other, published, peer-reviewed, IOCCG-approved protocol documents from the IOCCG website's Protocols page.

#### 5.3.2. Proposal: Protocol on Chlorophyll-a & accessory pigments determined by HPLC

On behalf of the proposers (Elisabetta Canuti, EC-JRC and Crystal Thomas, NASA), Fréd Mélin tabled the proposal for a protocol on chlorophyll-a & accessory pigments determined by HPLC. This protocol is currently missing from the community list. The proposed protocol would outline sample collection and

processing, HPLC analysis (including calibration and quality assurance), and data interpretation/ uncertainty budget determination. The objective is to enhance validation, and increase standardisation across labs.

It was raised that many documents already define the protocols for HPLC protocol, so what would be unique about these? Fréd indicated that current protocols are not very up-to-date, and that each lab appears to follow their own procedure, with very little international agreement on the protocol. There was discussion on the latter point. Ana Dogliotti suggested that an open procedure might be helpful, so that everyone can find a way to conduct their science, given their resources. Vivian agreed, further suggesting tiers of acceptability might also be helpful (best, acceptable, do not do unless..., etc.).

The proposal for this protocol was approved.

**Action 28/20:** IOCCG Project Office to communicate to the proposers that the Protocol on Chlorophyll-a & accessory pigments determined by HPLC was approved to move forward.

Robert raised that our current protocols mostly deal with how to make measurements, but there could be other protocols about integrating data, comparing sensors, etc. that we could think to expand and include.

## 6. Other Ocean Colour Activities

### 6.1. UN Ocean Conference

Fréd Mélin raised to the Committee that there is a UN Ocean Conference in France next year with an overarching theme of accelerating action with reference to SDG 14 (Life below water). These conferences are high-level, often involving governments, NGOs, etc, similar to the UN conferences. JRC is interested in being represented as part of the ocean and water unit. He was interested in knowing whether any of the agencies already had initiatives with respect to this conference. He also wondered whether IOCCG could play a role with a poster, booth, talk, etc. He is open to any interaction, feedback, or advice.

Hubert had a discussion with CNES about the conference and he proposed that there should be something from carbon from space or the use of space observations from the ocean. He sent some ideas 2 weeks ago. Aurelien Carbonniere indicated that CNES is involved, and that one week before the UN Ocean Conference is a scientific conference, with many research institutions in France involved. CNES is the space arm of the momentum. In order to scale up the effort, CNES has shared the message of the conference within CEOS so that other agencies can come together to propose something along the lines of the international Earth observation challenges. Hubert is one of the scientists interested and involved, and there will probably be many more from other disciplines. He indicated that he would need to get back to us with a more appropriate agenda.

Laura seconded the recommendation to be involved in the UN Ocean Conference. She said there is a conspicuous absence of remote sensing in many topics being discussed, so an increased presence is good. NASA will be there. She suggested that maybe IOCCG should act as a coordinating body to have a really strong presence from the ocean colour community.

Marie-Hélène indicated that the head of EO at ESA (Simonetta Chelli) is involved but does not know the extent of involvement. She agreed that IOCCG should ensure a presence there.

Aurelien indicated that one of the desired goals is to contribute to an ocean-earth indicator, with coordination of the space agencies falling under IPOS (International Panel for Ocean Sustainability)

It was agreed that IOCCG could play a role, but Fréd and Aurelien would need to communicate on potential contributions.

**Action 28/21:** Fréd Mélin and Aurelien Carbonniere to coordinate and make a census on potential contributions to the UN Ocean Conference.

### 6.2. Blending long time series products for multiple uses (multiagency buy-in for products)

Shubha Sathyendranath and Cara Wilson suggested that IOCCG could have a role in creating a blended, long-term time series of ocean colour for multiple applications. They suggested that IOCCG could help with coordination and cooperation of such a product, if there is multi-agency buy-in. A combined product may help to get more community buy-in, as the product would be from all the agencies combined. Some time series products are not complete in one respect or another, but if the community comes together, we can fill these gaps. If we have a group of people advising on how the products might be generated, we also have a higher scope of being able to improve the quality of products, uncertainty characterisation, etc.

Shubha gave some background through the lens of the global carbon budget, which is updated annually through very strong collaboration that feeds into IPCC reports. The global carbon budget has a focus on anthropogenic $CO_2$ in the atmosphere. Oceans are mentioned only as a reservoir, and the details of carbon storage and fluxes in the ocean do not appear in the global carbon budget reports. She suggested that we need a similar budget for ocean carbon, that could feed into the CEOS Aquatic Carbon Roadmap, for example, and has links to GEO Blue Planet activities, and are relevant to IPCC reporting. The need for a long-term consistent ocean colour data product has emerged from several breakout workshop recommendations at IOCS-2023, and recommendations as early as 2013.

