Kick-Off Meeting for the IOCCG Working Group on Ocean Primary Production

Date: 13th November 2023
Time: 10:00-16:00 (Local Time FL, US)
Meeting: Hybrid (In person/online)
Location: University of South Florida, Student Center, Coral Room, 200 6th Ave S, St. Petersburg, FL 33701

WG Members

Attending in-person: Bob Brewin, ZhongPing Lee, Shubha Sathyendranath, Žarko Kovač, Xin Liu, Gemma Kulk, Toby Westberry, David Antoine, Frédéric Mélin, Heather Bouman.

Attending online: Joaquim Goes, Jinghui Wu, Ryan Vandermeulen, Michael Behrenfeld, John Marra, Junwu Tang, Chin-Chang Hung, Peng Chen, Mini Raman, Tom Jackson

Apologies: Qiang Hao, Joji Ishizaka

Minutes

10:00 - 10:05	Welcome and round table introductions
10:05 - 10:45	Overview of WG and why we think an IOCCG report is needed (presentation by Bob). Discussions then focused on the structuring of the report and on Chapter 1 itself: - The need for a description of the role the ocean's play in the Earth's carbon cycle. Mention of the physical (solubility) and biological (through primary production) control on ocean carbon. Some discussions arounds timescales of biological component of the carbon cycles, also with respect to recent anthropogenic ocean carbon uptake (on shorter time scales, though to be dominated by solubility). Discussion on how PP feeds the various pathways for carbon storage. Can paleo-proxies help demonstrate the role of biology in ocean carbon storage on longer time-scales? - Group discussions on whether we should be including freshwater PP ("Aquatic" rather than "Marine" or "Oceanic"). It was agreed to not include freshwater in the WG on PP (no expertise in the current WG, we need to be careful not to make the report too big, and these environments have some unique characteristics). However, we need to highlight to the relevance of freshwater when discussing Earth System carbon cycle. - Similar discussions then on macroalgal PP (linked more formally to Blue Carbon), not the focus of this WG on PP, but relevance

	should be acknowledged in Chapter 1 when discussing Earth System carbon cycle. - Discussion around calling the WG report “Marine” or “Oceanic” Primary Production, seems to mean subtly different things depending on region. On the one hand, “Marine” may imply in China more coastal ocean systems, rather than open ocean, but on the other hand “Oceanic” may be not inclusive of “seas” in other regions. - Whether we go for “Marine” or “Oceanic”, we need to make a clear definition in Chapter 1. - Discussion around the need to carefully think about the goals of the report (synthesis of field) and audience of the report (space agencies, scientists, students). - Comments on the need in Chapter 1 to discuss basic features/regions in the ocean that limit PP: for example, nutrient limited surface waters in the subtropical ocean, and light limited high latitudes, perhaps diagrammatically showing where nitracline is, mixed-layer, etc., to communicate the limiting factors on PP in different regions (light / nutrients etc.). - Some discussions on new understanding in nutrient limitation (micro-nutrients, co-limitation) may help guide satellite PP models, perhaps having this in the Future perspectives section rather than Chapter 1. - Comments around structuring of report. Slight restructuring suggested, bringing components (definitions) of primary production (GPP, NPP, and NCP) into chapter 2, and moving fundamentals of PP modelling to chapter 4. - Some discussions on the timescales of the report (IOCCG recommend a 1 to 2-year period, though many previous reports have taken longer) …come back to this point at end of meeting when planning. - Should also keep in mind other initiatives, and aligning where feasible with these, for example, CEOS Aquatic Carbon Initiatives. Chapter 2: Fundamentals of phytoplankton photosynthesis and components of primary production. Discussions around what level of detail is required on fundamentals. Need to keep in mind the target audience (space agencies, scientists, students), and yet provide enough detail to link to in situ methods, components of PP (NPP, GPP, NCP etc.), and future perspectives on PP modelling (e.g., targeting other components of PP beyond NPP) chapter. Section needed on clear definitions of components of PP (GPP, NPP, NCP, Export PP, new and regenerated PP etc.)
10:45 - 11:30	Chapter 3: Relevance of scales and in situ methods for measuring primary production (in situ data links/compilation)

	- Some overview of key in situ methods for measuring primary production (pro/cons) required, and the temporal / spatial scales of the measurements (see Table in Platt et al 1992, new production chapter in Falkowski's book, https://link.springer.com/chapter/10.1007/978-1-4899-0762-2_15) and IOCCG Protocol on Aquatic Primary Production Figure 1.1. - Seems sensible to include a Table directing readers to where they can find in situ dataset on PP (like Brewin et al. 2021 Table 2 https://doi.org/10.1016/j.earscirev.2021.103604, but focused on PP) - Conversations around whether we should be compiling a dataset of in situ measurements to use in the report (in subsequent chapters) - On the one hand, it would be useful for the community, push the science forward, on the other hand, could require huge effort. Some discussions around whether the data be used in the report (matchups)? - Discussion around the large uncertainties in the in-situ measurements that are hard to quantify. - Group a little split on whether to create an in-situ dataset or not. - One solution would be to start small (e.g., using BATS and HOTS) and provide reader additional resources, for example, Jupyter notebooks to read data, implement algorithms and evaluate.
11:30 – 12:30	Chapter 4: Presentation on strategy to PP modelling (ZhongPing). Presented Chl-based, absorption-based, Carbon based. Advantages and disadvantages of these methods. Discussion around the differences in PP between models. In some cases, differences are known, and related to the way the model operates (e.g., CbPP model having higher PP in the gyres compared with VPGM, as it explicitly includes photoacclimation). Discussion around similarities in the approaches, all these approaches are fundamentally similar mathematically (though slight systematic differences in spectral models) and conform to the same set of four parameters (see Section 4 in Sathyendranath and Platt, 2007, http://www.iopan.gda.pl/oceanologia/491platt.pdf). Discussions / agreement around focusing efforts on improving the parameters of the model and not so much on the approaches to PP modelling themselves. Some discussions around the satellite products themselves, of relevance to PP, do these show consistent patterns with expectations. Should we also be doing more interrogating of the suitability of the satellite products for use in PP modelling.

