IOCCG-19 Committee Meeting
Cape Town, South Africa, 28 – 30 January 2014

MINUTES

1.0 Welcome and Opening Session

1.1 Introductory remarks

The Chairman, David Antoine, opened the meeting and welcomed participants to the 19th IOCCG Committee meeting. He thanked Dr. Jane Olwoch of the South African National Space Agency (SANSA) for SANSA's support in co-hosting the meeting, along with the Council for Scientific and Industrial Research (CSIR) and the University of Cape Town, which were gratefully acknowledged. David Antoine welcomed the four new IOCCG members and invited a brief tour de table for participants to introduce themselves. The list of participants is provided as an Annex to the minutes.

1.2 CSIR welcoming addresses

On behalf of the CSIR, Stewart Bernard warmly welcomed participants to Simon's Town, home of the South Africa navy. He expressed his thanks to Emlyn Balarin and the other helpers from the University of Cape Town, for all their help with arrangements and logistics and wished everyone a fruitful meeting.

1.3 SANSA welcoming address

Dr. Olwoch added her welcome to Cape Town, the mother city, and thanked Stewart Bernard and the organizers for inviting SANSA to contribute to this meeting. She welcomed particularly the international visitors and hoped they would have time to enjoy the local cultures of the Rainbow Nation. The South African National Space Agency (SANSA) was formed in 2010 with a mandate to provide co-operation in space-related activities, to foster research in space science, to advance scientific engineering through human capital, and to support the creation of an environment conducive to industrial development in space technologies within the framework of national government policy. Three directorates report to a corporate office in Pretoria: Earth Observation, Space Operations and Space Science Directorates.

SANSA Space Science program hosts the space weather center, while the Space Operations center deals with antennae, telemetry, and has partnerships with CNES. The Earth Observation Directorate is primarily a data provider, with some application development in conjunction with CSIR. They have a very active student program and fund a student portal which provides access to data for flood monitoring, fire monitoring and growth of informal settlements etc. SANSA's main focus is to provide service to government departments and public entities. They appreciate the support and collaboration from the numerous remote sensing experts in the South African EO community. Dr. Olwoch thanked the international space agencies and institutions that have formed partnerships with SANSA including ESA, EUMETSAT, NASA, INPE, CNES, JRC and many others. Ocean colour research presents many

opportunities to advance remote sensing for many societal benefit applications, and SANSA would like to play a more active role, as dictated by the local scientists.

1.4 South Africa's first Earth observation satellite: EO-Sat1

Michel Verstraete gave a presentation on the proposed operational Earth observation satellite, EO-SAT1, which is currently in the design phase. The primary objective is to characterize the state and evolution of vegetation over selected land areas, which is also important for climate change studies, with a secondary objectives (to be confirmed) of surveying the built environment, monitoring water and air quality and supporting natural hazards and human disasters management. There were a number of constraints including limited human, financial and material resources as well as the large data volumes and processing needs.

Examples of deliverables from exploratory studies include agriculture applications (crop health and yield), forest and land cover, water and air quality, algal and bacterial occurrence, water turbidity, aerosol load, infrastructure, informal settlements, hazards and disasters. The design life of the instrument will be around 5 years, and it will have a spatial resolution of between 2.5 and 100 m. Instrument development should start in early 2014 and the ground segment will be developed in partnership with research institutions and universities.

1.5 Current research in South Africa: inland and coastal research

Stewart Bernard summarized the research being carried out by various institutions on large in-inland water bodies and in coastal waters, which often have problems with eutrophication. It is important to understand phytoplankton functional types when examining the phytoplankton contribution to inherent optical properties (IOPs). Modelling studies can be used to examine systematic variability in phytoplankton IOPs and the effects on the light field. A two-layered sphere model was developed to allow for IOP modelling of various eukaryotic and vacuole containing prokaryotic functional types, with cellular variations in size, pigment complement and density. Currently, maximum band ratio algorithms exhibit high ambiguity in the determination of biomass, size and non-algal constituents, particularly at low biomass (chlorophyll concentrations >10 mg m^{-3} are required).

For inland waters, a maximum peak height algorithm has been developed which bypasses aerosol correction and uses fluorescence/reflectance peak heights with TOA MERIS wavelengths to determine eutrophic water biomass and cyanobacterial abundance. A number of other algorithms were discussed including spectral classification algorithms, regional switching algorithms for mixed Case 1/Case 2 waters, provisional Chl-a algorithms using HICO data, and operational algorithms for characterisation of the trophic status of inland water resources, amongst others. On the operational side, MERIS and MODIS products have been processed and disseminated for areas around Africa as part of GEO-NetCast (VIIRS and Sentinel-3 products will be added). The OceanSAfrica operational oceanography initiative is making data (including modelled data) available to end users throughout southern Africa.

1.6 Current research in South Africa: Southern Ocean research

Sandy Thomalla gave a presentation on South African bio-optics research in the Southern Ocean, aimed at understanding the sensitivities of the response of the Southern Ocean carbon cycle to climate forcing. Bio-optical research focuses on parameterising key optical properties of the phytoplankton population

(size, carbon content, community structure), and developing and validating regional ocean-colour algorithms to provide synoptic information on phytoplankton functional types and physiology. Ocean-colour remote sensing can be used to characterise the seasonal cycle and assess the biogeochemical response of the phytoplankton community to physical drivers, together with various *in situ* IOP and AOP measurements. The IOPs, in conjunction with satellite data and data from autonomous platforms (e.g. gliders and Bio-Argo floats), can be used to explore the distribution of particulate organic carbon, phytoplankton community structure and physiology in the Southern Ocean.

1.7 Adoption of IOCCG-19 agenda

The IOCCG-19 agenda was adopted by consensus with no modifications.

1.8 Adoption of the minutes from IOCCG-18 and status of actions (D. Antoine, V. Stuart)

The minutes of IOCCG-18 were approved by consensus. The Chairman summarised the status of action items from the 18th Committee meeting, most of which had either been completed, or would be addressed further during the meeting.

Action 18/1: Giuseppe Zibordi had submitted detailed comments on the Calibration Report to Robert Frouin. The comments were helpful and appreciated and the report has since been finalized.
Action 18/2: The framework under which the proposed Calibration Task Force should be developed will be discussed further under Agenda item 5.5.
Action 18/3: Gene Feldman had been in contact with CONAE regarding their involvement with IOCCG initiatives - IOCCG will keep in contact with CONAE in the future.
Action 18/4: A letter was written to ESA advocating for the addition of Sentinel-3 OLCI data to Giovanni, and a positive response had been received.
Action 18/5: Jim Yoder provided a copy of Carol Johnson's White Paper to IOCCG Committee members.

2.0 Status of IOCCG Working Groups

2.1 Uncertainties in ocean colour remote sensing

Roland Doerffer updated the Committee on the status of the working group on Uncertainties in Ocean Colour Remote Sensing, which was established in October 2011. The report was progressing slower than expected, since the calculation of uncertainties is a new field. The terms of reference and membership were reviewed, as well as the content of the proposed report. A draft version of the introduction has been completed, plus a chapter on sources of uncertainty. The remaining chapters still need to be written, each of which will be led by a different author. A meeting may be held in May 2014 to discuss progress, and a complete draft of the report is expected by Autumn 2014. Experimental uncertainty products will be included in the MERIS 4th reprocessing, which should start in 2015. Dr. Doerffer introduced the best practice protocols for defining Case-2 regional algorithms in the CoastColour project as well as the GEO Blue Planet initiative, for which he had created a movie demonstrating ocean-colour applications.

David Antoine noted that there was a very comprehensive list of topics to be addressed in the report, and he suggested that a statement be included at beginning of report outlining the level of detail for each topic. Milton Kampel pointed out that cross-calibration is important to determine uncertainties in general, and Ewa Kwiatkowska noted that, from S-3 experience, the quantification of reliable L1B uncertainties on TOA calibrated radiances had been the most difficult. It was recommended that algorithm providers should distribute uncertainties.

