16th IOCCG Committee Meeting
Dartington Hall, UK, 15-17 February 2011

MINUTES

1. Welcome and Opening Session

1.1 Introductory Remarks and Welcome

The Chairman, David Antoine, opened the 16th IOCCG Committee meeting and welcomed the participants to the UK (see Appendix I for list of participants), noting that almost the entire committee was present, a sign of their commitment. He thanked the Plymouth Marine Laboratory (PML) for hosting the meeting and for choosing such a lovely venue. A warm welcome was also extended to the four new IOCCG Committee members: Stephanie Dutkiewicz, Steven Greb, Dmitry Pozdnyakov and Juliette Lambin (the new CNES representative). The Chairman observed that this was a critical time for ocean colour, as many missions were coming to an end and planned new missions had not yet been launched. It was with some regret that he announced that the SeaWiFS mission had ceased functioning which emphasized the importance of maintaining ocean colour continuity. A short letter had been sent to Gene Feldman expressing the gratitude of the entire ocean colour community for the extremely successful mission. Trevor Platt also extended a warm welcome to all the participants and thanked them for travelling to England.

1.2 Adoption of the IOCCG-16 agenda, minutes from the 15th Committee meeting and status of actions

The agenda was adopted with no modifications, and the minutes the 15th IOCCG Committee meeting were approved as written. The Chairman summarised the status of the actions from the 15th Committee meeting, most of which had either been completed, or would be addressed during the meeting.

Action 15/1: Steven Greb will report on the Coastal GEO Inland and Nearshore Coastal Water Quality WG under agenda item 4.1.

Action 15/2: The Chairman had received information on various bio-optical training courses for the Summer Lecture Series proposal.

Actions 15/3: A link is now available on the IOCCG website showing current locations of the BIO-Argo floats.

Actions 15/4: This issue is on-going: IOCCG members are encouraged to contact their Argo representative to promote the BIO-Argo floats.

Actions 15/5: The draft report prepared by the Geostationary WG will be presented under agenda item 2.3.

Actions 15/6: The SCOR Guidelines for new working groups have been adapted and are now available on the IOCCG website.

Actions 15/7: A revised proposal encompassing all high-latitude/low-sun angle waters had been received from Marcel Babin and will be presented under agenda item 3.1.

Action 15/8: Roland Doerffer had received suggestions for members of his Uncertainty WG.
Action 15/9: Jim Yoder submitted a contributed paper to the Oceanography special issue on the Future of Oceanography from Space entitled "Study of Marine Ecosystems and Biogeochemistry - Now and in the Future".
Action 15/10: The Chairman sent a letter to KORDI endorsing the GOCI-2 instrument.
Action 15/11: Several suggestions for GOCI-2 band placement had been submitted to KORDI.
Action 15/12: Paul DiGiacomo had sent the IGOS reports to KORDI.
Action 15/13: The Chairman had sent a letter to CNES endorsing the proposed 3MI mission concept.
Action 15/14: IOCCG Committee members were encouraged to provide scientific feedback on optimal band selection for future ISRO ocean-colour sensors. This action is still open.
Action 15/15: Hans Bonekamp is representing EUMETSAT at the IOCCG-16 meeting.
Action 15/16: Paula Bontempi sent a paper on scientific achievements (submitted to Science) to David Antoine, as a start for a position paper.
Action 15/17: The INSITU-OCR was formed as a follow-on to SIMBIOS, and will be addressed under agenda item 5.2.
Action 15/18: A session on the OCR-VC took place at the "Oceans from Space" Symposium (Venice, 26-30 April 2010) and the follow-on SIMBIOS activity was discussed.
Action 15/19: A webpage for training course alumni has been set up on the IOCCG webpage.
Action 15/20: The need for standard training course material will be presented under agenda item 8.5.

Hans Bonekamp requested that IOCCG contact the OceanObs Committee to encourage them to formally publish the Community White Papers from the OceanObs'09 symposium (21-25 September 2009, Venice Italy).

ACTION 16/1: CHAIRMAN TO APPROACH THE OCEANOBS'09 COMMITTEE TO ENCOURAGE THEM TO FORMALLY PUBLISH THE WHITE PAPERS FROM THE VENICE SYMPOSIUM.

1.3 Overview of Activities of the NCEO

Andy Shaw presented an overview of the activities of the National Centre for Earth Observation (NCEO), a primary research centre in the area of Earth observation, based at the University of Reading. NCEO has a network of ~170 researchers across the UK with an investment of ~£5M per annum to develop UK national capability in EO science and applications through directed research programmes, informatics, EO services and facilities, and training and outreach. NCEO is the focal point for international collaboration with ESA and other space agencies. The core challenge is to use EO to test Earth system models stringently to help develop them to make better predictions. A number of different areas are being investigated including EO for climate, the carbon cycle, cryosphere, atmospheric composition, geohazards, hazardous weather and flooding.

ESA have opened the Climate Office in Harwell which is good for collaboration and development of the EO sector in UK. ESA have taken a lead with the Climate Change Initiative which will provide an observational database leading to new products for decision makers. Many new advances are being made in EO with new products, the capacity to handle data, training and better decision making. The IOCCG can help meet these challenges.

1.4 Generation of Ocean Colour CDRs

David Antoine presented his "Roadmap" document outlining the actions the IOCCG could take over the next 5-10 year period to develop global and multi-decadal ocean colour Climate-quality Data Records (CDRs). There have been many indications of changes in marine ecosystems and phytoplankton productivity over the past decade. Understanding these changes and their relationship to global changes in the physical environment requires a long CDR time series. Although there are already important merging activities, these are generally short-term and are agency specific. A new entity with a mandate to generate CDRs from data provided by space agencies is thus required. It could be linked to the space agencies, but independent from them. A number of short-term actions were proposed, which could be carried out by the IOCCG to help in the production of CDRs: a new IOCCG working group could be formed to evaluate ECVs produced by other agencies and there could be regular inter-agency team meetings as well as community consultation meetings. Possible longer-term actions (2012-2015 and beyond) could include global data assembly centres in charge of processing OCR datasets sets for production of OCR CDRs, a long-term stewardship and reanalysis facility for long-term archiving and reprocessing of these datasets, and an international project office. Detailed and frank comments from IOCCG Committee members were requested on the document.

ACTION 16/2: IOCCG COMMITTEE MEMBERS TO PROVIDE DETAILED COMMENTS ON THE CDR ROADMAP DOCUMENT (SUBMIT TO DAVID ANTOINE).

Mark Dowell remarked that the CEOS virtual constellations may possibly have an augmented mandate in the future, specifically related to how they can support the long-term generation of CDRs. This aspect may become the main focus of the constellations in the future. He suggested that the "Roadmap" document should be a scientific basis document and should restrict itself to providing scientific requirements and recommendations, and not address issues concerning implementation and governance (this should be left to the agencies to discuss and implement). He agreed to report back after the SIT meeting regarding a redefined mandate for the virtual constellations specifically addressing ECVs. He agreed that the IOCCG was in a perfect position to carry out the consultation role. He also considered the formation of a standing working group to evaluate ECVs to be a good idea although this might be better implemented under INSITU-OCR which can be funded by agencies (IOCCG is not in a position to fund a working group indefinitely).

The Chairman suggested that a possible short term action could be to arrange a community consultation meeting, perhaps in the Fall. Shubha Sathyendranath informed

the Committee that the ESA CoastColour project will hold their 2nd User Consultation Meeting in Lisbon from 19-21 October 2011. This could present a good opportunity for a side IOCCG meeting.

2. Status of IOCCG Scientific Working Groups

2.1 Phytoplankton Functional Types

Shubha Sathyendranath reported on the Phytoplankton Functional Types (PFT) working group which was progressing steadily. The resulting report will have six chapters organised as to how remote sensing can be used to detect specific algal blooms, or obtain information on phytoplankton size structure, as well as methods for detecting multiple functional types. A draft of the entire first chapter (Introduction) was completed. The second chapter, which explores various *in situ* techniques for observing functional types, was almost finished and good progress had been made with Chapter 3, which deals with the detection of single algal blooms by remote sensing. Chapter 4, on the detection of phytoplankton size structure by remote sensing, was partially done. There has been a lot of development in the last year related to this topic and the PFT working group was well integrated with other researchers working in this field. Chapter 5, examining methods for detecting multiple functional types needed more work but progress was being made, and Chapter 6 (directions for further work and concluding remarks) still had to be written. The WG should be in a position to finalise the draft report this year and have a final report by 2012. A new development in this field is the second PFT algorithm inter-comparison workshop and round robin exercise which may take place this year. It was not planned to incorporate the results of the workshop into the PFT report, but if it did go ahead, it should provide a forum for an opportunistic wrap-up meeting.

