IOCCG-18 Committee Meeting
Québec City, Canada, 5 - 7 February 2013

MINUTES

1.0 Welcome and Opening Session

1.1 Welcoming Address

David Antoine (IOCCG Chair) opened the meeting and welcomed participants to Canada. He thanked the University of Laval's Takuvik Program and the Canadian Space Agency for hosting and organizing the meeting. Three new IOCCG members were welcomed (Giuseppe Zibordi, Gene Feldman and Nick Hardman-Mountford) as well as several invited participants (see Appendix I for list of participants). Marcel Babin (Canada Excellence Research Chair in Remote Sensing of Canada's New Arctic Frontier, University of Laval) welcomed the participants to Quebec City and commented that the outside temperature of -23^{o}C was a big contrast to the previous meeting (held in Bali). He noted that the University of Laval had a large number of research scientists and students working on ocean colour remote sensing in the Arctic. Yves Crevier (CSA Project Manager) welcomed IOCCG-18 participants to Quebec and expressed his honour in being able to showcase Canadian remote sensing expertise and to demonstrate to senior management the importance of the group for coordinating ocean colour activities.

Various committee members paid a short tribute to Prof. André Morel, who sadly passed away in September 2012. Prof. Morel was a pioneer of ocean colour radiometry and a prominent member of the ESA science advisory committee. He was also instrumental in establishing the IOCCG in its formative years and never missed an IOCCG Committee meeting for the first 15 years.

1.2 Adoption of IOCCG-18 Agenda

The IOCCG-18 agenda was adopted by consensus with no modifications.

1.3 Adoption of the Minutes from IOCCG-17 and Status of Actions

The minutes of IOCCG-17 were approved by consensus. The Chairman summarised the status of the actions from the 17th Committee meeting, most of which had either been completed, or would be addressed further during the meeting.

Action 17/1: The Calibration Report had been finalized in consultation with the INSITU-OCR.

Action 17/2: Splinter sessions and keynote talks for the IOCS meeting had been finalized.

Action 17/3: Paula Bontempi will address the issue of SeaWiFS data from HRPT stations under agenda item 5.3

Action 17/4: The broad release of SeaWiFS data collected from HRPT stations after 2004 to NASA GSFC will be discussed under agenda item 5.3.

Action 17/5: Funding for MOBY and BOUSSOLE will be addressed under agenda item 5.4.

Action 17/6: A draft copy of the IOCCG calibration report is now available.

Action 17/7: Robert Frouin has ensured that the calibration report is consistent with the INSITU-OCR White Paper.

Action 17/8: IOCCG has sent a letter to KIOST noting the importance of having mirror data sites for GOCI data. This item will be further discussed under agenda item 5.5.

Action 17/9: The Wikipedia entry on ocean colour has been posted on-line and will be discussed under agenda item 8.2.

Action 17/10: IOCCG Committee members are requested to edit the Ocean Colour Wikipedia entry. This item is still open and IOCCG members are encouraged to make changes and well as additional entries.

1.4 Report on the Takuvik Joint Laboratory Program

Marcel Babin reported on the Takuvik program, a joint international laboratory program between Laval University (Canada) and CNRS (France) focussing on Arctic research. The starting point was the Malina project, which examined light-driven carbon fluxes in the Arctic Ocean. The Takuvik Science Program was established to investigate the impact of ongoing and predicted environmental change on Arctic Ocean ecosystems and carbon fluxes. The ocean Chair of Takuvik is held by Marcel Babin (Canada Excellence Research Chair). Funding will be received from the Canadian Federal Government and the Quebec Provincial Government for a total period of 7 years (2010-2017). Around 30-40 PhD and post-doctoral students have been hired at University Laval to work on the project. The next major initiative is the "Green Edge" project, to understand the dynamics of the spring bloom in the Arctic and to determine the carbon fluxes.

2.0 Updates on IOCCG Scientific Working Groups

2.1 Mission Requirements for Future Ocean-Colour Sensors

Paula Bontempi provided a quick update on the working group addressing "Mission Requirements for Future Ocean Colour Sensors" (IOCCG Report 13). She thanked WG members for their hard work in getting the report published in such a timely manner. The report is a follow-on to IOCCG Report 1, which focuses only on Chlorophyll-a. IOCCG Report 13 contains six chapters and extensive useful appendices, and is built around a Science Traceability Matrix (STM) which traces mission and observation requirements back to the science questions, which encompass nine main topical areas. The scientific questions are also mapped to the satellite data products needed to address the questions. Regarding field programs, vicarious calibration is essential for visible bands, and each mission should identify a vicarious calibration source. In summary, the report outlines the minimum set of requirements for ocean-colour missions that are key to achieving research and management objectives; some of these are very specific and detailed within the chapters, others are general recommendations. CEOS SIT would like to facilitate implementation of the recommendations in the report, as well as those specified in the INSITU-OCR White Paper, and IOCCG agency members were requested to submit their

responses by the next SIT meeting. ESA and CSA reported that they had run compliance matrices of the polar-orbiting ocean colour mission/instrument requirements using the report recommendations against the planned ESA and CSA ocean colour instruments/missions, respectively, and these agencies were highly commended by IOCCG for this. A follow-up action would be for each agency to consider the same approach for assessing the capacity of agency instrument(s)/mission(s) to enable ocean colour ECV production. In general, IOCCG Committee members found the report to be most useful, and appreciated having a set of clear community recommendations on various Cal/Val tasks.

2.2 In-flight Calibration of Satellite Ocean-Colour Sensors

Robert Frouin discussed some of the recommendations from the WG examining "In-flight Calibration of Satellite Ocean-Colour Sensors". The purpose of the report is to review techniques for radiometric calibration of ocean-colour sensors while they operate in orbit, and to provide recommendations on how to meet calibration requirements for science applications during mission lifetime. The report contains an introduction, three basic chapters (definitions, techniques that utilize onboard calibration devices, and techniques that use natural Earth targets) as well as a set of recommendations. Techniques are presented in detail with their accuracy, advantages, limitations, and application examples. All sections have been written but consensus is still required on some of the recommendations i.e. redundancy of techniques (all techniques should be taken into consideration), reflectance vs. radiance calibration (calibration should be done in terms of reflectance), suitable sites for vicarious calibration (MOBY is not the ideal site but has sufficient attributes), and data to be used for vicarious calibration (use all data available that meets the criteria).

Nick-Hardman-Mountford noted that there was some confusion about the properties of sites selected for vicarious calibration. It was pointed out that ideal attributes were given in the report even though it was difficult to obtain in practise. Giuseppe Zibordi was of the opinion that the report did not give the right importance to system calibration, which requires an independent chapter and a re-write, since some parts needed updating. He agreed to send detailed comments to Robert via email. The Chairman suggested that the report could be used as a basis for general discussions at the IOCS meeting in an attempt to incorporate inputs from the broader community.

ACTION 18/1: GIUSEPPE ZIBORDI TO SEND DETAILED COMMENTS ON SYSTEM CALIBRATION TO ROBERT FROUIN BY EMAIL.

2.3 GEOHAB/IOCCG Harmful Algal Bloom Working Group

Stewart Bernard summarized the progress of the IOCCG Harmful Algal Bloom (HAB) working group. He outlined the key considerations of the WG and noted that it was a combined WG between IOCCG and GEOHAB. The final report will have a strong reliance on case studies. Progress had been made since last year, and about half of the draft material had been acquired. The initial plan was overly ambitious with regard to processing large quantities of data and the group has been held up by ongoing issues with MERIS FR data, which represents a very important data source. Case studies are spread over different

ecosystems, including inland waters (causality of cyanobacterial blooms). The two primary deliverables of the WG are an IOCCG/GEOHAB monograph, followed by a special issue in a peer reviewed journal (potentially Marine Ecology Progress Series). The aim is to complete the first draft by May 2013, hold an editorial meeting in August 2013, and provide a complete draft monograph by the end of 2013. Some of the material to be included in the report is new and has not been published elsewhere e.g., the sensitivity studies and case studies, so the report will require a serious review stage.

Paula Bontempi suggested doing a quasi-internal review without going external to IOCCG. The Committee agreed that it would be better to publish the monograph first before writing a special issue. They also agreed that the sensitivity analysis per se was essential, since a concrete set of requirements that address these types of waters is not available.