	Discussion around other algorithms for different component of PP (GPP, NCP, new production, export production).
14:00-15:30	Jinghui gave presentation on use of an ocean-biome based method for parameterising an absorption-based PP model. Some discussions around the details/specifics of the biome-based method. CHAPTER 8; Presentation on uncertainties in PP satellite modelling (Frédéric Mélin), brief history of estimate of PP uncertainty (early work by Platt et al. 1988 DSR, through formal error propagation, 50% error in PP at best, international PPARR NASA exercise showing errors of a factor of 2 or more). Presented two examples of an uncertainty tree diagram for PP (formal uncertainty propagation), using the VPGM and a depth and wavelength resolved model (Platt et al.), capturing the range of uncertainty terms (including algorithm error). An extensive discussion followed on uncertainties. - Additional considerations needed when binning to larger temporal and spatial scales. - Discussions around systematic and random errors (random maybe not the best word), in that the random errors can get averaged out with large numbers of observations (power of remote sensing data, if measurements considered independent), but the systematic errors are those that remain. - Discussion around how one goes about incorporating uncertainties in the in situ data (many cases the model is tuned with) in this type of analysis, beyond uncertainties in the parameters (i.e. whether the in situ measurements are reflecting NPP or other PP components). - Similar approaches (tree diagram) should be adopted in the in situ methods for PP. - Question on whether these types of methods (tree diagram / formal error propagation) have ever been done in ecosystem models? CHAPTER 9: Future perspectives. An initial list of future perspectives discussed, including: Emerging satellite platforms (geostationary / hyperspectral); Other remote sensing approaches (Lidar, fluorescence, scatterometry, altimetry, SAR); Improving inputs (e.g. light see Frouin et al. 2018); growing array of autonomous platforms (IOCCG report 11); New in situ methods (?); New satellite approaches (more complex underlying relationships); Harnessing expanding time-series data (merged ocean colour products); integration with ecosystem models (IOCCG report 19); AI; and unifying approaches across interfaces (land and ocean)

	Discussion around some of these aspects. For example, Lidar penetrating 3 optical depths. Others mentioned including: Community structure (linked to hyperspectral); other products/components of PP (respiration, possibly with increasing autonomous datasets on oxygen); increasing knowledge on resource limitation (e.g. micro nutrient limitation, co-limitation etc.); better retrievals in the UV (improved IOP retrievals of CDOM); what diurnal ocean colour data (e.g. from geostationary platforms) can bring. CHAPTER 10 Socio-economic value of PP Presentation from Ryan Vandermeulen on fisheries and socio-economic perspectives. Covering how PP sets the upper limit on fisheries production, and that fisheries often in regions where NPP uncertainties are high. Mentions of the influence of phytoplankton community structure on trophic energy transfer; some slides on future model predictions (fish production mirroring NPP, strong influence from temperature and fishing efforts) and impact of climate change. Some slides on whether NPP is the right component to target, arguments NCP is better. Should also be considering changes in size structure and phenology (mismatches). Slides on the need for consistent, climate quality NPP data, as uncertainties in NPP will cascade to larger uncertainties in fisheries. Other socio-economic topics then briefly discussed among the group, including: carbon-based valuation (Jin et al. 2020 https://doi.org/10.1016/j.scitotenv.2020.141357 " *Barange et al. 2017* https://doi.org/10.3389/fmars.2016.00290); use of NPP in future carbon dioxide removal studies; for quantifying Global Carbon Stock takes (e.g. Global Carbon project https://www.globalcarbonproject.org); discussions around use of NPP for water quality monitoring (eutrophication, see Tilstone et al. 2023 http://dx.doi.org/10.1016/j.scitotenv.2022.158757); cost-benefits of increasing remote sensing data (question-related, in context of climate change, we are approaching a length of time-series long enough to study climate-change impacts on ocean colour); use of ocean colour for capacity-building (e.g., in low-income countries, where limiting environmental monitoring exists).
15:30-16:00	PLANNING AND NEXT STEPS Contributions to chapters of the report were identified (for those at the meeting), which will be circulated to the rest of the group after the meeting, for input and edits. The group discussed how regularly we should meet. It was decided that we should aim to meet quarterly, online, and perhaps one a year in person, potentially aligned with an international meeting (e.g., Ocean Optics, IOCS, Ocean Science etc.), if feasible.

	Format of the report was discussed. There is a tradition for these reports to be formatted in LaTeX. However, is seems sensible to develop individual chapters in Microsoft word, as more of the group members are familiar with Microsoft word, then with LaTeX, and Microsoft word has better facilities for editing and track-changes. When the final chapters are produced, they will be converted to LaTeX. For communication, it was decided to set up a Teams group, where information on the working group can be logged, chapters stored and updated. Most pressing was a discussion around Chapters 4-7 (Strategies to PP modelling). It was suggested that contributors to this chapter meet online in December, to flesh out the structure of the chapters.

IMMEDIATE ACTIONS (on Bob):

- Update the draft structure of the report following the KO meeting and to circulate, with suggested contributions to chapters, leads of chapters, and an approximate timeline.
- Set up a Teams Group for communication and storing chapters on the report.
- Organise/set-up quarterly online meetings (calendar invite with Teams link).
- Organise an online meeting in December for those contributing to Chapter 4-7 (Strategies to PP modelling), to flesh out the structure of the chapters.