2.2 Atmospheric corrections in coastal waters

Cédric Jamet outlined the rationale for the new IOCCG working group (WG) on atmospheric correction over turbid coastal waters, which are more challenging than open ocean waters (high temporal and spatial variability, adjacency effects, non-maritime aerosols and high suspended sediments and CDOM). The WG would not address inland and freshwater systems or bottom effects (out of scope of this report). The reason for forming a new WG was that IOCCG Report 10, edited by Menghua Wang, focussed only on open ocean waters and used standard atmospheric correction algorithms for SeaWiFS, MODIS and POLDER. Algorithms for SeaWiFS and MODIS have since been improved, and there is also a need to update coastal atmospheric correction algorithms.

Many different approaches have been developed over the past 14 years, some of which have been implemented in SeaDAS or BEAM. The goal is to select algorithms with very different hypotheses and conduct a round-robin exercise to understand the limitations of each algorithm and the range of validity. Sensitivity studies will be performed using simulated and *in-situ* datasets. Ideally all the algorithms will be implemented in SeaDAS using the same framework (one sensor). The challenge is to understand the advantages and limitations of each algorithm and their performance under certain atmospheric and oceanic conditions. Only atmospheric correction algorithms that deal with non-zero NIR water-leaving radiances will be considered. In addition, a discussion of the uncertainties budget will be undertaken. The end product will be an IOCCG report with recommendations for improving and selecting the optimal atmospheric correction algorithm over turbid waters. The first WG meeting was scheduled to take place at Ocean Optics in October 2014 but the Chairman recommended that a meeting take place earlier than that. Meeting costs will be included in the 2014 IOCCG budget.

Paula Bontempi recommended that the WG include a representative (perhaps Bo-Cai Gao) from the aerosol and cloud community, particularly for dealing with the coastal zones. It was noted that sun glint, aircraft corrections, optically shallow waters, and white caps/bubbles etc. would not be covered by the WG. Stewart Bernard pointed out that atmospheric correction in inland waters was another important issue that needed to be addressed (may be complemented by the water quality monitoring WG, Item 3.1). The approach of having all the algorithms in the same code was considered very valuable.

2.3 GEOHAB/IOCCG harmful algal bloom working group

Stewart Bernard reported on the combined GEOHAB/IOCCG working group, which had made substantial progress with the processing of satellite data for case studies and production of figures. There may be some divergence of opinion between the conclusions of this group, who have found that direct bio-optical identification of PFTs in coastal/inland waters is only possible in high biomass, Case 1 waters with very good atmospheric correction (apart from cyanobacteria), and that of the PFT WG, who may suggest otherwise. A first draft of the report should be available in 2-3 months. The aim of the WG is provide a resource that greatly improves communication between the ocean colour and harmful algal bloom scientific communities, and which also addresses the needs of non-specialists. The GEOHAB comparative ecosystem approach can provide a means of classifying ocean-colour techniques with regard to major organism type, impacts, geographical distribution, and ecosystem/ecological function. Several case studies will demonstrate the performance of both commonly available and emerging ocean colour techniques for specific bloom/ecosystem examples.

Likely conclusions are that poor atmospheric correction is a key issue: algorithms that bypass atmospheric correction (e.g. FLH, MPH, FAI) are thus very promising. The close clustering of narrow spectral bands from 620 – 750 nm is very important for HAB detection (e.g. MERIS/OLCI type bands). Dynamic switching and spectral classification algorithms potentially offer solutions across wide ranges of optical water types, while PFT algorithms appear only to work in high biomass areas (apart from cyanobacteria). Paula Bontempi noted that hyperspectral information collected in coastal zones might be really important and could help solve some of the problems.

2.4 Calibration of ocean colour sensors

The IOCCG Report on "In-flight Calibration of Satellite Ocean-Colour Sensors" was recently completed and it is now in print. The working group, chaired by Robert Frouin, reviews techniques for radiometric calibration of ocean-colour sensors while they operate in orbit and provides recommendations on how to meet calibration requirements for science applications during mission lifetime. For current ocean-colour missions, available techniques have not been fully exploited by space agencies - some of the recommendations still need to be implemented. The final report provides a good guide for future missions.

2.5 Phytoplankton functional types

Venetia Stuart reported on the phytoplankton functional types (PFT) working group, chaired by Shubha Sathyendranath, which was nearing completion. Three of the six chapters have been reviewed and edited, and complete author-reviewed drafts are available for the remaining chapters. Only the concluding remarks chapter remains to be written. The was some overlap with the HABs working group, but only a few cases, so no major conflicts. It was recommended that the limitations to the various approaches be clearly stated in the report, pointing out that this is an emerging field, with no definitive perspective.

2.6 Ocean colour remote sensing in Polar Seas

Marie-Hélène Forget gave a presentation on behalf of Marcel Babin, chair of the working group on ocean-colour remote sensing in Polar Seas. The goal of the working group is to determine the impact of climate change on polar ecosystems using remote sensing, by addressing the various problems and limitations. The report will include a review of the literature, an assessment of various algorithms and products, and will also provide a number of recommendations. The final draft version of the report will be ready within the next few months. The group planned to publish a synthesis of the report in *Oceanography*, because there is a lot of new material, although copyright issues were of concern to committee members. Paula Bontempi recommended publishing a short summary in *EOS*, and publishing the IOCCG Report before publishing the synthesis document. A database has been assembled from different sources (Arctic and Antarctic) to test the different algorithms. Paula Bontempi alerted the group to the publication of two synthesis volumes from the ICESCAPE mission, led by Kevin Arrigo, which may or may not contradict the draft Polar Seas report. Furthermore, NASA funded a synthesis of various primary production models in the Arctic Ocean (Matrai et al., 2013, Prog. Oceanogr.), which should be taken into account in the report, as well as a large Arctic field campaign, which will be published in Deep Sea Research later this year. The WG was urged to ensure that there were no contradictions with these studies, and were also advised to refer to the primary production ocean-colour round-robin study, carried out by Mary-Elena Carr et al. (2006). The final draft of the report should be ready by the end of March 2014.

2.7 Intercomparison of retrieval algorithms for coastal waters

This working group, chaired by Kevin Ruddick, had met briefly in Darmstadt at the IOCS meeting. There were some obstacles with the development of an *in situ* dataset, so it was recommended that a decision be made on the way forward after consultation with the working group chair.

ACTION 19/1: *Chairman to contact Kevin Ruddick regarding the status of the working group on "Intercomparison of retrieval algorithms for coastal waters".*

3.0 Proposals for New IOCCG Working Groups

3.1 Earth observations in support of global water quality monitoring

Paul DiGiacomo presented a proposal for a new IOCCG working group on Earth Observations (EO) in support of global water quality monitoring. Declining water quality has become a global issue of significant concern and there is an opportunity for satellite observations to examine various optical properties of inland and coastal waters. This proposed working group seeks to build a stronger linkage between the water resources management end-users and data providers, to fully realize current and future EO products. The goal and vision of the group are to provide a strategic plan for incorporation of current and future EO information into national and international near-coastal and inland water quality

monitoring efforts, to promote best practices, coordination of efforts and partnerships, and ultimately to work toward implementation of a global water quality monitoring service under the auspices of GEO.

The Terms of Reference are to assess the use of remote sensing data for coastal and inland water quality, to identify user needs and requirements, assess existing space-based and *in situ* observing capabilities, identify supporting research and development activities and user engagement/outreach. Members of the group have already been identified but they would also like to include an end-user. The first meeting will probably take place in Washington, DC in summer 2014 to finalize the scope and structure of the report and initiate writing assignments. Direct linkages exist with GEO/GEOSS and especially the Blue Planet Task, and the WG would complement the work of previous IOCCG WGs. The final report from this working group could also be a deliverable for the CEOS OCR-VC. Resources were requested from IOCCG for travel for ~15 people. NOAA agreed to cover the expenses of the printing and distribution of the final report.

Roland Doerffer mentioned that, in terms of water quality, only a few variables could be obtained from remote sensing, and suggested that the WG should clearly state that satellite remote sensing is not an ideal tool to determine water quality. Andrew Tyler pointed out that remote sensing was good for high-resolution chlorophyll data but not for chemical data (e.g. nutrients), although these were not required at high spatial resolution. It was recommended that different communities, such as hydrologists and land cover experts, be included in the WG - Paul DiGiacomo agreed to leverage that expertise. Stewart Bernard noted that there is a wide range of activities, including technical challenges, which should be fully addressed by the group.