2.4 Phytoplankton Functional Types

Shubha Sathyendranath gave a brief update on the Phytoplankton Functional Types (PFT) working group. The introduction as well as Chapter 4 were at a fairly advanced stage and were available for review by the PFT WG and IOCCG Committee. Chapter 2 (*In situ* Methods) is being edited and is almost ready for review after additional inputs by chapter authors. Inputs to Chapter 3 (Detection of Dominant Types) and Chapter 5 (Detection of Multiple Types) are almost complete, and Shubha will begin editing these chapters shortly. The first draft of Chapter 6 (Conclusions) is also being written. The target is to complete the full draft before the IOCCG splinter session on PFTs at the IOCS meeting in Darmstadt (May 2013).

A related item was the PFT Algorithm Intercomparison group. Nick Hardman-Mountford reported that the group had held two workshops to discuss preliminary results and were making significant progress, despite receiving no funding. One of the proposed outputs of the group is to write a user's guide to PFT algorithms. As this may have some overlap with the IOCCG PFT report, it has been put on hold until the IOCCG PFT report is finalised, although it is anticipated that it will be more of a practical guide to implementation.

Stephanie Dutkiewicz enquired whether there was any attempt to estimate the relative uncertainties of different functional types or size groups. Shubha replied that this had not been done, although there is an intercomparison in Chapter 4 which shows uncertainties implicitly. It is more difficult to do systematically for the PFT algorithms and the WG does not have the manpower to do a sensitivity analysis. Roland Doerffer noted that he had done some studies on different mixtures of phytoplankton, and they can only get two species from a mixture, at best. Furthermore the uncertainties will change depending on the contribution of each functional type. Mark Dowell enquired whether the group could perform a meta-assessment to determine which PFTs can be assessed better than others, even without an error characteristic. The modelling community would be interested in knowing which satellite products had greater confidence. Shubha replied that different publications are based on different data sets and that it was difficult to make a comprehensive evaluation.

2.5 Uncertainties in Ocean Colour Remote Sensing

Roland Doerffer outlined the Terms of Reference for the WG, the goal of which is to address all the different sources of uncertainty in ocean-colour applications. Many factors influence the radiance spectra, all of which must be considered. Uncertainties due to the bio-optical model will also reviewed. A password-protected Wiki has been set up for the WG to exchange information and assemble literature and contributions for the report. Contributions from WG members will be collected over the next few months, a meeting will be held in May 2013, and a draft version of the report will be submitted for review by October 2013, with the final version being completed by summer 2014.

A brief summary of the status of ESA's CoastColour project was also given, including data processing and consensus on the best practice protocols for defining regional algorithms for a specific area, which requires volunteers from the IOCCG. A user consultation meeting will be held in Darmstadt (after the IOCS meeting) to communicate the recent results of the CoastColour and SeaSWIR projects.

2.6 Ocean Colour Remote Sensing in Polar Seas

The rationale behind the formation of the Polar Seas WG is to examine ocean-colour remote sensing in polar seas in general, as well as to highlight some of the difficulties encountered in these areas i.e. prevailing low Sun elevations, ice-related adjacency and sub-pixel pollution effects, pronounced deep chlorophyll maximum, anomalous IOPs, persistent cloud cover, and optical peculiarity which affects ocean-colour algorithms including primary production algorithms. The terms of reference for the group include reviewing the current literature for Arctic and Antarctic oceans, assessing current ocean colour algorithms through inter-comparisons (including the impact of the deep chlorophyll maximum on primary production, the impact of clouds on products, current atmospheric correction schemes and examining phytoplankton blooms under the ice pack) and making recommendations to space agencies and the scientific community on algorithm development and future research avenues. The results and recommendations will be summarized in an IOCCG report on the topic. A draft report was presented to the IOCCG Committee for review. It includes first drafts of all the chapters, some of which require additional work. The report contains a lot of new material in the various chapters. It is anticipated that the final draft report will be ready by mid-2013. The working group also plans to publish a synthesis in the journal *Oceanography*, providing recommendations for future research avenues. Roland Doerffer commented that the report was a very comprehensive text-book account of Arctic issues but some of the chapters were too broad and had too much detail. This would be addressed once all the material had been received.

2.7 Intercomparison of Retrieval Algorithms for Coastal Waters

Kevin Ruddick submitted a presentation on the WG examining the "Intercomparison of Retrieval Algorithms for Coastal Waters". The main objective of the group is to understand how algorithm performance relates to algorithm design and calibration of specific IOPs. The group hopes to progress to consensus on algorithm design and approach, and will compare algorithms for coastal water products as well as inland waters, providing that *in situ* data is available. Two benchmark datasets were

assembled: hyperspectral *in situ* marine reflectances with one or more coincident Level 2 water products, and hydrolight-simulated hyperspectral marine reflectances which can be subsampled to any optical remote sensor. An example of the report structure was given as well as task leaders for the various chapters. The group hoped to have some preliminary results by the May 2013 IOCS meeting and were aiming at a first draft of the report to be submitted to IOCCG by November 2013. Critical issues for discussion include whether there was enough data for testing, as well as quality control of the *in situ* benchmark dataset, which could be published as a citable reference to be used for future IOCCG activities. The working group would be responsible for the entire report but they requested adding authors outside the WG on the basis of need (this was encouraged). The WG intends to setup algorithm comparisons via a highly automated web site, which could be kept running after completion of the WG for public use.

The Chairman agreed that this was an excellent idea for people to test their algorithms but he thought that the WG schedule was very optimistic. He also encouraged the group to engage a wider community at the IOCS meeting. Steve Greb pointed out that there was a critical need for *in situ* data in lakes, and recommended that Kevin contact the GloboLakes group. Mark Dowell pointed out that the simulated dataset from Report 5 (available on the IOCCG website) had been used extensively to test or evaluate algorithms, and he suggested that a longer-term objective should be for the IOCCG to have a dedicated WG to examine or generate simulated datasets. Stewart Bernard pointed out that it was also necessary to have good intellectual property arrangements with a mechanism in place to issue DOI's for datasets (the WHOI library can issue DOI's). A marker should also be included for users to contact the data provider if the data are going to be published.

2.8 Update on Bio-Argo

David Antoine provided a brief update on the Bio-Argo WG, which would like to maintain the link between IOCCG and Bio-Argo. The WG group is becoming a component of the Argo program, which is planning to extend the core mission for the next decade to include ecosystems and biogeochemistry. Beside O_2, the biogeochemical community has identified nitrate, chlorophyll-a, and particulate scattering as ready to be implemented on Bio-Argo floats. Other variables for the global array include pH, PAR, E_d, transmissiometry c_p (proxy of phytoplankton biomass) and CDOM. New sites for deployment include the Mediterranean Sea, Arctic and Antarctic. Several countries are now deploying and managing Bio-Argo floats equipped with at least chlorophyll-a and b_b sensors, including Norway, U.S., France, Australia, India and Germany, and several others have the funds to start. The success of Bio-Argo will rely in the capability to design an efficient data-management system for delivering quality-controlled data freely in real-time. Resources have to be allocated at a national level, and coordination is required at an international level.

Stewart Bernard pointed out that they had just bought four bio-optical floats but it was a tortuous process and it was not easy to integrate the hardware. Paula Bontempi also queried how to buy Bio-Argo floats. Was it necessary to first purchase Argo T&S floats and then add the Bio-Argo component? These questions would be relayed to Herve Claustre.

3.0 Proposal for New Working Groups

3.1 Atmospheric Corrections in Coastal Waters

David Antoine presented proposal on behalf of Cédric Jamet, to establish a new IOCCG working group on "Atmospheric correction over turbid coastal waters". Coastal waters are more challenging than open ocean waters because of the temporal and spatial variability, straylight contamination (adjacency effects), non-maritime aerosols (dust, pollution), suspended sediments/CDOM and anthropogenic emissions (NO_2 absorption). The goal of the WG is to inter-compare and evaluate existing atmospheric correction algorithms over turbid waters, and to understand the differences in retrieval algorithms using *in-situ* and theoretical data, as well as how the assumptions impact the quality of the retrievals. The working group aimed to complement IOCCG Report 10, which focused mainly on open ocean waters, and would focus only on atmospheric correction algorithms that deal with non-zero NIR water-leaving radiances. Currently there are very few papers evaluating round-robin atmospheric corrections. The proposed working group would have potential synergies with the IOCCG working groups on "Intercomparison of Retrieval Algorithms for Coastal Waters" and "Uncertainties in Ocean Colour Remote Sensing".