Nick Hardman-Mountford stated that JAXA had agreed to provide funding to host the algorithm workshop in Japan, and NCEO would also provide some support. The group would welcome IOCCG's endorsement. The Chairman commented that it would be good to include the results of the inter-comparison exercises in the IOCCG report, but this would delay report. Dr. Sathyendranath cautioned against comparing algorithms not intended for the same purpose, and agreed that the PFT report should not include the results of the inter-comparison exercises. Stewart Bernard enquired about plans to include a sensitivity study in the report. While the value of such a study was appreciated, there was no mechanism to carry out such an analysis, although it would be mentioned in the report. The consensus of the Committee was that the PFT algorithm inter-comparison exercise should be endorsed by IOCCG.

2.2 Bio-optical Sensors on Argo Floats

Stewart Bernard gave a presentation on the potential use of bio-optical sensors on Argo floats, on behalf of Hervé Claustre. Ocean colour remote sensing is a powerful tool but is restricted to the upper layer of the water column. Furthermore, cloudy areas are unobservable by remote sensing, and Cal/Val is essentially dependant on moorings or cruises (which have spatio-temporal limitations). The Argo programme with over 3,000

profiling floats, has contributed to a spectacular increase in the number of temperature/salinity profiles (over 95% of all CTD profiles). The recent development of low-consumption, miniature and neutrally-buoyant sensors which have been mounted on Argo floats for dedicated local or regional studies, have provided positive results. The IOCCG working group was involved in the preliminary steps before creating a comprehensive BIO-Argo program. The group identified three types of Argo-like floats for bio-optical/bio-geochemical studies: the Cal/Val float for validation activities, the BIO-Argo float for biogeochemistry and validation, and the CarboExplorer-Float for biogeochemistry. The objective was a large dissemination of BIO-Argo floats to build a very large data base to examine long-term trends. The WG had also contributed to a community White Paper at OceanObs'09, and other papers in peer-reviewed journals.

Currently there are only 15 BIO-Argo floats around the globe, but there are plans to launch around 150 floats (various classes) in different parts of the global ocean. The key to the success of the BIO-Argo floats is an efficient data management system, with real-time data delivery and quality control of operational data. In addition there should be a delayed mode QC delivery after data reprocessing. In the future, a standing committee should be established to coordinate and deal with technical and data aspects associated with BIO-Argo, and to encourage bio-sensors to be incorporated onto the Argo array. In addition, existing floats could be supplemented with bio-sensors and Iridium transmission. The draft IOCCG report is almost ready for submission and is also being translated into Chinese. Paul DiGiacomo suggested that a more detailed discussion was required to better integrate biology into the climate observing system, including GCOS. The Chairman recommended that a synthesis section or executive summary be included in the report. Feedback on the report was strongly encouraged, especially from modellers.

ACTION 16/3: IOCCG COMMITTEE MEMBERS TO PROVIDE FEEDBACK ON THE BIO-ARGO REPORT (SUBMIT TO HERVÉ CLAUSTRE).

2.3 Ocean Colour from a Geostationary Platform

David Antoine outlined the motivation behind establishing a WG to examine ocean colour from a geostationary orbit, and reviewed the terms of reference, most of which will be addressed in the IOCCG report. A near-final version of the report had been submitted to the IOCCG committee for review at the end of January 2011, and feedback was requested before the final report is published.

ACTION 16/4: IOCCG COMMITTEE MEMBERS TO PROVIDE FEEDBACK ON THE GEOSTATIONARY REPORT (SUBMIT TO DAVID ANTOINE).

The report will show that geostationary ocean colour observations are useful not only for coastal waters, but also for research in the open ocean. A few examples were given from the report including increased coverage and data availability. Five to six geostationary sensors (a true constellation) could provide near global coverage. Trevor Platt noted that it would be useful to have an estimate of the cost of a 5-sensor constellation.

2.4 Assessing Level-1 requirements for Ocean Colour Remote Sensing

Gerhard Meister reported on the progress of the WG to assess Level-1 requirements for ocean colour remote sensing. The group had held bi-monthly telecoms since its inception in 2009 and were working on the draft report, which was built around the science traceability matrix (STM) concept used by NASA. A wide range of science questions were addressed with corresponding ocean colour satellite products, each with satellite product definitions. A set of minimum spectral bands for addressing all the STM questions was also presented, as well as other design recommendations, calibration recommendations, orbit considerations etc. Chapters 5 and 6 are still in progress and the group was hoping to complete the full draft report by September 2011.

Kevin Ruddick enquired why a 1020 nm band was not included on future sensors. This band would be useful in coastal waters for atmospheric correction and TSM retrieval in extremely turbid water, and would also give a wider range of wavelengths to examine aerosols. Gerhard Meister agreed to look into the inclusion of this band after receiving justification.

ACTION 16/5: KEVIN RUDDICK TO PROVIDE JUSTIFICATION FOR THE INCLUSION OF A 1020 NM BAND ON FUTURE OCEAN COLOUR SENSORS (SUBMIT TO GERHARD MEISTER).

Mark Dowell pointed out that Chapters 2 and 3 were very forward-looking, and went above and beyond historical reports, but the requirements section did not have the same level of mapping, and often there were no accuracy requirements. He suggested that there was a need for studies on accuracy and that the WG should at least specify what were the implications for the requirements. He also queried whether the title of the report was appropriate, and suggested that it should be more of forward-looking. Shubha Sathendranath pointed out that there was often confusion with Level-1A and Level-1B, so perhaps the title should be along the lines "Mission Requirements for Future Ocean Colour sensors".

2.5 GEOHAB/IOCCG Harmful Algal Bloom (HAB) Working Group

Stewart Bernard reported on the joint GEOHAB/IOCCG harmful algal bloom working group. HABs were often used as a selling point for ocean colour, but the complexities of using remote sensing for HAB detection have not been fully examined. An increase in HABs correlates with an increase in urea on a global scale, as well as with increases in anthropogenic DON or DOP, although HABs are not only a result of eutrophication and also occur in upwelling systems, where the drivers are predominantly physical. The WG will also examine HABs in freshwater systems, especially cyanobacterial blooms. OCR is useful for detection and monitoring of HABs, but requires an appreciation of the sizable uncertainties associated with ocean colour applications in the optically-complex coastal zone. Effective HAB observation and prediction systems must include an understanding of system ecology.

The first meeting of the HAB working group took place Cape Town (August 2010) where a consensus of the scope of the WG was obtained *i.e.* to improve communication between

the ocean colour and HAB scientific communities, to highlight the ecological/ regional contextualisation of ocean colour techniques and products, to use the GEOHAB comparative ecosystem approach as a means of classifying ocean colour techniques, and to demonstrate the utility and performance of ocean colour techniques using a variety of case studies. The WG will also undertake a review of available algorithms, and provide some algorithm inter-comparisons, but is not intended as an algorithm round-robin. The two primary deliverables of the WG are a monograph in 1-2 years time, followed by special issue in a peer-reviewed journal, potentially Marine Ecology Progress Series. The next WG meeting will take place in mid-November after the GEOHAB Scientific Steering Committee meeting, to be held at Plymouth Marine Laboratory.

2.6 Uncertainties in Ocean Colour Remote Sensing

Roland Doerffer reported that the WG had not yet started as he had been busy with ESA-related studies. He outlined the scientific background and rationale for starting the WG and reviewed the Terms of Reference. He noted that the ESA Climate Change Initiative (CCI) had proposed the use of a common table of contents for an "Uncertainty Characterisation" document, which could also be used as a template for the IOCCG report. Uncertainty characterisation gives the basis for providing users with uncertainty information regarding, for example, precision, accuracy and error co-variance. Currently 9 members had been proposed (6 US and 2 from JRC) but good geographical distribution was required so suggestions for additional members were requested, especially from Asia and South America.

ACTION 16/6: IOCCG COMMITTEE MEMBERS TO PROPOSE ADDITIONAL MEMBERS FOR THE UNCERTAINTY WORKING GROUP, ESPECIALLY FROM ASIA AND SOUTH AMERICA (SUBMIT TO ROLAND DOERFFER).

Hans Bonekamp volunteered to become a member of the WG, noting that the EUMETSAT optical scientist would take over at a later stage. Stephanie Dutkiewicz pointed out that from an assimilation point of view, the magnitude of the error is not an issue, but it is critical to know the spatial and temporal variability of the errors. She indicated that she was also willing to be part of the WG. Dr. Doerffer informed the Committee that he would retire by end of the year and was hoping to complete the WG tasks by the end of the year, which may be unrealistic, but the work would have to be done for the CCI Project in any case. He planned to submit a revised WG proposal, and would kick off the WG by correspondence. He also requested funding for the first WG meeting.

ACTION 16/7: ROLAND DOERFFER TO SUBMIT A REVISED PROPOSAL FOR THE UNCERTAINTY WORKING GROUP.

2.7 Update on Calibration WG

The Chairman had contacted Robert Frouin regarding the Calibration WG, since it was desirable to have the report published around the same time as the Level-1 WG report. Dr

Frouin planned to complete the report by the end of 2011 and requested suggestions for someone to write the chapter on "In-Flight Calibration".

ACTION 16/8: IOCCG COMMITTEE MEMBERS TO MAKE RECOMMENDATIONS FOR SOMEONE TO WRITE A CHAPTER ON "IN-FLIGHT CALIBRATION" FOR THE CALIBRATION WORKING GROUP REPORT (SUBMIT TO ROBERT FROUIN).

