

13th IOCCG Committee Meeting
Paris, France, 12-14 February 2008

MINUTES

1.0 OPENING

1.1 Welcoming Address

The Chairman, James Yoder opened the 13th IOCCG Committee meeting, which was held at the UNESCO Headquarters in Paris, France. The meeting was attended by a total of 37 Committee members and invited guests (see Appendix I for list of participants). The Chairman expressed his appreciation to Maria Hood for hosting the IOCCG meeting at UNESCO. Dr. Hood warmly welcomed the participants and informed them about the opening of International Year of Planet Earth in the UNESCO Fontenoy Building, as well as other logistical information.

Patricio Bernal, the Executive Secretary of the IOC, then delivered a welcoming address. He noted that the Commission was established in the 1960's to coordinate research by various government organisations, and informed participants that the IOC was instrumental in the establishment the IOCCG in 1996. He noted that the group played an important role in bringing the synergy of various groups together, and hoped that the continuity of ocean-colour sensors could be maintained.

The Chairman made reference to the exchange of letters between himself and ESA regarding the Community Letter to NASA and NOAA, which raised concerns about the VIIRS ocean-colour sensor on the NPP mission. In the letter he had mentioned issues with MERIS, and apologised to ESA and to the IOCCG Committee for using IOCCG in his signature designation. This had caused some concern within ESA for which Dr. Yoder expressed his regret.

Robert Frouin encouraged better communication between the providers and users of ocean-colour data, and suggested that the IOCCG also try to provide up to date practical information about data accessibility. The Chairman proposed holding a separate meeting at the next IOCCG Committee meeting for the various agency representatives to discuss issues of concern.

ACTION 13/1: SCHEDULE A MEETING FOR ALL AGENCY REPRESENTATIVES AT IOCCG-14 COMMITTEE MEETING.

1.2 Adoption of Agenda

The agenda was adopted with two minor modifications: the GOOS presentation would be given by Thorkhild Aarup instead of Keith Alverson, and Steve Groom would give the ChloroGIN presentation in place of Shubha Sathyendranath.

1.3 Adoption of the Minutes of the 12th Committee Meeting

The record the 12th IOCCG Committee meeting was approved as written.

1.4 Status of Action Items Arising from the 12th Committee Meeting

The Chairman summarised the status of the actions from the 12th Committee meeting, most of which had either been completed, or would be addressed later in the meeting.

Action 12/1 and 12/2: – Error analysis in ocean-colour imagery would be addressed under Agenda item 8.2.

Action 12/3: – Regional algorithms would be discussed under Agenda item 7.2.

Action 12/4 and 12/5: – Drs. Platt and Hoepffner were working on the “Why Ocean Colour” report, which would be addressed under Agenda item 2.2.

Action 12/6: – A working group for geostationary sensors would be discussed under Agenda item under agenda item 7.1.

Action 12/7: The PFT working group would be discussed under Agenda item 10.2

Action 12/8: Robert Frouin had not received any comments on the Calibration report, which would be discussed further under Agenda item 2.4.

Action 12/9: A report on the Atmospheric Correction working group would be addressed under Agenda item 2.3.

Action 12/10: The proposed Ocean Colour Constellation would be addressed under Agenda item 6.2.

Action 12/11: A working group had been formed to look at optical instrumentation on Argo buoys and would be discussed under Agenda item 10.1

Action 12/12: The Chairman had corresponded with JAXA regarding potential sponsorship

Action 12/13: The Wikipedia entry would be discussed under Agenda item 8.1

Action 12/14: Advanced training course in Germany would be discussed under Agenda item 8.2

Action 12/15: A descriptor of the term OCR had circulated

Action 12/16: Dr. Yoder had represented the IOCCG at the NASA Ocean Colour Research Team meeting (April 2007).

Action 12/17: Access to MERIS RR data would be discussed under Agenda item 4.3

2.0 IOCCG WORKING GROUP STATUS

2.1 Global Ecological Provinces

Mark Dowell, co-chair of the Global Ecological Provinces working group, reported that he had not made as much progress with the provinces report as he had anticipated, due to other work commitments. Members of working group had expressed an interest in continuing the task beyond the working group by establishing a dedicated website to present interpretations of various classification schemes. As far as the IOCCG report was concerned, it was crucial to complete the third chapter as soon as possible. Most of the material for the rest of the report was already in hand and just needed to be collated and edited. Dr. Dowell agreed to meet with the co-chair, Trevor Platt, during the first quarter of the year to bring the report to closure.

ACTION 13/2: MARK DOWELL TO MEET WITH TREVOR PLATT IN FIRST QUARTER OF 2008 TO FINALISE GLOBAL ECOLOGICAL PROVINCES REPORT.

2.2 Why Ocean Colour Report

Trevor Platt reported that at last IOCCG Committee meeting the “Why Ocean Colour” report had been handed over to himself and Nicolas Hoepffner to complete. He had hired a person whose dedicated duty was to help bring the report to a conclusion. An advanced draft of the report was now available for inspection on the IOCCG meeting website. One of the unfinished chapters was a forward-looking perspective on the future of ocean-colour research and operations. At this point in time, suitable material had only been received from NASA. Dr. Platt requested that all the other agency representatives submit information on the future of ocean colour in their respective agencies, which could then be used to draft a community vision of the future.

ACTION 13/3: AGENCY REPRESENTATIVES TO PROVIDE TREVOR PLATT WITH A VISION FOR THE FUTURE OF OCEAN COLOUR (ESA, JAXA, NOAA, ISRO, KARI, SOA).

Nicolas Hoepffner mentioned that this report would represent a complete and concise statement of all the application of ocean colour in the field of oceanography and would be read by a large community. He noted that there were places where the report could be shortened as there was a certain redundancy in the text. There could also be implications with printing if the report were too long. In addition, some of the chapters were too technical.

Peter Regner pointed out that the focus of the report appeared to be on SeaWiFS and MODIS and that MERIS had not been mentioned (only as a footnote), even though operational activities were on-going in Europe. Dr. Platt replied that the report was not yet complete, and that it was a reversible problem. He noted that the structure of writing was not based on a mission foundation but rather a discipline foundation, and was written by volunteers. The less apparent role of MERIS was a lack of volunteer authors and could easily be amended. It was suggested that reference be made to some of Roland Doerffer’s work on Case 2 processing to deal with the under-representation of MERIS, and that GlobColour should also be mentioned. Dr. Platt requested that authors prepare some text on a short time scale accompanied by suitable MERIS imagery, and that certain images could also be replaced by MERIS images.

Paula Bontempi noted that this report was most critical and did not just need the addition of MERIS data. The report should convey the importance of ocean-colour science for climate research internationally. Each agency should think of applications that could be demonstrated in this report and it should be brought to attention that not all the questions had been answered yet, but that some steps had been taken. Dr. Platt agreed that this could not happen unless operations were firmly linked with research programmes in an iterative manner. Peter Regner suggested that Pan Delu and other Agency representatives be invited to make a contribution on operational ocean-colour monitoring aspects, and André Morel suggested that the last chapter should deal with climate change and the role of ocean colour in predicting change.

ACTION 13/4: ROLAND DOERFFER, SAMANTHA LAVENDER AND OTHER COMMITTEE MEMBERS TO PROVIDE SUITABLE TEXT AND MERIS IMAGERY FOR WOC REPORT.

ACTION 13/5: PAN DELU TO PROVIDE TEXT AND IMAGERY OF OPERATIONAL OCEAN-COLOUR MONITORING IN CHINA.

Jim Helbig suggested that a brief executive summary was required. Yves Crevier pointed out that at the last Committee meeting the need for a short, brochure-sized document (~10 pages) had been identified. Patricio Bernal mentioned that the IOC routinely produced 4-page, double sided, policy briefs to highlight the important points for policy makers, which had proved to be very useful. Trevor Platt confirmed the need for a 10-page summary at the front of the report, which could have the potential to be printed separately as a brochure, and Jim Yoder and Paula Bontempi offered to write the Executive summary.

ACTION 13/6: JIM YODER AND PAULA BONTEMPI TO PREPARE AN EXECUTIVE SUMMARY FOR THE WHY OCEAN COLOUR REPORT.

2.3 Atmospheric Correction Algorithms

Menghua Wang had submitted a brief progress report on the Atmospheric Correction working group prior to the meeting. Some progress had been made: detailed evaluation results for algorithm comparisons from various sensors (based on common simulated data sets) had been shared within the working group. The group had prepared draft text for various sections, but there were still many chapters that needed to be finished. The group intended to complete the results comparisons within the next few months and would try to prepare a comprehensive draft report by the end of 2008.

2.4 Calibration of Ocean-Colour Sensors

Robert Frouin recalled that at end of 2004 a major calibration workshop was held in Freemantle, Australia, which provided most of the material presented in the report (apart from material about on-board calibration devices). After the workshop, there appeared to be a loss of interest and motivation, so Dr. Frouin had started to write the remaining chapters himself, and was almost finished. He noted that an action item from the last meeting was to provide comments on the first three chapters, but he had not received any comments. The Chairman mentioned that he would be pleased to review the complete draft and could find other people outside the committee to help review as well. Dr. Frouin was of the opinion that this report was still timely and would be very useful as a reference. Stewart Bernard mentioned that calibration had been identified as one of the key areas in the BIO-Argo working group, and he would be happy to help as well.