IOCCG members encouraged the WG to include inland waters as well as biologically turbid (eutrophic) waters. The proposal would be further reviewed during the Executive Committee meeting based on feedback from IOCCG Committee members.

4.0 Contribution to CEOS OCR-VC Activities

4.1 Review of INSITU-OCR Recommendations

Giuseppe Zibordi reviewed the recommendations of the International Network for Sensor InTercomparison and Uncertainty assessment for Ocean Colour Radiometry (INSITU-OCR), which recently produced a White Paper (to be finalized within the next 6 months) with a series of recommendations and requirements for high accuracy and consistency of essential climate variables from present and future satellite ocean-colour missions (a joint initiative between CEOS OCR-VC and IOCCG). These recommendations fall into four categories:

- Space sensor radiometric calibration, characterization and temporal stability
- Development and assessment of satellite products
- *In situ* data generation and handling
- Information management and support

Giuseppe reviewed all the INSITU-OCR White Paper recommendations, most of which are addressed to Space Agencies contributing to the OCR-VC, in view of achieving the final goal of producing consistent long-term Climate Data Records. The range and complexity of activities required to thoroughly address the proposed recommendations entail an efficient coordination of inter-agency contributions. Options include establishing a central coordinating office with the main function of facilitating communication and merging information, as well as dedicated hands-on working groups to actively address specific

issues. Committee members suggested that a recommendation should also be made to Agencies to distribute both calibrated data as well as uncalibrated L1A data.

4.2 Proposal to Establish a New Task Force on Satellite Sensor Calibration

Ewa Kwiatkowska reviewed a proposal to establish a new task force on satellite sensor calibration. This is one of the recommendations from the INSITU-OCR White paper, which recognizes the need for the Space Agencies to facilitate collaboration among sensor characterization and calibration experts to maximize the accuracy and temporal and spatial stability of OCR records from individual missions. OCR necessitates a special consideration because its mission requirements are particularly demanding: 0.5% absolute uncertainty on sensor measured reflectances and a significantly lower uncertainty on spatial and mission-long stabilities. These challenging accuracies concern all applications, climate, research and services, and are most effectively addressed by a collective effort and heterogeneous expertise. The proposal calls for a permanent inter-agency platform to work together to tackle certain calibration issues (and not to produce an IOCCG report, as in traditional IOCCG working groups). The Space Agencies on the IOCCG Executive Committee contributing to the OCR-VC initiative are expected to support this Task Force with dedicated resources.

ESA appreciated the task force proposal as well as the INSITU-OCR White Paper, and identified a number of issues that were compliant as well as those that were difficult to handle. ESA strongly recommended separating on-orbit instrument calibration from vicarious calibration, which ESA feels should be the focus of this group, since they feel that CEOS IVOS is already addressing calibration at the instrument level. ESA recommended against establishing another group that is not integrated within an existing framework. Many IOCCG members agreed that the two topics, on orbit instrument calibration and vicarious calibration, need to be addressed together and that the task force should remain within IOCCG, but could liaise with the CEOS WGCV. Mark Dowell also pointed out that if this type of activity were to be kept under OCR-VC, it would be more prominent than if it were buried it in IVOS under WGCV. Furthermore, there is a direct interface to CEOS principles through the virtual constellations.

The first priority would be to identify recommendations that can be addressed by agencies themselves, and also highlight tasks that would benefit from scientific oversight from IOCCG. Shubha Sathyendranath noted that if the only impediment from ESA was that the group should be established under an existing framework, this would be easy to do as the group could be convened under the auspices of CEOS and IOCCG. If there were concerns about having additional meetings, the group could meet on the occasion of other existing meetings, such as the IOCCG annual meetings. The IOCCG Chair agreed to collect feedback from Committee members and make a recommendation regarding the establishment of the task force for final IOCCG agency consideration.

ACTION 18/2: DAVID ANTOINE TO MAKE A RECOMMENDATION ON THE PROPOSED NEW CALIBRATION TASK FORCE AFTER COLLECTING FEEDBACK FROM IOCCG COMMITTEE MEMBERS.

4.4 Potential OC Sensor for the Polar Communication and Weather Mission

Guennadi Kroupnik (CSA) reported on the Polar Communications & Weather (PCW) mission and other opportunities for ocean colour. It is important to have a robust modern infrastructure in the Arctic but currently there is a gap in broadband communication coverage as well as meteorological coverage over the Arctic due to the configuration of both low Earth orbiting satellites (LEO) as well as geostationary satellites (GEO). The highly elliptical orbit (HEO) satellites allow "quasi-geostationary" observations and communication services over the high latitudes, so a combination of LEO, GEO and HEO satellites can provide for complete global coverage. The proposed PCW mission has 3 components: communications, meteorological data and space weather monitoring. Two satellites in HEO orbit will provide 24/7 high data rate communication services. The core mission will respond to Government of Canada requirements, and includes a communications payload, an imaging spectroradiometer (20 channels, 0.5-1 km VIS, 2 km IR), and space weather suit of instruments. Only one channel is suitable for water quality and chlorophyll. Another instrument could potentially be included in the payload through possible collaboration with U.S. or the European Union.

A small microsatellite program was started 7 years ago and includes one small satellite and two microsatellites on a multi-mission platform. There are three candidate missions: altimetry, quantum key distribution demonstration mission and a hyperspectral mission. For the latter, the concept of a compact hyperspectral imager for Canadian land and ocean products has been proposed. A constellation of compact hyperspectral imagers would meet most of the requirements in the areas of interest to Canada.

4.5 CEOS OCR-VC Implementation

Paula Bontempi gave an update on the status of OCR-VC activities under CEOS, and reviewed the 3-year outcomes defined in the course of the CEOS Self-Study (CSS). These include OCR-VC development, the INSITU-OCR White Paper, the ECV Task Force, IOCCG Report 13 and the IOCS meeting. Other issues raised included the need for broad support on ocean-colour data exchange, the need to recognize that INSITU-OCR is a critical component to achieving ECVs (and the challenges of implementing INSITU-OCR), getting a better understanding of agency resources to support ocean-colour harmonization activities (NASA is willing to support a core office for INSITU-OCR) and the implementation of IOCCG Report 13. In a recent OCR-VC telephone conference with Mike Freilich (SIT Chair) one of the key points raised was that SIT should encourage CEOS agencies with responsibilities for ocean-colour missions to take note of the requirements and recommendations in both IOCCG Report 13 and the INSITU-OCR White Paper, and provide concrete feedback by SIT-28. For INSITU-OCR in particular, this feedback should include specific solutions/resources to implementing the proposed recommendations. Another point briefly raised was the operational oceanography White Paper by Eric Lindstrom (18 Dec 2012), which pulled together all the oceans constellations. Feedback would be requested via email.

4.6 Possible Rotation of OCR-VC Chairs

Regarding the OCR-VC co-lead rotation, Prakash Chauhan requested rotating off as co-chair. There was some discussion about Paul DiGiacomo as a replacement co-lead (to be confirmed by CEOS).

