POGO-SPONSORED TRAINING INITIATIVE
Report

1. Name of grant recipient (Proposal Coordinator)

Kristin Burmeister

2. Title of training

Best practices for biogeochemical ocean observation: instrumentation, operation, quality control.

3. Dates of training (e.g., 01 Jan 1999)

Start date: 15th Jun 2022

End date: 17th Jun 2022

4. Location of training (e.g. institute, city, country) Please indicate if online/in person/hybrid.

Scottish Association for Marine Science (SAMS), Oban, UK, hybrid

5. Number of trainees: 9 in-person (8 changed to virtual on late notice due to visa issues), 26 virtually

6. Other partners/funding sources

In-kind support from all training workshop partners via staff time (estimated values in excess of 6000 EUR) and travel expenditures of one trainer (Matthew Humphreys, NIOZ)

7. Provide an outline of the training course/initiative (objectives, format, topics)
Full programme can be included as an Appendix.

Biogeochemical measurements in ocean observing systems allow for assessment and sustainable management of oceanic ecosystems, yet they are underrepresented and underutilized. We created a POGO observational training to increase utilization of biogeochemical data sets and share experiences with moored and float biogeochemical sensors made by different projects to grow the biogeochemical observing system.

Program Highlights
1. **Mini-Conference (5 minutes presentation of participants)**
2. **Training Groups: 1) BGC-Argo, 2) Moored observations, 3) Ship-board and glider observations**
3. **Discussion - Do we need to standardize calibration and quality control of biogeochemical sensors? What do you want from the international community? What is a good approach to test new BGC sensors (Ship-board, Mooring, Argo)?**

The workshop took place as hybrid event. It was streamed live and online from Wednesday, 15 June to Friday, 17

For full program see workshop booklet in APPENDIX (p.3-24)

We used interactive tools like mentimeter (see APPENDIX Icebreaker, p.25-26, and APPENDIX Wrap up, p.27) and jamboard (see APPENDIX Breakout group feedback, p.28-30) to get equal contributions from virtual and in-person attendees

Video footage of SAMS facilities and instruments was provided in slack channel for virtual attendees who could not join the tour.)

8. Provide a summary of the students' performance and any informal feedback received
Please note that an evaluation questionnaire will be sent to the participants by the Secretariat and therefore we ask that you provide a list of trainees and their e-mail addresses. The questionnaire results will be shared with you in due course.

All in all very positive feedback. Technical tools like a slack group for questions/general communication and a meeting owl (360° cam, mic, speaker) allowed us to bring together the in-person and virtual attendees and allow both groups to interact on the same level.

Mainly because of VISA issues 5-8 participants needed to join virtually instead of in-person at short notice. A result of doing the in-person workshop in the UK. The great thing about the hybrid event was, that they still could attend.

See Appendix in this document for feedback from the participants.

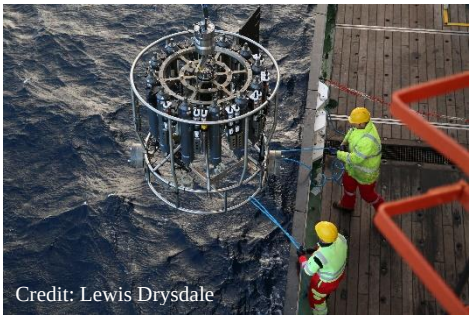
9. Do you have any plans for future collaboration with the students, the host institute (if applicable) or for future editions of the training course?

Participants on the workshop plan to organise similar workshop at their institutes in future. The training resources are available for all participants in the slack channel. The recordings of the training will be published on SAMS youtube channel (open for everyone).

10. List of trainees
Please fill in the attached Excel spreadsheet with the list of trainees.

APPEDIX – Workshop Booklet

Best Practices in Biogeochemical Ocean Observation: instrumentation, operation, quality control



POGO observational Training

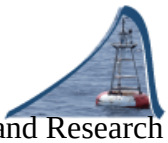
Scottish Association for Marine Science

15th – 17th June

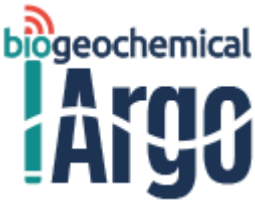
In collaboration with Scottish Association for Marine Science (SAMS, UK), National Oceanography Centre (NOC, UK), Argentine Scientific Research Council (CONICET) and the Hydrographic Service (Argentina), Oceans & Coastal Research, Dept. of Environmental Affairs (DEA, Republic of South Africa), Laboratory of Physical and Spatial Oceanography (LOPS, France), Institut Français de Recherche pour l'Exploitation de la Mer (IFREMER, France), Royal Netherlands Institute for Sea Research (NIOZ, Netherlands), Institute of Marine Sciences Rome section (ISMAR, Italy), Seabird Scientific (USA)