ESA has invested heavily in the Ocean Colour Climate Change Initiative (OC-CCI) which is a project that generates fundamental timeseries products that are multi-sensor, designed for climate research, but does not go as far as carbon. NOAA is also interested in long term time series and in the creation of time series products, which may be for a different set of reasons. Similarly, EUMETSAT. NASA has always had its strength in generating very high quality individual-sensor time series, and maybe there are questions around whether NASA wants a multi-sensor time series product. And there may be other agencies thinking along these lines for which we are not aware. So can IOCCG help coordinate efforts to reduce duplication and get community buy-in?

Shubha proposed that coordination and collaboration across agencies for a multiagency product could be taken up within the TF on Ocean Carbon and could contribute to the CEOS Aquatic Carbon roadmap. If the Committee agrees to the proposal, then the next step would be that space agencies that are interested could nominate someone, the group could meet online and discuss potential concrete steps to be taken in a coordinated fashion. Shubha added that, if accepted to move forward, the ESA Climate Office is willing to add support.

Cara added that NOAA Fisheries are very interested in long time series. NOAA has discussed making a product, but there are limited resources to do this, and it would be best to come together in a coordinated way.

Vittorio added that withIn the Copernicus Marine Service they also produce and/or serve global and regional timeseries (OC-CCI, GlobColour, and their own 1 km resolution product) and he would be very interested in joining this conversation. Consistency of the use of this long-term time series, especially for chlorophyll trends, may need to be part of this discussion. Shubha agreed that the discussion on how the data might be used to create trends and other interpretive products is important.

Claudia raised that this could also be extended to ESA Lakes CCI and freshwater. Marie-Helene said she thought it was a relevant and needed initiative to join forces. Regarding branding, she thought intercomparison will be important, and wondered if, similar to GRISST, we could do an ensemble and intercomparison between products, and maybe produce an ensemble mean as a single product, but also keep the original products from the teams available. Shubha indicated that she thought GRISST is indeed a good example model, and also an opportunity for learning, as we need to start early to limit the multitude of ensemble products available, as happened with SST..

Hiroshi indicated that he is also doing similar efforts and volunteered for JAXA.

Fréd indicated that he thinks the initiative is welcome and he wanted to move one step ahead to remember the Task Force on Climate Data Records where we spoke of things like intercomparison and

consistency of products, and one of the first challenges was to define clear activities, deliverables, and deadlines. Shubha agreed, Baby steps but actionable steps.

Laura indicated that she thought merged products were critical, especially when there are a number of sensors that phase in and out. NASA has been doing this across sensors with SeaWIFS, MODIS, etc for a long time, and have a number of harmonised products. So the ability exists within a number of different agencies. Laura hesitated to jump on board as she wondered where the gap or the need was. What are the products that would be generated that do not already exist right now? She also didn't think the TF on Ocean Carbon was the best umbrella for this initiative. Cara indicated that the need was coming from the operational users. She gave an example of trying to understand stock variability within fisheries, which requires a long time series, but no "satellite chlorophyll" product that was not linked to a sensor and its corresponding sensor timeline. A blended, cross-sensor product would be very helpful for these kinds of users. There was debate about whether these products actually do exist but are not widely known about.

Fréd raised that it was worthwhile to take stock of the products that exist, and also to go into details and understand if the merged or combined time series are good for climate and data records, maybe some applications but not for others. How does this jive with common SVC and common atmospheric correction. Ewa said that, as a community, we would gain legitimacy on this kind of interagency collaboration on the best products, but it is a large effort and many resources would need to be dedicated to this effort. It may also be useful for agencies working together on algorithms and data and maybe find something new and be able to improve the products just by collaboration. She sees this as an IOCCG product, not an agency product. Robert says the IOCCG was created exactly for these particular needs and solutions. He asked about implementation, as there needs to be a practical solution, however these details would be decided after the group has met and agreed to work together.

Paula indicated that we are not in any position to distribute data and also not in the position to tell the agency teams not to do what we are trying to do. If there are separate projects funded to derive different time series, then what does success look like? Cara indicated that these are excellent points. In terms of data dissemination, if the product is an IOCCG product, then it would belong to all the IOCCG agencies, and maybe all the agencies could distribute the product. Shubha agreed that distributed data availability is good, especially as there are large requirements for data storage and access that could be a shared burden across the agencies. She however reiterated that concluding on these logistics before the group has met and discussed is not ideal.