2.5 Bio-optical Sensors on Argo Floats

Herve Claustre, Chairman of the new BIO-Argo working group, was unable to attend the meeting so David Antoine gave his presentation. The working group was formed last year and the first WG meeting took place from 7-8 February 2008, in Villefranche. He noted that remote sensing was a powerful tool, but had limitations (restricted to the upper ocean, could not be used in cloudy areas, cal/val was dependant upon moorings or cruises). To reach its full potential, remote sensing must be complemented with other techniques. A network of ~ 3,000 Argo profiling floats currently samples the global ocean for temperature and salinity, down to depths of 2,000 m, which had led to a spectacular increase in the number of T & S observations at relatively low cost.

Recently, low-consumption, miniature, neutrally buoyant sensors (*e.g.* O₂ radiometers, fluorometers) had been developed and implemented on Argo floats for dedicated studies (*e.g.* SOLO and Apex floats). Argo floats with optical / biogeochemical sensors had the potential to provide high density, bio-optical-geochemical data at relatively low cost, and present a very promising avenue for synergetic applications with remote sensing of ocean colour. The BIO-Argo working group was established to investigate this topic and to make recommendations. Ideally, a BIO-Argo program should be implemented in close association with the physical community.

At the first WG meeting, a number of preliminary recommendations were formulated:

- i) Three types of Argo-like floats were recommended for bio-optical / bio-geochemical activities: VAL-Argo (validation only), BGC-ARGO (Biogeochemical and calibration) and C-Argo (for carbon).
- ii) A BIO-Argo mission simulator should be developed to evaluate additional costs (many related to energy costs).
- iii) A preparatory phase for the validation of different floats was recommended.
- iv) A pilot study was recommended before developing large scale applications (oxygen minimum zone a likely candidate).
- v) The WG should be opened to other scientists (an Asian representative, K. Johnson, plus members from the O₂ Argo group etc.)

Srinivas Kumar noted that INCOIS were active in deploying floats and had funding for another 200 floats. He agreed to propose someone from INCOIS to join the BIO-Argo WG.

ACTION 13/7: SRINIVAS KUMAR TO PROPOSE AN INCOIS CANDIDATE FOR THE BIO-ARGO WG AND SEND NAME TO HERVÉ CLAUSTRE.

Shubha Sathyendranath commented that POGO had looked into the idea of bio-optical sensors on Argo floats, but there were issues of sampling depths and demands on power supply. She suggested that it was worthwhile considering placing sensors on large marine mammals, as had been done successfully by the Census of Marine Life. Paula Bontempi noted that several groups at NASA had looked into putting various sensors on Argo floats, and that NASA could likely contribute funds to the proposed BIO-Argo pilot study. Maria Hood also noted that IOCCP had established a WG to put O₂ sensors on Argo floats and they had published a white paper on the subject.

2.6 Phytoplankton Functional Types

Cyril Moulin provided an update on the Phytoplankton Functional Types working group. Scientific discussions took place at the first WG meeting (Paris, July 2006) and a table of contents for an IOCCG report was drawn up at the second meeting (Montreal, October 2006). About one third of the contributions had been received to date. Jeremy Werdell (NASA) had agreed to include HPLC data with accompanying optical measurement in the NOMAD database for validation. Dr. Moulin provided an overview of the various chapters of the report and noted that he had been too busy over the past year to devote much time to the report, and that progress

had been too slow. In addition, the scope of the report required revision. This would be discussed at a WG meeting later that day.

The NOMAD dataset had been used to try and validate the Alvain *et al.* PFT algorithm. More than 80% of the cases had the correct identification of PFTs for haptophytes, but the success rate was lower for other functional groups. Other algorithms would also be validated.

CNES had funded a “PFT Inter-Comparison Project” led by H. Loisel to study various PFT algorithms, which was currently under way. The idea was to incorporate the results from this study into the IOCCG report. The results of the first inter-comparisons would be completed by July 2008, and would be distributed to WG members by email for discussion. The Chairman requested that Dr. Moulin contact him after the scheduled WG meeting to update him about the timeframe and plans for the WG.

ACTION 13/8: CYRIL MOULIN TO CONTACT JIM YODER ABOUT PLANS FOR THE PFT WORKING GROUP IN 2008.

3.0 OCEAN-COLOUR RELATED PROJECTS

3.1 ESA’s GlobColour Project

Samantha Lavender informed the Committee about the latest developments of ESA’s GlobColour Project. The second GlobColour user workshop was held in November 2007, and the third was scheduled to take place in Italy, in September 2008. The project was comprised of three phases: the first phase was a demonstration of feasibility (requirement baseline, software development, initial processing), the second phase was the generation and validation of the full product set, and the third phase was running the system in near real time.

Merged SeaWiFS, MODIS and MERIS GlobColour products were available from the start of SeaWiFS (09/1997) to the end of 2007, resulting in a very large (6-terabyte) dataset. A subset could be provided to users if required. The approach adopted by the GlobColour Project was not to choose one particular merging technique, but to apply an appropriate merging method to each product (weighted average, simple average, GSM model etc.). David Antoine’s statistical indicators from the individual-sensors’ products to the merged products showed that the main products (Chl, fully-normalized radiances and τ_a) were all performing well, with the best agreement between the three sensors being for nLw(490). The GSM Chl was always larger for MERIS than for MODIS-A or SeaWiFS.

Stephane Maritorena’s intercomparison summary with other similar initiatives demonstrated that the GlobColour data set provided better daily coverage due to the inclusion of MERIS data. The Chl data was consistent most of the time except in the coastal zone and the agreement between the GlobColour and REASoN merged CDM products was excellent. However, backscattering of particulates had some issues (MODIS b_{bp} values were more stable and reasonable, whereas values from SeaWiFS and MERIS were too high).

The GlobColour Project was scheduled to conclude at the end of 2008. Currently GlobColour chlorophyll data was being used by the European Marine Core Service, and there was interest in

continuing with the suite of GlobColour products. It was noted that GlobColour products were not yet at the quality required for climate change analysis.

Feedback from the user workshop indicated there was a strong interest for GlobColour to develop products specifically for the coastal zone. This could not be accomplished within the current project, but there were plans for a coastal zone preliminary study to generate products at a higher resolution (using MERIS full-resolution data) from various sites around the world. Feedback was requested from the IOCCG Committee on initial coastal sites for the preliminary study. Other suggestions were to consider including Parasol as a fourth sensor, to consider new products such (*e.g.* primary productivity, PAR), to distribute ocean-colour products to African users via ESA/DDS, and to assimilate GlobColour products into models.

ACTION 13/9: COMMITTEE MEMBERS TO PROVIDE SAMANTHA LAVENDER WITH SUGGESTIONS FOR COASTAL SITES FOR A GLOBCOLOUR PRELIMINARY STUDY.

In response to a question about the link between GlobColour and GEO, Dr. Lavender replied that GEO was aware of GlobColour and had discussions in the past. Shubha Sathyendranath inquired about the role of the IOCCG in evaluating GlobColour products, and was informed that the GlobColour documentation was routinely sent to IOCCG Committee members, and that an IOCCG representative attended all GlobColour meetings. The Chairman noted that it was difficult for IOCCG and IOCCP to provide feedback as a group, and meeting participants were encouraged to download GlobColour products for evaluation and provide feedback. He suggested that the IOCCG could consider sending more than one representative to the next GlobColour user workshop in Italy.

3.2 Role of Ocean Colour in IOCCP (International Ocean Carbon Coordination Project)

Maria Hood provided a brief overview of the IOCCP, which promotes the development of a global network of ocean-carbon observations for research. IOCCP maintains updated information on three global networks: repeat hydrography, underway $p\text{CO}_2$, and time-series stations. The IOCCP brings together the carbon community to analyze information from the networks to determine if the coverage is sufficient to meet research needs, if data from individual activities are comparable, and if mechanisms are in place to facilitate data sharing and data synthesis activities.

Recent activities include the publication of a “Guide of Best Practices on Oceanic CO_2 Measurement” and plans to conduct a number of training workshops based on the guide. A number of data synthesis activities were also being carried out including a Global Surface Ocean CO_2 Atlas based on an initial database of 1,250 cruises, which was the start of a pseudo-operational activity. A number of workshops are planned for this year, including one on ocean carbon and biogeochemistry time-series, and possibly a 2009 meeting on ocean CO_2 from space, in conjunction with the ocean-colour community (perhaps coinciding with the GlobColour and/or Ocean Optics meetings). New approaches for measuring ocean CO_2 included neural network techniques, using remote sensing data plus models to generate mixed layer depths, getting nutrients from that and correlating with *in situ* data and models.