Affiliated projects: OSNAP (https://www.o-snap.org/), RAPID (https://rapid.ac.uk/rapidmoc/), SAMOC/SAMBA (https://www.aoml.noaa.gov/phod/SAMOC_international/index.php), OVIDE (https://www.umr-lops.fr/en/Projects/Active-projects/OVIDE), PIRATA (https://www.pmel.noaa.gov/gtmba/pmel-theme/atlantic-ocean-pirata), BGC-Argo (https://biogeochemical-argo.org/), iAtlantic (https://www.iatlantic.eu/), CLASS (https://projects.noc.ac.uk/class-project/)

PIRATA
Prediction and Research Moored Array in the



OVIDE
Observatoire de la variabilité interannuelle et décennale en Atlantique Nord



Contents

Organising committee

Dr Peter Brown

Peter is a Chemical Oceanographer in the Ocean Biogeosciences group at the National Oceanography Centre in Southampton, UK. His work focuses on open ocean carbon system observations and their contemporary, preindustrial and anthropogenic components, and in particular on how biogeochemical processes interact with ocean circulation. He has experience of laboratory instrumental analyses of the marine carbonate system, transient tracers (CFCs, SF6) and oxygen across multiple GO-SHIP hydrographic cruises from the North Atlantic to the Southern Ocean. And he has deployed and recovered dozens of biogeochemical sensors and water samplers on moorings in the subtropical North Atlantic as part of the RAPID mooring array.

Dr Kristin Burmeister

Kristin is a postdoc in physical oceanography at SAMS (Oban, UK). Her research focuses on the variability of the Atlantic Ocean on seasonal to longer timer scales. She is investigating changes of temperature, salinity and biogeochemical components like oxygen and how they are related to variations in the large scale ocean circulation and climate modes. Therefore she uses a combination of observational data (ship sections, moorings, satellite) as well as the output of general ocean circulation models.

Dr Lidia Carracedo

Lidia is a researcher in the field of physical and biogeochemical oceanography at LOPS (Ifremer, France). She has a particular interest in the study of the spatio-temporal variability of the ocean state and its role as a carbon pump, and the underlying processes driving such variability. Her current research focuses on in situ observations and data analysis of physical and carbonate-system variables in the North Atlantic, a key oceanic region for the storage of anthropogenic carbon.

Dr Maria Paz Chidichimo

María Paz is a physical oceanographer at the Argentine Scientific Research Council (CONICET) and the Hydrographic Service in Argentina. She obtained her PhD from the International Max Planck Research School on Earth System Modelling and the University of Hamburg (Germany), afterwards she was a postdoctoral researcher at the University of Rhode Island (US). Broadly, her research interests are on how and why large-scale ocean currents change, their role in redistributing heat, salt and carbon around the globe, and how they relate to the global climate system. She has been conducting her research in large international programs to observe the ocean circulation in the North and South Atlantic and in the Southern Ocean. She has contributed as Lead Author to the IPCC SROCC. She is a member of the Executive Committee of the South Atlantic Meridional Overturning Circulation (SAMOC) initiative; she serves in the CLIVAR AMOC Task Team and the GOOS/GCOS Ocean Observations for Physics and Climate Panel (OOPC).

Dr Lewis Drysdale

Lewis is a sea-going oceanographer with field experience in the Arctic, Antarctic, and North Atlantic. He has worked for Marine Scotland and the National Oceanographic Centre. In his present role as Ocean instrumentation and robotics support scientist at SAMS he works primarily with gliders and CTDs in addition to undertaking data quality control and processing of glider and moorings data.

Dr Emanuele Organelli

Emanuele is a biological oceanographer with recognized expertise in the application of marine optics to the study of phytoplankton diversity and the ocean carbon cycle, both from in situ and from space. He received his PhD in marine ecology at the University of Florence (Italy), and then spent 8 years working as a postdoctoral fellow in France at the Laboratoire d'Océanographie de Villefranche (LOV), and in the UK at the Plymouth Marine Laboratory (PML). In 2019, he permanently joined the Institute of Marine Sciences (ISMAR) of the Italian National Research Council (CNR) as a Research Scientist. He has been involved in several national and EU funded projects and coordinated the H2020 Marie Skłodowska-Curie project "REOPTIMIZE". Now he is co-coordinating the "CAREHeat – Detection and Threats of Marine Heat Waves" project funded by the European Space

Agency on the Ocean Health actions. Since 2014, he is actively working (from implementation, QC and scientific exploitation) on optical measurements acquired by BGC-Argo floats, with a focus on radiometry. In 2016, he contributed to the first design and scientific implementation plan of the International BGC-Argo programme, and he is taking part in various working groups targeting BGC-Argo mission's improvement and sustainability in the future. He has authored more than 30 JRC papers. Here the link to his webpage and publication records:
http://www.ismar.cnr.it/people/organelli-emanuele-4/

Dr Matthew Humphreys

Matthew is a tenure-track scientist in the Department of Ocean Systems at NIOZ Royal Netherlands Institute for Sea Research on the island of Texel. He is interested in the changing biogeochemistry of the modern ocean, with a focus on CO2. He conducts ocean-going, observation-based research alongside theoretical studies of the marine carbonate system and develops related scientific software, primarily in Python.