3. Proposals for New IOCCG Working Groups

3.1 Using ocean colour remote sensing for studying and monitoring high latitude areas

The Chairman presented a proposal on ocean colour remote sensing in polar seas, on behalf of Marcel Babin. The original proposal submitted last year had focussed too much on Arctic waters, but the current proposal includes the Antarctic as well. It is important to access information on the entire Arctic and Antarctic Oceans to determine the impact of climate change on primary production, CDOM photo-oxidation, transport of dissolved and particulate organic matter and coastal erosion etc. The use of OC remote sensing in polar seas is impeded by a number of specific difficulties such as ice-related adjacency and sub-pixel pollution effects, low sun elevations, a pronounced deep chlorophyll maximum, peculiar photosynthetic parameters and a high contribution of CDOM. Preliminary Terms of Reference for the WG were presented as well as proposed membership. It was anticipated that the first meeting would be held in October 2011 with a second meeting in March 2012, and the draft version of the report should be ready by October 2012.

Ian Robinson pointed out that the gridding of L3 products was very important as it could influences statistics. The consensus of the Committee was that the WG should go ahead with its proposed activities, and suggestions for membership should be sent to Marcel Babin.

ACTION 16/9: IOCCG COMMITTEE MEMBERS TO SUBMIT SUGGESTIONS FOR MEMBERSHIP FOR THE POLAR SEAS WORKING GROUP TO MARCEL BABIN.

3.2 Round-Robin Inter-Comparison of Retrieval Algorithms for Coastal Waters

Kevin Ruddick outlined his proposal for a working group to inter-compare retrieval algorithms for coastal waters. The objectives of the WG are to examine how algorithm performance relates to algorithm design/calibration, and would focus on algorithms for coastal water products such as chl-a, TSM, IOPs, diffuse attenuation coefficients and euphotic depth. The terms of reference for the WG were reviewed and the end result of the WG would be an IOCCG report. Two key meetings were proposed: a kick-off meeting in June 2011 after which the benchmark datasets (*in situ* and simulated) would be released, and a workshop with algorithm providers in November 2012 to discuss results. The WG would be open to data providers and algorithm providers, including 12 of the 13 registered algorithm providers from CoastColour (~40 people in total).

Paul DiGiacomo pointed out that there was a strong user need for CDOM which could perhaps also be incorporated. David Antoine enquired why the WG was restricted to coastal waters, and recommended that Case-1 waters also be included, especially for IOPs, while Stewart Bernard suggested including inland waters. Dr. Ruddick responded that it was more feasible to include inland waters than Case-1 waters. Prakash Chauhan noted that ISRO could contribute good hyperspectral datasets for coastal waters. Dr. Ruddick agreed to take all the Committee's comments into account and prepare a revised proposal.

ACTION 16/10: KEVIN RUDDICK TO PREPARE A REVISED PROPOSAL FOR THE ROUND-ROBIN INTER-COMPARISON WORKING GROUP, TAKING INTO ACCOUNT COMMENTS RAISED DURING THE IOCCG-16 MEETING.

4. Ocean Colour Projects Related to the OCR-VC

4.1 Report on GEO inland and near-coastal water quality working group

Steven Greb updated the Committee on the Satellite, Lakes Observatory Initiative, for estimating water clarity in various lakes, as well as the GEO Inland and Near-Coastal Water Quality WG assigned to GEO Task WA-08-01g. The goal is to develop a fully operational, spatially comprehensible, global inland and near-coastal water quality information system by 2015, although the water quality WG was not far enough along to accomplish this target. A workshop was held in Geneva in 2007 and a GEO water quality report produced. Since that time, the terms of reference for the WG have been developed and an algorithm workshop was held in May 2009. Top priority issues are that the group should address both coastal and inland waters, and should also consider issues associated with both satellite and *in situ* data. Dr. Greb tentatively proposed the formation of an IOCCG WG to investigate algorithms for inland and coastal waters as well as water quality monitoring.

Stewart Bernard remarked that there was some overlap with the proposed algorithm round-robin WG, especially for assimilating simulated datasets, and he did not see the need for a new group. Mark Dowell suggested that a summary report of what is being done with regard to water quality would be useful.

4.2 ESA's Ocean Colour Climate Change Initiative and CoastColour Project

Shubha Sathyendranath informed the committee about the ESA's Climate Change Initiative (CCI) which is addressing 11 Essential Climate Variables (ECVs), one of which is ocean colour. The IOCCG is listed in the Statement of Work as the expert body. The project is driven by the user perspective (climate modellers, research scientists) and the major challenge is to meet the stringent GCOS requirements to quantify and reduce errors for climate research. A major focus is the User Consultation Report which provides an analysis of the User Consultation Survey, which was carried out using the IOCCG mailing list. Some 100 people responded to the survey which identified requirements according to type of application, type of model etc. and also product requirements.

Requirements vary according to use of data, and most users consulted were interested in error estimation and characterisation, which is a big focus of CCI. All users would like long-term, reliable, quality-controlled, stable products, and a seamless integration of Case-1 and Case-2 waters. CCI has a focus on chlorophyll and IOPs, but users are also interested in additional products such as diffuse attenuation coefficients and PFTs.

Product validation will be accomplished in 4 parts: (i) comparison of ocean colour products against field-based datasets, (ii) inter-comparison between various products from different satellites, (iii) tests on trends, their errors and limits, and (iv) comparison of ocean colour ECV products to models. The first version of the User Requirements Document (URD) is under review, and comments from IOCCG Committee members were requested. The IOCCG Report on Level 1 requirements is complementary to the ESA URD, and permission has been sought to reproduce relevant material, with due acknowledgment.

Users will be kept engaged for feedback on CCI products. A clear role for IOCCG would be to broaden the user community, and to support the proposal for a round-robin inter-comparison of algorithms. The priority for CCI is Case-1 waters, while that of CoastColour is Case-2 waters. Another role for the IOCCG could be stewardship of *in-situ* data for validation. OC-CCI is charged with generating a long, high-quality, multi-sensor, merged time series of ocean-colour data for climate research, which is a multi-agency challenge. Interfaces exist to other agencies but could be strengthened. IOCCG is in a position to promote such an initiative, through existing mechanisms such as the OCR-VC and the CEOS Climate WG. Stephanie Henson pointed out that the responses on the utility of CZCS data may have been more positive if the question on this sensor was re-phrased. Stephanie Dutkiewicz agreed to collect comments from IOCCG Committee members on the URD.

ACTION 16/11: IOCCG COMMITTEE MEMBERS TO PROVIDE COMMENTS ON THE OCEAN COLOUR CCI USER REQUIREMENTS DOCUMENT AND SUBMIT TO STEPHANIE DUTKIEWICZ.

ESA's CoastColour Project

Roland Doerffer summarised the main objectives of the CoastColour Project, which are to fully exploit the MERIS FR data in the coastal zone, to develop, validate and inter-compare different Case 2 algorithms, to actively demonstrate and promote MERIS capabilities for complex water and to prepare for future exploitation of MERIS and Sentinel 3 products. There is a global network of 42 users with a geographic distribution of test sites. A number of standard and experimental products are being tested and uncertainties for each product, at each pixel, will be provided. The work programme includes an international, multi-sensor round-robin to help select the optimal Case-2 algorithm for a given region and application.

4.3 Update on Chinese Ocean Colour Satellite Programme

Zhihua Mao reported on the Chinese satellite programme. The HY-1B satellite, launched in April 2007, carries two sensors (COCTS and CZI) and is still working well. COCTS is

a 10-channel visible and infrared radiometer while CZI is a 4-channel CCD camera. HY-1B data was being evaluated using simulation techniques. Some examples of comparisons of reflectances according to wavelength were presented. In addition, validation of the PCOART model was presented which helped to improved data quality. The HY-2A mission will be launched this year carrying a microwave imager, a radar altimeter and a scatterometer. HY-1C/1D and HY-1E/1F are the follow-on ocean colour missions (AM and PM satellites respectively) scheduled for launch in 2014 and 2017.

4.4 Ocean colour studies in Russia: information on the Meteor-3M satellite mission

Dmitry Pozdnyakov gave a presentation on the Meteor-3M satellite mission. The "Meteor-M" satellite series is designed for operational provision of global hydro-meteorological data for weather forecasts, ozone layer dynamics, assessment of radiation fields, and monitoring marine environments and ice cover in Polar Regions. Meteor-3M №.1, launched in 2009, carries multi-spectral scanning devices for studying marine productivity. Examples of several applications in the northern Caspian Sea were given. Meteor-3M № 2 (replica of № 1) will continue the series of multi-purpose satellites and is scheduled for launch in 2013. METEOR-3M" № 3 is intended to complement data provided by №s 1 and 2, to extend the range of environmental applications, and is scheduled for launch in 2015. METEOR-3M" № 3 will carry a Coastal Zone Scanner (6 channels, 410-786 nm) to monitor shelf and near coastal zones, and an Ocean Colour Scanner for open waters (8 channels, 402—885 nm). Dr. Pozdnyakov agreed to provide information on these sensors for the IOCCG webpage.