The topic would be further discussed among the space agencies at the executive meeting.

**Action 28/22:** IOCCG Exec to further discuss blending long time series products for multiple uses (multiagency buy-in for products) in the Executive meeting.

***Follow-up from Exec-39 (26 April 2024)****: In order to gauge the feasibility of this task, the IOCCG Executive Committee recommended that an ad hoc working group of experts with a broad knowledge of ocean colour product calibration and processing, uncertainties, and product intercomparison including associated challenges, be formed to create a set of recommendations, gaps, needed resources, and the possible path forward. The aim of the group will be to advise the IOCCG on whether such a task is feasible, clearly documenting the steps that would need to be taken, and why and/or how they may or may not be possible.*

***Action from Exec-39:*** *IOCCG Project Office to collect names of nominees for the ad hoc working group from space agencies within 2 weeks, contact them by email and schedule a kick-off meeting.*

## 7. IOCCG Capacity Building

### 7.1. Update on plans for the 2024 Summer Lecture Series, Hyderabad, India

Nimit Kumar, the new coordinator for the IOCCG Summer Lecture Series (SLS), introduced himself to the Committee and gave a bit of background on the new location for the SLS, which will be held at the International Training Centre for Operational Oceanography (ITCOocean) at Indian National Center for Ocean Information Services (INCOIS) in Hyderabad, India, in November 2024.

Applications for the SLS closed in February 2024, and 126 applications were received. Applicants hailed from 34 countries and represented 31 nationalities, with ages ranging from 21-44. A total of 30 participants were selected for the course. Nimit thanked the application reviewers, as well as the planning team for the SLS (David Antoine, Laura Zoffoli, Raisha Lovindeer, Shubha Sathyendranath, Susanne Kratzer, Vittorio Brando, and Uday Bhaskar) for their fortnightly meetings, guidance, and coordination.

### 7.2. Training - GOCI-II at COSPAR, Busan, South Korea

As part of the support from IOCCG to the 45th Committee on Space Research (COSPAR) Scientific Assembly, being held in Korea, KIOST is organising a training session on GOCI-II. Jongkuk Choi gave a brief history of the COSPAR Scientific Assembly, which is a biennial event that has occurred since 1980. COSPAR 2024 will be held in Busan Korea from July 13 - 21, hosted by the Ministry of Science and ICT and the Korean National Committee for COSPAR. The local organiser is the Korea Astronomy and Space Science Institute and the Korean Space Science Society.

The training will be an introduction to GOCI-II data and GTBX (GOCI ToolBoX) and will be held on Thursday, 18 July from 09:00 – 12:30 (including 0.5h break). KIOST was also invited by the scientific event's main organiser, Stefano Vignudelli (CNR) to have a scientific session on GOCI-II and progress in development and exploitation of satellite ocean colour and optical imagery. The session will be held on 15 July 11:00 – 12:30. A total of 6 presentations on GOCI have been submitted to the session, and it will be chaired by Jongkuk. KIOST was also asked to support the local organiser, and there will be an exhibition booth on GOCI-II from 14 - 18 July, with financial support from the Korea Hydrographic and Oceanographic Agency (KHOA).

### 7.3. 2024/2025 IOCCG Trevor Platt Memorial Scholarship

The first IOCCG Platt Scholarship round was launched in 2022 and two scholars awarded in 2023. Raisha indicated that both scholars (Arjun Adhikari and David Gonzalez Rivas) were scheduled to present their research at the IOCS-2023 meeting, with their travel supported by IOCCG. While David presented his poster, Arjun was unable to make the IOCS meeting, and will instead present his scholarship research at Ocean Optics XXVI in October this year.

The 2024 IOCCG Platt Scholarship was awarded to Hellen Kizenga (Tanzania), who will be conducting her research on *seasonal and interannual variability in phytoplankton biomass and phenology (bloom timing) along the Tanzanian waters using ocean colour sensors* this summer at the Bedford Institute of Oceanography in Halifax, Canada, supervised by Emmanuel Devred. Like the previous scholars, Hellen will be invited to present her scholarship research at the next IOCS meeting. Raisha thanked the reviewers who joined her in reviewing the applications for the 2024 round: Fréd Mélin and Marie-Hélène Rio.

