Report

Short Training

“NASA Sponsored Workshop on Calibration and Validation of Ocean Color Remote Sensing”

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1. Description of the short training opportunity

The NASA Sponsored Workshop on Calibration and Validation of Ocean Color Remote Sensing (also "Ocean Optics Class") is a bi-annual training opportunity for graduate students hosted by the University of Maine in the United States in collaboration with Bowdoin College. In the four weeks of the course's duration, lectures on elementary physics of the light-ocean interaction are combined with laboratory sessions and hands-on training activities that aim at the development of practical skills in the field of Optical Oceanography. Topics covered in this course include (as outlined in the course description):

- Light in the aquatic environment
- Inversion methods and ocean colour remote sensing
- Optical assessments of the ocean's biogeochemistry
- Optical instrumentation, handling, measurement uncertainties
- Radiative transfer software training
- Field measurements along the optically diverse coastal waters of Maine

This and more information on the course can be found here: https://www.us-ocb.org/calibration-validation-ocean-color-remote-sensing-2023/ (accessed: 2023-04-26).

The 2023 workshop has been hosted at the Bowdoin College Schiller Coastal Studies Center in Harpswell, Maine. The students and TAs were finding accommodation and meals provided through the financial support by NASA, which is carrying the workshop. All other cost associated with the participation were covered individually (travel costs, travel insurance …). In this case, Québec Océan provided financial support to cover costs of travel, insurance, and visa.

2. Syllabus and outline of the received training

This one-month workshop included theoretical lectures and hands-on laboratory work as well as guided experiences and experiments in the field. Most importantly, the emphasis of this training lies in collaboration and teamwork of the participants. The instructors hereby follow the objective to establish a strong community of next-generation optical oceanographers.

Theoretical lectures in the first half of each day were put into practice through thematically matching laboratory work in teams of varying size and constitution. The results of which were presented the following morning and opened to discussion. This allowed for the critical reflection of approaches to the tasks.

During the third week, the research vessel RV IRA C hosted all participants in a half-day cruise to Harpswell Sound and the Gulf of Maine. Multiple experiments and student group projects were using the data acquired from a multitude of optical instruments during the cruise. For instance, the workshop provided multiple ACs, an optical cage for IOP measurements, the profiling radiometer HyperPro (*Sea-Bird Scientific*) as well as PySAS (Haëntjens et al., 2022) and an inline-system which ran continuous measurements from multiple sensors over the duration of the cruise.

The project teams subsequently processed all data and presented project updates over the following days of the remainder of the workshop. The last day concluded this training and learning experience with a presentation of the final results that each group had accomplished.

3. Personal reflection on the training and learning experience

It's been a great honour to participate at the 2023 Ocean Optics Class (which is the synonym name of the workshop and indicative of the community building aspect). The four weeks have been rich in developing confidence in the deployment and – more importantly – the processing, evaluation and presentation of data derived from optical sensors in an oceanography context. The aspects of calibration of in-situ sensors and remote sensing algorithms and even more so validation of the results through redundancy in the measurements and critical assessment have been themes that echoed throughout the course.

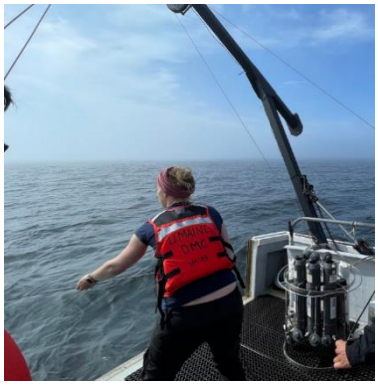
The lectures of the teaching staff were of very high quality and performed in diverse ways; I appreciated the diversity, as some teaching techniques may resonate better with some than with others. Depending on the level of pre-existing knowledge in the subject, the first week may be intense and cognitively demanding. Equally, it also offers the rare opportunity to learn from experts and establishing high-quality routines in ocean optics work.

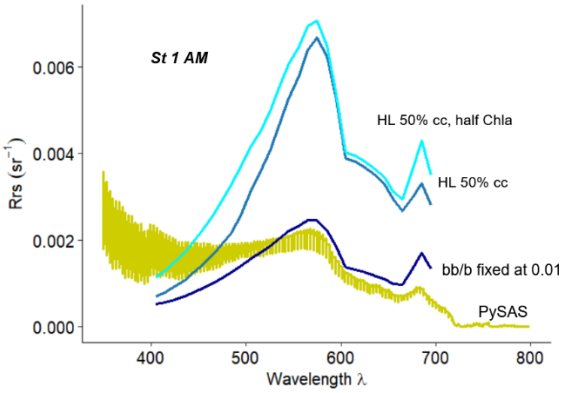
One of the most cherished aspects has been the teamwork with future colleagues in the field. Most evenings are filled with collaborative coding and discussions of data of the day. Many of the discussions that accompanied the thematic work have been brilliant ways of sparking curiosity for different parts of this field and prompting reflections on what it means to be a part of the community.

It has been an exclusive chance to process data for inherent optical properties (IOPs) of different phytoplankton cultures and wholistic water samples of the nearby waters in Harpswell Sound. Furthermore, to identify the composition of present communities in the water further, the use of the Imaging FlowCytobot (IFCB) as well as the Optical Laser diffraction instruments (LISST, Sequoia Scientific Inc.) have been explored. The scattering properties of different particles in the forward direction (LISST) or the backward direction (Hyper-BB, *Sequoia Scientific Inc.*, or ECO-BB instruments, *Sea-Bird Scientific Instruments)* were distinctions in the use of these instruments that participants were fortunate to learn about. Hyperspectral instruments like the Hyper-BB backscattering sensor (*Sequoia Scientific Inc*.) or the ac-s (*Sea-Bird Scientific Instruments*) allowed insights into the current approaches and new insights from higher resolution optical sensors. With the upcoming NASA PACE mission, the use of hyperspectral sensors for validation and calibration will become more and more important.

The Ocean Optics Class offers the opportunity to develop skills related to state-of-the-art optical sensors and remote sensing technologies. The course generally covers a wide array of topics, from elementary physics of light interaction with water to cutting-edge technologies and current developments in the field like the use of polarization to characterize water constituents and their effect on the underwater light (e.g., with the LISST Horizon, *Sequoia Scientific Inc.).*

This experience has been inspiring and encouraging to explore a wider range of optical measures for the study of oceanography. The standards and workflows of the workshop will greatly improve the quality of products generated in my PhD research.





Picture *left*: Deployment of the profiling radiometer Hyper-Pro during the scientific half-day cruise in Harpswell Sound and the Gulf of Maine (photo by: Meredith Kime). *right*: Observed PySAS remote sensing reflectance (R_{rs}) in comparison to three modelled spectra from Hydrolight simulations based on IOP data acquired on the cruise. We hypothesised after our analysis, that the backscattering (b_b) had been overestimated by the in-situ IOP instrument (BB9).

References:

Haëntjens, N., K. Forsythe, B. Denholm, J. Loftin, and E. Boss. 2022. pySAS: Autonomous solar tracking system for surface water radiometric measurements. *Oceanography* 35(2):55–59, https://doi.org/10.5670/oceanog.2022.210.