3.3 GOOS (Global Ocean Observing System) and the Role of Ocean Colour

Thorkhild Aarup presented an overview of the GOOS project, which was established to provide international and intergovernmental coordination of sustained observations of the oceans. Objectives of GOOS include improving weather and climate prediction, improving management of marine and coastal ecosystems and resources, and enabling scientific research. GOOS was comprised of two components: an open ocean component advised by the Ocean Observations Panel for Climate (OOPC) and a coastal component advised by the GOOS Scientific Steering Committee (GSSC) and its PICO sub-committee.

Major accomplishments to date include Global GOOS (the open-ocean observing system for climate), Coastal GOOS (the coastal ocean observing system), and Societal Benefits (relevant components of GOOS used for operational hazard warnings). The open-ocean module of GOOS consisted of a number of systems *e.g.* Argo profiling floats, surface measurements from volunteer ships, global drifting surface buoy arrays, and continuous satellite measurements of SST, height, winds and ocean colour. GCOS (Global Climate Observing System) published an implementation plan for the global observing system for climate, and a supplementary report for the satellite-based component, which included requirements for ocean colour. Similar reports had also been produced by Coastal GOOS for the coastal ocean observing modules. Requirements for ocean colour tabled in these reports were fully compatible with those tabulated in the IGOS coastal theme report.

Satellite observations have played a major role in the development of GOOS, and ocean colour was identified as a core observation variable in several GOOS reports. Both the open ocean and coastal modules of GOOS had stated strong support for continuation of the satellite ocean-colour sensor series, and ChloroGIN had been adopted as a GOOS Pilot Project. Global GOOS relied primarily on satellite ocean-colour measurements whereas Coastal GOOS had a strong reliance on satellite ocean-colour remote sensing, as well as an *in situ* component of observations.

Paula Bontempi noted that ocean-colour observations were a suite of observations and that ocean biological and biogeochemical observations were critical, but did not appear to be supported by the open-ocean component of GOOS. Dr. Aarup reported that biogeochemical variables were being slowly incorporated into the GCOS plan. Srinivas. Kumar announced that Indian Ocean GOOS had adopted the ChloroGIN project and were working on providing products to members of GOOS, as well as establishing time-series stations to support product validation. Paul DiGiacomo noted that the open-ocean component of GOOS had a strong focus on physical observations and that there was a need to go back as a community to make sure that ocean biogeochemistry interests were adequately represented.

3.4 Joint efforts between Japan-Korea-China

Joji Ishizaka updated the Committee on joint efforts between Japan, Korea and China to address local concerns about the East China Sea, including high turbidity, harmful algal blooms, very large jelly fish (>1 m), and impacts from the construction of dams.

The Changjiang River discharged high concentrations of silt and CDOM into the East China Sea which could be monitored using satellite remote sensing. Inter-annual variations in chlorophyll over the last 10-years could also be monitored using remote sensing of ocean colour. Over the past 10-years the area had become very eutrophic. Under the North West Pacific Action Plan (NOWPAP) and Coastal Environmental Assessment Regional Activity Center (CEARAC), two working groups had been established with close connections to the IOCCG. WG3 focused on HABs while WG4 focussed on remote sensing (eutrophication and oil spills). The group had published several reports as well as a guideline for “Eutrophication in Coastal Area using Satellite Data”, and had held a number of international workshops and training courses including the NEAR-GOOS/ NOWPAP training course on Remote Sensing Data Analysis (Nagasaki 2007). Plans for 2008/09 included a Coastal Environment Assessment Workshop (7 March 2008) and a second training course, which required collaboration from other organisations.

Another initiative was the Yellow Sea Large Marine Ecosystem Regional Ocean Colour Algorithm project, which was a collaboration between Korea, Japan and China for data sharing and analysis. Preliminary empirical in-water algorithms for Chl, CDOM and TSM had been developed. Other activities included collaboration with IOC/WESTPAC to stimulate other Asian countries to do more research in this area. The terms of reference for the WESTPAC Ocean Colour Project included promotion of ocean-colour remote sensing applications in the WESTPAC region, networking with regional experts, improving basic oceanographic science for ocean-colour remote sensing and designing and implementing ocean-colour pilot projects.

Trevor Platt commented that Japan, Korea and China would form a natural part of the ChloroGIN network, but Dr. Ishizaka cautioned that it might be very complicated because of data sharing policies between the three countries. Paula Bontempi requested suitable field data to be contributed to SeaDAS, which would be very valuable for everyone.

4.0 AGENCY REPORTS

4.1 NASA (USA): Status of SeaWiFS and MODIS Missions

Paula Bontempi reported on NASA activities since the last IOCCG meeting, which included MODIS-Terra ocean colour evaluations and processing, investigation of vicarious calibration sources and methods for ocean colour sensors, NO₂ absorption correction algorithms, analysis on the effect of BRDF diffuse transmittance and implementation of new global products for evaluation (Fluorescence Line Height, PIC (calcite), POC, KPAR, Z_{eu}). Community feedback on the new products was welcomed.

The NOMAD/SEABASS data set had been updated and version 2 was expected to be released soon, and would include *in situ* data from the last three years as well as new measurements (POC, Z_{eu}, KPAR). HPLC data had been removed from SeaBASS for correction. NASA was also organising an IOP algorithm workshop to precede Ocean Optics XIX (October 2008), to achieve community consensus on the most effective algorithmic approach for producing global-scale, remotely sensed IOP products.

An onboard telemetry communication problem occurred with SeaWiFS on 1 January 2008, and the sensor had been in safe hold since that time. Instrument and spacecraft hardware function were unaffected. There was a planned switch to the B-side computer during February 2008 by GeoEye, Inc., (operators of the spacecraft) to resolve the believed problem. Other minor issues included a node drift approaching 1300 GMT, re-analysis of temperature correction and occasional momentum wheel anomalies (backup momentum wheel available).

The NASA group continues to provide free and open access to all ocean-colour mission datasets. It was recommended that all agencies should strive for this, to advance the science of ocean colour. SeaDAS continued to provide multi-satellite datasets, and NASA was currently in discussions with ISRO to provide OCM display and processing within SeaDAS. NASA's "OceanColor Forum" provided support for user and community discussion. SeaDAS training workshops had been held in various countries, and NASA was interested in participating in IOCCG training classes internationally.

Datasets from all sensors would be reprocessed, beginning in ~June 2008. Several updates would be implemented, including the vicarious calibration using the latest MOBY dataset, and updated Chlorophyll and K490 algorithms via NOMAD-2.

4.2 NOAA (USA): NPP and NPOESS Missions and Future Plans

Paul DiGiacomo gave an update on the NPP and NPOESS missions. NPOESS had been completely restructured and a number of sensors had been re-manifested which would delay the launch of NPP till June 2010. NPOESS was scheduled to be launched in January 2013. NPP compatibility tests had been completed and the initial phase of algorithm development was ~85% complete. The NOAA Satellite Operations Facility had also been completed.

It was noted that the VIIRS sensor on the NPP would not be capable of providing climate-quality ocean colour data, but very effort was being made to implement changes to VIIRS on the NPOESS-C1 spacecraft to ensure performance for ocean-colour imaging that meets radiometric standards for climate-quality data. Discussions and coordination efforts were underway with ESA (MERIS) and ISRO (OCM-II) regarding international sources of ocean-colour data in case of a gap in the ocean-colour data stream.

An Analysis of Alternatives study (AoA) had been undertaken to address NOAA requirements for advanced coastal waters imaging capability. Both the LEO and GEO solutions studied were feasible and could meet NOAA requirements for high-temporal, operational Coastal Waters Imaging (CWI) in 2014, if funding were available. However, at this point in time NOAA was not funding or developing any ocean colour sensors except VIIRS through the IPO.

Other NOAA ocean-colour activities included investment in MOBY, a valuable community resource for vicarious calibration of ocean colour satellite sensors for which NOAA had assumed responsibility, and the NOAA CoastWatch Program which provided access to NRT satellite data to protect and manage U.S. coastal ocean resources, and understand climate variability.

4.3 ESA (European Union): MERIS Mission and Sentinels

Peter Regner reported on the MERIS sensor aboard the Envisat spacecraft, which would reach six years of operation on 1 March 2008. All systems were in excellent shape and the mission continued to provide high quality data. However, the limiting factor was on board fuel supply - the current mission would only operate till 2010. A new orbit control strategy had been proposed to member states to extend mission operations from 2010 until 2013 (after the launch of Sentinel 3) and approval was expected later this year. No significant degradation of MERIS applications was anticipated.

MERIS data quality and product improvement were addressed continuously through the MERIS Quality Working Group & MERIS Validation Team. The third reprocessing of the complete MERIS archive was planned for the second half of 2008. A new fast registration procedure was introduced for MERIS L1 and L2 reduced resolution and full resolution products systematically available on the Internet. A full proposal was required for full resolution data outside European coverage (NRT service for North America in preparation).

The 2nd MERIS/AATSR workshop would take place in Frascati, Italy from 22-26 September 2008. In terms of capacity building, ESA had conducted an “Advanced Training Course in Ocean Remote Sensing” in Hangzhou, P.R. China (October 2007) and would conduct another training course in Norway (2009), for European students.