### 7.4. Training Recap - Satellite-based tools for investigating aquatic ecosystems, Online/Plymouth, UK

This was a joint training between the Trevor Platt Science Foundation (TPSF), IOCCG, and other sponsors, and Shubha gave the recap. The training had two components, an open online component with lectures that occurred weekly from April to July, and an in-person component held at the

Plymouth Marine Lab (PML), UK, in conjunction with the Trevor Platt Science Symposium in August. The full report of the training is available on the IOCCG website. A poll of the trainees, conducted by IOCCG, indicated large support for a repeat of a similar online+in-person training course in conjunction with a symposium. The TPSF is considering another round, which might be held in Chile. Shubha requested the continued joint support of the IOCCG for this training event.

### 7.5. Training Recap - Satellite Ocean Colour Validation, CETT, Cordoba

Carolina Tauro gave a brief recap of the training event led by IOCCG in conjunction with CONAE that occurred during the two days prior to the Committee Meeting. The training on Satellite Ocean Colour Validation was attended by 22 participants hailing from Argentina and Brazil. The training included lectures by Robert Frouin, Jeremy Werdell, Áurea Ciotti, Ana Dogliotti, Juan Gossn, and Fréd Mélin, with support from other IOCCG members, including Shubha Sathyendranath, Emmanuel Devred, and Laura Lorenzoni. Participants found the training very useful, especially those on the SabiaMar Mission Team, which was well represented.

#### 7.5.1. Discussion

As a follow-up, Áurea made an invitation to the Committee. She indicated that she teaches a biological class—a week dedicated to field with lab observations. It is attached to Universidade de São Paulo, and is provided completely in English. She proposed a collaboration within Argentina and to rotate the location of the course, with the idea to have it every couple of years. With this in mind, the next course would be in 2025. There was support for this idea to continue and promote a course in the region.

Ewa indicated that EUMETSAT has developed training resources, case studies, and Jupyter notebooks that focus primarily on Sentinel 3/6 and other marine products, but they contain general knowledge of ocean colour and the science behind ocean colour data. She indicated that it would be good to share contacts with Áurea, specifically for Hayley-Evers King and Ben Loveday, who are in-charge of training at EUMETSAT. They could assist with the planning for the next year's course in the region.

Shubha requested that capacity building in South America be a priority for IOCCG, not only for training courses, but also for collaboration across a network. Vivian Lutz indicated that a network was formed in the past (ANTARES) and it worked well for a while through similarity of courses and knowledge exchange. They ran two projects together, but it takes effort and resources to maintain the network, especially for dedicated people and time. She indicated that maybe now it is easier to stay in touch and keep momentum through social media and electronic communication. Shubha indicated that the network also facilitated sharing of new biological instruments and measurements throughout the region.

## 8. Organisation and Membership

### 8.1. Requesting financial support for events from the IOCCG

Raisha Lovindeer raised that IOCCG space agencies may continue to make ad hoc requests for IOCCG to support their ocean colour related events, but that the extra travel funds that became available because of the COVID-19 Pandemic had been exhausted. Although future requests are welcome, they will continue to be received on an ad hoc basis, and will only be considered based on available funding. Laura and Marie-Hélène thanked IOCCG for assisting with events where funds were allocated from NASA or ESA, including the upcoming ISSI forum. Paula stressed that it was important to keep funding requests open and equitable.

Shubha reminded the group that ad hoc funding requests, if accepted, should be clearly earmarked in the IOCCG budget, which is approved by the Executive Committee at the start of the year, but that it was also important for IOCCG to maintain the flexibility to respond to these requests if funding is available.

### 8.2. Managing the IOCCG carbon footprint

Shubha raised the question of reducing the carbon footprint of IOCCG activities. She estimated that the largest carbon footprints were associated with the IOCCG Committee meetings and the IOCS meetings, which included international travel. She asked whether the IOCS Meeting could be every 3 years instead of 2 years, noting however, that we had synchronised the meeting with other standing events.

Marie-Hélène suggested that having a virtual Committee meeting and then a partial Committee meeting at IOCS might be helpful. Mark Baird indicated that the IOCS exists in the context of other meetings, and people may self-select to travel less and attend meetings when hosted in their region. Vittorio made a similar point, about self-selection when meetings are frequent. Mark also added, in contract, that a conference every 4 years might make the meeting more special. It was felt that although online meetings were helpful, a virtual meeting for the IOCS was untenable.