ACTION 16/12: DMITRY POZDNYAKOV TO PROVIDE UPDATES ON THE METEOR-3M MISSION FOR THE IOCCG WEBSITE (SUBMIT TO VENETIA STUART).

5. Agency Contributions to the OCR-VC Implementation Plan

5.1 Current status of the OCR-VC Implementation Plan

Mark Dowell reported on the implementation plan for the Ocean Colour Radiometry-Virtual Constellation (OCR-VC), which was initially proposed by Jim Yoder as IOCCG Chair. He outlined the mandate of the VC's which build on existing projects and activities to provide political visibility. Many of the OCR-VC targets are linked to CEOS WGs, *e.g.* providing high quality data sets (WGCV), data harmonization and supporting ECVs (WGClimate), facilitating timely and easy access to data (WGISS), and capacity building and outreach (WGEdu).

At the last IOCCG meeting in Rio de Janeiro, two priorities were identified for the OCR-VC: (i) inter-agency ocean colour ECV implementation strategy and execution, and (ii) inter-agency effort on activities related to sensor inter-comparison and uncertainty assessment of datasets required for ECV generation. The latter resulted in the formation of the INSITU-OCR (International Network for Sensor InTercomparison and Uncertainty assessment for Ocean Colour Radiometry). Progress on these two priorities included

feedback on the GCOS Implementation Plan, input for the Climate SBA, continued work on product level gap-analysis for OCR across CEOS agencies, and the kick-off of ESA's ocean colour CCI project. In addition, there was an INSITU-OCR side meeting at Oceans from Space, and a dedicated Cal/Val workshop at the CEOS IVOS conference in Oct. 2010 (held at JRC).

The OCR-VC is taking advantage of IOCCG output *e.g.* Reports 8 and 9, the SAFARI symposium and ChloroGIN workshop. Foreseen milestones include a preliminary OCR Community White Paper on INSITU-OCR by summer 2011 and preparation of a preliminary implementation strategy for the ocean colour ECV (Q4 2011), in consultation with the CEOS WGClimate.

5.2 Update on the INSITU-OCR and OCR Cal/Val workshop

Hiroshi Murakami reported on the INSITU-OCR, a concerted inter-agency effort on activities related to sensor inter-comparison and uncertainty assessment of datasets required for the generation of ocean colour ECVs. This represents one of the main priority areas of the OCR-VC. In addition, recommendations and required resources are being addressed. The INSITU-OCR was initially proposed at the IOCCG-15 meeting, (January 2010), a side meeting was held at the Oceans from Space conference (April 2010), and it was introduced at the CEOS Plenary (November 2010). In addition, an OCR Cal/Val workshop was held at JRC (October 2010) in conjunction with the CEOS WGCV-IVOS. Many of the current IOCCG WGs are addressing critical aspects including atmospheric correction, vicarious calibration and Level-1 requirements of ocean colour sensors. A preliminary OCR Community White Paper on requirements for the INSITU-OCR will be produced by summer 2011. Topics discussed at the JRC workshop included calibration, *in situ* data (protocols and validation), algorithm development, and product inter-comparison and data merging. The group promoted networking across agencies and had intended to identify gaps at the agency/sensor level but this was not done because of time limitations. They identified resources required for individual activities and made recommendations which were linked to Quality Assurance for Earth Observation (QA4EO) process.

5.3 NASA Update

Gerhard Meister briefed the Committee on NASA's ocean colour-related activities. The Ocean Biology Processing Group was responsible for producing ocean colour products from various sensors. An orbit-raising manoeuvre for SeaWiFS was executed successfully in July 2010, but then communication had been lost and the sensor ceased functioning. SeaWiFS reprocessing was successfully completed in November 2009 and again in September 2010. Both MODIS-Aqua and Terra are in nominal operations and beyond their scheduled life time, but it was suspected that operations will continue for both sensors. MODIS-Aqua reprocessing was completed in April 2010 and there is now a much improved agreement between MODIS and SeaWiFS for clear-water Chl –a. The trend in the fluorescence line height was also adjusted. Another reprocessing of MODIS-Aqua is expected to start soon. MODIS-Terra reprocessing was completed in January 2011 resulting in good agreement with SeaWiFS and MODIS Aqua, but the required

corrections were very large, so data should be used with caution. VIIRS is undergoing testing at Boulder, Colorado and is scheduled for launch in October 2011. The NASA Ocean Biology Processing Group (OBPG) will evaluate the data from VIIRS but the products will be distributed by NOAA.

In June 2010 the ESA-NASA Framework for Cooperation evaluated a proposal for bulk data exchange between NASA (MODIS Aqua and Terra, SeaWiFS) and ESA (MERIS). The OBPG goal is for MERIS products to be processed with NASA algorithms for comparative trend analysis. MERIS processing capability (FR and RR) has been incorporated into SeaDAS.

Future NASA missions include the Aerosols, Clouds and Ecosystem (ACE) mission carrying several sensors including a hyperspectral ocean colour radiometer (1-km spatial resolution). The ACE mission has a scheduled launch date of 2020 or later. The PACE mission (Pre-ACE) will carry two instruments only (an ocean colour radiometer and a polarimeter) with similar requirements, and should be launched around 2019. NASA's GEO-CAPE mission (Geostationary Coastal and Air Pollution Events) will provide surface reflectance at high spectral, spatial and temporal resolutions from a geostationary orbit for studying air quality issues and their impact on global atmospheric composition processes. The data will also be used to address key water quality, ocean chemistry, and ecological science questions in the coastal ocean and its response to climate change. Three instruments will be carried on one spacecraft: a UV-VIS-NIR spectrometer (7-km nadir spatial resolution, hourly repeat), an Event-imaging spectrometer (250-m resolution), and a TIR correlation spectrometer (CO observations). Launch date has not been set but 2018 would be the earliest.

NASA also has collaboration with ISRO regarding OCM-2 data. A processing software chain was developed using algorithms and formats consistent with SeaWiFS and MODIS. The source code was provided to ISRO and also distributed to the research community through SeaDAS. In addition, instrument calibration and sensor performance was evaluated and a baseline instrument calibration was established that enabled production of meaningful OC products with standard NASA algorithms.

5.4 ESA: Status of Envisat/MERIS and Sentinel-3 Mission

Peter Regner reported that the Envisat orbit had been lowered by 17.4 km in October 2010 to allow operation of the mission for an additional 3 years. Envisat continues to operate well. It is now in a 30 day cycle with no orbit inclination control so the orbit will drift over time. To date no anomalies have been reported due to the different orbit and MERIS continues to provide stable and well calibrated data. MERIS 3rd reprocessing was underway: Level-1 was completed using an improved instrument radiometric degradation model and improved pixel classification. Level-2 reprocessing is still on-going but should be completed soon. Vicarious calibration was accomplished using BOUSOLLE and MOBY data, which removed much of the bias. The Case-1 Chl algorithm was changed to OC4Me and a new Case-2 water neural network was used. The target date for completing the 3rd reprocessing is around March 2011.

Over the next few years, a number of new long-term operational EO satellite series will be launched in Europe in the frame of the GMES programme. GMES is an official EU program with high political support from European member states. Five Sentinel missions are currently under development as operational missions representing the European contribution to the GEOSS. These missions will substantially increase the ability to provide, on a sustained basis, reliable, frequent, consistent, timely and long-term collections of remotely-sensed data of uniform quality to European and national policy makers. The GMES space component is coordinated by ESA. Sentinel-3 is the global land and ocean monitoring mission and two units (A/B) are required in orbit at the same time to fulfil the data requirements for the GMES services. The optical payload includes the Ocean and Land Color Instrument (OLCI) and the Sea and Land Surface Temperature Radiometer (SLSTR). OLCI has 15 MERIS bands plus 6 additional bands. It is tilted to minimise sun-glint, and full resolution (300m) is acquired systematically over both land and ocean. It will have improved data delivery timeliness within 3 h of acquisition for L1 and L2. Launch of the Sentinel-3A is currently foreseen as mid-2013. EUMETSAT is in charge of the operation of the OLCI marine part and ESA will be the operator of the land part. Launch of Sentinel-3B is around 2017 pending approval of associated budgets. The primary use of Sentinel-3 is for marine monitoring services in response to European policy priorities. The operations concept will rely on a Core Ground Segment providing the primary access to Sentinel missions data as well as a Collaborative Ground Segment funded nationally or via services outside of the ESA GMES Space Component programme. The Collaborative Ground Segment shall provide either additional data acquisition and RT production capabilities or offer complementary products and innovative tools and new applications. The data policy is free and open access to Sentinel-3 data to all users.

An advanced ESA-MOST training course on ocean remote sensing will take place in October 2011 in China.

