First Meeting of the IOCCG Ocean Color Radiometry
Essential Climate Variable/Climate Data Record Working Group
Glasgow, Scotland, October 7, 2012
Report Submitted: January, 2013

Attending: Co-Chairs Nic Hoepffner, Jim Yoder and Members Stephanie Henson, Stephane Maritorena, Bryan Franz, Menghua Wang, Ewa Kwiatkowska, Frederic Melin, Antoine Mangin and a substitute for Hiroshi Murakami. Hubert Loisel was unable to attend.

1. The WG first discussed the terms of reference (TOR) to the group and the modifications suggested at the last IOCCG meeting. The WG agreed that significant progress could be made on the TOR before the IOCCG meeting in 2014 and some progress by the IOCCG meeting in 2013. The WG agreed that the focus was on basin to global scale ECV/CDR time series for **climate related studies** which require long records – the longer the better.

2. The WG discussed the ECV/CDR metrics for ocean color as listed in the recent GCOS document and the CEOS response. The WG believes that the metrics are somewhat arbitrary and the targets, at least for stability and accuracy, will not be achievable with the current suite of instruments. It was also not clear to the WG as to the reason for 30km horizontal spatial scale for Chl a. The WG group also discussed the definitions of accuracy and stability. The WG tentatively accepted the current GCOS definitions, but may recommend changes after further consideration. GCOS currently defines accuracy as the difference between satellite and sea truth measurements. Stability is defined as the change in accuracy with time.

The WG will not recommend any changes, until it can provide non-arbitrary alternatives.

3. Four members reported on their respective group efforts to produce time series of OCR-derived products from data collected by one or more satellite sensors.

Bryan Franz reported on NASA-GSFC efforts to produce Lw and Chl time series involving multiple sensors, primarily focusing on data collected by SeaWiFS, Aqua, Terra and MERIS. The GSFC group has tried to work with data from the OCR sensor on Oceansat, but without much success since it is not a global sensor. The GSFC group has been unable to achieve 5% agreement for Lw measured by the various instruments.

The point was also raised as to the respective benefits of merging data from multiple sensors or simply concatenating the data sets to produce long time series. Some argued that merging data made sense to produce, for example, daily products since merging generally improves daily coverage, but was perhaps of less value for multi-year time series. The point was also made that monthly resolution was probably adequate for a CDR for Chl concentration, but higher temporal resolution was required to produce a CDR who purpose was to quantify changes in phenology.

Stephane Maritorena reported on MEaSUREs which is a NASA-funded effort to produce an ocean color CDR. The MEaSUREs group uses the GSM model to calculate IOPs from SeaWiFS, Aqua and MERIS sensors using a statistical fit to all available data for each pixel to first generate Lw (R) spectra. In MEaSUREs and GlobColour, the uncertainty of each product

is obtained AT EACH PIXEL of an image from the covariance matrix used in the fitting technique (e.g. Levenberg-Marquardt). MEaSUREs tested and validated these uncertainty estimates by comparing the model-based error estimates (=from the covariance matrix) to the actual errors (= difference between the GSM estimates and the in situ value) using the NOMAD data set.
Matchups are used as a "validation" tool.

Antoine Mangin reported on GLOBColour efforts to produce a long time series of merged data from SEaWIFS, Aqua and MERIS data at 4.6 km resolution. The project continues although GLOBColour has officially ended. Processing is very similar to that used by MEaSUREs in that they use the GSM model to calculate IOP products. Uncertainties are also calculated using matchups between satellite and in situ data.

This group has also analyzed trends in the global data using both parametric and non-parametric statistics. The non-parametric statistics indicate whether certain pixels are increasing or decreasing during the time series. The results showed that with 97.5% certainty, 2.5% of the global pixels are increasing and 2.5% are decreasing. The spatial patterns in the global ocean of regions showing increasing and decreasing trends were generally coherent.

“Bias” and “Trend” and the difference between them were discussed.

Frederic Melin reported on the ocean color CDR/ECV project that is part of ESA’s CCI program. The products include Chl, RRS, bb, aph and aCDOM.

The CCI project is also using SeaWiFS, Aqua and MERIS data. One important distinction between this effort and the 3 other efforts summarized above is that the CCI program used a different model for atmospheric correction (POLYMER) for the MERIS data which led to more valid pixels for Lw retrievals.

CCI also used the Moore et al. “fuzzy logic” scheme to partition the global ocean into bio-optical provinces. Validation results are investigated for each bio-optical water type to calculate the error (RMSD or bias).The error for a given location is then a weighted average of the errors associated with the different optical water types (or classes), with the weights being defined by the class membership of that location (probability of belonging to each optical water type).

Also calculated bias between sensors (and for each province), and calculated random error associated with each sensor.

For the future, the CCI project will consider processing SeaWiFS, Aqua and future sensor data using the POLYMER atmospheric correction approach to harmonize atmospheric correction among the various sensors.

4. Following the discussions, the WG identified the actions described below which are listed by tasks in the WG Terms of Reference (TOR).

TOR 1. Develop a Roadmap for completion of the first assessment.

Not discussed at first meeting.

TOR 2. Recommend comparison/evaluation metrics.

Based on what we know now, what protocols are recommended to?