Paula shared that in February 2024 the Ocean Sciences Meeting in New Orleans was attended by 6200 people, and the early career scientists felt they had fallen behind in networking and job opportunities because it had been so long since they had met. Shubha indicated that while networking is important, carbon emissions are a pressing problem and will require solutions that are different from what we have done in the past. Cara suggested that we could network by using virtual sessions at some cadence (perhaps every 2-3 months or so) to try to encourage exchange and connection between scientists.

Marie-Hélène stated that there are many other meetings throughout the year that add to the problem. She gave the example of the plans for 2025: Living Planet Symposium in June, Ocean Carbon meeting in September, IOCS-2025 in December. Perhaps there are too many. She indicated that the young people are looking to us to see our behaviour and are keen to change their behaviour.

Laura indicated that maybe we do something that is a combination of meetings. Considering a cadence of 3 years for IOCS would mean an overlap with Ocean Optics (OO). There was discussion on whether these could be combined. Raisha indicated that she had a discussion with Heather Benway about the potential combined OO and IOCS meetings. However, after discussing, both Raisha and Heather did not think it feasible as the essence of both meetings are different and would be lost in a combined meeting. Poster sessions and some plenary talks overlap, but not the work that takes place inside the breakout sessions at an IOCS, and OO has no parallel sessions, so there would be a tug-a-war over the format. IOCS is also sponsored directly by the space agencies as a way to connect with and gauge the ocean colour community. Paula indicated that there was a push to bring the OO Meeting back to optical oceanography, and we would really need to be creative to pull off a combined meeting.

There was also a majority feeling that 3 years was too long to wait to host an IOCS meeting. Vivian suggested improving the hybrid possibilities for IOCS, even if the meeting is held every 2 years. Shubha said that if 2 years is an absolute must, then perhaps we can try for a hybrid meeting. She also indicated that wherever possible, we should try and combine meetings. Ewa agreed, indicating that maybe we could be more judgemental about the in-person meetings and especially the locations in which they are held, favouring places with more direct/shorter flights/more options for ground travel, and locations that already have a higher number of the meeting's participants. Shubha indicated that this may rule out meetings in the southern hemisphere.

There was consensus for the IOCCG Committee meeting to alternate between in-person and virtual during a year of the IOCS meeting. Although IOCS occurs later in the year, having the following in-person Committee Meeting in early Spring seemed to work well (as was displayed by the current meeting, which took place after the IOCS in November). It also allows more time for discussion as the agencies could continue to give their updates to the community at the IOCS meeting.

Tim Malthus asked whether we had made any attempt to quantify the carbon produced by our events, or perhaps considered opportunities to offset. Paula shared that OO has started to do something for the town that hosts the meeting, even selecting a charity to give funds, which is a kind of off-set, if not carbon. Marie-Hélène responded that while off-setting might be convenient, not emitting is of course better than emitting and then offsetting.

Shubha reiterated that sacrifices were required. She was not satisfied that we had done enough to reduce our carbon footprint with the current discussion, and requested to keep the discussion open.

**Decision 28/1:** To better manage the IOCCG's carbon footprint, IOCCG will have in-person committee meetings every 2 years (2024, 2026, 2028, etc) and fully virtual committee meetings during years in which an IOCS meeting is convened (2025, 2027, etc). In-person Committee meetings will maintain a virtual option (hybrid).

**Action 28/23:** IOCCG to continue to discuss reduction of the carbon footprint of the group.

### 8.3. Proposal for hosting next in-person IOCCG meeting

Hiroshi Murakami, on behalf of the Japanese Ocean Colour community, proposed Tokyo for the next in-person IOCCG Committee Meeting. He raised that it had been 28 years since the IOCCG had a Committee meeting in Japan (IOCCG-2 in 1997). He proposed a few locations in Tokyo that are all accessible from the airport and would be within walking distance from nearby hotels.

Hiroshi proposed mid to late March was best to host the meeting. GCOM-C will support the meeting. The Japanese community would appreciate an opportunity for exchange with the IOCCG Committee members, and are proposing to host poster sessions in the meeting room before, after, or during breaks to help to facilitate this exchange.

Shubha moved to accept the generous invitation to have the next in-person meeting in Tokyo (2026), and this was accepted by the Committee. As the IOCS is scheduled for December 2025, Shubha proposed to push the date of the Committee Meeting a bit later, to roughly April/May timeframe.

