IOCS Breakout session #2 - In water radiometry on autonomous profiling floats in support of satellite ocean colour validation activities

Chair: Vincenzo Vellucci

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Introduction

The IOCS Breakout Session #2, “In water radiometry on autonomous profiling floats in support of satellite ocean colour validation activities” took place on December 1st at 14h30 in the Chromium room of the Darmstadtium in Darmstadt (DE) with about 50 on-site and 15 on-line participants.

The workshop addressed a central challenge for ocean colour remote sensing: the ocean is difficult and costly to sample using traditional ship-based methods, resulting in persistent global under-sampling of physical and biogeochemical properties. Over the last two decades, autonomous profiling floats have transformed open-ocean observing capabilities. The Argo programme, launched in the 2000s, dramatically increased global coverage of temperature and salinity observations. Building on this success, the BGC-Argo mission is scaling up sustained observations of biogeochemical variables (including chlorophyll-a and backscattering).

Early attempts to use radiometry-equipped floats for satellite validation started in the 2010s with multispectral upwelling radiance sensors, but these efforts did not transition into operational programmes. More recent developments—such as floats designed explicitly for system vicarious calibration and new BGC-Argo platforms integrating hyperspectral radiometers—have revived the prospect of deploying radiometry in the open ocean, with improved protocols, processing standardisation, and uncertainty characterisation aligned with FRM principles. The objectives of the breakout session were to present the state of the art of in-water radiometry on profiling floats and to discuss how hyperspectral BGC-Argo data could be integrated into satellite validation workflows (including commissioning phases of new missions).

Agenda

Time	Description	Presenter)	
14:30	Introduction	V. Vellucci	Sorbonne University, IMEV
14:35	State of the art of in-water radiometry instrumentation and data acquisition protocols	G. Zibordi	EOSCIENCE
14:50	The HyperNav, a profiling float designed for PACE system vicarious calibration	N. Haëntjens	University of Maine, School of Marine Sciences
15:05	The Provor CTS5, a BGC-Argo float to deploy radiometry at Argo scale	E. Leymarie	CNRS, LOV
15:20	Questions		
15:30	Coffee Break		

16:00	The BGC-Argo profiling floats programme, status and synergy with satellite OC	H. Claustre	CNRS, LOV
16:15	Potential of BGC-Argo floats as data source for satellite OC validation	A. Mangin	ACRI-ST
16:30	Discussion		
17:15	Wrap-up		
17:30	Session ends		

Session summary

Vincenzo Vellucci opened the session by recalling the historical development of in-water radiometry on profiling floats, from the first pioneering deployments to today's renewed efforts enabled by hyperspectral systems. He then outlined the main goals and key questions of the breakout: assessing protocol readiness for satellite ocean-colour validation and identifying priorities for scaling radiometry within BGC-Argo.

Giuseppe Zibordi presented *"State of the art of the in-water radiometry instrumentation and data acquisition protocols"*, focused on how in-water radiometry can deliver robust reference measurements for satellite ocean-colour validation when protocols are rigorously applied. He emphasized key acquisition requirements such as stable profiling conditions, control of instrument tilt and self-shading, and careful treatment of near-surface data affected by wave focusing. He defined quality assurance (QA) as all actions ensuring correct execution of measurements through the strict implementation of protocols, including pre- and post-field calibration of system components, proper installation, and practices that minimise operational issues. Quality control (QC) was described as post-measurement processing to flag questionable products, for instance when geometry requirements are not met, when spectra show strong negatives in blue/red, anomalously high near-infrared values, or unexplained spectral inconsistencies.

Nils Haëntjens presented *"The HyperNav, a profiling float designed for PACE system vicarious calibration"*. He described HyperNav as an autonomous platform pairing a dedicated radiometric payload with a profiling float and key ancillary measurements (e.g., high accuracy pressure and tilt) required for corrections and QC. The system was presented as a practical approach to increase the number and diversity of high-quality system vicarious calibration matchups for PACE-OCI. The system is currently used for PACE-OCI SVC.