1. compare data from different missions during overlap periods and what are the appropriate metrics to express the results?
2. determine which missions provide data appropriate for including in a CDR and what are the evaluation metrics?
3. What should be the criteria to call a time series a CDR (length of record? Known uncertainties?)

(Fred, Bryan, Antoine, Ewa, Stephane)

TOR 3. Record and evaluate differences among existing OCR ECV products and recommend how differences can be resolved.

Using both practical and statistical considerations, what is the minimum number of data points within a pixel of a composite image for it to be included in a time series? What weighting schemes should be used, if any, to build multiple day composites (e.g. monthly composites) from daily composites (Antoine, Bryan, Ewa, Menghua, and Fred)?

For CDRs related to climate, what are the advantages, if any, of merging data from multiple sensors versus concatenating. (Stephane, Menghua, Bryan, Fred)?

Do we introduce a bias by merging/comparing data from satellites sensors that have different equatorial crossing times, e.g. 10 am versus noon? What do the results from moored and continuously recording bio-optical buoys show that could provide a partial answer to this question?

TOR 4. Establish criteria to be satisfied by OCR ECV products and recommend actions needed to ensure the quality and consistency required by GCOS.

The WG will critically examine the OCR target and planned metrics used to date by GCOS and endorsed by CEOS, specifically stability, accuracy, time/space resolution and other metrics. For example, could stability be better defined in relation to a mission-long time series of imaging the moon at ca. monthly intervals (like for the SeaWiFS mission) or with solar views using paired diffusers (e.g. like MERIS)? What are the appropriate references for the accuracy metrics, i.e. how are the metrics justified? (Antoine, Bryan, Ewa, Nic, and Jim agreed to consider this issue).

Can we use data or models to specify trend expectation and use those results to set expectations and criteria for what satellites can deliver? (Stephanie, Menghua)

What temporal resolution is needed for trend analyses of concentration (e.g. Chl) or measurement unit (Lw) time series versus what is required to determine climate impacts on phenology? What are other considerations for trend analyses, e.g. spatial resolution? (Stephanie, Menghua)

Are there trends in other data, e.g. in situ phytoplankton/bio-optical biomass time series at regional to global scales that show trends similar to what has been observed in satellite data sets? Possibilities include secchi disk, Greenness index, MOBY, other?) (Nic, Stephane)

TOR 5. Respond to CEOS requests for review of OCR ECVs.

The co-Chairs will send a copy of the final report of this first WG meeting, and of future reports of the WG, to the OCR-VC co-chairs.

TOR 6. Establish contact with the SST-VC.

Contact SST VC to find out their approach for bias, merging, etc. (Jim, Ewa).

TOR 7. Evaluate agency efforts to develop/help develop and archive ECVs.

Not discussed at first meeting.

The WG agreed to meet again during the IOCS in Darmstadt (Frankfort), Germany, in May, 2013.

Ocean Color Essential Climate Variable Working Group (ECV WG)
for Ocean Color Radiometry (OCR) in Relation to the
Group for High Resolution SST (GHRSST) Project.
December, 2012
Jim Yoder, Co-chair of OCR-ECV-WG

I spoke with NOAA's Ken Casey about the relation between SST processing in the GHRSST project and the SST Virtual Constellation (SST-VC). Ken has been involved with GHRSST for more than a decade and is also involved with the SST-VC. In brief, GHRSST, although more mature, has similar goals for SST as the ECV-WG has for ocean color and has essentially the same relation with the SST-VC as the ECV-WG does (via IOCCG) with the OCR-VC. The main difference is that GHRSST has been around for more than a decade and is thus farther along for SST than we are for ocean color.

GHRSST is a "coalition of the willing" with participation open to those groups with interest and resources to generate SST products. GHRSST includes an effort to produce climate data records. There is no central funding; each group obtains funding from appropriate agencies.

The GHRSST science team, which meets once per year, consists of those who represent agency-funded projects involved in producing products from SST measurements, including projects that include merging *in situ* and satellite data. The next GHRSST team meeting is in June, 2013, at the Woods Hole Oceanographic Institution, and Co-chair Yoder will likely attend part of the meeting as a guest. GHRSST publishes the proceedings of their meetings (see https://www.ghrsst.org/files/download.php?m=documents&f=121207144549-GHRSSTXIIIProceedingsIssue1Rev0.pdf) and hosts a website (https://www.ghrsst.org/).

GHRSST's initial thinking was that the participants would converge on common requirements, common formats and common processing frameworks. At some point it became clear that this was too ambitious given the diversity of interests represented in the project, so they now endorse a suite of products referred to as a "cube". Their current cube involves 61 products.

At one point, GHRSST was moving towards an ECV-producing framework using NOAA's extensive requirements for a CRD. However, they eventually backed off this approach and instead moved towards a common product assessment approach. GHRSST is thus taking an approach similar to the one we discussed for ocean color products at our recent ECV WG meeting in Glasgow. In other words, OCR ECV products may be produced in somewhat different ways by different groups, and the ECV-WG should determine how these different products compare.

The active agencies supporting participants in GHRSST include NOAA, NASA, ESA, UK-Met Office, EUMETSAT and Australian Met Office. JAXA is also involved although full participation is difficult owing to the constraints of their national data policy. ISRO is considering participation, and Brazil, China and Korea are possibilities.