### 8.4. Proposals & requests for hosting future in-person IOCCG meetings

Menghua Wang agreed on the spot to present on behalf of Xianqiang He, who was not able to make the session. Xianqiang submitted a presentation proposing to host the future in-person meeting (after JAXA) in Hangzhou, China. This proposal was accepted by the Committee in principle, but the date proposed was the year 2026, corresponding to the prior cadence of annual in-person meetings. As Xianqiang was not present at the session, the Committee requested to know whether the proposal was still viable for the new date, in 2028.

**Action 28/24**: IOCCG Project Office to find out if the proposal to host an IOCCG Committee Meeting submitted by Xianqiang He will still be viable in 2028.

### 8.5. Rotation of IOCCG Committee Members

Hubert Loisel will rotate off the IOCCG Committee following this meeting, as he has completed two terms.

Ana Dogliotti was also up for rotation after completing her first term, but was requested to remain for a second term. Members made suggestions and nominations for new members to be added to the list of previous nominations for the Committee. Rotations will be discussed further at the Executive meeting. Robert suggested that a role for a policy maker/manager or other stakeholder be made available on the committee.

## 9. Any Other Business

### 9.1. Joint Inter-Agency Request to In situ Radiometer Manufacturers

Juan Gossn presented virtually to the IOCCG on behalf of the HyperCP team. He proposed for IOCCG to issue a request to manufacturers of in situ radiometers that would assist with FRM (Fiducial Reference Measurement) compliance. He gave an overview of HyperCP, which is an open source processor for in situ radiometry that processes raw data and gets Rrs. During the FRM4SOC-2 workshop, there were some requirements of the in situ instruments to be able to meet FRM compliance. Manufacturers

seemed on board to the requirements during the workshop, but then became unresponsive to follow-up communications after the workshop. A request to the manufacturers has been drafted, for them to provide absolute calibration coefficients, consider taking part in comparison experiments, and to help to propagate the FRM guidelines, procedures and tools. The letter includes resources to assist with this request. Juan requested IOCCG feedback and permission to route the request through the IOCCG, with Juan as the follow-up contact. He suggested publishing the letter through the IOCCG website, and he would follow up with manufacturers directly.

There was discussion about whether the request should be only for above-water radiometers. It was decided that IOCCG would make the request, but that in-water should also be included, and the wording should cover all relevant instruments. A point was raised about the cost and incentive to the manufacturers. It was stated that this was not a mandate, and manufacturers that included these requirements were likely to sell more instruments.

The request was considered an addendum to an existing protocol, and could be included on the IOCCG Protocols page.

**Action 28/25:** IOCCG Project Office to publish, as an addendum to existing protocols, the requirements for manufacturers regarding in situ and above-water radiometers, after Juan Gossn checks to ensure the requirements are generic enough so that there is no specificity for above-water.

### 9.2. Open discussion and feedback on changes to the Committee meeting

There was open discussion on the effectiveness of the changes to the structure of the Committee meeting agenda and meeting format. The most positive aspects were: open time available for discussion of items, rather than a stream of presentations; and effectiveness of the hybrid format in which the online participants felt included in the discussions. Other comments were:

- The roundtable of agency expectations was a good check-in, and Project Office and Chair should summarise the feedback and use it as the basis for future meeting discussions and actions.
- Suggested discussions and brain-storming on the vision for the future of the community, **where we want to be in the next 10-20 years. Useful to cover in the next IOCS meeting.**
- We could work harder to gather information from the community about how well IOCCG is serving the community, as well as general feedback. Suggestions included a feedback form on the IOCCG website, and also **using the IOCS meeting more effectively to get feedback from the community to IOCCG/agencies and vice versa.**
- There is an opportunity for IOCCG to **include more on lakes and rivers, and get closer to GEO Aquawatch** and synchronise the two communities, as the respective missions are relevant and complementary.
- A need to use the Committee's expertise in the room (working meeting), and **include more science discussion within the meeting**.
- A call to give more attention to **thorough review by the Committee of the documents submitted to the IOCCG** (white papers, report chapters, requests etc), and if the expertise is not available within the committee, to find and invite the scientific expertise to review these documents. Possibly consider an honorarium for review. Along these lines, maybe review the size of the Committee to see if it needs expanding to cover gaps in scientific expertise.
- Ensure we follow through with actions discussed.

## 10. Closing

Shubha moved to close the meeting and thanked everyone for their input. She especially thanked Carolina Tauro and the IOCCG Project Office (Raisha) for organising, and CONAE for hosting both the training and the meeting, and providing transportation. Her thanks extended to all the CONAE staff who were wonderfully supportive across the five days.