MERIS data are used operationally in the frame of MarCoast (Marine & Coastal Environmental Information Services), an ESA funded GMES project, delivering satellite-based information services including chlorophyll concentration, transparency, turbidity, sediment concentration and dissolved organic matter maps. Algal bloom alerts and evolution forecasts are also available. Users for these information services are primarily national and regional government authorities responsible for the collection of data to support environmental reporting. MarCoast is due to be completed by the end of 2008 and ESA and the EC are currently coordinating the transfer of MarCoast services into the EC FastTrack scheme.

Dr. Regner also provided an update on the Sentinel-3 mission, an element of the GMES system. Sentinel-3 would be an operational mission for oceanography and global land applications and would provide continuity of the MERIS mission for ocean colour. The Sentinel-3 payload would include the Ocean and Land Colour Instrument (OLCI), a pushbroom-type imaging spectrometer similar to MERIS but with extended spectral and spatial coverage and a de-pointing of about 12° to avoid the sunglint problem. A two-satellite constellation was required to meet the full operational service requirements. Sentinel-3A was scheduled to be launched in October 2012 with a design life time of 7 years, while Sentinel-3B would be launched 30 months later. The Sentinel mission should be able to satisfy operational GMES user requirement needs.

4.4 CSA (Canada): - Reception of MERIS FR NRT data in Canada and Use of Ocean Colour in Canada's Public Service

Yves Crevier provided a brief update on CSA's involvement in ocean-colour activities. CSA had responded to an expression of interest articulated by Canadian users for continuous access

to MERIS NRT full-resolution data. CSA had invested in an upgrade of the Canadian ground infrastructure to receive and process MERIS data, they had negotiations with ESA on data accessibility and distribution, and there was elaboration of an action plan to allocate resources. The ground infrastructure for the reception of MERIS data had been completed and Level 0 data were being received. ESA had agreed to process the L0 data until implementation of a fully operational processor at the Canada Centre for Remote Sensing (CCRS) in spring/summer of 2008.

Two ground receiving stations in Canada would acquire data over most of the North American continent. CCRS would coordinate the acquisition of MERIS data and would archive L1-b data and higher products (30 day rolling archive for NRT data). Near-real time processing would take 3-4 hours, and L0 data would be repatriated by ESA. CSA would be the Principle Investigator for all Canadian users, allowing free and easy data access to all Government of Canada users. CSA would facilitate data availability for the next 3 years or until the end of Envisat. In this way, CSA expressed a continued interest in national and international ocean colour activities, and would continue to support IOCCG in the future. CSA would also contribute to the international recognition of ocean colour through the SAFARI Project.

Jim Helbig reported on the use of ocean colour by Canada's Public Service. A partnership existed between the Department of Fisheries and Oceans (DFO) and CSA which resulted in a number of ocean-colour related projects. A project entitled "Ocean's Pulse" (2003-2006) conducted optical observations in the Atlantic, Pacific and Arctic Oceans, developed regional algorithms (e.g. to discriminate diatoms), and carried out studies relating the spring bloom to fish recruitment. The Ecosystem-Based Management project (2006-2007) used Earth-observation based tools for fisheries management. The current project "Building Ocean Colour into Operations" (2007-2008) would provide an improved data portal and data streams, develop an algorithm for *Alexandrium* blooms in the Bay of Fundy, and assimilate ocean-colour data into physical models. Jim Gower carried out research on MERIS applications (e.g. discriminating *Sargassum* blooms). DFO provided office space and support for the IOCCG Project Office, and officially acknowledged IOCCG's important contributions in application of ocean colour, which were an integral part of DFO programmes. DFO also looked to the IOCCG to provide leadership and inform senior managers about the role of ocean colour in ocean science and management.

4.5 CNSA (China): New Developments with Haiyang 1-B Ocean-Colour Satellite

Pan Delu reported on the Chinese ocean colour satellite HY-1B, which had been in orbit since April 2007. It carried two payloads: the Chinese Ocean Color and Temperature Scanner (COCTS) and the Coastal Zone Imager (CZI), similar to the ones carried on HY-1A (launched in 2002). Data was received by three ground stations in Beijing, Hangzhou, SanYa (a fourth receiving station was being built in Mudanjiang). Another two ocean-colour satellites were scheduled for launch in 2009 (HY-1C) and 2012 (HY-1D).

Satellite cross-calibrations had been carried out between SeaWiFS and COCTS and the calibrated radiance data was reasonable for ocean-colour mapping. New application software entitled MAPP (Marine Remote Sensing Data Application and Mapping Toolbox) had been used in the ESA-MOST Dragon training programme (Oct 2007, Hangzhou, China) to generate

water quality classification images using satellite ocean-colour data. MAPP software was also useful for merging HY-1B data with data from sensors such as MERIS, SeaWiFS and MODIS, and retrieving water quality parameters such as total suspended material and particle organic carbon.

4.6 INPE (Brazil): High Spatial Resolution Cameras for Coastal Studies

Milton Kampel gave a brief report on INPE's Earth observation programme. INPE did not have any ocean colour sensors, and the MAUVE/SWIPE mission presented at IOCCG-12 had been postponed. However, there was a need for high spatial resolution cameras for coastal studies. Brazil currently uses LANDSAT and MODIS-class satellites for monitoring deforestation. Brazil also had strong collaboration with China through the joint development of the high-resolution CBERS earth-imaging satellites (China-Brazil Earth Resources Satellite) used for agriculture, geology, hydrology, oil spill detection and ocean and coastal monitoring. Comparisons between MODIS and WFI (Wide Field Imager) reflectances were reasonable. INPE was considering a RSS-1 satellite with an advanced wide field imager (AWFI) with 40 m resolution to work in conjunction with CBERS-3. There was a possibility that RRS-2 (scheduled for launch in 2012) could carry an ocean-colour sensor. Plans for a small Multi-Mission Platform (MMP) were also discussed. Possible payloads included optical imagers (CBERS heritage), radar, scientific (GPM sensors) and oceanographic sensors (MAUVE/SWIPE).

4.7 JAXA (Japan): Status of SGLI mission on GCOM-C

Joji Ishizaka gave a presentation provided by Hiroshi Murakami (JAXA) on the status of the Second generation Global Imager (SGLI) on the GCOM-C mission. The GCOM-W (water) satellite would be launched in January 2012, and would carry AMSR-2, while the GCOM-C (climate) satellite was still under evaluation but was tentatively scheduled to be launched in early 2014. The satellite would carry the SGLI radiometer as a follow-on mission to ADEOS-II which carried the GLI instrument.

The targets of the GCOM mission were long-term observation system (> 10 years), integrative use with other earth observation systems, contribution to numerical climate models, contribution to operational use (weather forecast, disaster monitoring, fishery management) and enhancement of new satellite data usability. The new SGLI sensor would continue most of the GLI observations (sea surface temperature, ocean colour, aerosols, cloud, vegetation, snow/ ice) and would have two polarization/ multi-direction channels to enable improvement of land and coastal monitoring, and retrieval of land aerosols. The 250 m resolution would enable detection of fine structures in the coastal area *e.g.* river outflow, regional blooms, small currents.

Data from both GCOM-W and -C would be available free-of-charge, online for registered science users. JAXA and NOAA recently started discussions about GCOM (-W and -C) and NPOESS collaboration (data receiving/exchange, and science activities). JAXA also hoped to collaborate with ESA's Sentinel-3 and Korea's geostationary GOCI missions. In addition, JAXA and CNES were making collaboration plans about future (> 10 y) geostationary missions.

In the near future (~2010), the SGLI science group hoped to support IOCCG again, through a research-type contract with specific outputs (*e.g.* reports, software). If IOCCG activities were strongly connected to the framework of GEOSS implementation, it would help JAXA to contribute financially to IOCCG.

4.8 CNES (France): Parasol Mission

Eric Thouvenot informed the Committee about CNES's ocean-colour space related programmes and perspectives. CNES's Parasol mission was a micro-satellite carrying the POLDER-3 sensor. It was launched three years ago and had been used for ocean colour since the loss of ADEOS-2, although this was not the initial plan. The main concern after launch was the problem with the 443 nm channel, which was now lost to ocean colour. The swath of POLDER-3 was similar to MODIS but had a coarser resolution. Algorithm improvements were undertaken to improve radiometric calibration and to improve processing algorithms. A residual stray light effect had been corrected empirically leading to major improvements in the quality of marine products (accuracy improved by a factor 1.5 to 2). An extended analysis of marine products against the BOUSSOLE data showed that the temporal calibration drift was well corrected, although there was evidence of an effect on viewing geometry, which needed investigation. POLDER-3 was not optimal for ocean colour because of the loss of the 443 nm channel, but comparisons with MODIS have indicated that the data were qualitatively acceptable, within known limits.

Recent activities include development of the POLMER algorithms, to adapt improvements of POLDER-3 algorithms to MERIS. A new sun-glint correction algorithm had been developed, to improve the global coverage of sensors affected by sun-glint, with excellent results. Vicarious calibration activities were carried out primarily with BOUSSOLE (co-funded by ESA and CNES). The full dataset acquired by the buoy was available from the BOUSSOLE website.