3.2 Discussion: Do we need a new working group on ocean colour and coral reefs?

David Antoine enquired whether there was any support for a new WG on ocean colour and coral reefs, and anyone willing to submit a proposal and lead a WG. The Committee recommended that benthic habitat mapping should be conducted first. Heidi Dierssen pointed out that most of the research is currently done with aircraft, since the satellite pixel size is too large for many habitats. Landsat has a higher spatial resolution and could be used to map the distribution of coral reefs. Gene Feldman suggested that before creating a new WG, it was necessary to create an inventory of what work is being done currently, including limitations. SeaWiFS had been used in the past to identify the location of coral reefs. Steve Ackleson noted that it was also necessary to define requirements for in-water measurements (e.g. spectral reflectance of the sea floor). Nick Hardman-Mountford reported that in Australia, work is being carried out on merging MODIS and Landsat data, using the spectral resolution from MODIS and high spatial resolution from Landsat. It was agreed that hyperspectral, high spatial resolution sensors are the right direction. Gene Feldman suggested that the IOCCG could put out a request to the community to prepare an inventory of what has been done, and what can be addressed using ocean-colour remote sensing, perhaps providing some form of compensation from IOCCG, although the Chairman was not sure this was the right direction for IOCCG. Stewart Bernard noted that the IOCCG could play an important role in the repurposing of sensors such as Sentinel-2 or Landsat, the primary missions of which are not water, but they can be used for water applications. In summary, there

is some interest in forming such a working group, but this initiative might be wider in scope than just coral reefs. Nick Hardman-Mountford agreed to talk to colleagues in Australia who might be interested in a preliminary scoping exercise to see how to proceed further in practise.

ACTION 19/2: *Nick Hardman-Mountford to talk to colleagues regarding a preliminary scoping of current coral reef research using ocean colour remote sensing.*

4.0 International Ocean Colour Science Meeting

4.1 Report on first IOCS meeting

David Antoine briefly recapped the rationale, structure and outcomes of the successful first International Ocean Colour Science Meeting (Darmstadt, May 2013), sponsored by EUMETSAT, NASA, CNES and ESA. The meeting attracted ~230 participants, both space agency representatives as well as research scientists, and included a number of invited keynote talks as well as breakout splinter sessions. A final report has been circulated and the feedback from the meeting was excellent. It was suggested that a short report also be written up in *EOS* after the next IOCS meeting, highlighting the international participation and conclusions. One of the recommendations from the meeting was for follow-on workshops (see below).

4.2 Report on follow-on IOCS workshop: Vicarious Calibration

Ewa Kwiatkowska reported on a recent follow-on workshop, which realized the recommendations from the IOCS splinter session on System Vicarious Calibration (SVC). The workshop had a direct link to recommendations from the INSITU-OCR White Paper as well as IOCCG Report #13. System vicarious calibration is an integral part of ocean-colour Earth observation programs, and is essential to meet the accuracy requirements of ocean-colour missions. International coordination and cooperation is essential and standardisation is critical. The goals of the workshop were to achieve a consensus on requirements for SVC *in situ* data, infrastructure and methodologies, to agree on SVC standardization, and to advance the vision for the future. A summary report and presentations are available on the IOCCG website. Recommendations and actions from the WS include (i) the need for multiple *in situ* measurement sites supporting SVC, (ii) standardization of uncertainty estimates for *in situ* measurements supporting SVC, (iii) establishment of an inventory of *in situ* measurements, in particular, access to Kavaratti buoy data administered by ISRO (KIOST were thanked, for their open data policy), (v) harmonisation of protocols for SVC gain derivation, (vi) recommendation for SVC during early phases of a mission for operational services and (vii) recommendation to evaluate the impact of using oceanic regions located in the northern hemisphere for SVC in the NIR. Peter Regner thanked Ewa for conducting the successful workshop at ESRIN, which produced an accurate and concrete list of actions and recommendations. In addition, the need for redundancy of *in situ* measurement sites should be emphasized, and the location of such sites should be discussed further.

4.3 Proposed IOCS follow-on workshop: PFT workshop

Taka Hirata reviewed the proposal for a workshop on Phytoplankton Composition from Space. Much work has been done regarding phytoplankton functional types (PFT) algorithm development and intercomparison, as well as algorithm evaluation and validation. No consensus had been reached as to how to represent phytoplankton groups using *in situ* measurements. The goal of the proposed workshop is to obtain consensus on the quality of current global PFT products and the representativeness of *in situ* measurements. Furthermore they would like to provide a roadmap to operationalize satellite PFT products and examine avenues for product intercomparisons and new product development. A two-day workshop was planned, either at Ocean Optics 2014 (Portland, ME, October 2014), or at the end of 2014 in Bremen or Dubai. The Chairman noted that the relationship of this activity with the current PFT working group was unclear, and he suggested that the objectives should be clarified, as well as any complementarity or redundancy. Stephanie Dutkiewicz pointed out that *in situ* validation is crucial, but was not covered in the current PFT report. The general consensus was that if the emphasis of the workshop was on validation and standardisation of protocols, as well as determining the best conditions to characterise certain water types, then the workshop could be supported.

ACTION 19/3: *Taka Hirata to work with Astrid Bracher in revising the PFT workshop proposal, taking into account the IOCCG Committee's recommendations.*

4.4 Proposed IOCS follow-on workshop: Protocols for In Situ Observations

Steve Ackleson reported on the proposed workshop to coordinate and update ocean optics protocols for deriving properties from IOPs. This coordination activity builds on the IOCS meeting and will take place the weekend before the Ocean Optics conference (October 2014). Parameter-specific discussion leads have already been identified, and the goal is to develop detailed roadmaps for the way forward, establish timelines, identify funding sources and develop a communications plan so that the protocols are accepted by the international community. The NOAA QARDTOD (Quality Assurance of Real Time Ocean Data) project will lead an activity, and Australia's Integrated Marine Observing System (IMOS) will also be represented. The leads will be responsible for updating the NASA and other community accepted protocols. Standardisation is a key discussion and the use of appropriate standards for IOPs will be addressed. Stewart Bernard reiterated the importance of reporting errors for all measurements and also pointed out that there are no turbid water protocols. Roland Doerffer noted that ancillary data (metadata) has a large impact on data quality, and currently there is no way to report this. It was also mentioned that parameter-specific protocols are instrument dependant, and new instrumentation may have to be developed. Peter Regner advised the Committee that this protocols initiative is strongly supported by ESA/ESRIN.

4.5 Ideas to coordinate *in situ* measurement protocols

The IOCCG Committee discussed a proposal by Jeremy Werdell (NASA) related to the coordination and revision of *in situ* measurement protocols. Currently, these activities are uncoordinated and there are missed funding opportunities. Dr. Werdell proposed the formation of a small IOCCG Task Force to track measurement protocol activities within the international ocean-colour community and to catalogue and share relevant information in this regard. Members would be representatives of funding agencies with broad perspectives on ocean-colour community needs and knowledge of their agencies' goals and opportunities. The group could meet via telephone conferences to examine what has been done with respect to protocol revisions and funding opportunities, and the IOCCG could host a web site to disseminate all relevant lists, protocol revisions and information. This would enable international communication about the refinement of *in situ* measurement protocols, reducing redundancy in efforts. Jeremy Werdell had offered to lead or contribute to this activity. Andrew Tyler recommended that this group should also engage with the lakes community. The IOCCG Committee responded very positively to the proposal, which represents a dynamic, living activity - a perfect function for the IOCCG. Jeremy would be encouraged to lead and move forward with this initiative.

ACTION 19/4: *Chairman to contact Jeremy Werdell to encourage him to move forward with the in situ measurement protocols co-ordination activity.*

4.6 Ideas for 2nd IOCS meeting, USA

The same overall structure would be retained for the next IOCS meeting, with perhaps a reduced number of parallel splinter sessions (from 4 to 3 parallel sessions), although others recommended having enough parallel sessions to deal with all the proposed topics at the time, or extending the meeting to 4 days. This will be discussed closer to the meeting. The next IOCS meeting should take place in May 2015, probably on the west coast of USA (San Francisco or Seattle), although this was open for discussion. Suggestions for topics and keynote speakers were also welcome.