4.7 Report on ESA's Climate Change Initiative

Shubha Sathyendranath gave a brief update on activities undertaken under ESA's Ocean Colour Climate Change Initiative (CCI). Implications of the marine ecosystem's responses to climate change are such that algorithms have to be robust, retrieval of properties of the ecosystem should not rely on correlations between each other, and the use of empirical relationships in the algorithms should be minimal. Simple band ratios may not be sufficient for climate-change studies: algorithms that exploit optical properties of phytoplankton types should be favoured. Spectrally-resolved water-leaving radiances and bio-optical models that allow spectral variations in phytoplankton absorption are key. Results of various intercomparisons were reported on last year: the Polymer algorithm will be used for MERIS processing, but standard NASA algorithms will be used for MODIS and SeaWiFS data. A band-shift algorithm was used to ensure consistency of wavelengths in the time series of radiance data in merged products. A bias correction algorithm was used to reduce inter-sensor biases that might cause spurious trends in merged data. An optical water-type approach was used for error specification in products on a pixel-by-pixel basis. Initial results of error frequencies indicate that GCOS requirements are not being met at 412 nm, but better results were obtained at 443 nm. An iterative loop will be put in place with continuing science input to improve products, and algorithm intercomparisons will be carried out periodically to re-evaluate the most suitable algorithms. The CCI project is ready to produce the first full time-series of OC-CCI products. The CCI Project is preparing for the next round-robin and exploring the incorporation of data from additional sensors (OCM-2 and VIIRS). Input from IOCCG was requested to improve the evaluation criteria and scoring system as they get ready for the next comparison. They also want to explore additional collaboration with NASA and NOAA, for example, to evaluate the best set of auxiliary data (ERA-Interim v/s NCEP) to be used in the processing; to explore further the MERIS spectral matching atmospheric correction method for NASA sensors, and to add VIIRS to the CCI data stream. Collaboration with ISRO is being pursued with respect to the use of OCM-2 global data.

4.8 Task Force on ECV Assessment and Relation to CCI

James Yoder reported on the first ECV WG meeting which was attended by most WG members. The group was charged with producing basin-to-global scale ECV/CDR time series of ocean-colour products (specifically L_w and derived products) for climate-related studies. The group agreed that ECV/CDR metrics for ocean colour, as listed in the recent GCOS document, and the targets (at least for stability and accuracy) will not be achievable with the current suite of instruments. They tentatively accepted the current GCOS definitions for stability and accuracy, but may recommend changes after further consideration. Four international efforts to produce OC time series were reviewed at the recent meeting of the task force including NASA-GSFC (L_w and Chl time series involving multiple sensors), the NASA-funded MEaSUREs project (using the GSM model to calculate IOPs), GLOBColour which is

producing a time series of merged data from SeaWiFS, Aqua and MERIS data at 4.6 km resolution using a process similar to MEaSUREs, and the CDR/ECV project that is part of ESA's CCI program (time series based on SeaWiFS, Aqua and MERIS data). NASA-GSFC is unable to achieve 5% agreement for L_w measured by the various instruments. The group had held a brief discussion on data merging and the advantages of merging data from multiple sensors versus concatenating data sets to produce long time series. Some argued that merging data made sense to produce daily products, since merging generally improves daily coverage. They agreed that monthly resolution was adequate for a CDR for chlorophyll concentration, but higher temporal resolution was required to produce a CDR to quantify phenology. A study by S. Henson and M. Wang concluded that reaching the CEOS chlorophyll stability target may not be adequate to resolve decadal trends in chlorophyll. Furthermore, monthly resolution is insufficient to characterize the seasonal cycle of phytoplankton, and also insufficient to detect long-term trends in phytoplankton phenology and its change. The Group for High Resolution SST (GHRSST) project has some insights that could be used for ocean colour: they have adopted a "common product assessment approach" to assess differences between products. The ECV task force plans to meet briefly before the IOCS meeting and will produce a more complete report of their initial objectives before the IOCCG meeting in 2014. The task force could potentially evolve to start doing comparisons but would require agency support to carry out these projects.

4.9 CEOS WG Climate

Mark Dowell reported on the CEOS WG on Climate, the mission of which is to facilitate the implementation and exploitation of the ECV time-series through coordination of activities undertaken by CEOS member agencies. GCOS provides a process and an explicit set of requirements that space agencies are currently adopting in implementing their programmes. The GCOS satellite supplement provides target requirements for satellite instruments and data and CEOS responds to meeting these requirements. There is a strong requirement from GCOS for a thorough product review, quality control and documentation. An ECV inventory questionnaire has been released that addresses both existing/past missions and future/planned missions to identify gaps and shortfalls. Responses were requested at the dataset level. To date, eight ocean-colour products had been submitted. The CEOS self-study initiative was championed by NASA as the SIT Chair. There could be some important consequences that could affect the Virtual Constellations, which will undoubtedly emerge as an important implementation mechanism.

5.0 Agency Reports on Important New Items

5.1 ESA: Update on Sentinel-3 Development

Peter Regner provided an overview of the current situation with ESA Earth observation missions. Envisat formally entered into phase F in May2012, with pending work related to data management to be covered by the EOEP-4 (2013-2017). MERIS data continuity will be ensured through the Sentinel-3 mission, which is an operational multi-instrument mission designed for the operational needs of the GMES program. The Ocean and Land Colour Instrument (OLCI) is the successor to MERIS but with a

number of significant improvements. Full performance will be achieved with two satellites: Sentinel-3A is scheduled for launch not before April 2014 and S-3B 18 months later. The OLCI instrument delivery is planned for fall 2013 but the overall satellite schedule is primarily driven by the availability of the SLSTR: several technical problems have introduced significant delays. The Sentinel-3 operations concept is based on a core ground segment (EUMETSAT will serve the marine user community with marine products, and ESA the land community) and a collaborative ground segment for supplementary access to Sentinel data and a frame for international cooperation.

The core ground segment development is on track for the launch of S-1 (2013), S-2 (2014) and S-3 (2014). Cal/Val activities are essential for the quality of the mission. A complete framework for S-3 quality control and monitoring of the mission performance will be achieved through a variety of means including a joint ESA-EUMETSAT validation team, a quality working group, a Mission Performance Centre (MPC) contract and international Cal/Val partners. OLCI core user products will be systematically processed in the Core Ground Segment and will be made available free of charge to users in line with the Sentinel Data Policy which is awaiting finalization by the European Commission. The principles include open access and free of charge. Funding of the Sentinel operations by the European Commission is not yet established and is still marked by uncertainty.

5.2 EUMETSAT: Development of Ocean Colour Services

Ewa Kwiatkowska outlined EUMETSATS's involvement with Sentinel-3. Their mandate includes operationally processing and distributing instrument data and marine products from S-3, operationally monitoring and controlling the S-3 platform and payloads, and providing support to the marine user community. EUMETSAT depends heavily on cooperation with users (e.g. through the EU MyOcean program). In addition they will provide support for the ESA flight operations segment, and ground segment procurements. ESA and EUMETSAT are preparing a joint Cal/Val plan which encompasses agency and community contributions. At the Joint Cal/Val planning meeting the clear community recommendations from IOCCG Report 13 and the INSITU-OCR White Paper were very important. The draft OLCI instrument and marine product Cal/Val plan was reviewed by the S-3 mission advisory group in October 2012. ESA and EUMETSAT released a joint call for a Sentinel-3 Validation Team (S3VT) under the GMES Collaborative Ground Segment initiative. About 80 submissions have been received with a strong representation of ocean colour. The first meeting will take place in November 2013. In conclusion, EUMETSAT depends heavily on user requirements and community recommendations and is seen as an operational data provider for science, climate, environment and services.

5.3 NASA Update on Past, Current and Future Missions and Research Planning

Paula Bontempi provided a brief update on past, current, and future NASA missions as well as research planning. Gene Feldman reported on the status of two action items (17/3 and 17/4) from the last IOCCG meeting regarding the broad release of SeaWiFS data collected from HRPT stations to GSFC. Of the total 132 SeaWiFS authorized HRPT stations, 83 delivered data to NASA. In 2004 NASA lost the ability to provide licences to ground stations but they continued to collect data. Over the past 3 years NASA has been working with GeoEYE to obtain all SeaWiFS data. GeoEYE (recently bought out by DigitalGlobe)

have agreed to provide NASA with access to all of the SeaWiFS HRPT data that currently reside in the DigitalGlobe digital archive from years 1997-2010. They have also allowed NASA to request copies of all SeaWiFS HRPT data collected by remote ground stations for incorporation into the NASA archive, and will allow all ground stations that may have collected data under contract, to release their SeaWiFS data holdings to NASA without fear of violating the terms of their agreement with DigitalGlobe. They have also agreed to place all of the OrbView-2 (SeaWiFS) data in the public domain. NASA will get in touch with all the HRPT stations regarding obtaining the SeaWiFS 1-km dataset.