CNES was performing a variety of research and development activities, including requirements for a geostationary satellite for ocean colour (GEOCO). Applications would include a contribution to carbon cycle research, detection and monitoring of HABs, monitoring turbidity and eutrophication in coastal waters, and operational oceanography. The main features of ocean colour observation from a geostationary platform included short revisit times (~30 min.), high spatial resolution (100-500 m), improvements for cloud elimination, better signal-to-noise ratios due to high acquisition times, and excellent complementarity with LEO satellites. CNES would investigate new instrument design with improved capabilities (100 m class resolution) and would cooperate with KARI regarding calibration and validation of GOCI.

4.9 KORDI/KARI (South Korea): Plans for the Geostationary GOCI Mission

Yu-Hwan Ahn gave a presentation on KARI's planned Geostationary Ocean Color Imager (GOCI) to be loaded on COMS (Communication Ocean & Meteorological Satellite), scheduled for launch in June 2009. Another COMS-2 geostationary satellite was planned for 2014. Mission requirements of GOCI included detecting, monitoring and predicting short term biophysical phenomena, monitoring the health of marine ecosystems and providing improved fisheries information for the fishing community.

GOCI has 8 spectral bands, including bands for fluorescence detection, a long focal length for high spatial resolution, and very long integration times for high signal-to-noise values. Radiometric test would be carried out soon for determination and validation of the radiometric model, and verification of the instrument performances. GOCI data distribution policy was under discussion with the government (may be free). The Chairman enquired whether the IOCCG could do anything to encourage distribution of the data and agreed to talk about it after the meeting.

ACTION 13/10: JIM YODER TO TALK TO YU-HWAN AHN ABOUT KARI'S DATA POLICY FOR GOCI DATA.

4.10 ISRO/INCOIS (India): Status of OCM-2 on Oceansat-2

Rangnath Navalgund reported on India's global Oceansat-2 mission, which would carry three instruments including the OCM-2 ocean-colour sensor. The orbit of Oceansat-2 would be identical to that of Oceansat-1. OCM-2 was similar to OCM-1 apart from the 765 nm band being moved to 740 nm to avoid O₂ absorption, and the 670 nm band being replaced by 620 nm for better quantification of suspended sediments. Modes of operation would include local area coverage at 360-m (real time transmission) and global area coverage at 4-km (on-board recording). ISRO was currently in discussions with NASA and NOAA regarding sharing local area coverage data. OCM-2 data products would include basic L1 products (radiance products), L2 geophysical products (Chl, TSM, K_d and AOD), and L3, 4-km binned products which would be available to the international community. The Oceansat-2 Announcement of Opportunity for international users was publicized in January 2008 and covered a number of research areas (retrieval algorithms, cal/val, application of ocean-colour data for research, synergistic studies using multi-sensor and assimilation of geophysical parameters into models). The NRSA data centre would carry out data dissemination, and GAC products would be available on the internet. Scientists interested in 360-m coverage for Cal/Val purposes could make arrangements to have this data collected on board.

An OC-4 type algorithm had been developed for OCM-2, which would be improved once data was collected. A permanent Cal-Val site was being set up near Kavaratti on the west coast of India (Case 1 waters). An optical buoy would collect hyperspectral observations of light, chlorophyll-a, temperature and aerosol optical depth for vicarious calibration. Extensive ship campaigns would also be organized for validation of geophysical data products and inter-sensor calibration would be conducted with missions such as MODIS and MERIS. A large number of applications of OCM-2 data were planned, including a major one for enhanced potential fishing zone (PFZ) detection and species-specific fish forecasts.

The remote sensing programme in India was driven by the applications, especially the high demand from the fishing community. Future OC sensors would include a 12-band OCM-3 sensor in ~5 years time, with fluorescence bands. In addition, the government had already approved plans for a High Resolution GEO Imager (HR-GEO) with 50 m spatial resolution. Modules for this imager would include a high-resolution multi-spectral imager, a hyperspectral imager (VNIR and SWIR) and a thermal sensor.

5.0 NEW MISSIONS

5.1 NASA plans: Missions and Projects

Paula Bontempi updated the Committee on NASA's advanced planning for future missions, which was driven by the status of current research missions, as well as the user community. The SeaWiFS mission had been very successful, providing over 10 years of data resulting in over a million unique publications. Emerging scientific questions in ocean biology and biogeochemistry research translated into four key science requirements: global separation of in-water constituents and advanced atmospheric corrections, high temporal and spatial resolution coastal measurements, active assessments of plant physiology and functional composition, and mixed layer depth. These science requirements in turn translated into observational strategies. Mission concept studies were being carried out on a Global Hyperspectral Imaging Radiometer, Geostationary Hyperspectral Imaging Radiometer(s), a Multi-Spectral High Spatial Resolution Imager, and a Portable Sensors from Suborbital Platforms. Other instruments to be investigated included a Variable Fluorescence Lidar, a Mixed Layer Depth and Illumination Sensor, and an Ocean Particle Profiler.

A number of ocean-colour related missions had been recommended for the 2013-2016 timeframe, including HypSPIRI (hyperspectral mission), GEO-CAPE (a geostationary hyperspectral imager for air quality forecasts) and ACE (aerosol-clouds and ecosystem mission). An advanced OC radiometer called GOCEP (Global Ocean Carbon, Ecosystems, and Coastal Processes) was proposed for ACE to tackle key processes and properties such as coastal processes, export carbon, air-sea interactions, ecosystem health, plant functional groups etc. The potential future sensor would be an ocean-dedicated mission with 19 aggregate bands in total, including bands in the near-ultraviolet (for absorbing aerosols) and short-wave infrared (for improved atmospheric correction in coastal waters). Technology improvements would enhance detector performance, some activities of which were already funded and underway. It was noted that new observational requirements for advancing research in ocean biology and biogeochemistry would not be met by the VIIRS sensor, or any simple expansion of the SeaWiFS or MODIS designs. GOCEP was the path for meeting the science needs of today and into the future.

The ACE mission would make significant advances in aerosol-cloud interaction and would also quantify the ocean carbon uptake (aerosol interference had been a major limitation in past OC missions). The ACE mission payload would consist of four instruments flown on two platforms with ACE-A carrying the GOCEP scanning radiometer. The ACE mission was scheduled for launch in September 2015.

NASA had undertaken another mission concept study entitled Plant Physiology and Functional Types (PPFT) to examine the composition, function, and health of land and water ecosystems. This mission would use a small, high spatial resolution (60 m) imaging spectrometer to cover global land and coast/shallow water every 19 days. All components had flown in space so the mission was ready to go, in theory. Another preliminary study had used data from the CALIOP instrument (Cloud-Aerosol Lidar with Orthogonal Polarization) to quantify subsurface backscatter.

5.2 Opportunity for Ocean-Colour Sensors on the Iridium Satellite Series

Mike Rast reported on opportunities for ocean-colour sensors to be placed on the commercial Iridium communication satellite network, a 66-satellite, polar orbiting, constellation. Plans were underway to replace the current constellation, for deployment in 2013, and Iridium had 50 kg spare payload capacity on each platform. New partnerships were being discussed with commercial entities and governments. An optical imager had been considered a good candidate for deployment on 6 satellites. L0 data could be fed to Iridium ground stations and then sent to appropriate data centres for processing. Foreseeable difficulties would include meeting the radiometric accuracy requirements (high SNR is essential). This type of scenario could be used to close coverage gaps for long-term monitoring of ocean colour. David Antoine had represented IOCCG at the recent Iridium meeting in London, which was appreciated.

5.3 Introduction to the Hyperspectral Imager for the Coastal Ocean (HICO)

Curtiss Davis introduced the HICO (Hyperspectral Imager for the Coastal Ocean) imager, which had been developed through the Naval Research Laboratory. Extensive studies had shown that visible hyperspectral imaging was the only tool available to resolve the complexities of the coastal ocean from space. In coastal areas, dark water scenes and bright sky required a high SNR imager with high sensitivity in the blue to resolve dissolved/suspended matter. In the spring of 2007, a combined payload of HICO and RAIDS was manifested for the Japanese Experiment Module–Exposed Facility (JEM-EF) on the International Space Station. The mission would demonstrate scientific and naval utility of maritime hyperspectral imaging from space (bathymetry, water optical properties, bottom type) as well as new and innovative ways to develop and build the imaging payload. HICO would be launched to the International Space Station from the Tanegashima Island launch site 9 July 2009, with one year of operations planned. In response to a questions from the Chairman about whether it would possible to place HICO on an Iridium satellite, Dr. Davis replied that small inexpensive instruments such as HICO would be ideal for that type of platform.

6.0 INITIATIVES RELATED TO GEO

6.1 Overview of GEO as it Relates to IOCCG

Mike Rast briefed the Committee on the activities of the Group on Earth Observations (GEO) as related to ocean colour. The role of GEO was to coordinate international efforts to build a Global Earth Observation System of Systems (GEOSS), targeted at 9 societal benefit areas. Priorities of GEO for the 2008-2010 timeframe were to harmonise data and services, to ensure sustainability of observing systems (important for ocean colour), to carry out a cost benefit analysis and to investigate feasibility of using the Iridium NEXT platform. GEO had a strong focus on coastal zones and a new GEO-coastal initiative had been established to coordinate the direction of activities on different continents to try and provide a routine operational system *e.g.* a data and information network in Africa (ODINAFRICA), a NOAA coastal services center in the US and the MERCATOR operational system in Europe. GlobColour products were available on a global scale to enable climate forecasts and Antares had been established in the Southern Hemisphere and had evolved into the global ChloroGIN network, with help from GEO.