5.5 EUMETSAT: Capabilities and Involvement in Ocean Colour Services

Hans Bonekamp outlined the primary objective of EUMETSAT which is to establish, maintain and exploit European systems of operational meteorological satellites. EUMETSAT is an operational agency providing European metrological services and they are responsible for procurement of ground segment and launch services. The Sentinel-3 programme is co-funded by ESA and EC. ESA is leading the development of the S3 ground and space segments and EUMETSAT is supporting the ground segment development through ESA/EUMETSAT integrated teams and collaborative activities. ESA will be responsible for producing land L2 products, while EUMETSAT will be responsible for producing the marine L2 products. Data will be disseminated from both agencies.

The Sentinel-3 mission advisory group will soon appoint an optical scientist who will interface with the IOCCG. EUMETSAT are also constructing a new dedicated building for the installation of the Ground Segments. Data dissemination of OLCI will be operational, near-real time and freely available. FR data will be collected over the whole globe but there is still some debate about whether the FR data will be processed only over

coastal zones, or over the entire globe. For climate monitoring, EUMETSAT will provide and maintain satellite-based Climate Data Records (CDRs) over decades with the highest possible level of accuracy, homogeneity, reliability and stability. Reprocessing capability is mandatory, the frequency of which will be specified in the Cal/Val plan. There will also be interaction with algorithm providers.

5.6 CSA: Support to the Ocean Colour Community

Yves Crevier reported that CSA's interest in ocean colour is to enable end-users to exploit ocean colour data in support of programs such as fisheries management, ecosystem protection, coastal zone management, and climate change. CSA is a relatively small agency, with a relatively small budget and currently invests in robotics, rovers, space exploration as well as Earth observation (mainly SAR but also including OCR). In this regard CSA has invested in operationally-focused science (estimating primary production in the Canadian Arctic, water quality products etc.), as well as building MERIS infrastructure in Canada for the reception and processing of MERIS full resolution, NRT data. The investment made by CSA has led to improved management of Canadian marine resources while preparing Canadian users to take advantage of the ESA Sentinel-3 Mission.

One of the key elements is to demonstrate how investment made by CSA returns as societal benefits. This is being supported through programmes such as SAFARI and FARO. Canada is a world leader in the ocean colour community with a large community of researchers working on projects with various international space agencies. However, there is no single Canadian voice to CSA on ocean colour so a proposal has been submitted to develop a "science cluster" to provide a common voice for the community (government, universities, industry) on satellite remote sensing of the oceans. CSA participation in IOCCG is a mutual arrangement: the IOCCG adds value in science and advocacy roles, translates the outcomes to societal benefits and plays and important role in defining new missions, linking the science with the end-users needs and providing a common global perspective. CSA supports and contributes to IOCCG and FARO and contributes to the accessibility of MERIS data.

Dr. Crevier also introduced the proposed PolarSAT geostationary constellation for polar communication and weather, which may be of some use to the OC community. The mission will include two instruments in a Molniya-type orbit scheduled for launch in 2014 and 2015. The mission will provide almost continuous visibility of the polar area.

5.7 KORDI: GOCI mission update and plans for GOCI-II

Yu-Hwan Ahn reported on the geostationary GOCI mission as well as plans for GOCI-II. The GOCI ground spatial resolution is 500 x 500 m and is sampled 8 times per day over a target area of 2500 x 2500 km divided into 16 frames. The GOCI/COMS mission was launched on 27 June 2010. All in-orbit functional tests carried out by KARI and ASTRIUM were fine, as well as the ground tests carried out by KARI and KORDI. Image post-processing (GDPS) tests are still on going. There were small changes in the radiometric calibration before and after launch which were corrected. The solar diffuser

aging factor is being monitored (~0.35%) and the radiometric gain is ~1-2% lower over time. The main atmospheric correction algorithm for GOCI is the SSMM v 2 (Spectral Shape Matching Method) with the optional SGCA (Sun Glint Correction Algorithm). The SSMM method agrees well with MODIS in clear and mixed waters, but not for turbid waters in the red wavebands.

One of the problems is the discrepancy of slot-to-slot of signal intensity which is currently under investigation and should be resolved soon. Level-2 processing is being implemented using the GDPS software (similar to SeaDAS). GOCI image quality compared well with MODIS-Aqua. GOCI data can be used to monitor suspended solids, sea ice, forest fires, volcanic eruption and movement of ash, typhoons, heavy snow and dust, all with a high temporal resolution. GOCI Level-1B data should be available by April 2011, free of charge, and within 2 h for local users (1 d for foreign users).

The follow-on GOCI-II mission was approved by the government in 2010 and is scheduled for launch in January 2018. Emphasis will be placed on coastal regions using a multi-sensor approach to include environmental measurements at a high temporal resolution (every hour) to monitor long term global climate change. Key requirements include 13 spectral bands (up from 8 for GOCI) with a spatial resolution of 250 m (cf. 500 m for GOCI). Additional requirements for IR bands are still under examination. Night time observations are also being investigated.

5.8 JAXA: GCOM-C/SGLI progress

Hiroshi Murakami updated the Committee on the GCOM-C mission, which is in engineering model development. It was anticipated that the minimum budget would be obtained so the next phase could be started, including sensor development and calibration, software implementation, and algorithm development. A second research announcement had been released. Details of standard products and research products will be designed this year. SGLI characteristics include a finer spatial resolution (250 m) for coastal observations, and polarization/along-track slant view channels which will improve land, coastal, and aerosol observations.

Standard GCOM-C data products (Levels-1, 2 and 3) will be distributed free of charge from the JAXA data portal, a common system for several other missions. The current policy is that re-distribution is limited to pre-defined users identified by JAXA. All Level-0 data will be received at the Svalbard station, via a direct receiving capability with a scheduled downlink. Algorithm and Cal/Val information will be distributed via the JAXA website.

5.9 Update on NOAA contributions to the OCR-VC

Paul DiGiacomo reviewed NOAA's contributions to the Ocean Colour Radiometry-Virtual Constellation. Addressing OCR Continuity, NOAA supports VIIRS on NPP (NPOESS Preparatory Project). JPSS is NOAA's portion of the restructured National Polar-orbiting Operational Environmental Satellite System (NPOESS) program. JPSS will provide operational continuity of satellite-based observations and products for

NOAA Polar-orbiting Operational Environmental Satellites (POES) and the NPP mission. VIIRS should be ready for launch by 25 October 2011. The empirical algorithm OC3V (equivalent to MODIS OC3M) has been requested as the default operational algorithm for chlorophyll retrieval, switching from the Carder semi-analytical algorithm, and likewise a request is being made to update associated coefficients specifically for VIIRS spectral bands. Mission level reprocessing is not part of the JPSS operational program, but it is recognised that this is a critical requirement for the NPP/VIIRS data stream, so efforts have been initiated to implement the necessary hardware (storage and processors) required through alternative mechanisms within NOAA. Eight working groups are investigating ocean Environment Data Record (EDR) products and calibration.

An *in situ* vicarious calibration facility for ocean colour sensors, such as MOBY, is required to ensure high quality data sets. The current MOBY is > 14 years old, and is aging/failing so a new buoy is needed. Funds for MOBY-C, as well as MOBY continuation funds, have been requested but not yet secured. Regarding the "Data Harmonization" objective of OCR-VC, the NOAA/NESDIS Center for Satellite Applications and Research has submitted an internal NOAA proposal on "Satellite Ocean Colour Radiometry Fundamental and Thematic CDRs" which will examine the effect of on-orbit vicarious calibration on OCR, quantify product uncertainties, evaluate algorithms and develop an approach to merge SeaWiFS and MODIS-Aqua products for U.S. coastal waters.

Regarding the "Timely Access to Data" objective of the OCR-VC, MODIS and MERIS data have been used successfully to support the Deep Water Horizon oil spill responders. MERIS data were being received via CSA and/or ESA and there is continued interest in acquiring full resolution OCM-2 data for U.S. coastal waters. Upcoming NOAA operational OCR products will include global maps of *E. huxleyi* blooms (late 2011), MODIS SWIR-based coastal ocean colour products (early 2012), a chlorophyll frontal product (early 2012) and unique NPP products (~October 2013). Lastly, addressing the "Capacity Building and Outreach" objective, NOAA is active in the GEOSS Coastal Zone Community of Practice (CZCP) which brings together data providers and users to ensure that their observational needs are coordinated and addressed. A series of regional user workshops are underway.

The Chairman enquired whether the IOCCG should write a letter reiterating the need for MOBY, and it was agreed that words of support would be most welcome.

ACTION 16/13: CHAIRMAN TO SEND LETTER TO NOAA REITERATING THE NEED FOR ANOTHER MOBY.

