Minutes of the First Meeting

of the IOCCG Working Group

'L1 Requirements for Ocean-Colour Remote Sensing'

April 20-21, 2010

Bethesda, Maryland (Washington, D.C.), USA

Participants:

- Charles R. McClain (chair, NASA)
- Paula S. Bontempi (co-chair, NASA)
- Gerhard Meister (co-chair, NASA)
- Steven Delwart (ESA)
- Bertrand Fougnie (CNES)
- Hiroshi Murakami (JAXA)
- Menghua Wang (NOAA)

McClain and Bontempi welcomed the participants in the room and on the phone. The outbreak of a volcano on Iceland had made travel to the US impossible for Delwart and Fougnie, so arrangements had to be made to allow for a telecon. This lead to a substantial rearrangement of the original agenda. The meeting started with presentations on lessons learned from heritage sensors and plans for future missions. The presentations will be made available on the IOCCG website.

Meister reported on the lessons learned from SeaWiFS and MODIS. Although being a low-cost sensor, SeaWiFS was able to create a high quality 13+ year time series because of a very effective lunar calibration, sensor tilt in track direction to avoid sun glint, and low polarization sensitivity. MODIS provides much higher SNR, fluorescence bands, and a stable orbit, however it suffers from polarization sensitivity (especially MODIS on Terra), striping, and glint contamination.

Delwart reported on ESA's Sentinel 3, with the ocean radiometer OLCI. OLCI is similar to MERIS, but includes more bands, an across-track permanent tilt for improved sunglint avoidance, and a default 300m spatial resolution over land and ocean. The list of OLCI products includes 12 ocean color products and 3 atmospheric products. The product definition is not necessarily identical to other agencies, which will need to be considered when defining the products for the report.

Murakami reported on the mission concept for GCOM-C, a series of three satellites that will cover more than a 10 year time span. Main features are a resolution up to 250m, three polarization angles in two bands (637.5nm and 868.5nm, tilted into forward looking direction), UV, SWIR and temperature bands.

Fougnie presented results from several CNES phase 0 and R&D studies for ocean radiometers. Optimum SNR were similar to those obtained by the ACE group. The spatial resolution requirements for the AOT seem to be higher than those for the aerosol type. Polarization and straylight corrections should be small. The POLYMER algorithm (spectral decomposition) seems to be able to produce good results in the presence of glint. Pixel growth with scan angle is an undesirable feature that is significantly reduced by certain sensor designs (e.g. POLDER).

McClain presented the current IOCCG science traceability matrix (STM). The IOCCG STM uses the ACE ocean biology STM as a blue print, several modifications had already been made during previous telecons. It was agreed that the STM would provide the structure upon which the report will be based.

The band set of the ACE radiometer (27 bands) was sent by email to the group for evaluation which of these bands should be recommended. The list contained the center wavelengths, bandwidths, typical radiances, maximum radiances, and SNR. Some members of the group thought that the list was too extensive. The process of defining the list of recommended bands is an important task for the coming months.

The process of modifying the STM continued after the presentation. E.g., the second question under science question 6 needs to be reworded, and science question 7 should provide examples (water quality, coral reef health). Furthermore, the approach column needs to be connected with product requirements column, e.g. by listing each product under the approach elements.

McClain also presented the NASA ocean color products. The three validated products are nLw, chlorophyll-a, and diffuse attenuation coefficient at 490nm. There are nine unvalidated products, which however do have relatively mature algorithms. There are also six exploratory products with algorithms that are not as far progressed yet.

Three derived products were not mentioned in the product column of the STM, although they were needed by (at least) one of the approaches in the previous column: 1) primary production 2) particle size distribution 3) dissolved organic matter. It was not immediately clear if physiological properties were needed by any approach.

The accuracy requirements are a difficult issue. Should these requirements be in absolute terms or relative? It is not clear if the science community is ready to develop them for each product. It is clear that this working group does not have sufficient expertise and resources to develop them for this report. However, in cases where these requirements have been established (e.g. for chlorophyll-a and water-leaving radiances), they can be adopted for our report.