Three GEO work plan tasks were related to IOCCG's remit:

- AG-06-02 (Data Utilization and Aquaculture) - IOCCG was playing major role in this task by enhancing utilization of Earth observations in fisheries and aquaculture through the SAFARI project, funded by CSA.
- CI-06-06 (Global Ocean Observation System) – this task was led by GOOS and improved coordination of coastal and marine climate observations.
- EC-06-07 (Regional Networks for Ecosystems) - This Task would build upon existing initiatives (*e.g.* ANTARES) to develop a global network for ecosystems, and coordinate activities to strengthen observing capacity in developing countries.

Other potential relationships between GEO and IOCCG included capacity building activities (Mombassa training course), GEO initiatives such as Iridium, publications (RSE Special Issue) and the proposed Ocean Colour Constellation. Ocean colour would be very important for GEO in the future. Many systems contributed to GEOSS and the success of GEOSS would depend on data and information providers implementing a set of arrangements for collecting, processing, storing, and disseminating shared data and products.

6.2 IOCCG Proposal to CEOS to Form an Ocean-Colour Constellation

The Chairman reported on IOCCG's proposal to CEOS for an Ocean Colour Constellation. At the SIT meeting last year, Mark Dowell had presented IOCCG's proposal, but CEOS was not accepting proposals for new constellations at the time. It made sense for IOCCG to take the lead in coordinating an ocean-colour constellation looking towards the future. Dr. Yoder had resolved to obtain an endorsement of the constellation from CEOS, and would also determine whether CEOS wanted IOCCG to coordinate the effort. Dr. Yoder had prepared a 1-page proposal to be presented either at the SIT meeting at Woods Hole in April 2008, or the SIT meeting in Japan (fall 2008).

Mike Rast pointed out that CEOS had not yet finalized their Constellations Process Paper, but he nevertheless encouraged the IOCCG to continue with their plans until the process was fully developed. Mark Dowell suggested that the proposal be updated with reference to the various GEO tasks related to ocean colour (*e.g.* the SAFARI Project). In the proposal all international agencies that operated ocean-colour sensors were listed as possible collaborators.

6.3 New SAFARI Project

Trevor Platt informed the Committee about the newly established SAFARI project (Societal Applications in Fisheries & Aquaculture using Remotely-Sensed Imagery), which was an element of GEO. He noted that the timescale for building SAFARI had been very quick. He had been approached by GEO to help identify opportunities for enhanced utilization of Earth observations in fisheries and aquaculture and had developed the SAFARI programme, which CSA had agreed to fund for 3 years, starting in October 2007. The idea was to integrate fisheries applications of Earth observation data (mostly ocean colour) under the general context of ecosystem based management for the world. A secretariat had been set up at the Bedford Institute of Oceanography with Trevor Platt, Venetia Stuart and one new doctoral-level scientist helping. The SAFARI Project would address GEO Task number AG-06-02, which fell under the societal benefit area of agriculture, which included fisheries and aquaculture. Currently,

there was more activity in fisheries and ocean colour than in aquaculture, but both were mentioned.

Some of the elements that might be included in the scope of SAFARI were the Japanese information system for fishermen, the very successful work in India on ocean colour and fisheries, and the Canadian effort to use ocean colour to construct ecological indicators for the pelagic zone. The SAFARI project would coordinate closely with ChloroGIN (GEO Task EC-06-07) and also the proposed constellation of ocean-colour satellites. There would be a high scientific content notwithstanding the emphasis on societal benefits. The opening event would be an international workshop to take place in Halifax (March 2008), funded by CSA. At the workshop the programme of SAFARI would be refined, and the text for an IOCCG monograph on the topic would be developed.

Next year, an outreach session for fishing industry and environmental managers within Canada was planned, and a major international symposium was scheduled for the end of the 3-year period. There had been an explosive interest in this timely topic which would hopefully turn out to be constructive. Stewart Bernard suggested that the use of ocean colour in HABs should be included as an element of SAFARI, and Samantha Lavender pointed out that there was strong usage of ocean colour and SST in fisheries management in New Zealand.

The Chairman encouraged the SAFARI Project to consider publishing their report through the IOCCG as the topic was relevant to the objectives of the IOCCG. The report could be reviewed by the IOCCG Committee before publication.

6.4 ChloroGIN Project to Address GEO Task EC-06-07

Steve Groom reported on the ChloroGIN project (Chlorophyll Globally Integrated Network) which addresses GEO Task EC-06-07. The project was conceived during an IOC/GOOS/POGO/GEO -sponsored workshop in Plymouth, September 2006, to build upon existing initiatives to develop a global network of organization-networks for ecosystems, and to coordinate activities to strengthen observing capacity in developing countries. ChloroGIN was inspired by the ANTARES network of South America, which was created under the auspices of the IOCCG. The project included *in situ* as well as satellite data, with three initial principal regional centres (Latin/South America, southern Africa, and India) linked by good communications to three northern centres (UK, the European Commission, and USA). *In situ* Chl measurements were performed using fluorometry, since most developing countries did not have access to HPLC instruments. During the first 5-year phase, map products would be regularly updated on a web site at each centre. In the Indian Ocean region, an automatic data processing chain had been setup at INCOIS to process MODIS-Aqua data (Chl-a, SST, K₄₉₀ and TSM). Daily, weekly and monthly composite images for these 4 products were disseminated via the INCOIS website. In addition, 8 time-series stations were planned for coastal waters to complement the ocean-colour measurements. INCOIS was in the process of providing MODIS data products of coastal regions of a number of near-by countries.

The ChloroGIN Africa web portal was similar to Antares, with high resolution MODIS data being obtained from UCT and low resolution data obtained from JRC. MERIS data could also

be accessed to complement the MODIS data. JRC also had an African Marine Information System (AMIS) with GIS capability.

ChloroGIN was also selected as one of the demonstration projects in DevCoCast, a proposal by regional data providers (PML, JRC, MARE, DMI) to the European Commission to utilise the GEONETCast concept to provide satellite Chl and SST data from MODIS, MERIS, SeaWiFS and AVHRR to developing countries in Africa as well as Brazil and China. It was hoped that additional partners would join the team and it was also expected that additional products would be provided.

6.5 GEO Data Sharing Principles Applicable to Satellite Ocean-Colour Data

Paula Bontempi was asked to say a few words on data sharing principles in general. She noted that the first meeting of GEO called for data access globally to meet the specific objectives of GEOSS *i.e.* understanding the Earth system including weather, climate and oceans. In NASA's view, all *in situ* and remote access data supporting international science (*e.g.* global climate research and global operational applications) should be freely available (apart from agreements). The GEOSS data sharing principles included 3 key points:

- i) There will be full and open exchange of data, metadata, and products shared within GEOSS, recognizing relevant international instruments and national policies and legislation.
- ii) All shared data, metadata, and products will be made available with minimum time delay and at minimum cost.
- iii) All shared data, metadata, and products being free of charge, or no more than cost of reproduction, will be encouraged for research and education.

These were excellent principles to start with, and NASA recommended that the focus should not be on any one organization or any one country, but rather on the support of our science for the benefit of mankind and the Earth. The focus should be on lower level (0, 1A) data access and sharing, and all metadata required to understand the data should also be made available (*e.g. in situ* data for vicarious calibration and data product validation). It was recognised that various agencies had to function within certain constraints, but as members of the IOCCG we should encourage agency representatives to advocate for unrestricted data access for future missions. For long term analyses it was critical to have enough data available to start looking at climate-driven trends *etc.* Uncertainties could be reduced and operational forecast capability improved with more data available (and better validated and calibrated data).

The Chairman noted that if CEOS were to endorse an ocean-colour constellation to support GEO, then GEO data sharing principles would be the basis for the mode of operation, which was another good reason to go through a formal process for endorsement.

7.0 PROPOSALS FOR NEW IOCCG WORKING GROUPS

7.1 Proposal for a Working Group to Address Ocean Colour from a Geostationary Orbit

David Antoine reviewed the motivation for proposing a new working group to address ocean-colour observations from a geostationary orbit. A number of projects had been submitted to

agencies over the past decade, and the Korean Geostationary Ocean Colour Imager (GOCI) was scheduled to be launched next year. A number of other missions might also be approved in the near future, so it was an opportune time for IOCCG to form a working group to address requirements, advocate for coordination, and foster collaboration.

The advantages of a geostationary orbit for ocean-colour studies include better temporal coverage, the possibility of following episodic events at the scale of hours (*e.g.* red tides, dissemination of sediments), and improving the match between the temporal scale of satellite observations and those of models. Other potential applications include examining the daily cycle of ocean properties *e.g.* aerosols, eliminating the effect of clouds from ocean-colour measurements and better observation of planetary waves.