5.10 CNES Programs in Ocean Colour: Parasol mission and geostationary interests

Juliette Lambin provided an update on CNES programs in ocean colour science, one of the major interests of CNES Earth observation programs. CNES supports a strong scientific community through dedicated research funding as well as several large-scale

projects. CNES launched the Parasol mission in 2004 to monitor clouds and aerosols, but it also has ocean colour capability. The mission is aging and has been moved to a lower orbit to minimize risk of collision. Mission extension has been granted until the end of 2011; 2012 is currently under review. The follow-on mission is the 3MI instrument concept (multispectral, multidirectional and multipolarization). A Phase 0 study is underway to design a "next generation" polarimeter (similar to the 3MI concept) for deployment on NASA's PACE mission. A secondary interest is a geostationary mission. A decision was made to start a "Phase 0" study at CNES on an Ocean Colour Advanced Permanent Imager (OCAPI). This concept had been submitted to ESA but it was not selected despite good reviews. Phase 0.2 of the GEOCAPI instrument (geostationary) is still on-going at CNES (Lead Investigator: David Antoine). The target launch date is now closer to 2020. CNES is also contributing to high quality data sets by supporting various Cal/Val activities such as the BOUSSOLE Project, SIMBADA radiometers, gliders and the development of the next generation of BIO-Argo floats. CNES also supports core/downstream services through Mercator-Ocean with funding directed to research and development activities with a focus on "Green Mercator". Mercator is the lead of the MyOcean Project (GMES Marine Core Services).

5.11 Status of ISRO OCM-2 Mission

Prakash Chauhan reported on the status of the Oceansat-2 mission (launched in 2009) carrying the OCM-2 instrument. Local area coverage (LAC) is at 360 m resolution with real time transmission to ground stations around India while global area coverage (GAC) is at 1-km resolution with on-board data recording. Full global coverage is acquired in staggered mode over 8 days due to power constraints for the other instruments. A permanent Cal/Val site has been set up near the island of Kavaratti in the Lakashdweep Sea with an optical buoy to collect hyperspectral observations of light, chlorophyll-a, temperature and aerosol optical depth. This *in-situ* data set has been used for vicarious calibration of ocean colour radiance from OCM-2. Inter-sensor calibrations with MODIS and SeaWiFS have also been executed, and lunar calibration of OCM-2 is under way in conjunction with NASA. Initially, large discrepancies were found in the radiometric behaviour of OCM-2, which overestimated TOA in most channels compared to Oceansat-1. Better agreements were obtained after application of revised calibration coefficients. Some differences were also obtained when comparing OCM-2 and MODIS data. OCM-2 data can now be processed in SeaDAS following extensive collaboration between ISRO, NASA and NOAA. For global data product generation, OCM-2 data yields large gaps in the southern hemisphere as a result of sun glint (the instrument is only tilted once per year). The entire data set from January 2010 to January 2011 is being processed with the help of NASA. GAC 1-km data products are now freely available via a web portal, which also provides L1 radiance products. LAC data and geophysical products are available from the NRSC Data Centre in Hyderabad.

Future ISRO ocean colour missions include plans for multi-spectral, multi-resolution imaging instruments on a geostationary platform (HR-GEO). Furthermore, there are plans for another three polar orbiting satellites, each carrying a 13-band OCM instrument (Oceansat-3A, B and C). OCM-3 will have fluorescence capability and perhaps two

additional thermal bands, with a resolution of at least 500 m. Input was requested from IOCCG members regarding band placement for OCM-3.

ACTION 16/14: IOCCG COMMITTEE MEMBERS REQUESTED TO SUBMIT SUGGESTIONS FOR BAND PLACEMENT ON OCM-3 TO PRAKASH CHAUHAN.

5.12 INPE: Argentine-Brazilian SABIA-mar mission

The Chairman presented an update on the joint Argentinean/Brazilian SABIA-Mar mission on behalf of Milton Kampel. Requests for funding of Phase A had been approved. Brazil will provide the platform (Brazilian Multi-Mission Platform – MMP) as well as the payload for global observations, while Argentina will provide the regional payload. Launch costs will be shared and use of data will be guaranteed for both parties (open data policy). The SABIA-Mar ocean colour instrument will have a total of 16 bands, with a swath of 2800 km and a resolution of 1 km. The SABIA-Mar mission has been split into a global mission with 1.1 km spatial resolution and 2200 km swath (SABIA-Mar 1, scheduled for launch in 2016), and a regional mission with 200 m spatial resolution and 200 km swath (SABIA-Mar 2), although this has not been fully approved.

6 OCR-VC Way Forward

6.1 GHRSST: Data Processing Framework - Status and Developments

Andrea Kaiser-Weiss provided a good example of what has been accomplished within the SST community through the GHRSST Project (Group for High Resolution Sea Surface Temperature), an operational and mature service providing SST to operational users and the science community. Data flow is based on regional data assembly centres (29 in total) and then ingested into a global data assembly center with strict quality control and a meta-data repository (30 day rolling archive). A range of products are generated for various projects. The basis for data sharing is to have a common format to ensure data stability, using common standards and common processing. The GHRSST Data Specification Revision 2.0 has just been released. The data is then transferred to a long-term stewardship and reanalysis facility with an emphasis on adhering to international standards. The GHRSST international science team examines ways to improve data and applications through a number of working groups (validation, problems in high latitudes, rescue & reprocessing historical archives, inter-comparisons etc.). A SST virtual constellation was recently proposed to CEOS. Data usage requires quality flags and error estimates and handling the diurnal variability. GHRSST is independent but well linked to national and international space agencies, Met-Offices and major research institutes. It also interacts with a number of international projects.

6.2 OCR Contributions to GCOS and CEOS WG on Climate

Mark Dowell reported on OCR in the new GCOS implementation plan. The action to implement continuity of ocean colour radiance datasets through the OCR-VC was assigned to CEOS space agencies, in consultation with IOCCG and GEO. The products required for the ocean colour ECV had been redefined to include water leaving radiance

as well as oceanic chlorophyll-a concentration. CEOS recently endorsed the formation of a WG on Climate to coordinate and encourage collaborative activities between the world's major space agencies in the area of climate monitoring. The mandate of this new WG is to facilitate the implementation and exploitation of Essential Climate Variable (ECV) time-series through coordination of the existing activities undertaken by CEOS member agencies. Mark Dowell is the Chair of this new CEOS WG. The WG was starting to map roles and responsibilities and could recommend ocean colour as a pilot project to be promoted in CEOS at large.

6.3 Prioritization of the OCR-VC Implementation Plan

Mark Dowell pointed out that the Chairman's "Roadmap" document provided the scientific basis for the OCR-VC implementation plan. This could be used in the implementation plan or published as a separate document. He suggested that the IOCCG should consider the creation of an IOCCG standing working group on ECV quality control. He also suggested that the IOCCG could be proposed as a pilot study for the CEOS WG on Climate, to which the Committee agreed. Ocean colour radiometry is the only ECV that represents the biosphere. Mark Dowell agreed to go ahead and see if the opportunity existed for a pilot study, and would keep the Chairman informed.

6.4 OCR-VC way forward, including the INSITU-OCR network

Mark Dowell highlighted the priorities of the INSITU-OCR network, including the publication of a White Paper to document the recommendations and identify the gaps and resources required (*e.g.* support for MOBY-C). The material from the Ispra meeting (Cal/Val, data processing, algorithms, data merging, data access) could be used, but he would also like to confirm a writing team. Mark Dowell and Hiroshi Murakami agreed to prepare an outline of the White Paper and would contact specific people to try and find a lead for the project. The introductory material could be taken from existing IOCCG reports.

ACTION 16/15: MARK DOWELL AND HIROSHI MURAKAMI TO PREPARE AN OUTLINE FOR THE INSITU-OCR WHITE PAPER.

Mark Dowell also requested that each agency nominate someone to contribute to the preparation of this document. He agreed to send the template to the agency representatives so that they could nominate someone to contribute towards a specific section.

ACTION 16/16: IOCCG AGENCY REPRESENTATIVES TO NOMINATE RESPONSIBLE PERSON TO JOIN THE WRITING TEAM FOR THE INSITU-OCR WHITE PAPER (SUBMIT TO MARK DOWELL AND HIROSHI MURAKAMI).

Both Hiroshi Murakami and Mark Dowell would like to rotate off as co-leads of the OCR-VC. They agreed to help but could no longer lead the group. Prakash Chauhan had been contacted to substitute Hiroshi Murakami and he agreed in principle, with some limitations on travel. Peter Regner had agreed to replace Mark Dowell. The transition

from existing co-leads to new co-leads would take place after the SIT meeting. Mark Dowell would attend the CEOS meetings as the Climate WG Chair so he could give presentations for the OCR-VC as well, if required. Additional OCR-VC meetings would be required if the virtual constellations are tasked to foster implementation of the ECVs.

7. Ocean Colour Related Projects

7.1 CSA sponsored projects SAFARI and FARO

Trevor Platt reported on two GEO programs related to ocean colour that are coordinated internationally from Canada: the SAFARI and ChloroGIN Projects. ChloroGIN is a global international network for promoting ocean colour and related satellite and in-water observations to assess the state of marine, coastal and inland water ecosystems for the benefit of society. It addresses GEO Task EC-09-01c (Regional Networks for Ecosystems). ChloroGIN has a number of regional nodes including the Antares program in South America, which developed from IOCCG and POGO training initiatives, and a program in the Indian Ocean coordinated by INCOIS (includes East Africa, India and Mauritius). The group is trying to develop another node in East Asia with the help of Joji Ishizaka. GEO has offered to help find sponsors for regional work in underdeveloped countries, specifically for infrastructure development. A proposal has been submitted to GEO along these lines, and it has passed the first level of approval.