She thanked the Committee members for their engaged discussions over the course of the meeting. A special thanks was also issued to Committee members who arrived early and participated in the training course; those who gave lectures at the course; and those who thoroughly read and reported on working group progress and task force requests.

The meeting was adjourned.

## Appendix I: List of Participants

Committee Members

- Ana Dogliotti - CONICET
- Áurea Ciotti - Universidade de São Paulo
- Aurelien Carbonniere - CNES (virtual)
- Cara Wilson, Immediate Past-Chair - NOAA Fisheries
- Carolina Tauro - CONAE
- Chuanmin Hu - USF (virtual)
- Claudia Giardino - CNR-IREA (virtual)
- Emmanuel Devred - Bedford Institute of Oceanography
- Ewa Kwiatkowska - EUMETSAT
- Frédéric Mélin - EU-JRC
- Hiroshi Murakami - JAXA
- Hubert Loisel (virtual)
- Jeremy Werdell - NASA Space Flight Center
- Jongkuk Choi - KIOST (virtual)
- Laura Lorenzoni - NASA
- Marie-Hélène Rio, ESA, (virtual)
- Mark Barid - CSIRO (virtual)
- Menghua Wang - NOAA
- Paula Bontempi - U. Rhode Island
- Raisha Lovindeer, IOCCG Project Office
- Shubha Sathyendranath, Chair - PML
- Steve Groom - NCEO (virtual)
- Tim Malthus - CSIRO (virtual)
- Vittorio Brando - CNR-ISMAR (virtual)
- Xianqiang He - SIO (virtual)

Invited Participants

- Vivian Lutz - CONICET
- Robert Frouin, Past Chair - Scripps Institute of Oceanography
- Matthew Steventon - CEOS Secretariat (virtual, item 4.1 OCR contributions to CEOS Aquatic Reflectance ARD)
- Sean Bailey, NASA (virtual, item 4.1: OCR contributions to CEOS Aquatic Reflectance ARD
- Jamie Shutler, Ocean Carbon TF Chair, U. Exeter (virtual, Item 4.2: Aquatic Carbon Roadmap)
- Nimit Kumar - IOCCG SLS Coordinator, INCOIS (virtual, item 7.1: SLS-2024)
- Juan Gossn - HyPerCP, EUMETSAT (virtual, item 9.1: Request to Radiometer Manufacturers)

## Appendix II: List of Action items

| | Action | Status |
|---|---|---|
| 28/1 | Carolina Tauro and Robert Frouin to create and send a specific list of items where help is required for SABIA-Mar to the IOCCG Project Office for distribution to the Sensor Calibration TF and IOCCG Committee members for assistance. | **Completed** (list provided and distributed) |
| 28/2 | Ana Dogliotti & Aurea Ciotti to create a census of the instruments already available in South America. | **In-Progress** (survey preparation, meeting on 3 July 2024 ) |
| 28/3 | IOCCG Project Office to create a new page of sensors leveraged for ocean colour with support from space agencies who should send the information on sensors that should be included. | **Completed-modified** (still needs to be better populated https://ioccg.org/resources/missions-instruments/current-ocean-colour-sensors/) |
| 28/4 | Raisha Lovindeer & Shubha Sathyendranath to go through the list of expectations made by the space agencies and implement follow-up actions. | |
| 28/5 | Jeremy Werdell to begin to collate the inventory of validation activities in a document with the help of the IOCCG Project Office. | |
| 28/6 | IOCCG Project Office to alert the community about the idea for collating and adding POC and DOC data for inland and coastal waters to existing community databases such as SeaBASS and GLORIA. | **Completed** (suggested placed in Aug 2024 news bulletin) |
| 28/7 | IOCCG Project Office to communicate feedback from the meeting about new IOCS recommendations to breakout workshop co-chairs. | **Completed** (feedback sent to co-chairs 22 May 2024) |
| 28/8 | Cara Wilson to put together the first draft list of items (based on IOCS recommendations) that could be collated | **Completed** |