Paula Bontempi reported on the MODIS Aqua and Terra missions. Aqua ocean-colour products showed a large increase in water-leaving radiances in the 412 band which has since been mitigated using desert sites as a calibration source. The effect on chlorophyll products is minor, but a reprocessing of data starting from 1 Jan 2011 is expected in the near future. MODIS-Terra reprocessing will follow, using MODIS Aqua as a calibration source.

Suomi-NPP VIIRS is performing reasonably well. NASA is supporting the evaluation of the operational products from NOAA (Level-2 EDRs), while also evaluating the potential of the instrument to support continuity of ocean-colour science. NASA-derived chlorophyll is in good agreement with MODIS. The Hyperspectral Imager for the Coastal Ocean (HICO), which will stay on the international space station until 2014, was handed over to NASA in December 2012, and NASA is currently developing a data policy.

NASA's next planned OC mission is PACE (Pre-Aerosol, Clouds, and ocean Ecosystem), scheduled for launch in the FY 2020 timeframe. This is a 3-year mission with a hyperspectral sensor focussed on global ocean-colour acquisitions. The Science Definition Team (SDT) had produced a report which took into account the recommendations from the draft INSITU-OCR White paper. In FY2013 NASA will release a Request for Information (RFI) for ocean-colour vicarious calibration approaches and instrumentation, define the mission acquisition approach, establish the expected partnership issues such as contributed instruments, define the baseline mission science objectives and release an Announcement of Opportunity. Other planned missions include ACE (Aerosol-Cloud and ocean Ecosystem) for the 2023 timeframe and GEO-CAPE, a geostationary mission to be launched in 2018 as a secondary payload hosted on commercial geostationary satellites.

NASA and ESA have a data exchange agreement whereby OBPG has ingested and processed the full MERIS RR Level-1B archive from the 3rd ESA reprocessing. Results show good consistency with SeaWiFS and MODIS and all data is being distributed through the NASA Ocean Color Web. MERIS Level-1B full resolution data will be ingested next. NASA's Ocean Biology and Biogeochemistry program is also providing field support (various cruises) as well as expanded support for SeaBASS.

5.4 NOAA Update on VIIRS

Paul DiGiacomo provided a summary of NOAA ocean-colour activities, including VIIRS data access. VIIRS Level-0 and Level-1B data from the JPSS Interface Data Processing Segment (IDPS) have been available via CLASS (NOAA's Comprehensive Large Array-data Stewardship System) since last year. VIIRS ocean-colour Level-2 (EDR) data from the IDPS have just been declared as "Beta" status and will soon be

available via CLASS. Global Level-3 VIIRS ocean-colour data will be available from NOAA CoastWatch for operational users in Spring 2013. Reprocessing of IDPS ocean-colour data is expected to occur by the end of 2013. There are three sets of algorithms in the IDPS ocean-colour chlorophyll EDR data processing which are being evaluated using various monitoring sites around the world. Results have also been compared with MODIS-Aqua global images and show that although there are still some issues with VIIRS data, VIIRS (IDPS) and MODIS-Aqua nLw's and chlorophyll-a data are generally quite comparable. VIIRS can potentially provide high-quality global ocean-colour products in support of research and operational applications. Upcoming plans include continuing Cal/Val activities as well as algorithm refinements and improvements.

MOBY operations are being funded by the JPSS Program; it has been functioning extremely well with no issues since the launch of VIIRS. However, MOBY technology is 20 years old and needs a technology refresh. A funding request has been submitted to the JPSS Program to replace MOBY optics and control system. However, funding provided for FY13 does not include support for the refresh activity so current instrument operations will become increasingly risky without refresh. NOAA CoastWatch will support the eventual transition of VIIRS ocean-colour data into operations following established NESDIS processes. They will distribute global VIIRS NRT data to users, and will continue to distribute MOBY data.

5.5 KIOST Update on GOCI-I and II Missions

Joo-Hyung Ryu (Korea Ocean Satellite Center) updated the committee on the current status of the GOCI-I and II missions. There are no significant technical issues for GOCI operation. Approximately 960 scientific data users are supported by the GOCI data service as well as domestic government users (near-real-time data service). A GOCI image portal site provides a service to Korean citizens (frequency 8 times per day). Recently, the GOCI operation committee approved the concept of redistribution mirror sites for international scientific users. The GOCI Data Processing System (GDPS) version 1.2 will be released in March 2013 and will provide a number of new products (e.g. water current vector, fish ground index and yellow dust in the ocean) as well as batch processing and an improved user interface. On-going GOCI Cal/Val and research projects were also reviewed. Continued ship-based efforts will collect matchup data for the open ocean

GeoKompsat -2B will carry the GOCI-II instrument, which will focus on monitoring the coastal and global ocean environment with better spatial resolution (250 x 250 m) and spectral performance than GOCI. The instrument is scheduled to be launched in 2018 and will have a new capability supporting user-definable observation requests e.g. clear sky area without clouds. The main difference between GOCI-II and GOCI is the global-monitoring capability (once or twice per day), which will meet the requirements for global, long-term climate change studies.

5.6 JAXA: GCOM-C/SGLI New Developments

Hiroshi Murakami reported on GCOM-C/SGLI developments. The mission aims to improve land, coastal, and aerosol observations and is scheduled for launch in winter FY2015. Coastal regions will be observed

at 250 m resolution and other areas at reduced resolution (coastal areas to be defined). The SGLI radiometric calibration strategy will be led by a joint team comprised of the JAXA GCOM-C hardware development group and the data-analysis and application group, and will use multiple methods (solar diffuser, LED, Moon, and vicarious calibration). The SGLI engineering model is under evaluation and the flight model is the next step.

The first draft algorithm was provided to JAXA by PIs in autumn 2011. The evaluation results are reflected in the design of the operational processing system which will produce standard as well as research products, some of which will be considered for Level-3 production. The next research period (April 2013 to March 2016) will include coastal algorithm development through characterization of coastal IOPs. G-COM-C1 products will be released to the public one year after the launch, and will be free of charge for internet acquisition.

5.7 INPE: Argentine-Brazilian SABIA/Mar Mission

Milton Kampel had submitted a presentation on the SABIA-Mar mission, which is implemented jointly by CONAE (Argentina) and AEB/INPE (Brazil). The mission is based on a constellation of two satellites, SABIA-Mar 1 and SABIA-Mar 2, and the associated ground segment and operations logistic infrastructure. The mission is still on track but had been delayed for political reasons, and is now scheduled for launch in 2018. The primary instruments consist of two multispectral cameras: one for global ocean imaging at low resolution (1 km), with a daily revisit and on board recording capability (MUS-L), and the other with a 200 m resolution for coastal and inland waters, with a 4-day revisit time and on board recording capability under specific requirements (MUS-M). SABIA-Mar is a truly global mission and will complement existing missions. Committee members recommended that INPE take advantage of the recommendations in IOCCG Report 13 for calibration etc. Jim Yoder suggested that CONAE should be approached to become an IOCCG member. Gene Feldman agreed to approach representatives from CONAE, since he is involved with the Aquarius mission.

ACTION 18/3: GENE FELDMAN TO APPROACH CONAE REPRESENTATIVES REGARDING POTENTIAL IOCCG MEMBERSHIP.

5.8 CNES: Ocean-Colour Developments

Juliette Lambin gave a presentation on CNES ocean-colour developments. Ocean science is one of the major interests of CNES's Earth observation program, with a strong focus on physical ocean observations (altimetry, salinity and wind/waves) but they also support ocean colour through the PARASOL mission, Sentinel-3 and GeoOCAPI. The Parasol mission monitors clouds and aerosols and has ocean colour observing capability (with polarimetry) and is still operating well, but in a lower orbit (collision avoidance). The mission has been extended up to 2013 after a successful mission extension review. Some Level-2 ocean colour products are generated by CNES, but distribution is upon request only.