The SAFARI Project aims to accelerate the assimilation of EO data into fisheries research and ecosystem-based fisheries management. This includes development of a world-wide network of scientists working in this field, and also includes capacity building. One initiative of the project was to prepare a monograph which was published in the IOCCG series of reports. An international symposium on remote sensing and fisheries was held in Kochi, India (February 2010) and was preceded by training course, and followed by a ChloroGIN workshop. The special issue of the ICES Journal of Marine Science containing the papers from symposium had just been published. The SAFARI and ChloroGIN Programs are linked under the FARO Project, but the identity of each is preserved. International coordination of these two programs has been funded by CSA for 3 years. Some proposed activities under FARO include another ChloroGIN workshop, and a second international symposium on remote sensing and fisheries (possible venue Mar del Plata, Argentina). In addition, there will be outreach to the fishing sector and the publication of a full length book on remote sensing and its use in biological oceanography (to be edited by Peter Koeller).

7.2 Models to derive pigment specific growth rates and surface leaving irradiance

Stephanie Dutkiewicz spoke about some of work she was doing using ecosystem models to understand global ocean ecosystems and the health of the oceans. The philosophy behind the models is that there is a lot of genetic diversity in phytoplankton populations, and various forces such as competition for resources and predation will select which types survive, resulting in a particular community structure selected by the environment. The models are initialized with many potentially-viable organism types and interactions.

Parameters (rates) are chosen randomly within a reasonable range, and the system is allowed to self-organize. After 10 years, a fairly distinct seasonal cycle is obtained, many phytoplankton groups die out, and some survive in distinct habitats. These are placed into functional groups (*e.g.* diatoms), with different traits (*e.g.* gleaners, nitrogen fixers). Pigments and absorption spectra dictate the vertical distribution of phytoplankton functional types in the water column. The model can be used to understand biogeography, nutrient supplies, phytoplankton diversity etc.

Currently models relate (usually in validation) most directly to remote sensed Chlorophyll products, but new model developments are leading the way to relate also to satellite data such as water leaving radiance, backscattering and absorption. Model output of these quantities will provide a closer (and potential cleaner) link with ocean colour data, especially functional types. The MIT ecosystem model is developing such model products.

There is a growing community using ocean colour for data assimilation, mostly these are using Chlorophyll. However water leaving radiance, might be more useful for assimilation, and other data, such as that from the BIO-Argo floats for vertical distribution, will be essential. As ocean biogeochemical data assimilation becomes more mature, the role of ocean colour products for assimilation could be the topic of a future IOCCG working group. Mark Dowell endorsed this suggestion to bring together modellers and OC scientists to discuss assimilation as it is important for the CEOS WG on Climate, and he would be willing to contribute.

7.3 Ocean colour activities in Australia

Peter Fearns gave a brief overview of ocean colour activities in Australia, on behalf of Scarla Weeks. There is a national collaborative research infrastructure (NCRIS), as well as an integrated marine observing system (IMOS) with a marine data archive, which includes remote sensing data, accessed through the IMOS data portal. A new project is a web-based interface enabling users to access processing modules (NeAT). A shallow water working group and a bio-optics working group provide guidance and support for bio-optical activities in Australia (funded through IMOS). The Lucinda Jetty has a number of optical instruments providing measurements for validation of coastal-ocean colour radiometric products applied to biogeochemistry and climate studies in Australia. A number of other projects were discussed including inter-comparison of shallow water bathymetry, development of an algorithm to retrieve water column properties in shallow water, sediment mapping, green tides in China, HABs in the Swan river, and modelling particulate scattering using the DALEC instrument.

8. Capacity Building

8.1 IOCCG Summer Lecture Series

The Chairman outlined his proposal for a high-level IOCCG Summer Lecture Series which fell within the overall objectives of the IOCCG. Past IOCCG training activities

were devoted primarily to capacity building in developing countries. This could be complemented with a permanent, recurrent Summer Lecture Series, dedicated to high level training in the fundamentals of ocean optics, bio-optics and ocean colour. The course is timely as there are not many such courses in universities and well-trained scientists are required to make progress in the next decade. The goal is to focus specifically on major unresolved issues that impair progress, through a series of lectures presented by highly-respected scientists in their respective fields. The duration of the course would be 2-3 weeks and it would take place in Villefranche. Feedback on the proposal from IOCCG Committee members included recommendations that this new initiative should not develop at expenses of existing initiatives. They also indicated that the cost was rather high (it has since been reduced) and that hands-on sessions should be include, although this might lead to confusion with other more practical training initiatives. The decision would be left up to the lecturers. The proposal has been updated taking the Committee's comments into account, and proposals for funding have been submitted to various institutions. Discussions had also taken place with Emmanuel Boss, as there was some concern about possible conflict with the summer course at Darling Marine Center (University of Maine), taking place this summer. Currently there were 8 confirmed lecturers, with a few other tentative lecturers for this summer. The budget was based on no cost to the students and most of the funding required was available this year. If it was decided that the course should be postponed to next year, then most of the funds could be transferred.

Trevor Platt enquired whether the IOCCG budget had also been adjusted downward, since the other costs had been reduced, and was assured that the direct contribution from IOCCG would be reduced, if possible. Stewart Bernard pointed out that elucidating the structure of the training course was very important and should include aspects such as theory, in-water optics and transfer to applications. Roland Doerffer suggested that a fee should be charged because some students might be able to obtain funding. It was envisaged that 12 students would be accepted, based on selection criteria. Trevor Platt was concerned that students from developing countries might not be selected based on the criteria, and that part of the role of the lecture series should be to give opportunities to everyone. Yves Crevier enquired whether the course would always take place in France, since much of the funding was coming from France. The Chairman noted that it was recurrent funding, but the course could be moved to another location at a later stage. Paul DiGiacomo could perhaps cover the travel costs of lecturers from NOAA in 2012. There was a general consensus that the course should be postponed until the summer of 2012. Ian Robinson offered to help with the planning of the training course.

8.2 Potential ocean colour training course in Southeast Asia

Tasuku Tanaka introduced the joint Masters course between the Center for Satellite Remote Sensing & Ocean Sciences at Udayana University (Indonesia), and Yamaguchi University (Japan). It was difficult to organise such a joint course because the semesters do not overlap and each university has different requirements, but the goal was for students to obtain a double degree (one from each university). The lectures are delivered simultaneously via the internet between 15:10 to18:15 (Bali time), with two shared remote lectures per day. Lectures include radiative transfer, digital image processing,

disaster mitigation (GIS using satellite measurement), environmental remote sensing, oceanography and climate change. Udanaya University is looking for prominent scientist to give lectures for the current series of Masters students. Dr. Tanaka requested that IOCCG Committee members volunteer to give one or two lectures at the time of the next IOCCG Committee meeting in Bali (February 2012). About 10 lectures (at most) were required, 1.5 h each, focussing on ocean colour. Further details would be provided in due course. Trevor Platt noted, for information, that there were plans to hold a POGO training course in Nha Trang, Vietnam, in September/October next year.

ACTION 16/17: IOCCG COMMITTEE MEMBERS ENCOURAGED GIVE A 1.5 H LECTURE AT UDAYANA UNIVERSITY, INDONESIA, IN CONJUNCTION WITH THE IOCCG-17 MEETING (CONTACT TASUKU TANAKA).

8.3 Third NOWPAP training course on remote sensing data analysis

Hiroshi Murakami reported on the NOWPAP-PICES joint training course on remote sensing data analysis, on behalf of Genki Terauchi (NOWPAP CEARAC). The course will take place from 8 – 12 October 2011 in Vladivostok, Russia. The objective is to contribute towards capacity building in countries in the Northwest Pacific, to promote the utilization of remote sensing techniques for monitoring and assessment of open-ocean and coastal environments. NOWPAP requested financial support from IOCCG for one lecturer and one trainee to attend the course, and also requested that IOCCG disseminate the announcement of the training course (through the IOCCG mailing list and website). This would be discussed during the Executive meeting.

8.4 Handbook of satellite remote sensing image interpretation

Venetia Stuart updated participants on the "Handbook for Satellite Remote Sensing Image Interpretation", a training tool for researchers, teachers, and end-users interested in obtaining a better understanding of the structure and functioning of marine pelagic ecosystems using freely-available satellite data, including ocean colour data. The project is a joint project between the EU PRESPO Project and the IOCCG. Currently 18 case studies have been completed (with a further 2 in progress), based on a wide range of satellite imagery centered on four themes: air/water quality, phytoplankton & macroalgae, fisheries & aquaculture, and marine ecosystem characterization. The handbook is currently available in the "Training & Education" section of the IOCCG website, as well as on the PRESPO website. A limited number of DVDs will be issued by PRESPO in both English and Spanish, and the CSA-sponsored FARO Project will print a limited number of copies of the handbook

8.5 Next Africa training course/ Resources for IOCCG training courses

Mark Dowell reported that the next Africa training course would tentatively take place at the Mauritius Oceanography Institute (November 2011). Additional sponsors were still required so the date may slip to 2012. He also outlined the rationale for creating a collation of standardised ocean colour training material on behalf of Nicolas Hoepffner. This would avoid multiple handouts (often poor quality), the material could be used for

different training courses and it would provide a means for standardising the course syllabus for basic and intermediate courses (advanced courses would depend on state-of-the-art). The documentation would also help participants prepare for the course. An IOCCG working group could be established to produce the first version of the book. They could review the current status of OC training courses, examine the utility of a standardized training course material, establish an optimized structure of OC courses, review and harmonize the scientific content of a basic OC training course, and prepare training material to be published by IOCCG or by JRC in the Science & Technology series.