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| | for the US Decadal Survey white papers, and work backwards from the timeline of the white paper submissions to set some deadlines by June 2024. | (draft list sent to Project Office on 10 May 2024) |
| 28/9 | IOCCG Project Office to publish links to open access code for algorithm development in the software tab on the IOCCG website. | **Completed** ([https://ioccg.org/resources/software/](https://ioccg.org/resources/software/) updated May 2024) |
| 28/10 | Agencies should continue to review and update the existing recommendations from the IOCS meetings that are targeted at the agencies. | **Completed** (Review completed at Exec-39) |
| 28/11 | IOCCG Project Office to survey the IOCCG agencies to find the 2-3 big issues that the IOCS-2025 meeting could address or contribute towards. | **Completed** (Survey sent 18 June with 31 July deadline) |
| 28/12 | Vittorio Brando along with agency volunteers (Sean Bailey and Hayley Evers-King) to coordinate with Matt Steventon and the original authors of the Aquatic ARD to determine what changes and updates are needed to harmonize ocean requirements in the document. | **Completed** (meetings on-going, held 22 May 2024, 24 June, planned 8 July ) |
| 28/13 | Committee members to give their feedback directly on the Aquatic_Carbon_Roadmap_Outline_v2.docx by 1 June 2024. | **Completed** (draft Roadmap emailed to Marie-Helene on 19 June , but more feedback might be required) |
| 28/14 | Laura Lorenzoni to invite a leader from CEOS Coast to the next IOCCG Committee Meeting to understand possible synergies. | **Completed** (email sent 25 April to Merrie Neely, who requested Paul DiGiacomo [or Rashmi or Aurelien] to attend the next IOCCG meeting) |
| 28/15 | IOCCG to invite a leader from CEOS Coast / GEO AquaWatch to be on the IOCCG Committee (after action 28/10) | |

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| 28/16 | Cedric Jamet to submit the as-is draft of the Intercomparison of Atmospheric Correction Algorithms over Optically-Complex Waters in 2 months time so the Committee can see the progress | **Completed** (Report sent to PO on 8 July 2024) |
| 28/17 | IOCCG Committee to read and make comments on the draft OC-SVC White Paper | **Completed** (comments sent to chairs 22 May 2024) |
| 28/18 | IOCCG Project Office to investigate the resources to implement a forum or mechanism for information sharing on protocol documents on the IOCCG website. | **In-Progress** (emails between webmaster started 2 May 2024) |
| 28/19 | IOCCG Project Office to link other, published, peer-reviewed, IOCCG-approved protocol documents from the IOCCG website's Protocols page | **Completed** (updated Protocols page) |
| 28/20 | IOCCG Project Office to communicate to the proposers that the *Protocol on Chlorophyll-a & accessory pigments determined by HPLC* was approved to move forward | **Completed** (email sent 13 May 2024) |
| 28/21 | Fréd Mélin and Aurelien Carbonniere to coordinate and make a census on potential contributions to the UN Ocean Conference | |
| 28/22 | IOCCG Exec to discuss blending long time series products for multiple uses (multiagency buy-in for products) to be discussed further in the Executive meeting. | **Completed** (Discussed at Exec-39 meeting) |
| 28/23 | IOCCG to continue to discuss reduction of the carbon footprint of the group. | |
| 28/24 | IOCCG Project Office to find out if the proposal to host an IOCCG Committee Meeting submitted by Xianqiang He will still be viable in 2028. | **Completed** (Xianqiang He confirmed 2028 is OK) |
| 28/25 | IOCCG Project Office to publish, as an addendum to existing protocols, the requirements for manufacturers re In situ and above-water radiometers, after Juan Gossn checks to ensure the requirements are generic enough so that there is no specificity for above-water. | **Completed** (Juan sent revised wording on 5 June. Addendum published on website on 30 June) |

## Appendix III: List of Decisions from IOCCG-28 and Following Exec-39

| | Decisions |
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| D-28/1 | To better manage the IOCCG's carbon footprint, IOCCG will have in-person committee meetings every 2 years (2024, 2026, 2028, etc) and fully virtual committee meetings during years in which an IOCS meeting is convened (2025, 2027, etc). In-person Committee meetings will maintain a virtual option (hybrid). |
| D-EX39/1 | The IOCCG Executive decided that the IOCCG chair position should be held for a minimum of 3 years, and can be extended to a maximum of 5 years total. Extensions beyond 3 years are at the discretion of the IOCCG Committee and the Chair. The immediate past-chair remains on the IOCCG Committee as an advisor, preferably for the duration of the Chair's initial term, and for any extended terms at their own discretion. |
| D-EX39/2 | To increase acceptance of IOCCG Reports as peer-reviewed documents, IOCCG will have an open procedure for peer-review of the IOCCG Reports that mimics the peer-review of the IOCCG Protocols (3-4 invited reviewers + 60-day community comment on the draft posted on the IOCCG website) |