A phase 0 study has been started for OCAPI (Ocean Colour Advanced Permanent Imager) on a geostationary platform (GeoOCAPI). A mission review is planned for April this year, in preparation for

transition to phase A, which has not yet been funded but is first on the waiting list. OCAPI is still a high priority for ocean-colour science and is strongly dependant on international cooperation. The GeoOCAPI mission requirements include 16 spectral bands, signal-to-noise ratio <400, and spectral resolution from 10 to 40 nm (depending of the spectral domain and uses). Three main scenarios for ground spatial resolution were investigated for the VNIR domain: 500 m and larger for the open ocean (Case-1 waters); 100 m for coastal and inland observations (Case-2 waters); and 250 m for Case-1 and Case -2 waters. Full disk coverage is envisaged but coastal areas are the goal at the higher resolution. The satellite's revisit frequency would be 1 h. Feasibility and cost studies lead by CNES with industrial support indicate that GeoOCAPI 250 m is the chosen design and could be taken to space before 2021. Specifications for GeoOCAPI 100 m are more difficult to reach and may require additional analysis to demonstrate the feasibility of the concept. GeoOCAPI would be similar to GOCI but with better performance. Both the geostationary as well as geosynchronous orbits are being investigated.

5.9 CSA's interest in ocean colour

Yves Crevier reported on CSA's support of the ocean-colour community. IOCCG is very important for CSA as it provides exposure to direct stakeholders (DFO, EC, DND, academic sector) as well as Canadian scientists. CSA's mandate is focussed on responding to the Canadian Government by demonstrating societal benefits and outcomes that are expected from significant public sector investments in space. CSA does not have any optical missions or sensors, but IOCCG is a very cost-efficient way of exposing the science community to what is being done to meet requirements. CSA's investments in ocean colour are focussed on four components: supporting and providing access to missions that meet user requirements, facilitating the development of a Canadian Ocean Colour Network, investing in operationally-focused science, and going beyond the science to societal benefits. This is accomplished through coordination with IOCCG and also CEOS.

CSA funds the Radarsat 1 and 2 missions, and CSA's main priority is usage of that data. CSA is exploring synergies between SAR and optical data for ocean-related activities. In other areas, there is an opportunity to add an ocean-colour sensor on the Polar Communication and Weather (PCW) satellite system, for which CSA is exploring potential international alliances. In addition, concept and feasibility studies have been carried out for development of a compact imager for a potential microsatellite constellation.

Canada has a large community of researchers in different parts of Canada working on projects with various space agencies. CSA would like to support the establishment of an advisory group to provide a common voice for the Canadian ocean colour community (including government, universities and industry). The concept of a Canadian Ocean Colour Network (COCN) has been approved and will be financially supported by CSA for 3-5 years.

5.10 Update on Chinese OC Missions

Zhihau Mao gave a presentation on the potential use of the UV sensor on the Chinese HY-1B satellite, which is still working well after 6 years in orbit. A sensor with two UV bands (345-365 nm, 375-395 nm)

will be installed in the new HY-1C/D (AM and PM) mission, scheduled for launch in 2015. A potential use of UV bands on HY1C/D is for monitoring ocean pollution, especially oil spills. One of the main problems is atmospheric correction. A new atmospheric correction algorithm based on UV bands has been developed by Xianqiang He et al. (Optics Express, 2012) for processing satellite data over turbid coastal waters. Application of the algorithm using UV imagery has yielded promising results for monitoring oil spills as well as monitoring CDOM.

6.0 Other Ocean Colour-Related Initiatives

6.1 Gap Bridging/Filling between Missions

Gene Feldman (NASA) led an open discussion on the issue of gap bridging and filling between missions. SeaWiFS, OCM and MERIS are no longer functioning but a wealth of new ocean-colour missions is planned. The challenge is how to most effectively use the data we have. Climatologies from various missions look similar but there are differences – some real and some artefacts arising during processing. The goal is not to homogenize everything but rather to quantify the differences between missions. There will always be a problem with gaps in ocean-colour data sets (temporal, spatial and spectral). Other than having agencies try to ensure that they have new missions ready to go to provide overlap (an unlikely scenario), there is very little that can be done to provide for the new, "overlapping" data streams. Furthermore, the ocean-colour time series is built from a heterogeneous set of instruments. Until each agency agrees to have a minimal set of common bands, we will not be able to construct a homogeneous dataset. The challenge is to understand how best to utilise the data we have and to try and make the inter-comparisons of the various data sets more credible. Can long *in situ* time series (and models) help bridge the gaps and assess the differences?

Paula Bontempi pointed out that IOCCG Reports 1 and 13 had been written to agree on a common band set. The challenge now is implementation. Shubha Sathyendranath pointed out that the ocean-colour community has never had an operational ocean-colour sensor, although operational applications are being discussed. With Sentinel-3 we are now at a cross road. With the ESA plans to maintain successors, we will have a continuously-maintained standard in space, which can then be used as a baseline, which is very important and something that the SST community has had for a long time. As things evolve the minimum requirements will also evolve. Jim Yoder pointed out that as products mature and inversions independent of bands are used, we might not have a need for common bands. A wider issue, however, is how can agencies collectively address problems such as ECV's, and how do we push these ideas forward? The IOCS meeting is a good start and the splinter sessions should come up with clear recommendations.

There are a number of other issues behind gap filling. Free and open access to data in a user friendly way is absolutely critical. All future missions need to have a commitment that the data will be open and freely available, along with processing software, knowledge of how the data are processed, the ability to reproduce the data, and some estimate of uncertainties. Stewart Bernard noted that the dynamic aspect of gaps should be appreciated as it allows users to assess the effects of different sensors dropping in and out of orbit.

6.2 Utilizing the Giovanni System for the Distribution of Sentinel-3 OLCI Data

James Acker gave a brief review of the easy-to-use Giovanni data system, which hosts data from numerous ocean-colour missions and models. Giovanni can be used to compare data from different missions using a variety of tools: time-series, averages, area plots, interactive scatter plots and animations, and has broadened the use of ocean-colour data in general. Giovanni represents one interface for different types of data and is NetCDF compliant. There are a number of reasons to add Sentinel-3 OLCI data to Giovanni including expanded usage and visibility of the data, simplifying access to the data and enabling multi-disciplinary use of OLCI data with other data products (CO_2, precipitation). Giovanni operates on Level-3 (global gridded data) but ESA does not have current plans to produce Level-3 OLCI data. There are currently four options to getting OLCI Level-3 data, all of which require funding: i) ESA evolves ODESA/BEAM software to create Level-3 OLCI data products, or modifies SeaDAS for this purpose, ii) ESA provides Level-2 OLCI data to the NASA OBPG, which would utilize their existing data processing capability to create Level-3 OLCI data products, iii) ESA provides Level-2 OLCI data directly to the GES DISC or, iv) ESA selects and funds a contractor/investigator to produce OLCI Level-3 data products compatible with Giovanni.

It was agreed that IOCCG could officially advocate for the addition of Sentinel-3 OLCI data to Giovanni. Peter Regner suggested that another option would be for ESA's CCI program to explore the Giovanni system to gauge its usefulness and to give ESA a way to promote it.

ACTION 18/4: IOCCG TO WRITE A LETTER TO ESA ADVOCATING FOR THE ADDITION OF SENTINEL-3 OLCI DATA TO GIOVANNI.

6.3 How do Global Ocean Modelling Studies use Ocean-Colour Data?

Stephanie Dutkiewicz carried out a survey of journal articles to examine how ocean physical, biogeochemical and ecosystem numerical modelling studies were using ocean-colour data, and what products were being used. Most studies use chlorophyll (85%) and primary production (40%) and most used data from SeaWiFS (85%). All studies used Level-3 gridded data. The majority of studies used OC data for evaluation i.e. for validating output (such as Chl or Primary Production) from the model. Models can also provide information about ocean-colour products or inferences, for example, the impact of missing data on the calculation of phytoplankton phenology metrics, or the requirements of continuity. Models show that, in order to detect a trend, we require a time series of at least 40 years.

Numerical models do not just use ocean colour data, but rather a whole suite of data. The variance and bias of a model can be tested, but the use of error estimates will likely alter these metrics. A subset of models in the IPCC Assessment Report 5 now has an ocean carbon component, because of the large uncertainty in feedbacks in the carbon system in CMIP4 experiments. ECVs have been compiled in part for model evaluation. Reasonable estimates of OC product uncertainties are thus required to evaluate models. Better documentation of other products might encourage modellers to use other ocean-colour data apart from just chlorophyll and primary production.

