IOCS-2019 Breakout Workshop Title "Going beyond HPLC: Coming to rapid consensus on science requirements for assessing phytoplankton composition from satellite imagery"

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New orbital imaging spectrometers are being developed that cover the ultraviolet, visible, and near infrared spectrum with a stated objective of assessing phytoplankton composition and diversity across the world ocean. The capability to quantitatively retrieve major phytoplankton taxonomic groups or size classes based on their optical signature has been demonstrated in the open ocean using in the open ocean using satellite data from multispectral (MERIS, MODIS, SeaWiFS) as well as very highly spectrally resolved (< 1nm, SCIAMACHY) sensors. However, the enhanced utility of hyperspectral imaging (with spectral resolution between 4 to 7 nm) still needs to be demonstrated across diverse aquatic regimes and the science requirements need to be specifically designed for phytoplankton group detection from satellites. We believe it is imperative that community members focusing on ocean colour phytoplankton composition come together in a short timeframe to assess the minimum set of recommendations required to establish field programs for validation datasets, and thus maximize the utility of future hyperspectral, as well as multispectral, imaging missions. Specific questions need to be addressed which we will introduce by speed talks and then discuss within the breakout group.

OBJECTIVE: *What kinds of laboratory, field, airborne, and satellite data and modelling efforts are required for algorithm development and validation of aquatic biodiversity across the globe?*

More detailed questions that need to be addressed at the IOCS breakout group include:

1. *Can we develop minimum recommendations for a useful set of measurements and for whether there are suites of measurements that meet most of the objectives:*
   - *What kinds of laboratory, field, airborne, and satellite data are required to develop a comprehensive database in terms of biodiversity data and optical metrics to develop algal diversity bio-optical algorithms across the globe?*

2. *What blooms can be feasibly detected and how are they relevant to global biogeochemistry?*
   - *What surface blooms have the potential to be differentiated (in terms of type, morphology, concentration, size range, biogeochemical or ecological function) using hyperspectral imaging?*

- *What are known blooms that can be differentiated (low hanging fruit – well characterised blooms)?*
- *Which blooms are known to be challenging to be differentiated with multi-spectral data but might be better resolved with hyperspectral data?*
- *What blooms would be useful for water quality, eutrophication, fisheries stock assessment, and other applications?*
- *How do these blooms fit into Phytoplankton Functional Type categories?*
- *Would it be useful if the community comes to consensus on a "minimum" list to attempt to be retrieved globally with sufficient accuracy? For example, the PACE website lists a selection of blooms with different ecological functions. Are these appropriate, sufficient and possible to differentiate?*
- *What role can synthetic data sets and IOP/radiative transfer modelling play in the evaluation of hyperspectral vs multi-spectral detection, most particularly for phytoplankton assemblage characteristics?*

3. *How do we best utilise existing programs or recommend new programs to validate satellite approaches for detecting ephemeral blooms in the sea?*
   - *How do we best respond to events of opportunity – regions with known blooms occurring?*
   - *Would it be useful to manufacture experimental blooms for algorithm development? How representative are such experimental systems to natural blooms (particularly if they are stock phytoplankton)?*
   - *Are a suite of well-placed moorings sufficient to characterise diversity of blooms over time?*
   - *How do we best utilise aircraft or drone data for validation?*