5.0 Contribution to CEOS OCR-VC Activities

5.1 Implementation of the CEOS OCR-VC, including ToR

Paula Bontempi reported on the current status of the CEOS Ocean Colour Radiometry - Virtual Constellation (OCR-VC) and reviewed recent achievements and outcomes. Each agency supports some aspect of this virtual constellation. One of the main issues is ensuring free, open and timely sharing of all current and future OCR data. Near-future plans include facilitating agency follow up to recommendations from IOCCG Report #13, implementation of the INSITU-OCR (International Network for Sensor Inter-comparison and Uncertainty assessment for Ocean Color Radiometry), including the proposed establishment of a multi-agency Project Office, and implementing linkages with relevant components of the GEO Blue Planet Task, including ECVs, ChloroGIN, GODAE-OceanView, Coastal Services, Future Earth, etc. Other plans include establishment of an OCR Calibration Task Force and

progressing on specific technical and programmatic actions from the IOCS meeting. Many of these elements are also scheduled activities in the revised Terms of Reference. IOCCG Committee members again raised the issue of free and open access to Level-1A data, which is very important, as well as calibration and validation of OCR data.

5.2 Task force on ECV assessment

James Yoder reported on the IOCCG Essential Climate Variable (ECV) Task Force. The group had met twice, and interacted via email, to discuss how to produce basin to global scale ECV/CDR time series of ocean-colour products (specifically L_w and derived products) that are consistent and well-calibrated, and useful for climate-related studies. Many groups are currently producing ocean-colour time series including NASA-GSFC (L_w and Chl time series involving multiple sensors), the NASA-funded MEaSUREs Project (they use the GSM model to calculate IOPs), ESA's GLOBColour Project (they also use GSM model to produce a time series of merged data) and ESA's CCI Program. A modelling study by Henson and Wang have shown that mean trends in Chl are of the order ~ 0.1-0.5% per decade, suggesting that the GCOS Chl stability target (3% per annum) may not be adequate to resolve decadal trends in Chl. 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.

Within the last few months ESA's CCI project has released merged and biased corrected MERIS, MODIS and SeaWiFS data with associated per-pixel uncertainty information. Templates are also available to map ocean-colour data from standard grids onto Longhurst provinces to calculate uncertainties. The band-shifting software package used by CCI to help deal with the issue of wavelength differences among sensors is also available. Bryan Franz (NASA GSFC) will start comparing CCI products (merged time series of OC radiances) with standard NASA OC3/OC4 products and identify opportunities for further improvement. Stephanie Henson is analyzing the time series of CCI derived products for trends, as well as interannual changes in phenology, and Fred Melin is comparing the CCI Chl time series with mission-specific products (MODIS, SeaWiFS, MERIS) and merged ones (MEaSUREs, GlobColour). After evaluating the new CCI products, the ECV task team may be able to produce a set of recommendations for improvements, which CCI or NASA could potentially implement to produce a new data set for the Task Team to evaluate. The different groups should hopefully converge on a cooperative approach for the implementation, evaluation, and improvement cycle. Dr. Yoder indicated that it might be beneficial to appoint a new Co-Chair for the IOCCG ECV Task Team who is involved in the actual processing and analyses. The Committee agreed that interaction with GCOS was necessary to understand how to propose different requirements.

ACTION 19/5: *Mark Dowell to initiate liaison with GCOS regarding requirements for the ocean colour ECV.*

ACTION 19/6: *Jim Yoder and Nic Hoepffner to discuss potential candidates for a new ECV Task Force Chair.*

5.3 Achievements in the first 3 years of ESA's OC Climate Change Initiative

Frédéric Mélin reported on the current status of ESA's Ocean Colour Climate Change Initiative (CCI). This is a project partnership with the Plymouth Marine Laboratory as the main partner. The first public release of the entire dataset (standard ocean-colour variables) took place in December 2013. The processing chain includes atmospheric correction using best algorithms from round-robin comparison (POLYMER selected) and band-shifting, bias correction, merging and production of ocean products using best algorithms from round-robin comparisons (many different algorithms tested). One validation database (including Chl-a, K_d, IOPs and R_{RS}) was compiled from existing AERONET-OC, BOUSSOLE, HOT, MERMAID, NOMAD, SeaBASS databases. Another important application of an *in situ* database is to define uncertainty maps for each optical water type (uncertainty estimates computed for each pixel, can be compared with GCOS estimates). CCI products can be compared with other single-mission products or merged products (e.g. MEaSUREs, GlobColour). Linear trends can be compared, and CCI data products can also be assimilated into marine ecosystem models.

Phase 2 of CCI will start soon and will run for another 3 years, analysing the V1 dataset, conducting new round-robins with an extended *in situ* data base and placing more emphasis on inter-mission consistency and the analysis of additional missions. Jim Yoder pointed out that uncertainty is a measure of accuracy if *in situ* data are taken as "truth", although this is far from the case as there are several sources of error (instruments, human error etc.). In this respect, the satellite record is potentially much more stable.

5.4 Copernicus regulation

Ewa Kwiatkowska reported on the new Copernicus regulations concerning the satellite data policy, on behalf of Mark Dowell. The new regulation will repeal existing GMES regulations and will enter into force in mid-2014. This policy promotes the access, use and sharing of Copernicus information and data on a free, full and open basis. There will be no restrictions on use or users, and it can be used for commercial and non-commercial purposes. This data policy applies to data and information generated inside Copernicus, including the Sentinel mission data, but does not apply to *in situ* data, which are dependent on data providers.

Michel Verstraete mentioned that it was important to look at the fine print since data providers are limited as to what they can provide. There was consensus that a consolidated recommendation should be submitted to the EC from IOCCG regarding free and open access to Level-1A data. Ewa was tasked with identifying where such a recommendation should go.

ACTION 19/7: *Ewa Kwiatkowska to identify where a letter of recommendation from IOCCG to the EC regarding Copernicus data policy should be directed.*

ACTION 19/8: *IOCCG Executive Committee to help draft letter of recommendation from IOCCG to the EC regarding Copernicus data policy.*

5.5 Proposed task force on satellite sensor calibration

Ewa Kwiatkowska briefed the Committee on the status of the proposed permanent inter-Agency task force on satellite sensor calibration, submitted at the IOCCG meeting last year. The motivation for the proposal came from one of the recommendations from INSITU-OCR White Paper, to create a framework for collaboration on satellite sensor calibration among Space Agencies engaged in the OCR-VC initiative. The goal is to maximize the accuracy and temporal and spatial stability of OCR data records by providing expert knowledge on calibration and characterization issues. The group will have close interaction with the extended ocean-colour community and will communicate via telecons and community meetings. The Task force has not been initiated officially but the group has met opportunistically on various occasions. The group plan to meet at the next S-3 Validation Team meeting (Oct /Nov 2014) and will have another splinter session at the next IOCS meeting (Spring 2015).

A proposal for the affiliation is a joint IOCCG and CEOS OCR-VC activity (it should be an activity recognized by CEOS WGCV IVOS). The scope of the Task Force includes ocean-colour satellite instrument calibration and characterization, but not system vicarious calibration. Gerhard Meister (NASA GSFC) was proposed as a Chair for the Task Force.

It was recommended that system vicarious calibration efforts should be continued, and that meetings could be organised side by side. There was already one member of the calibration task force in the system vicarious calibration group. There was consensus that the new Task Force on satellite sensor calibration should move forward and establish Terms of Reference and an annual work plan. Peter Regner informed the Committee that ESA could contribute to this specific group.

ACTION 19/9: *Ewa Kwiatkowska to move forward with the satellite sensor calibration task force, and establish Terms of Reference, in conjunction with other members of the group.*

5.6 Discussion: Forming an inter-agency INSITU-OCR Project Office

Giuseppe Zibordi led a discussion on the formation of an INSITU-OCR Project Office, which would address a wide range of activities recommended in the INSITU-OCR White Paper (June 2012). There are a number of critical actions related to space sensor radiometric calibration, development and assessment of satellite products; *in situ* data generation and handling; and information management and support. The range and complexity of the activities required to address the recommendations cannot be supported by a single space agency, suggesting sharing activities and responsibilities among agencies. Inter-agency coordination could be implemented through two complementary components: a central coordination office with the main function of facilitating communication; and a series of dedicated hands-on working groups actively addressing specific issues or activities (e.g., space sensors calibration, protocols for *in situ* measurements, bio-optical modeling, data management).