6.4 Australian Ocean Colour Community Activities

Nick Hardman-Mountford provided a brief overview of ocean-colour related research in Australia. They are developing a community of practise around three spheres: CSIRO Earth Observation Informatics TCP program, TERN (Terrestrial Ecosystem Research Network) and IMOS (Integrated Marine Observing System). The CSIRO Earth Observation Informatics TCP (Transformational Capability Platform) directed by Arnold Dekker is an umbrella for promoting and coordinating EO activities across CSIRO. Initial activities included obtaining funds to contribute towards IOCCG activities, the phytoplankton algorithm database project, and coordinating the Australian Sentinel-3 validation team proposal to ESA. The Lucinda Jetty Coastal Observatory is used as part of IMOS to provide reliable data streams for calibration and validation of satellite ocean-colour products in coastal waters. Two complementary data streams are acquired: above-water radiometry and in-water measurements of the optical properties. In addition, two spectroradiometers have been installed on research vessels. The CSIRO Marine Carbon Biogeochemistry Cluster evaluates organic and inorganic carbon stocks, nutrient stoichiometry, characterises isotopic carbon signatures and derives rates of accumulation. A variety of research topics are being addressed by Australian ocean colour scientists.

6.5 Oceans and Society: Blue Planet

Shubha Sathyendranath reported on the GEO Blue Planet initiative, which has been supported by CSA. GEO is structured around nine Societal Benefit Areas (SBA's) but there is no SBA for oceans so the visibility of the oceans is low, even though oceans are present in almost all SBA's. The Blue Planet initiative is working to bring together the oceans community under a single umbrella. The Blue Planet task is broken down into four components led by four central players: CEOS (for space), POGO (*in situ*) GOOS (sustained observations of oceans) and GODAE (for modelling). Each of these organizations in turn reaches a vast network of existing observing system elements and programmes, governance bodies and data management systems (e.g. IOCCG through CEOS). Blue Planet brings together a wide and diverse community of governmental and academic researchers, and provides new platforms for integration of multiple streams of data into products that provide real value to users (e.g. sustainable fisheries). The first Blue Planet Symposium took place in Brazil in November 2012 and brought together over 70 ocean community experts representing 24 countries and/or organisations. The symposium resolved to: establish further synergies between the various Task components, develop a White Paper to elaborate contributions of various programs and elements, and publish the key contributions from the symposium. Specific items that could be targeted within IOCCG include integrating in a more complete fashion *in situ* and satellite observations to place ocean colour on a broader platform and to enhance applications for SBA's.

6.6 Inland and Coastal Remote Sensing Activities

Steve Greb gave a brief report on inland and coastal remote sensing activities in the U.S. and globally. The goal of the "Global Water Quality Products and Services" component of the GEO Inland and Coastal Water Quality WG is to integrate *in situ* and remote sensing water quality data. A workshop on Remote

Sensing of Near-Coastal and Inland Waters was held in Wisconsin with support from NASA. Science recommendations from the WS include establishing a unified optical data repository, establishing standard measurements for *in situ* campaigns, and establishing a professional identity to include freshwater and coastal areas, for better cross project and cross-national harmony. The group is also interested in establishing an IOCCG WG to address remote sensing of water quality. A number of related projects were mentioned including Diversity of Inland Waters (funded by ESA), Global Lakes Sentinel Services (GLaSS), GloboLakes (coordinated by Andrew Tyler, University of Stirling) and Global Lake Temperature Collaboration (GLTC - coordinator- John Lenters, University of Nebraska). In addition, a GEO Water Quality Webinar Series had been set up to discuss different topics every 2 months.

7.0 International Ocean Colour Science Meeting

7.1 Rationale and Overview of Arrangements for IOCS Meeting

David Antoine discussed the arrangements for the first International Ocean Colour Science meeting to take place in Darmstadt from 6-8 May 2013, coordinated by the scientific planning and organising committees. The meeting will be a mix of agency talks, a few keynote talks, poster sessions and 12 breakout splinter sessions discussing a range of topics. This is a working meeting, the goal of which is to have concrete outputs from the splinter sessions. It was agreed that the plenary session reports should be moved to the end of the poster sessions. Splinter chairs were requested to prepare a short report with specific recommendations and actions after the meeting. The success of splinter session depends on the keynote speakers addressing core issues, and making the link to some of the splinter sessions.

8.0 Capacity Building

8.1 Report on the IOCCG Summer Lecture Series

David Antoine reported on the recent Summer Lecture Series (2-14 July, 2012) which was attended by a group of 17 highly-motivated students (post-docs and young researchers from a range of backgrounds) selected from 106 applications. All the lectures were video recorded and are available on the IOCCG website along with the PowerPoint presentations. Many organisations provided support for the training course which was acknowledged. Tentative plans are to hold another training course in Villefranche in 2014 (or somewhere different) using the same formula with a similar budget. Feedback from the students indicated that two weeks was the right length for the course. Suggestions from the students for future training courses included having female lecturers, as well as having lectures on topics such as phytoplankton functional types.

There was some discussion regarding the possibility of merging, or having better coordination with the Ocean Optics Summer Course held at the University of Maine's Darling Marine Center. David would contact Emmanuel Boss to see if, scientifically, the two courses could be easily merged. The scope of the courses is different but they are nevertheless complementary.

8.2 Ocean Colour Wikipedia Entry

Nick Hardman-Mountford informed the Committee that he had posted Mark Dowell's material on "Ocean Colour" onto the Wikipedia site, and had added internal and external links. There is a lot of potential for this Wiki entry but volunteers are needed to post additional material e.g. from text books or IOCCG reports. Robert Frouin noted that it was a good first draft, but was aimed at the general public. He recommended that the ocean colour entry should be comprehensive but not exhaustive and should link as much as possible to other Wiki pages. The history of ocean colour could be a separate page. Emmanuel Boss had an excellent text book and could perhaps be persuaded to post some of that material. In addition links should be created to Gene Feldman's ocean colour material.

8.3 Request for Sponsorship of NOWPAP Training Course in China

The Chairman had received a request for funding for the 4th NOWPAP CEARAC training course on remote sensing data analysis, to be held at the Ocean University of China in Qingdao in fall 2013. The objective of the course is to contribute to capacity building of countries in the Northwest Pacific in utilizing remote sensing techniques for monitoring and assessment of the marine and coastal environment. They requested financial support from IOCCG for one lecturer and one trainee to attend the course. This request would be discussed during the Executive meeting.

8.4 Potential Applications of Ocean Colour in the Eastern Caribbean

Brian Whitehouse of OEA Technologies Inc. (Canada) is developing a marine monitoring and forecasting system for the six independent states of the Organization of Eastern Caribbean States (OECS). They would like help with using space borne remote sensing techniques, largely in relation to applications involving ocean colour and SST. OEA Technologies would like to recommend that the OECS host a workshop in late 2013, and invite a representative of the IOCCG to give a presentation on potential applications of ocean colour radiometry to coral reef and sea grass management. If successful, government agencies could be encouraged to commit to sponsoring a subsequent hands-on training course in the area. The IOCCG Committee recommended that Dr. Whitehouse engage with scientists in the area who have been doing ocean colour research in the Caribbean for some time. These include Roy Armstrong (Puerto Rico), Frank Muller-Karger (Univ. South Florida), Jorge E. Corredor (Univ. Miami), Paula Coble (Univ. South Florida) and Nic Hoepffner from the JRC (which has a mandate to conduct training in Africa-Caribbean-Pacific countries).

9.0 Any Other Business

9.1 Review Policy for IOCCG Reports

The Chairman addressed the issue of a review policy for IOCCG reports. Up to now, the draft reports are circulated within the Committee for an internal review. Should the IOCCG invite external reviewers for a more thorough review? Shubha Sathyendranath noted that IOCCG reports have an outstanding reputation in the community, and this reputation should be guarded jealously. The review process

should be rigorous, and if there are enough experts on the Committee who provide detailed reviews for specific topics, that should be sufficient to ensure quality. If there is no thorough review from members, a formal review should be sought outside of the Committee. Other approaches were also considered such as placing the draft reports on the website with an online form to itemize comments and asking the WG Chairs to send out separate chapters for independent review.

9.2 Issues Arising from IOCCG-18 Meeting

9.2.1 Ocean colour requirements: There was some discussion regarding the requirements in the GCOS Supplement: where do they come from and is there a good rationale behind these requirements? It is important to have good references with substance. Jim Yoder referenced a White Paper by Carol Johnson who provides an analysis on why certain accuracies are required.