Stewart Bernard suggested that they should consider a web-based book for the training material, with quick printing options which could be easily updated. It was proposed that the training material be constructed in the form of modules, which would allow for more flexibility in the structure of a course. Paul DiGiacomo suggested that a standing IOCCG WG should be formed to keep oversight and interest. The IOCCG Committee agreed with the proposal and acknowledged the need for this type of documentation. It was suggested that Nicolas Hoepffner prepare a formal WG proposal using the guidelines on the IOCCG website.

ACTION 16/18: NICOLAS HOEPFFNER TO SUBMIT A FORMAL PROPOSAL FOR A NEW IOCCG WORKING GROUP TO PRODUCE STANDARDISED IOCCG TRAINING MATERIAL.

9. Organisation and Membership

9.1 Rotation of Committee members

The Chairman requested suggestions for potential new IOCCG members, and noted that only one member would be rotating this year.

9.2 Proposal to host IOCCG-17 Committee meeting

Tasuku Tanaka invited Committee members to attend the next IOCCG meeting, to be hosted by Udayana University (Bali Island, Indonesia). The university has approximately 18,000 students in 10 facilities, and also had a strong post graduate program. The Masters courses in the department of Environmental Science focussed on the coastal environment, marine biology & fisheries, and oceanography & remote sensing. The Center for Remote Sensing and Ocean Sciences (CReSOS) was established in 2004 at the University of Udayana, and is supported mainly by JAXA, PORSEC, Japan Fisheries Information Center, the National Institute of Aeronautics & Space, and Bogor Agricultural University. Dr. Tanaka is the Director of this Institute. By consensus, the dates for the next IOCCG Committee meeting were fixed at 28 February to 1 March 2012.

9.3 Proposal to host IOCCG-18 Committee meeting

Yves Crevier proposed hosting the IOCCG-18 meeting in eastern Canada in January/February 2013. The meeting would be organised in collaboration with Marcel Babin who recently received a Chair of Excellence for studying remote sensing in the Arctic. The meeting would be co-hosted between CSA and the Chair of Excellence. Regarding the venue, he would look for a similar set up to Dartington Hall, perhaps the Chateau Montebello in Quebec. The Chairman indicated that this proposal would be seriously considered. Prakash Chauhan proposed to host the IOCCG-19 Committee meeting (2014), either in Ahmedabad, located in the historic state of Udaipur, or in Bangalore. The Chairman welcomed a proposal from ISRO next year.

9.4 Closing Comments

The Chairman thanked Venetia Stuart for coordinating the arrangements of the meeting, and thanked PML for hosting meeting in such a lovely venue. It was a very intense, productive and fruitful meeting and he noted that every year there were more items on agenda, resulting in an interesting and motivating environment. He noted that it had been a pleasure to chair the meeting and wished everyone a safe trip home. Paul DiGiacomo thanked the Chairman for his time and efforts.

Actions - 16th IOCCG Committee Meeting
Dartington, UK, 15-17 February 2011

Action	Brief description	Status
16/1	Chairman to approach the OceanObs'09 Committee to encourage them to formally publish the White Papers from the Venice symposium .	Open
16/2	IOCCG Committee members to provide detailed comments on the CDR roadmap document (submit to David Antoine).	Open
16/3	IOCCG Committee members to provide feedback on the draft BIO-Argo report (submit to Hervé Claustre).	Open
16/4	IOCCG Committee members to provide feedback on the draft Geostationary Report (submit to David Antoine).	Open
16/5	Kevin Ruddick to provide justification for the inclusion of a 1020 nm band on future ocean colour sensors (submit to Gerhard Meister).	Closed
16/6	IOCCG Committee members to propose additional members for the Uncertainty Working Group, especially from Asia and South America (submit to Roland Doerffer).	Open
16/7	Roland Doerffer to submit a revised proposal for the Uncertainty Working Group.	Open
16/8	IOCCG Committee members to make recommendations for someone to write a chapter on "In-Flight Calibration" for the Calibration Working Group report (submit to Robert Frouin).	Closed – (Gene Eplee proposed)
16/9	IOCCG Committee members to submit suggestions for membership for the Polar Seas Working Group to Marcel Babin.	Open
16/10	Kevin Ruddick to prepare a revised proposal for the Round-Robin Inter-Comparison working group taking into account comments raised during the IOCCG-16 meeting.	Open
16/11	IOCCG Committee members to provide comments on the Ocean Colour CCI User Requirements document and submit to Stephanie Dutkiewicz.	Open
16/12	Dmitry Pozdnyakov to provide updates on the METEOR-3M mission for the IOCCG website (submit to Venetia Stuart).	Closed

16/13	Chairman to send letter to NOAA reiterating the need for anothe MOBY.	Closed
16/14	IOCCG Committee members to submit suggestions for band placement on OCM-3 to Prakash Chauhan.	Open
16/15	Mark Dowell and Hiroshi Murakami to prepare an outline for the INSITU-OCR White Paper.	Open
16/16	IOCCG agency representatives to nominate responsible person to join the writing team for the INSITU-OCR White Paper (submit to Mark Dowell and Hiroshi Murakami).	Open
16/17	IOCCG Committee members are encouraged to give a 1.5 h lecture at Udayana University, Indonesia, in conjunction with the IOCCG-17 meeting (contact Tasuku Tanaka).	Open
16/18	Nicolas Hoepffner to submit a formal proposal for a new IOCCG working group to produce standardised training material.	Open

Appendix I: LIST OF PARTICIPANTS

16th IOCCG Meeting Dartington Hall, UK (15-17 February 2011)

Invited Participants		**Affiliation**
Ahn, Yu-Hwan	-	KORDI, Korea
Antoine, David (Chair)	-	LOV, Villefranche, France
Barciela, Rosa	-	UK Met Office, UK
Bernard, Stewart	-	CSIR, South Africa
Bonekamp,Hans	-	EUMETSAT
Brotas, Vanda	-	Plymouth Marine Lab, UK
Chauhan, Prakash	-	ISRO, India
Crevier, Yves	-	CSA, Canada
DiGiacomo, Paul	-	NOAA, USA
Doerffer, Roland	-	Helmholtz Center Geesthacht, Germany
Dowell, Mark	-	Joint Research Centre (JRC), Italy
Dutkiewicz, Stephanie	-	Massachusetts Institute of Technology (MIT), USA
Fearns, Peter	-	Curtin University of Technology, Australia
Greb, Steven	-	Wisconsin Department of Natural Resources, USA
Groom, Steve	-	Plymouth Marine Laboratory, UK
Hardman-Mountford, Nick	-	Plymouth Marine Lab, UK
Henson, Stephanie	-	National Oceanography Centre, UK
Hirata, Takafumi	-	Hokkaido University, Japan
Kaiser-Weiss, Andrea	-	GHRSST Project Officer, NCEO, UK
Lambin, Juliette	-	CNES, France
Mao, Zhihua	-	Second Institute of Oceanography (SIO), China
Meister, Gerhard	-	NASA Goddard Space Flight Center, USA
Murakami, Hiroshi	-	JAXA/EORC, Japan
Pan, Delu	-	Second Institute of Oceanography (SIO), China
Platt, Trevor	-	POGO, UK
Pozdnyakov, Dmitry	-	NIERSC, Russia
Regner, Peter	-	ESA-ESRIN, Italy
Robinson, Ian	-	University of Southampton, UK
Ruddick, Kevin	-	Belgian Institute of Natural Sciences, Belgium
Sathyendranath, Shubha	-	Plymouth Marine Laboratory, UK
Shaw, Andy	-	Deputy Director, NCEO, UK
Stuart, Venetia	-	IOCCG Project Office, BIO, Canada
Tanaka, Tasuku	-	Udyana University, Bali, Indonesia

Apologies		**Affiliation**
Babin, Marcel	-	Université Laval, Québec, Canada
Bontempi, Paula	-	NASA HQ, USA
Claustre, Herve	-	LOV, Villefranche, France
Helbig, James	-	DFO, Canada
Hoepffner, Nicolas	-	Joint Research Centre, Canada
Ishizaka, Joji	-	Nagoya University, Japan

Kampel, Milton	-	INPE, Brazil
Morel, André	-	LOV, Villefranche, France
Weeks, Scarla	-	Univ. Queensland, Australia
Yoder, James (Past-Chair)	-	Woods Hole Oceanographic Institution, USA