Paula Bontempi gave a brief presentation on lessons learned from NASA's SIMBIOS program, highlighting what was done and providing suggestions for moving forward with the follow-on INSITU-

OCR. SIMBIOS had four goals (i) ensuring development of internally consistent research products and time series, (ii) developing methodologies for cross-calibration of satellite ocean-colour sensors, (iii) developing methodologies for merging data from multiple ocean-colour missions, and (iv) promoting cooperation between ocean-colour projects. SIMBIOS had a competed science team and a project office. Project staff activities included managing the SeaBASS dataset, support services, sun photometer instrument pool, calibration round-robins, data product validation, and cross-calibration and data merging. Lessons learned: high quality data are needed for both vicarious calibration and product validation. SIMBIOS deployed multiple instruments and collected continuous data over the oceans and was considered a success story in how to engage the ocean-colour community and tackle technical issues. Regarding actions for the proposed follow-on INSITU-OCR program, research announcements could be drafted and released together, agencies could target specific scientific problems of interest, supporting what is most relevant, and a centralized database like SeaBASS, could be established. NASA currently has a Field Program Support Office located at NASA GSFC. Their key tasks include protocol review and development, field data collection (validation & algorithm development) and quantifying field measurement uncertainties. The office is recompeted every 5 years, and could be re-written as the INSITU-OCR Project Office.

The Chairman encouraged other agencies to engage and contribute practically to this initiative. Peter Regner informed the Committee that ESA/ESRIN was willing to support a European component, which could coordinate activities in Europe and interface with the office in US, although there was no final conclusion about the mechanism. There was some concern about having two offices, although the consensus was that it could work by having planned activities to bring the groups together e.g. periodic science team meetings. Paul DiGiacomo was also concerned about a fragmented approach and stressed the importance of taking note of structures already in place (e.g. OCR-VC, Task Force on Instrument Calibration etc.) and understanding which components are being addressed though which avenues. Ewa Kwiatkowska informed the Committee that she did not have guidelines from EUMETSAT management although they were very supportive of the IOCS meeting and the follow-on workshops, and they would like to continue supporting those kinds of activities e.g. a permanent task force on instrument calibration.

Giuseppe Zibordi suggested that the first step would be for each agency to examine the recommendations from the White Paper to see which are relevant for their agency to address as a contribution towards the OCR-VC activity. All agencies have a large number of on-going activities that are relevant to INSITU-OCR. Paula Bontempi agreed that the INSITU-OCR White Paper represents a consensus document laying out a road map of activities that should be followed. NASA was willing to invest heavily in these types of inter-agency activities e.g. to expand SeaDAS to include modules for all sensors. Gene Feldman suggested that IOCCG issue a strong recommendation for all agencies to make their processing software available to the SeaDAS/BEAM consortium. All the recommendations from the White Paper should be put into an Excel sheet so that each agency could indicate which topics they could address, and gaps could be identified and targeted as a priority. Giuseppe Zibordi agreed to draft such a spreadsheet to map INSITU-OCR recommendations against current and planned activities of each space agency.

ACTION 19/10: *Giuseppe Zibordi to prepare an Excel spreadsheet for mapping current and planned activities of each space agency with INSITU-OCR recommendations.*

6.0 Agency Reports on New/Emerging Initiatives

6.1 ESA: Update on Sentinel-3 development

Peter Regner gave an update on the status of the Sentinel-3 mission, which was built by ESA under the Copernicus program. Sentinel-3 is not just an ocean-colour mission but also includes the Sea & Land Surface Temperature Radiometer (SLSTR) and a Topography package. The mission consists of two satellites in orbit for spatial coverage, allowing the whole planet to be covered every 2 days. Data will be available within 3 h of acquisition. Test campaigns reveal a good overall level of compliance to the performance requirements, and similar or better performances than MERIS. The development status for both S-3A and S-3B satellites is quite advanced but the date for readiness for launch is driven by the SLSTR instrument which still has major issues with various components. The earliest launch date is the end of June 2015.

OLCI will produce a similar product suite to MERIS, with systematic processing of all OLCI data at 300 m and 1200 m. Uncertainty estimates will also be provided on a per pixel basis for all products. Data access is per user type including rolling archives, Internet downloads, and EUMETCAST services. Recently a Sentinel-3 validation team was formed, the first meeting of which took place in November 2013 at ESA/ESRIN. Users will be supported by the Sentinel-3 Toolbox which has a similar structure to BEAM, and will include a CoastColor processor. It is also intended to support VIIRS and OCM products by compatible SeaDAS modules.

6.2 JAXA: GCOM-C/SGLI new developments

Hiroshi Murakami reported on the GCOM-C1/ SGLI mission, which has 250-m resolution and 1400-km swath, with a new launch date of 2016/2017. The budget for the mission has been approved so the target launch year is becoming more realistic. Target issues for GCOM-C1 algorithm development include characterization (data collection) of coastal IOPs and improvement of the candidate aerosol models. A second research announcement started in April 2013 (until March 2016) and two researchers from NASA and NOAA are part of the PI team. They are working on SGLI pre-launch calibration and characterization as well as calibration of *in-situ* instruments. All GCOM-C1 data will be downlinked either via the Svalbard downlink station or the Japanese near-real time station. There will also be direct downlink capability to other local stations via individual agreements with JAXA.

All land and coastal areas will be observed at 250 m by SGLI – coastal areas include the continental shelf or up to 200 sea-miles, but small islands are defined as offshore, and the Antarctic will be observed at 1-km resolution, except for some Cal/Val targets. The 250 m mode is limited by downlink data volume per path. GCOM products will be released to the public one-year after launch, and all products will be free of charge for Internet acquisition.

Gene Feldman enquired about the lowest level of data product that would be distributed, ideally Level-1A. This is still under discussion, but may be possible via a direct stream from Svalbard. It should also be possible to provide data processing software if there is a special agreement.

6.3 CSA: Access to missions that meet Canadian user requirements

Yves Crevier briefed the Committee via Skype, on CSA's support to the ocean-colour community. Canada's new Space Policy Framework will be released in early 2014 outlining the Government's strategic goals for its space activities. Funding of new space projects will come from multiple partners with a co-investment approach. This will provide a strong framework to support the Canadian Industry. CSA still has a strong interest in ocean colour and will enable end-users to exploit ocean-colour data in support of programs for fisheries management, ecosystem protection, coastal zone management, and climate change. CSA investments are related to supporting and providing access to missions that meet user requirements and facilitating, in this specific case, the development of a Canadian ocean-colour network.

CSA will develop a business case for the PCW mission (Polar Communication Weather). An RFI was posted and results will be received soon. The business case for PCW should include information on the definition of the mission, the concept of operations, the costs and schedule, the business partners, the potential national and international alliances, the technical feasibility and the implementation model.

The Microsat Program is another opportunity for CSA to respond to the needs of the Canadian Government and potential partners, and is open for international collaboration. The potential micro-sat constellation includes WATERSAT, a mission to observe Canadian coastal and inland water productivity and its impact on fisheries and pollution. IOCCG Report# 13 was used for definition of the Statement of Work for development of a business case for WATERSAT, which is still in the feasibility phase.

CSA also has partnerships with other agencies to support access to data of interest for Canadian scientists (e.g. data from the Sentinel missions). An Interdepartmental Tiger Team (CSA, EC, NRCan, DFO, DND) is working on a business case for reception, processing, archiving and distribution of Sentinel data within Canada. The target is to be ready and able to receive and process S-1 data by mid-2014.