ACTION 18/5: JIM YODER TO PROVIDE A COPY OF CAROL JOHNSON'S WHITE PAPER.

Gene Feldman also provided a table from Volume 3 of the SeaWiFS pre-launch Technical Memorandum Series (http://oceancolor.gsfc.nasa.gov/SeaWiFS/TECH_REPORTS/PreLPDF/PreLVol3.pdf) which shows the possible origin of the 5% radiance accuracy requirement. Jim Yoder noted that there are still some issues that are outside the reach of the Committee, but the perceived requirements should at least be documented. IOCCG Report 13 covers many of these issues e.g. the chapter on stability requirements and where they come from. Also, accuracy requirements from a user perspective are documented in tables in back of the report. Roland Doerffer pointed out that some of these issues are partly covered by the Uncertainty WG although they examine the entire system. The Chairman agreed that it was important to track the origin of these numbers. This issue could be introduced as one of the points for discussion at the upcoming IOCS meeting.

9.2.2 Issue of simulated data sets: Mark Dowell noted that a lot of people are making use of the simulated data sets from IOCCG working groups (e.g. from IOCCG Report 5). Is there an opportunity for a more dedicated activity defining the scope of these datasets? Nick Hardman-Mountford informed the Committee that there may be potential for publishing these datasets in the journal Earth System Science Data. Either through this process, or by publishing the data in online repositories such as Pangaea, allows each dataset to be assigned a DOI and becomes a citable source. It would be good to identify datasets that can be posted on the IOCCG website. Stewart Bernard was gearing up to post a dataset primarily for eutrophic waters.

9.2.3 Calibration task force: A final agreement for the framework for this initiative was not reached, although ESA recommended that vicarious adjustment be separated from instrument calibration, and that the activity be carried out under the CEOS umbrella. It was pointed out that the term "vicarious calibration" could confuse outsiders since it is used in many different ways in the literature. The most appropriate terminology for satellite ocean colour vicarious calibration is "system vicarious calibration". Recent terminology such as "vicarious adjustment calibration" may be misleading. Ewa Kwiatkowska pointed out that within the (instrument) calibration task force there will be expertise for vicarious calibration as well. It was stressed that the establishment of the task force is the first concrete activity

coming from the recommendations in the INISTU-OCR White Paper. Traceability to that document should be maintained and the task force should be run by agencies contributing to the White Paper i.e. an Agency, bottoms-up approach. The Chairman noted that this subject was still open and could be addressed at the IOCS meeting and through email correspondence after the meeting. Once an agreement has been reached, the task force could start to be implemented.

9.2.4. Data from Sentinel-3: Stewart Bernard raised the issue of how to deal with the very large datasets that will come out of Sentinal-3. The current structure for using data is not good enough and new tools need to be developed to help the community use these new, very large datasets. Gene Feldman suggested that the IOCCG make a recommendation to Agencies that support large ocean colour datasets to identify what tools and methods they have adopted to provide access to the data and make it more efficient for end-users. In addition Mark Dowell would suggest to CEOS that they use ocean colour as a case study, since they deal with data portals and data access across all agencies.

9.2.5 Water Quality WG: Steve Greb reiterated that the inland people were interested in forming an IOCCG WG to address remote sensing of water quality in near-coastal and inland waters. They would submit a proposal before the IOCCG-19 meeting.

10.0 Organisation and Membership

10.1 Rotation of Committee Members

The Chairman thanked the five committee members stepping down for their contributions and service to the Committee over the past three years (Stephen Greb, Stephanie Dutkiewicz, Joji Ishizaka, Dmitry Pozdnyakov and Tasuku Tanaka) and requested suggestions for new members.

10.2 Proposal to Host IOCCG-19 Committee Meeting in Cape Town (2014)

Stewart Bernard proposed hosting the IOCCG-19 meeting in Cape Town, which is a beautiful city with a rich cultural heritage and great food and wine. There is a strong history of South Africa's involvement in ocean colour and they also have a strong bio-optical group. The presence of IOCCG in Cape Town would be very constructive for the national ocean colour effort. Stewart presented two potential venues, both of which were about 45 minutes from the airport. He also hoped to hold an aligned workshop on bio-optics in eutrophic waters with a few invited speakers and about 20-30 participants. Possible dates could be discussed via email.

10.3 Proposals for Hosting IOCCG-20 Committee Meeting (2015)

At the last IOCCG meeting there was some discussion about NASA and NOAA potentially hosting the next IOCCG meeting in the USA. Paula Bontempi noted that Hawaii always comes up as a venue, as well as northern California and Santa Fe. Other suggestions could be distributed via Email.

10.4 Closing comments (D. Antoine)

The Chairman thanked all participants for attending the meeting, and expressed his appreciation to the hosts and organizers. He noted that it was a great pleasure to chair the group as well as the meeting itself.

Appendix I: LIST OF PARTICIPANTS

Québec City, Canada (5 - 7 February 2013)

Invited Participants		**Affiliation**
Acker, James	-	Wyle Information Systems/NASA GSFC, USA
Antoine, David (Chair)	-	LOV, Villefranche, France
Babin, Marcel	-	Université Laval, Canada
Bai, Yan	-	Second Institute of Oceanography, China
Bernard, Stewart	-	CSIR, South Africa
Bontempi, Paula	-	NASA HQ, USA
Briand, Paul	-	CSA, Canada
Crevier, Yves	-	CSA, Canada
DiGiacomo, Paul	-	NOAA, USA
Doerffer, Roland	-	Helmholtz Center Geesthacht, Germany
Dowell, Mark	-	Joint Research Centre, EU, Italy
Dutkiewicz, Stephanie	-	Massachusetts Institute of Technology, USA
Feldman, Gene	-	NASA GSFC, USA
Forget, Marie-Hélène	-	Université Laval, Québec, Canada
Frouin, Robert	-	Scripps Institution of Oceanography, USA
Greb, Steven	-	Wisconsin Department of Natural Resources, USA
Hardman-Mountford, Nick	-	CSIRO, Perth, Australia
He, Xianqiang	-	Second Institute of Oceanography, China
Kroupnik, Guennadi	-	CSA, Canada
Kwiatkowska, Ewa	-	EUMETSAT, EU, Germany
Lambin, Juliette	-	CNES, France
Mao, Zhihua	-	Second Institute of Oceanography, China
Murakami, Hiroshi	-	JAXA/EORC, Japan
Ott, Michael	-	Department of Fisheries and Oceans, Canada
Regner, Peter	-	ESA-ESRIN, Italy
Ryu, Joo-Hyung	-	KIOST, Korea
Sathyendranath, Shubha	-	Plymouth Marine Laboratory, UK
Stuart, Venetia	-	IOCCG Project Office, BIO, Canada
Yoder, James (Past-Chair)	-	Woods Hole Oceanographic Institution, USA
Zibordi, Giuseppe	-	Joint Research Centre, EU, Italy

Apologies		**Affiliation**
Ahn, Yu-Hwan	-	KIOST, Korea
Chauhan, Prakash	-	ISRO, India
Ishizaka, Joji	-	Nagoya University, Japan
Kampel, Milton	-	INPE, Brazil
Pozdnyakov, Dmitry	-	NIERSC, Russia
Platt, Trevor,	-	POGO, Plymouth Marine Laboratory, UK
Ruddick, Kevin	-	Belgian Institute of Natural Sciences, Belgium
Tanaka, Tasuku	-	Udyana University, Bali, Indonesia

Appendix II: LIST OF ACTIONS IOCCG-18 MEETING

Action	Brief description	Status
18/1	Giuseppe Zibordi to send detailed comments on system calibration to Robert Frouin by Email.	Closed
18/2	David Antoine to make a recommendation on the proposed new Calibration Task Force after collecting feedback from IOCCG Committee members	On-going
18/3	Gene Feldman to approach CONAE regarding potential IOCCG membership.	Closed
18/4	IOCCG to write a letter to ESA advocating for the addition of Sentinel-3 OLCI data to Giovanni.	Closed
18/5	Jim Yoder to provide a copy of Carol Johnson's White Paper.	Closed