Breakout Workshop: Remote sensing of optically complex and shallow waters

Report

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Description:

Optically complex waters and shallow water environments continue to present unique challenges to our evolving understanding of ocean color remote sensing, and to the operational and mission capabilities we are bringing to bear on the problem today. By definition, complex waters contain optically active constituents which fail to co-vary in concentration or optical characteristics with one another, thus belying the assumptions we tend to use in the open ocean to invert reflected sunlight for the estimation of those constituent properties such as chlorophyll concentration. Also, variations in the vertical dimension further complicate the matter. Shallow water reflectances are often anomalously high (i.e. routinely masked and problematic for atmospheric correction), and characterized by extreme spatial heterogeneity compared to most other aquatic environments, while also contributing an additional unknown parameter to the inversion of the light field beyond the capability of standard semi-analytical approaches. Most current and legacy ocean color sensors are not optimized for observing optically complex or shallow waters – for example having too few spectral channels for accurate separation of inherent optical properties or characterization of phytoplankton pigments, saturating over shallow or turbid pixels, or underestimating constituent concentrations due to spatial/vertical sampling limitations, among other problems. These technological limitations exist despite the fact that many of these waters are situated near-shore or inshore and host fragile and important ecosystems such as coral reefs and fisheries that are important to human life, while being significantly impacted by human activity. As more sophisticated sensors are developed with higher spatial, temporal, and spectral resolutions, as well as polarization sensitivity and active sensing through LIDAR, their capabilities have the potential to vastly change and improve how we study optically complex and shallow waters remotely. This workshop is designed to explore these recent developments and consider whether our theoretical understanding is keeping pace with technological capabilities scheduled to come online in the near future.

Breakout workshop presentations:

To provide a full picture of the challenges and status of current knowledge and technology, this breakout workshop is composed of the following presentations:

Colleen Mouw: Overview of the challenge of complex waters
Antonio Mannino: Requirement of the sensing of "new" water in high latitudes
Chuanmin Hu: Floating algae
Yingcheng Lu: Oil spill
Yongxiang Hu: Lessons from CALIPSO
Deric Gray: Ocean LIDAR
Rodrigo Garcia: Advancement of shallow water algorithm
Eric Hochberg: CORAL project and implications

Discussion:
There were active and "intense" discussions after the presentations, ranging from data to capacity, with a summary presented below:

1. "Complex" water is not limited to coastal or shallow environments. Oceanic waters also consist of optically significant and varying properties including CDOM and bio-optical pigments that do not necessarily co-vary with chlorophyll-a concentration, though they do contain relatively lower amounts of nearly all biogeochemical components.
2. There is a strong demand for more high-quality in situ data, which includes (but is not limited to) measurements in high altitude lakes and in high latitude (Arctic/Antarctic) waters, reflectance data in the UV and near-IR, as well as libraries of substrate reflectances, etc. It is strongly recommended that, in addition to submitting data to designated data center (e.g., SeaBASS), members of the community publish their valuable data in data journals.
3. To tackle the issues/challenges related to remote sensing in complex waters, simply relying on aquatic color is not enough. It is important to incorporate information from other sources, such as temperature, vertical profiles (LiDAR), mix-layer depth, etc. Measurement and reporting of such in situ parameters are strongly recommended in order to fully understand and interpret the complexity of various aquatic environments.
4. The establishment a few "super sites" worldwide – where the community can obtain time series measurements of broad environmental parameters – is recommended in order to improve our understanding of complex waters and the remote sensing thereof.
5. The expansion of ocean lidar remote sensing suggests the development and distribution of a community-accepted simulation system for active remote sensing analogous to Hydrolight for passive remote sensing.
6. The first-order product from passive or active remote sensing is still an optical product, such as the inherent optical properties. In addition to continuing the refinement of algorithms for IOPs, it is recommended to expand the training and the application of IOPs for biogeochemical studies.