CSA is keen to support coordination and collaboration between Canadian ocean-colour scientists, which has led to the formation of a Canadian ocean-colour network called NetCOLOR (Network on Coastal, Oceans and Lakes Optical Remote-sensing), which held its first planning meeting in December 2013. The scope of the group is to federate and coordinate ocean-colour activities within Canada at various levels (academia and government, Eastern and Western Canada) to develop a critical mass of scientists to influence and advise CSA on specific needs and requirements from the community. With its critical mass of scientists, NetCOLOR will be in a position to generate more visibility on ocean-colour issues before the new space governance authority in Canada. As such, it is expected that ocean-colour requirements, proposals for new missions, international partnerships and key science questions will represent the position of the federated community. In this context, CSA Earth Observation programs are able to support Canadian ocean-colour activities. The NetCOLOR proposal is currently going through

an evaluation process, but it is hoped that it will be officially supported. If so, the Network will hosted by University of Laval (Takuvik Program) and will serve as link with IOCCG, with Venetia Stuart as a representative on the panel. Based on the needs and requirements of IOCCG, CSA would like to identify a scientific expert from the group to better contribute to IOCCG objectives.

CSA is also willing to contribute to IOCCG activities over the next 3 years. The Chairman expressed his thanks to CSA for confirming their support to IOCCG and for their effort in getting the proposal accepted. He was also pleased to see NetColor getting off the ground.

6.4 NASA: redistribution of satellite data (past and current missions)

Gene Feldman updated the committee on the redistribution of satellite data by the NASA Biology Processing Group. They process data from multiple missions with a common methodology, which makes inter-comparisons easier. All multi-mission data sets are available online via NASA's OceanColor web, along with the SeaDAS archive, which hosts the *in situ* data. Users can easily select *in situ* data for which there are coincident satellite acquisitions, in order to compare *in situ* and satellite data and test algorithms. This can be done across all missions, which all have common parameters.

NASA would like to propose that all agencies distribute source mission data at Level-0 or Level-1A, along with the appropriate software to process to Level-1B. This greatly minimizes data transfer resource requirements that are often a mitigating factor in data sharing. Periodic reprocessing of the Level-1B data is required to achieve climate quality products. Because the data volumes for new missions are so massive, repeated redistribution of the entire global Level-1B archive after each reprocessing, to multiple agencies or researchers, is extremely inefficient and may not even be feasible.

Ewa Kwiatkowska pointed out that for Sentinel-3, the Level-0 products are considered internal ground segment products. EUMETSAT does not own the code to go from L0 to L1 since ground segment development contracts are not administered by EUMETSAT and private companies are contracted to do this. Furthermore, the concept of Level-1A data products does not exist for Sentinel-3 OLCI, i.e. the first user products are Level-1B. Access to the Level-0 to Level-1B processor and its source code is something that IOCCG could address since the Sentinel-3 Validation Team has also requested distribution of Level-0 data and the source code.

6.5 NASA update on future missions and research planning

Paula Bontempi gave an update on NASA current and future missions, and research planning. The two MODIS instruments on Terra and Aqua continue to operate with no major anomalies. Changes in radiometric performance are being tracked through solar and lunar calibration measurements, and are correctable but not necessarily predictable, leading to occasional partial reprocessings. NOAA is the official processor and distributor of Suomi NPP VIIRS data but NASA OBPG has routinely processed and distributed the data since the start of the mission (Level-1A, Level-2, Level-3). The data are processed with standard NASA algorithms to maximize consistency of derived products with the historical record.

Results are generally in good agreement with MODIS in 2012, but agreement degraded in 2013 with VIIRS Chlorophyll biased low, primarily due to an apparent 5% upward shift in VIIRS R_{rs} trends in the blue. A new Chlorophyll-a algorithm (OCI) is being used to achieve better retrievals in oligotrophic waters. NASA has written a data policy to use the high-resolution data from the HICO (Hyperspectral Imager for the Coastal Ocean) instrument on the International Space Station. The majority of the HICO dataset is now publically available through the NASA GSFC OceanColor web site.

The PACE (Pre-Aerosol , Cloud, and Ecosystem) mission, which is focused on global ocean ecosystems and carbon cycling, is tentatively scheduled for launch in 2018/2019. The mission will specifically target phytoplankton stocks and their diversity (PFTs), assess changes in ocean carbon, and aims to understand human impacts and change. PACE will have high spectral resolution (5 nm) and spatial range, as well as strict data quality requirements. The GEO CAPE (Geostationary Coastal & Air Pollution Events) mission is still in pre-formulation but there are continuing science studies that provide recommendations on requirements as well as collaboration with the Korean GOCI team. A number of research opportunities related to PACE and Suomi NPP are available through NASA ROSES Space and Earth Sciences Competitions.

6.6 Update on NOAA ocean colour activities: VIIRS

Paul DiGiacomo provided an update on NOAA ocean-colour activities. Menghua Wang leads the JPSS ocean colour EDR (Environmental Data Record) Cal/Val team, which has built ocean-colour near-real-time data monitoring and evaluation capability. VIIRS ocean-colour data has been declared provisional status (January 2014) but the product quality may not be optimal. Extensive comparisons between VIIRS ocean-colour data with those from MODIS-Aqua showed that both data sets were consistent in 2012, but discrepancy started to appear since early 2013, especially in oligotrophic areas. This is related to VIIRS SDR calibration issues, which should be resolved. In general, VIIRS ocean-colour normalized water-leaving radiance spectra show reasonable agreements with *in situ* measurements at MOBY, AERONET-OC sites, and various other ocean regions. Reprocessing will be done once the SDR calibration issue has been clarified. The technology refresh for MOBY (Marine Optical Buoy) was funded in early 2013 and will yield a more robust system capable of collecting more data and at higher quality.

Suomi-NPP mission data is accessible through NOAA CLASS (www.class.noaa.gov/). NOAA is also actively engaged with EUMETSAT for receipt and utilization of OLCI data as part of broader U.S./European coordination group. NOAA is also expanding upon existing NOAA/JAXA partnerships for GCOM-C/SGLI as well as ongoing technical interactions with KIOST regarding COMS/GOCI data.

6.7 KIOST update on GOCI-I and II missions

YoungJe Park provided an update on the GOCI sensor onboard the Korean geostationary COMS satellite. GOCI was launched in June 2010 and has a design life of 7 years. The target area is 2,500 km^2 (centered on 130°E, 36°N) and eight Level-1B images are acquired per day. The instrument is in stable condition with less than 1% degradation per year. GOCI NIR bands have a much higher signal-to-noise ratio than

SeaWiFS although the blue bands are similar to SeaWiFS. This is reflected in the Chlorophyll concentration, which has low RMS errors at low Chlorophyll concentrations.

GOCI data is continuously distributed through the KIOST website, 8 images per day. A trial service of ISDR-corrected images is distributed via a portal site. Near-real-time data service is provided to 25 institutes via direct ftp. There is also a public user by portal site and a Mirror Site for international scientific users. *In situ* data are used for vicarious calibration. An Aeronet station has also been installed between Japan and China, which is working well. GOCI data can be used to detect ocean fronts and ocean currents and can also be used to monitor movement of harmful algal blooms, which have a high reflectance around 700 nm. Having 8 images per day also allows for applications such as monitoring dumping and dredging sites, sea ice, and smog (aerosols). KIOST carries out collaborative research with LOV, MUMM, NOAA and PML, and GOCI calibration campaigns with NASA, CNRS and LOV. In 2014 they plan to release GOCI GDPS ver. 1.3 (GOCI Data Processing System) which has a number of improvements (atmospheric correction, cloud screening etc.). The fourth annual GOCI validation campaign will take place in September in the West Sea and East China Sea and all interested researchers are invited to participate in this event.

The GOCI-II mission is focused on monitoring the coastal and global ocean with better spatial resolution and spectral performance (13 bands) than GOCI, and will be launched at the end of 2018. Coastal areas will be observed at 300 m resolution, and once per day there will be full disc coverage at 1 km resolution. GOCI-II will have a new capability, supporting user definable observation requests such as clear sky area and special-event areas. GOCI-II will perform observations 8 times per day, the same as GOCI. The main difference between GOCI-II and GOCI is the global-monitoring capability, which will meet the requirements of global climate change research.

6.8 EUMETSAT: Development of ocean colour services

Ewa Kwiatkowska reported on the development of ocean-colour services at EUMETSAT. Two updates from EUMETSAT concerning the EC's Copernicus program are the free, full and open data policy for all global users and the EUMETSAT delegation agreement with the EC. EUMETSAT has established a delegation agreement with EC regarding Copernicus marine, surface topography, atmospheric chemistry and Third Party data, as well as mission and system operations, maintenance and development, mission management, and services to users. EUMETSAT will also support the EC for the definition of user requirements and respond to changing user requirements. IOCCG has big role to play in defining long-term marine and ocean- colour services, and the IOCCG documentation is very useful and appreciated.