Edouard Leymarie presented *"The Provor CTS5, a BGC-Argo float to deploy radiometry at Argo scale"*, introducing CTS5 as a BGC-Argo–compliant platform designed to host in-water radiometry within an operational network. He stressed its full parameterisation, enabling mission designs tailored to radiometry (profiling strategy, sampling timing in the upper ocean, and coordination with ancillary observations needed for corrections and QC). When equipped with a hyperspectral radiometer, CTS5 was presented as a strong candidate platform for satellite ocean-colour validation in open ocean.

Hervé Claustre presented *"The BGC-Argo profiling float programme, status and synergy with satellite ocean colour"*. He highlighted the programme's maturity through the large cumulative number of profiles and the high number of new profiles acquired each year. He also underlined that BGC-Argo data are maintained within the Argo data system, with observations managed through Data Assembly Centers (DACs) and distributed via Global Data Assembly Centers (DACs) using common procedures for formatting, QC, and dissemination, an essential foundation for consistent and scalable use in satellite ocean colour applications.

Antoine Mangin presented *"Potential of BGC-Argo floats as data source for satellite OC validation"*, describing the shift from early float-based validation focused on chlorophyll-a toward satellite radiometry validation enabled by REFINE radiometry floats. He emphasised uncertainty-aware validation, presenting triple-collocation approaches that combine satellite ocean colour products, BGC-Argo observations and model outputs to statistically estimate uncertainties and support objective flagging of satellite–float comparisons. He noted that, with appropriate QC and processing aligned with FRM protocols, float-derived Rrs products are approaching FRM readiness, and that BGC-Argo is already used operationally for ocean-colour quality control.

Review of previous recommendations

The following recommendations from previous IOCS meetings were considered relevant to this BW session:

Data & Datasets				
2015.10.1	There is a clear need for a centralized access (or information) point for BGC-Argo data	Community	Actioned	https://biogeochemical-argo.org/data-access.php
High Latitudes				
2017.05.3	More In-situ data from non-summer months is needed	Community	OPEN	Argo and BGC-Argo help a lot, as some saildrone deployments. However they are still limited to a few parameters. Innovative ways of collecting autonomously (or quasi autonomously) more diverse data sets have to be invented.
Protocols & Training				
2017.08.1	The current best practices for in-water measurements are not described and need to be detailed.	Community	Actioned	We worked on a protocol document that detailed the in-water measurement practices
Resolution – spectral, spatial, temporal				
2017.01.5	Continue to mature the development and curation of hyperspectral optical databases and products (e.g. PFTs) for use in algorithm development..	Community	Actioned	new cured data collections were released, e.g. Lehmann et al. Scientific Data 2023, Valente et al. ESSD 2022

In addition, the IOCCG Report Number 11 (2011) provided recommendations for the development of a network of bio-optical profiling floats.
To note that the second recommendation (2017.05.2) of the above list should be updated to "Actioned" as BGC-Argo floats now include several optional sensors in addition to the 6 core variables.

Recommendations

The discussion converged on several priorities to enable reliable radiometry at Argo scale that were summarized into four recommendations. An additional recommendation emerged from the need to better link satellite OC measurements with particulate backscattering coefficients measured on board BGC-Argo floats.

1) [to community] It is recommended to follow metrological principles for calibrations of radiometric sensors used on BGC-Argo profiling floats. Actions have to be taken 1) to intercompare radiometric measurements on BGC-Argo with other in-water profiling systems (e.g. HyperPro), and 2) to characterise long-term sensor drift by recovering floats, when possible, for post-deployment calibrations.
2) [to agencies] The community recommends the use of BGC-Argo float for validation of satellite OCR products.
3) [to community and agencies] There is a need to promote discussions between the BGC-Argo and ocean color communities through dedicated actions (e.g. working groups and workshops).
4) [to community] Work is needed toward building a community processor for common in-water radiometric profilers with associated uncertainties complying with FRM protocols.
5) [to community] The use of a shorter wavelength for bbp measurements (e.g. in the green region) on board BGC-Argo floats should be considered in addition or alternative to 700 nm.