For the accuracy requirements of water-leaving radiances (nLw), a value of 5% has often been used in the past. However, this value was developed for a specific case (nLw at 443nm, oligotrophic open ocean). It was agreed that the ESA approach of using an absolute value is more general. The actual accuracy value of 0.0005 for the marine reflectance at 442nm is very similar to the nLw specification above, so there is good agreement on the magnitude. One remaining problem is that this value is only defined for one wavelength. The atmospheric correction approach suggests that the accuracies will be worse at shorter wavelengths and better for longer wavelengths.

For the accuracy requirement of chlorophyll-a, three agencies (NASA, ESA, and JAXA) use a value of 30-35%. JAXA and ESA relax these requirements for coastal and case-2 waters, respectively. It seems likely that chlorophyll-a is the only product where a product accuracy can be directly translated into required top-of-atmosphere radiance accuracies (about 0.5% at 442nm).

It was decided to change the title of the last column in the STM to 'Mission Measurement Requirements' and subdivide it into 5 boxes:

1) OC radiometer
2) Anc. data sets
3) vicarious calibration program
4) product validation program
5) Data systems/latency

Box 2 should discuss ozone concentrations, total water vapor, surface wind velocity, surface barometric pressure, NO_2 concentration, and relative humidity. Box 4 should discuss network of time series sites (radiometric, etc.); calibration round robins; protocol definition/development; pigment round robins; dedicated, coordinated validation data collection; and open data archives (e.g. SeaBASS, MERMAID).

McClain, Bontempi, Wang, Murakami, and Meister drafted an outline for the report, see below. It will be sent to the remaining working group members (Delwart, Fougnie, Ahn) for comments. The goal is to reach consensus on the draft during the next telecon, which is scheduled for May 7th. The draft identifies the lead authors for each of the seven chapters. It is expected that the lead authors will be provided support from either other working group members or members of their respective science community, if needed.

The title of the report was modified - this may need to be confirmed by the IOCCG.

The work on the draft is expected to continue through summer, a provisional deadline for a draft for each chapter was set for September 15th, 2010. The next working group meeting will be held in Europe (location to be decided by Delwart and Fougnie), tentative dates were set for November 9th-10th.

<u>Outline for final report of L1 requirements working group:</u>

(names in brackets provide chapter leads/editors)

Title:
Satellite radiometer requirements for observing aquatic optical, biological and biochemical properties

Chapter 1: Introduction (Bontempi, McClain)

Chapter 2: Science Questions and Applications (McClain, Bontempi)

- 9 subsections (from IOCCG STM)

Chapter 3: **Approaches (McClain, Bontempi)**

- 10 subsections (from IOCCG STM, list parameters for each, provide references)

Chapter 4: Product requirements (Delwart)

- Intermediate products (atmospheric correction parameters, e.g. AOT, angstrom)
- Basic products (remote sensing reflectances, nLw)
- Derived products (e.g. chlorophyll-a, primary production, IOPs, etc.)
- Provide relevant citations, describe basic idea, required bands (summary table/figure)
- Spatial and temporal requirements, global coverage

Chapter 5: Space Measurement and Mission Requirements (Fougnie, Meister, Delwart, Wang)

- Radiometer
  + Prelaunch characterization (straylight, polarization, etc.)
  + TOA radiance accuracy (on-orbit calibration methodology (e.g. lunar, solar diffuser, vicarious))
  + Band-coregistration
  + Spectral band specifications, tilt, SNR, other sensor specifications
- Ancillary data sources (see minutes)
- Field programs
  + Vicarious calibration program
  + Product validation program (see minutes)
- Data processing requirements and distribution
- Spacecraft requirements

+ Direct broadcast
+ Downlink
+ Orbit (polar, local crossing time, orbit maintenance)
+ Calibration maneuvers
+ Geolocation accuracy

Chapter 6: International Cooperation (Murakami, Bontempi, Delwart, Fougnie)

- Focus: international cooperation on prelaunch calibration and in-situ measurements, cross sensor comparisons
- In-situ data sharing, algorithm coordination, science team structure with international component
- Inventory of existing mechanisms that could be used for this purpose (e.g. SeaBASS)

Chapter 7: Conclusions (Bontempi, McClain)

- Summarize, show STM matrix

Appendices:

- Heritage and planned missions
- References