ESA and EUMETSAT have joint planning and preparation for the Sentinel-3 mission (launch mid-2015), including a joint call for Sentinel-3 Validation Team (S3VT). Over 40 proposals related to ocean colour were received. There is no funding for PIs although here are EC programs relevant to Copernicus, which can support S-3 Cal/Val efforts in principle (e.g. Horizon 2020). The S3VT Implementation Plan is in the process of being written and there are clear recommendations from this team including distribution of L0 or L1A data with access to source codes. IOCCG could be of great help in this regard. L0 data is

considered an internal product and EUMETSAT plans to distribute L1B and L2 data. NRT Sentinel-3 data will be distributed via EUMETCast. In addition there will be a long-term archive and an on-line rolling archive of the last one month of data.

6.9 CNES: Ocean colour developments

Juliette Lambin reported on CNES's ocean-colour missions via telecon. The Parasol mission with the POLDER instrument was terminated at the end of 2013 since it was long past its nominal lifetime. L1 products were disseminated and L2 products have been generated and can be supplied upon demand. CNES has two ocean-colour related projects: the geostationary ocean colour OCAPI project, which is still in preliminary phase 0. The main concern is the high cost, but they are using remaining funds to look at options for cost reductions. Another aspect is a possible cooperation scheme to share costs of the mission with other IOCCG agencies, if there is any interest in such a project?

In April CNES will conduct a national consultation of the scientific community to see what kind of missions CNES should work on. Strong support for a geostationary mission will once again be expected. CNES is trying to enlarge the Earth science community, by looking at geostationary observations of land surfaces where they require frequent revisit.

Lastly, Juliette reported on thematic centers in CNES where the system processing and research on algorithms are carried out in a multi-mission framework. The idea is to have four thematic centers, for oceans, land, atmospheric chemistry, and clouds/aerosols. Active discussions are underway with IFREMER to include all space borne data as well as *in situ* data. This is a good way to develop ocean colour science and is open to the international community.

6.10 INPE: Argentine-Brazilian SABIA/mar mission

Milton Kampel gave an update on the joint INPE/CONAE SABIA-MAR mission between Argentina and Brazil. Data will be used for environmental monitoring and will be integrated with *in situ* data. The proposal was to design, build, launch and operate an ocean-colour observing mission, sharing tasks equally between the two countries and maximizing the enrolment of national industries in each country. The primary objectives are to observe marine reflectance in the open sea and in coastal and inland waters, determine optical properties and water constituents and study marine biosphere resources and the role of marine (phytoplankton) biomass in the global carbon cycle. A secondary sensor will estimate sea surface temperature for the study of marine currents and air-sea interactions. Application areas include fisheries and aquaculture, water quality (coastal and inland waters), harmful algal blooms, climate studies, CO_2 uptake, coastal management /tourism (including coral reefs), oil spills and seeps, weather forecast, and environmental monitoring.

There will be two identical satellites in tandem mode (1-2 days revisit), on two different satellites, to ensure global coverage. Brazil is in charge of the platform and Argentina the payload. To accomplish the objectives, and to cover global and regional scenarios, the primary instrument on-board SABIA-Mar will have the capability of observing the global ocean at 1-km at nadir (low resolution) with onboard

recording capability. Regional coastal and in-land waters will be observed at medium resolution (better than 200m at nadir), and 1-2 days revisit, with real time data downlink and on board recording capability under specific requests. IOCCG input was requested for the proposed spectral, spatial and radiometric requirements. The goal is to set 0.5% for the TOA radiance uncertainty for all bands. There will be direct broadcast in NRT and all data will be available free of charge. The scheduled launch date is the beginning of 2018.

ACTION 19/11: *IOCCG Committee members to provide feedback to Milton Kampel regarding proposed bands for the SABIA/MAR mission.*

6.11 ISRO: Ocean colour applications in India and update on OCM-3

Mini Raman gave the ISRO presentation via Skype, on behalf of Prakash Chauhan. India has launched two Ocean Colour Monitors (OCM. The data is used operationally, and is available at 360-m (local) and 1-km (global). Global OCM-2 data is being reanalyzed to try and solve some of the radiometric problems. A comparison of reprocessed monthly radiances indicates that OCM Chlorophyll is still overestimated compared to MODIS. OCM-2 data products are available on-line from the National Remote Sensing Center (NRSC). An important EO service is the generation of potential fishing zone advisories (PFZ), based on geolocation of oceanographic features. These advisories are used to predict fishing grounds and reduce search time. Other applications include detection of algal blooms e.g. *Noctiluca* and examining cyclone induced ocean productivity.

The Oceansat-3 instrument is scheduled for launch in 2015/16. It will have 13 channels for ocean colour, plus another two for SST. ISRO is also discussing a geostationary satellite for launch in the 2016/17 timeframe, with 6 multispectral bands in the visible and NIR, and 158 hyperspectral bands with 320 m pixel resolution. It will be aimed at 93^{o}E, covering an area from the Arabian Sea to the Sea of Japan, twice per day for the hyperspectral bands, but a higher temporal resolution could be achieved upon request. All *in situ* data from the Kavaratti Cal/Val site would be made available for sharing via the ISRO MOSDAAC site, and can be used for multi-sensor Cal/Val. ISRO has also kindly agreed to print another IOCCG report.

6.12 Update on Chinese OC missions

Zhihua Mao Second provided an update on Chinese ocean colour missions. The HY-1B ocean colour satellite launched in April 2007 is still working well. The next generation HY-1C and D will be launched together in 2015 (morning and afternoon satellite). In addition, the ocean dynamic satellites (HY-2A and HY-2B and HY-3A) can also be used to study the ocean. Dr. Mao also discussed a new approach of atmospheric correction based on UV bands for turbid coastal waters, as well as another model (ENLF) for estimating aerosol scattering reflectance from satellite remote sensing data.

7.0 Other Ocean Colour Related Initiatives

7.1 Global observatory of lake responses to environmental change (GloboLakes)

Andrew Tyler presented the UK funded GloboLakes project for detecting lake responses to environmental change, led by a consortium of researchers from the UK. There are over 300 million lakes around the world, which are fundamental to global food security, water security and global biogeochemical cycling. Lakes are 'sentinels' of environmental change, and Earth observation provides a powerful approach to monitor lakes globally. The GloboLakes project will examine data from ~1000 of the world's largest lakes to investigate the state of lakes and their response to environmental change drivers (this represents 2/3 of all inland waters with a surface area greater than 1-km^2). The GloboLakes observatory will provide information on parameters such as lake surface water temperature, TSM, CDOM, Chl-a and the pigment phycocyanin (for cyanobacterial blooms), which will be generated from a ~20-year time series (1997 onwards) of observations from SeaWiFS, MODIS, MERIS, and the forthcoming Sentinel satellites. Long-term datasets such as this provide a powerful tool to describe ecosystem function, variation and resilience to ecosystem change. Uncertainties in all components will also be characterised. The project includes a forecasting component to understand key lake types and sensitivities. The LIMNADES database, consisting of IOP, AOP and ancillary data from around the world, is being developed to calibrate and validate algorithms. The group is also working with partners from a number of other projects including Brockman Consultants, GLASS, INFORM etc. In future the group hopes to fund the standardisation of protocols for inland waters.

7.2 Ocean colour activities within the Australian bio-optical community

David Antoine described Australian ocean-colour activities on behalf of Nick Hardman-Mountford who was unable to attend. CSIRO's Earth Observation & Informatics Transformational Capability Platform (EOI-TCP), directed by Arnold Dekker, plays a national coordinating role and helps to develop capability in the country as well as leverage national infrastructure for efficient use and develop networks for national coordination. In parallel, the Australian Government has produced a series of reports highlighting the need for national coordination to ensure long-term access to, and efficient use of, EO data. CSIRO will take the lead in coordinating Australian research priorities, and EOI-TCP has coordinated efforts to contribute to the Sentinel-3 validation team. This includes the Lucinda Jetty coastal observatory as well as fixed and moored bio-optical measurement systems and satellite data processing capability through IMOS. Some examples of operational applications of ocean colour in Australia were also given (e.g. use of CDOM to map freshwater extent on the Great Barrier Reef). An invitation was extended to the international ocean colour community to partner with them in Australia to leverage international collaboration.