Possible terms of references for such a working group could include demonstrating the value of the geostationary orbit for ocean-colour observations (research and operational uses), preparing an inventory of the most significant proposed projects and existing missions, examining the complementarity of LEO and GEO orbits, and listing requirements. Membership would include representatives from USA, Korea, India, China, Japan and CNES. Dr. Antoine was prepared to chair the WG.

The Chairman recommended that the WG also interact with other communities (*e.g.* atmospheric science) and perhaps include a representative from the meteorological community. Curtiss Davis indicated that he would be happy to serve on the WG committee. The goal of the WG should also be to focus on interagency connections and help coordinate activities. Rangnath Navalgund noted that the design of instruments for geostationary platforms required optimization between land and ocean, which was also something the WG could address.

7.2 Proposal for a New IOCCG WG to Address Regional Algorithms

Mark Dowell presented a proposal for a new initiative on regional and class-based algorithms. There was a need to describe the variability in parameterizing inversion algorithms so they were applicable at the global scale but remain quantitatively accurate for both the open-ocean and coastal seas. Additionally, there was a persistent request from users of OCR products for information on uncertainties of products at the regional scale. The motivation for such an initiative arose through ChloroGIN and GMES activities as well as from students attending IOCCG training courses. The traditional IOCCG-report-based approach would not be suitable for this type of initiative. Rather an interactive access to the information through a web-based interface was proposed. This could include a live, map-based bibliography of regional algorithms, a series of protocols documenting agreed approaches for implementing new regional algorithms, and round-robin exercises to compare different regional and class-based approaches. The proposed activities could start in 2009 and should take 24-36 months to complete. Dr. Dowell welcomed feedback on his proposal.

Paula Bontempi mentioned that this initiative was similar to a proposed NASA workshop (to take place at Ocean Optics), to create a data set for testing algorithms. The coordination of this type of activity was very important. André Morel noted that atmospheric correction was not mentioned and was something that should be taken into account. This proposal would be discussed during the IOCCG Executive meeting.

8.0 CAPACITY BUILDING

8.1 Ocean-Colour Radiometry Entry for Wikipedia

At the IOCCG meeting last year Mark Dowell had proposed to provide an initial IOCCG-approved entry for “ocean colour” in Wikipedia, the free on-line encyclopaedia. The proposed outline included Wikipedia’s standard elements (title and definition, background) as well as a section on applications (water quality, fisheries, HABs, sediment transport). The initial content would include textbook definitions, links to NASA’s OceanColor Web and the IOCCG web page, links to sites with global or regional datasets, and links to relevant space agency programmes. Editors for initial content would include T. Platt, N. Hoepffner, P. Bontempi, G. Feldman, J. Acker, P. Regner, G. Campbell and others.

Dr. Dowell proposed the following as the definition of ocean colour: “Ocean Colour is a technology, and discipline of research, concerning the study of the interaction of visible electromagnetic radiation with constituents in aquatic environments. In general the term is used in the context of remotely-sensed observations, often made from earth orbiting satellites”.

The draft text would be sent out to the editors by the end of February 2008, the reviewed text would be received by mid-April and published in Wikipedia by the end of April 2008. The Chairman suggested that the tremendous impact of ocean colour on biological oceanography should be clearly stated, and Mervyn Lynch suggested including climate in the list of applications.

ACTION 13/11: MARK DOWELL TO SEND PROPOSED TEXT FOR WIKIPEDIA ENTRY ON “OCEAN COLOUR” TO EDITORS. FINAL VERSION TO BE PUBLISHED ON-LINE BY END OF APRIL 2008.

8.2 Training Course on Inversion Procedures

Roland Doerffer updated the committee on plans for the training course/workshop on inversion procedures in ocean-colour remote sensing that was discussed at last IOCCG meeting. The course would deal with complex waters with different optical components. For these types of waters, inverse modelling methods were required together with an estimate of the retrieval uncertainty. The objectives of the workshop were to provide an overview of inversion methods and models, to prepare bio-optical models and training data sets for inversion methods and to learn how to use a number of inversion techniques. In addition, error analysis and the determination of the scope of the algorithms would be discussed. The course was intended for scientists or advanced graduate students working with ocean-colour in coastal waters. Participants should have a strong mathematical background as well as experience in programming.

The course would consist of lecture sessions covering the theory, application and demonstration of software to be used during the course, exercises in form of a project, and demonstration of the results. The final day would consist of a workshop on error analysis and the determination of the uncertainty range. The course would take place in Lauenburg, Germany in October/November 2008 and could accommodate 15 participants and 5 lecturers. Software used for the

course would be distributed in advance, and all participants should bring their own laptops. Support from GKSS (10K euro) had been requested and additional funds were required to support the invited lecturers.

The workshop on uncertainties would address two major problems: data that are out of scope of the algorithm and secondly, sensitivity of the algorithm to concentration changes.

8.3 Report on CSA-Sponsored Training Course in Canada

Venetia Stuart reported on the IOCCG training course that took place at the Memorial University of Newfoundland (MUN) from 7-11 May 2007. The course was sponsored by CSA and was primarily intended for Canadian students, although a number of international students were also accommodated (total of 19 students). The facilities at MUN were excellent and outstanding support was received from the computing personnel. The course consisted of a series of morning lectures presented by local and international experts, as well as afternoon practical sessions (group projects using SeaDAS). Short presentations were given by each group at the end of the week, which were of a very high standard and reflected the knowledge acquired during the course, and the enthusiasm and effort put in by the students.

Course evaluations at the end of the training course indicated that the students learned a lot in a short space of time and that the course presented a great opportunity for participants to network with specialists in the field. Many of the students indicated that they would have liked more time for the practical sessions, and that the course could have been a bit longer, although this was not possible due to financial restraints. Many letters of appreciation had been received by the IOCCG Project Office, and also by CSA.

8.4 Report on JRC Ocean-Colour Remote Sensing Training Course in Africa.

Nicolas Hoepffner reported on the EC-JRC ocean colour training course which took place in Mombassa, Kenya (24 September – 5 October 2007). A total of 18 participants from 11 different countries attended the course. The objective was to provide the theoretical basis of ocean-colour measurements and to promote applications of ocean-colour radiometry in Africa. Fellowships for the course were provided by JRC, IOCCG, GEO and others. The first week was dedicated to providing a theoretical basis of ocean colour through morning lectures and afternoon practical sessions which familiarized students with BEAM and SeaDAS processing software. The second week was dedicated to applications of ocean colour and the execution of mini projects, for which an impressive amount of work was done. Evaluation questionnaires indicated that the students were very satisfied with the course content and the way it was run.

8.5 Video: “The Science of Ocean Colour”

Roland Doerffer updated the Committee on the status of his DVD entitled “The Science of Ocean Colour”. A 30-minute version (in German) was shown at the GeoMovie Film Festival in Göttingen (May 2007) and a 20-min version was shown during the Environmental Film Festival in Lüneburg (Jan. 2008). Furthermore, the 45-min full version (in English) was used for teaching purposes during ocean-colour training course in Mombassa, and a 6-min version (with

subtitles) was on display at the ChloroGIN exhibit during the GEO conference in Cape Town (Nov. 2007). An interview with Prof. André Morel was recorded in June 2007.

The final DVD would include the 45-min final version with a chapter menu, the 6-min version with subtitles for exhibitions, a 20-min short version, plus a 30-min interview with Prof. Morel. The Chairman enquired about resources from IOCCG but was informed that GKSS could cover the costs. A native speaker was required, and Paula Bontempi pointed out that NASA had an excellent production team that would do it free of charge. Production and distribution of the DVD should be completed by June 2008.

8.6 Request for IOCCG to Support SPIE Conference in New Caledonia.

Robert Frouin informed the Committee about the SPIE symposium to be held in New Caledonia this year. The scope of the symposium encompassed global environmental change, disaster prediction, remote sensing technologies, and natural resource management. The symposium brings together policy makers and scientists to exchange ideas and share current knowledge, about remote sensing and also the expected societal benefits. Part of the conference would focus on coastal ecosystems, and short courses or workshops are often held in conjunction with the symposium. Dr. Frouin enquired whether the IOCCG would be interested in participating and sponsoring this symposium (either financial support or help with the organisation of workshops and training courses, including instruction). Workshops would include fishery management, coral reefs *etc.* The Chairman suggested that the issue of sponsorship be discussed further during the Executive meeting.

8.7 Request for Support of Satellite Oceanography Summer School 2008 (Mexico)

The Chairman had received a request for support of a training course on Satellite Oceanography to be held in Ensenada, México, from 3-23 August, 2008. Trevor Platt informed the Committee that these courses were run every few years and were well funded from a variety of agencies. Support of this course would be discussed during the Executive meeting.