8.0 Capacity Building

8.1 Plans for second IOCCG Summer Lecture Series

David Antoine briefed the Committee on the next IOCCG Summer Lecture Series (SLS), which is scheduled for 21 July to 2 August 2014. For the previous SLS, 106 applications were received, but the course was limited to only 17 students. A key attribute was that all the lectures were recorded and are currently available from the IOCCG website. The 36 lectures have been downloaded over 19,000 times in total, and provide an excellent teaching resource. The lectures will be recorded again this year, and there will be several new lecturers, providing an excellent resource for students and researchers to learn about optics and ocean colour. CNES (France) has provided a significant contribution for the second SLS, and the OCB Program (US), and SCOR (US) have offered to sponsor a number of students and lecturers. In addition, the Villefranche observatory (OOV), the Villefranche oceanography laboratory (LOV), and the "GIS-COOC" have also contributed resources for the 2014 SLS. Applications are open until mid-March 2014, and selected students will be announced by mid-April, based on their knowledge of optics and remote sensing. David Antoine was willing to continue holding the course in Villefranche, although other institutes with resources are welcome to host the course. Volunteers were requested to serve on the Selections Committee - Heidi Dierssen and Andrew Tyler offered. Proposals were requested for other parallel IOCCG training initiatives, and Stewart Bernard proposed holding a training course for optically complex waters, which could feed into updating the *in situ* protocols.

9.0 Discussion on IOCCG Website

Agency members provided information on their respective missions to update the sensors page on the IOCCG website. It was recommended that direct links be provided to satellite data from the sensors page.

ACTION 19/12: *Agency members to provide Venetia Stuart with links for satellite data, as well as other information on their agency's sensors.*

10.0 Organisation and Membership

9.1 Rotation of IOCCG officers, and handing over to the new IOCCG Chairman

Roland Doerffer was officially rotating off the Committee, and he was thanked for his substantial contributions to the IOCCG Committee over many years, which were greatly appreciated. It was agreed that new IOCCG committee members were required in the area of applications/services, as well as algorithm development. A final decision on new members would be made during the Executive meeting.

10.2 Proposal to host IOCCG-20 Committee meeting in the USA (2015) (NASA/NOAA)

Paul DiGiacomo proposed to host the next IOCCG meeting in the US, perhaps on the east coast (Washington DC or New York City) since the IOCS meeting would probably take place on the west coast in 2015 (San Francisco or San Diego). This would be discussed further during the IOCCG Executive meeting.

10.3 Proposals for hosting IOCCG-21 Committee meeting (2016)

One possibility would be to go back to Paris, UNESCO-IOC, to help strengthen ties with GOOS etc. CNES also offered to act as the official host.

10.4 Closing comments

David Antoine noted that his four years of Chairmanship had been a rewarding experience because everyone on the Committee was willing to contribute, and a lot of progress had been made. He noted that the IOCCG was an interesting committee to chair and he acknowledged his predecessors, Trevor Platt as well as Jim Yoder, who had played a big role in the development of the OCR-VC. He also thanked Venetia Stuart for her hard work and dedication as the IOCCG Project Scientist. The Chair was officially handed over to Stewart Bernard.

Stewart Bernard was flattered and honoured to have the opportunity to Chair such a great Committee and he recognized that he was walking in the footsteps of giants. He acknowledged David's huge contributions over the past few years, which included orchestrating and conducting the first Summer Lecture Series as well as the first International Ocean Colour Science meeting. David Antoine and Jim Yoder were both presented with tokens of appreciation for their tenure as IOCCG Chair: ceramic bowls inspired by the sea and made by a local artist, John Newdigate.

Photo credit: Gene C. Feldman

Actions - 19th IOCCG Committee Meeting

Cape Town, South Africa, 28 – 20 January 2014

Action	Brief description	Status
19/1	Chairman to contact Kevin Ruddick regarding the status of the working group on intercomparison of retrieval algorithms for coastal waters.	Closed
19/2	Nick Hardman-Mountford to talk to colleagues regarding a preliminary scoping of current coral reef research using ocean colour remote sensing.	Closed
19/3	Taka Hirata to work with Astrid Bracher in revising the PFT workshop proposal, taking into account the IOCCG Committee's recommendations.	Closed
19/4	Chairman to contact Jeremy Werdell to encourage him to move forward with the *in situ* measurement protocols co-ordination activity.	Closed
19/5	Mark Dowell to initiate liaison with GCOS regarding requirements for the ocean colour ECV.	On-going
19/6	Jim Yoder and Nic Hoepffner to discuss potential candidates for a new ECV Task Force Chair.	On-going
19/7	Ewa Kwiatkowska to identify where a letter of recommendation from IOCCG to the EC regarding Copernicus data policy should be directed.	Closed
19/8	IOCCG Executive Committee to help draft letter of recommendation from IOCCG to the EC regarding Copernicus data policy.	On-going
19/9	Ewa Kwiatkowska to move forward with the satellite sensor calibration task force, and establish Terms of Reference, in conjunction with other members of the group.	On-going
19/10	Giuseppe Zibordi to prepare an Excel spreadsheet for mapping current and planned activities of each space agency with INSITU-OCR recommendations.	Closed
19/11	IOCCG Committee members to provide feedback to Milton Kampel regarding proposed bands for the SABIA/MAR mission.	On-going
19/12	Agency members to provide Venetia Stuart with links for satellite data, as well as other information on the sensors.	On-going

Appendix I: LIST OF PARTICIPANTS

Cape Town, South Africa (28-30 January, 2014)

Invited Participants		**Affiliation**
Ackleson, Steve	-	Ocean Leadership, Washington, D.C, USA
Antoine, David (Chair)	-	LOV, Villefranche, France
Bernard, Stewart	-	CSIR, South Africa
Bontempi, Paula	-	NASA HQ, USA
Choi, Jongkuk	-	KIOST, Korea
Dierssen, Heidi	-	University of Connecticut Avery Point, USA
DiGiacomo, Paul	-	NOAA, USA
Doerffer, Roland	-	Helmholtz Center Geesthacht, Germany
Dutkiewicz, Stephanie	-	Massachusetts Institute of Technology, USA
Feldman, Gene	-	NASA GSFC, USA
Forget, Marie-Hélène	-	Université Laval, Québec, Canada
Hirata, Taka	-	Hokkaido University, Japan
Jamet, Cédric	-	Université du Littoral Côte d'Opale, France
Kampel, Milton	-	INPE, Brazil
Kwiatkowska, Ewa	-	EUMETSAT, EU, Germany
Mao, Zhihua	-	Second Institute of Oceanography, China
Melin, Frederic	-	Joint Research Centre, Italy
Murakami, Hiroshi	-	JAXA/EORC, Japan
Olwoch, Jane	-	South African National Space Agency, South Africa
Park, Youngje	-	KIOST, Korea
Regner, Peter	-	ESA-ESRIN, Italy
Stuart, Venetia	-	IOCCG Project Office, BIO, Canada
Tyler, Andrew	-	University of Stirling, UK
Verstraete, Michel	-	South African National Space Agency, South Africa
Yoder, James (Past-Chair)	-	Woods Hole Oceanographic Institution, USA
Zibordi, Giuseppe	-	Joint Research Centre, EU, Italy

Remote Participation		
Crevier, Yves	-	CSA, Canada
Dowell, Mark	-	Joint Research Centre, EU, Italy
Hardman-Mountford, Nick	-	CSIRO, Perth, Australia
Lambin, Juliette	-	CNES, France
Raman, Mini	-	ISRO, India

Apologies		**Affiliation**
Babin, Marcel	-	Université Laval, Canada
Chauhan, Prakash	-	ISRO, India
Frouin, Robert	-	Scripps Institution of Oceanography, USA
Platt, Trevor	-	Plymouth Marine Laboratory, UK
Ruddick, Kevin	-	Belgian Institute of Natural Sciences, Belgium
Ryu, Joo-Hyung	-	KIOST, Korea
Sathyendranath, Shubha	-	Plymouth Marine Laboratory, UK