8.8 Proposed SAC/ISRO International Training Course

Rangnath Navalgund informed the Committee that ISRO was planning a 2-week international training course on techniques and applications of ocean-colour remote sensing, which would coincide with the initial phase of operations of OCM-2. The course would be similar to the course organised under the IOCCG umbrella in Ahmedabad (February 2001). The proposed training programme would be available to researchers and professionals from Asia-Pacific countries. ISRO's Space Applications Centre (SAC) in Ahmedabad had excellent facilities for conducting training courses including state-of-the-art laboratories, hardware/software for satellite data processing and analysis, as well as scientific expertise. The course would include lecture sessions covering theory and applications of satellite oceanography and ocean colour, and practical sessions for training on image processing from Oceansat-1 and-2 and SeaWiFS/MODIS. Lectures and technical support would be given by scientists from India and abroad.

Dr. Navalgund requested IOCCG endorsement of the training programme and feedback on the curriculum content. He also encouraged IOCCG Committee members to lecture at the course,

and indicated that IOCCG sponsorship of students would be welcome. The dates had not been fixed, but the course would most likely take place in January/February 2009.

9.0 MISCELLANEOUS

9.1 "The Arcane Colouring of Natural Waters" by Marcel Wernand.

Robert Frouin brought the Committee's attention to a M.Sc thesis by Marcel Wernand entitled "The Arcane Colouring of Natural Waters", an interesting historical account of ocean colour from the first observations by sailors up until the theory was explained by Raman. He enquired whether the IOCCG would consider publishing this book. A more general question was whether IOCCG should publish material other than the IOCCG report series. This type of monograph was educational and would fall under the mandate of the IOCCG. The Chairman noted that the matter of publishing other material also raised the issue of IOCCG's limited budget. Trevor Platt was of the opinion that the costs involved would be substantial, and that an initiative such as this could only be undertaken if book was sold to generate revenue. Up until now, the IOCCG reports were free of charge. André Morel noted that he had read the manuscript and had found it very interesting. He suggested that UNESCO be approached because if IOCCG went ahead with publishing this manuscript they would likely receive many other such requests.

Samantha Lavender suggested publishing the book on the internet, but it was pointed out that Dr. Wernand already had it on the web. It was also suggested that the manuscript could be formatted to look like an IOCCG report, or that TOS might be approached as a publisher. The Chairman agreed to discuss these options with the sponsoring agencies at the Executive Committee meeting.

9.2 Issues with HPLC Processing and Data Analysis.

Paula Bontempi spoke about a major issue in the NASA research community. The SeaHARRE-3 round robin activity for HPLC analyses discovered that the laboratory that processed all the water samples for phytoplankton pigment analysis was deficient in meeting criteria for satellite data validation. The problem was caused by a flow-cell design in the Thermo UV6000 detector, which had significant stray-light problems that produced a non-linear response at the detection wavelengths used in all of the analyses. The SDSU methodology assumed the detector response was linear, so all of the calibrations and the subsequent pigment quantifications required re-evaluation (*i.e.*, both C18 and C8 methods). Since >21,000 HPLC samples had been impacted, it was decided to remove all HPLC data from SeaBASS until a correction scheme had been devised. A peer-reviewed "parametric correction scheme" had been developed by an investigative team, and was currently being implemented. The final correction scheme would be published on line. It was noted that some laboratories with the same detector produced good quality data using careful optical tuning and calibration procedures, before chemical calibration and analysis of samples.

Round-robin type activities were invaluable for catching these types of problems. Unfortunately the SIMBIOS programme (Sensor Intercomparison for Marine Biological and Interdisciplinary Ocean Studies), which carried out round-robins activities, had been terminated abruptly in 2003. Since then there had been a lot of interest in starting another SIMBIOS type

follow-on programme. Ultimately, this type of programme would only work if it were addressed as a group, and not only led by NASA. Mark Dowell suggested that a component for a new SIMBIOS-type initiative could be included in the text for developing an ocean-colour constellation.

It was noted that the OC-4v4 algorithm would not be affected and no major changes in products were expected. However, all accessory pigments and pigment ratios were affected. Shubha Sathyendranath commented that these problems highlighted the need to carry on with fluorometric analyses as a fall-back. In addition, there were large regions of the globe where scientists did not have the resources necessary to carry out HPLC analyses.

10.0 ANY OTHER BUSINESS

Yu-Hwan Ahn informed the Committee about an ocean-colour training course scheduled to take place in South Korea this year. The Ministry of Science and Technology (MOST) proposed holding the 1st GOCI International User Group Symposium from 29-30 October 2008, with 15 invited speakers focussing on ocean-colour applications from a geostationary platform. In conjunction with this symposium they would also like to conduct a 2-day a training course for ocean-colour scientist (dates to be determined). Dr. Ahn invited IOCCG Committee members and members of the new geostationary working group to participate in the training course and to attend the symposium. The Chairman noted that this initiative did not appear to have budget implications, and would be discussed during the Executive meeting. Joji Ishizaka informed the Committee that NOWPAP was also looking at conducting a training course which could perhaps be combined with the Korean proposal. The training course would also be relevant to the proposed IOCCG working group on geostationary satellites.

11.0 ORGANIZATION AND MEMBERSHIP

11.1 State of the IOCCG Finances

Trevor Platt noted that over the past few years there had been a change in the financial status of the IOCCG Committee. In the beginning agencies gave cash, but as time went by some agencies reduced their contributions, at a time when expenses were increasing, or in some cases, funding never materialized. Another bureaucratic trend was that several agencies offered support in-kind, instead of cash. Earmarked funds or contributions in-kind do not always work *e.g.* if an agency agreed to print a report during a certain fiscal year, but the report was not completed in time, then the agency would not contribute at all. Dr. Platt requested that agencies fund in cash, if possible, and in a timely manner, but noted that in kind contributions were also welcome.

The Chairman added that given the increased interest in GEO, and since IOCCG had taken on the responsibility of trying to coordinate satellite ocean-colour missions (via a constellation), the IOCCG should promote idea that it would continue to coordinate these activities in the long term. The IOCCG would have to be careful on how to proceed with limited resources and taking on new responsibilities (training courses, reports, meetings). Shubha Sathyendranath suggested that perhaps the POGO approach could be adopted by IOCCG *i.e.* membership dues.

11.2 Call for Nomination of New Committee Members

The Chairman noted that Mervyn Lynch (Australia) had completed his term of service, so there was one vacancy on the IOCCG Committee for next year. He welcomed suggestions for a new member, preferably from Australia.

11.3 Plans for 2009 Committee meeting

Pan Delu informed participants that the Second Institute of Oceanography had agreed to host the 14th IOCCG meeting in Hangzhou, China. He recommended holding the meeting in April and was open to suggestions for dates (dates selected were 20-22 April 2009). After the meeting, SOED proposed hosting a 2-day workshop, which all IOCCG members were invited to attend and participate.

11.4 Invitations from Members to Host the 2010 IOCCG Committee Meeting

Milton Kampel announced that INPE would be pleased to host 15th IOCCG meeting in Rio de Janeiro, Brazil. There were direct flight from most countries, and a good infrastructure. The meeting could be held at any time of the year apart from the week of the Rio carnival (13-16 February 2010).

Rangnath Navalgund announced that ISRO would also be happy to host the meeting in Ahmedabad.

11.5 Closing Comments

The Chairman noted that there had been very good attendance at the meeting and thanked everyone for their participation. The field of ocean colour was going in many directions, so it was important to try and help coordinate the various activities and ensure that the users were well served.

LIST OF PARTICIPANTS
13th IOCCG Committee Meeting, Paris, France
12-14 February 2008

IOCCG Members

Ahn, Yu-Hwan
 Antoine, David
 Bernard, Stewart
 Bontempi, Paula
 Crevier, Yves
 Davis, Curtiss
 Delu, Pan,
 DiGiacomo, Paul
 Doerffer, Roland
 Dowell, Mark
 Hoepffner, Nicholas
 Ishizaka, Joji
 Kampel, Milton
 Kumar, Srinivasa
 Lavender, Samantha
 Lynch, Mervyn
 Navalgund, Ranganath
 Platt, Trevor (Past Chair)
 Regner, Peter
 Sosik, Heidi
 Thouvenot, Eric
 Yoder, James (Chair)

Affiliation

KORDI, Korea
 LOV, Villefranche, France
 University of Cape Town, South Africa
 NASA HQ, USA
 CSA, Canada
 Oregon State University, USA
 State Oceanic Administration, China
 NOAA, USA
 GKSS, Germany
 JRC, Italy
 JRC, Italy
 Nagasaki University, Japan
 INPE, Brazil
 INCOIS, India
 University of Plymouth, UK
 Curtin University, Australia
 ISRO, India
 Bedford Institute of Oceanography, Canada
 ESA/ESRIN, Italy
 Woods Hole Oceanographic Institution, USA
 CNES, France
 Woods Hole Oceanographic Institution, USA

Invited Participants

Aarup, Thorkhild
 Alverson, Keith
 Bernal, Particio
 Bouman, Heather
 Deschamps, Pierre-Yves
 Forget, Marie-Hélèn
 Frouin, Robert
 Groom, Steve
 Helbig, James
 Hood, Maria
 Morel, André
 Moulin, Cyril
 Rast, Michael
 Sathyendranath, Shubha
 Stuart, Venetia

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 POGO, Canada
 IOCCG Project Office, Canada