Dr Clare Johnson

Clare is a PDRA at the Scottish Association for Marine Science (SAMS). Her interests lie at the interface of physical and chemical oceanography and for the last few years she has been working on using moored biogeochemical sensors on the OSNAP mooring array in the subpolar North Atlantic.

Dr Sam Jones

Sam is a postdoctoral physical oceanographer under the OSNAP and CLASS programmes, studying large-scale oceanographic processes. He works with a range of in-situ observational platforms and their data, including deep ocean moorings, CTD, Argo and robotic gliders. Particular strengths in data analysis and visualisation, primarily using Matlab for data processing. Sam completed a PhD in coastal marine physics at SAMS in April 2016. Prior to this, Sam worked as a data scientist for the British Oceanographic Data Centre (BODC), maintaining the real-time data systems for UK Argo between 2009 and 2012.

Dr Brian King

Brian is an oceanographer at the National Oceanography Centre, Southampton, UK; his background is in Applied Mathematics and Physics. His PhD was in numerical modelling in a Mathematics department, but as a post-doctoral researcher his career moved into observational oceanography. During the 1990s he participated in a number of cruises as part of the World Ocean Circulation Experiment (WOCE), mainly contributions to the WOCE Hydrographic Program. He has been a member of the International Argo Steering Team since its first meeting in 1999, which marked the start of the Core Argo program the following year. He ahs been centrally involved in the evolution of the Argo data system, which ensures that Quality-Controlled data are freely available in Real-Time to all users, with further quality control provided in Delayed-Mode for climate studies. As Argo expanded from the Core Mission, delivering physics measurements in the upper 2000 dbar, he became co-Chair of the international Deep Argo Mission Team, and led the UK effort to deploy floats capable of 6000-dbar operation. In March 2022 he deployed the first three UK floats to measure all 6 parameters in the BioGeoChemical Argo Mission.

His research interests are in budgets, inventories, transports and variability of physical and biogeochemical properties of the oceans at basin scale, especially heat, freshwater and carbon, and their importance for understanding climate change. Away from Argo he has participated in more than 25 research cruises on the UK's deep-water research vessels, most recently as a contribution to the Global-Ocean Ship-Based Hydrographic Investigations Program (GO-SHIP). Around half of his cruises have been as Chief or co-Chief Scientist. He is a passionate advocate of the free and timely distribution of ocean data to ensure its widest possible use.

Dr Tarron Lamont

Tarron is a Physical Oceanographer based at the national Department of Forestry, Fisheries and the Environment, in Cape Town, South Africa. Her primary research interests focus on investigating circulation patterns and driving forces of dynamics and variability in the Benguela Current Large Marine Ecosystem, the Agulhas Current Large Marine Ecosystem, and around island ecosystems in the Southern Ocean. She serves as a member of the international South Atlantic Meridional Overturning Circulation (SAMOC) Executive Committee and leads the South African contribution to the international SAMOC Initiative.

Darren Rayner

Darren is a physical oceanographer specialising in collecting observations from moored sensors. He has extensive practical and technical experience with deep-water mooring systems and sensors, along with the processing, calibration and quality control of collected timeseries. He has been working with BGC sensors on the RAPID mooring array since 2015.

Dr Ian Walsh

Ian is a consulting research scientist working on ocean carbon uptake, flux and fate particularly pointed to ocean-based carbon dioxide removal (Ocean CDR). He was most recently Director of Science at Sea-Bird Scientific, an international supplier of oceanographic and aquatic research and monitoring instruments, where he consulted with scientists and engineers worldwide on instrumentation and ocean observing systems. Previously, Dr. Walsh was a research professor at Oregon State and Texas A&M Universities participating in many large international and interdisciplinary research efforts, spending almost two years at sea on more than forty research cruises, and authoring more than twenty-five widely cited research papers. Dr. Walsh's research interests include the use of optical data on the particle field to understand basic biogeochemical processes and the influence of physical forcing on those processes, and carbon fluxes and fates including predictive modelling.

Anneke Sperling

Anneke is a third-year undergraduate studying Marine Science at SAMS. Her studies focus on the physical oceanography of the ocean with special interest in large-scale ocean circulation and ocean-atmosphere coupling. She is currently doing an internship at SAMS, analysing bottom pressure recorder measurements and their potential to more accurately measure the Atlantic Meridional Overturning Circulation.

Workshop Dynamics

What will happen each day?

The workshop is a hybrid event. The physical part will take place at the Scottish Association for Marine Science, Oban, UK.

The Workshop will be live and online Wednesday, 15 June to Friday, 17 June between 8:15-12:00 and 13:00-16:15 GMT (UTC) each day. During the first part of the day (8:15-12:00 GMT) the mini-conference consisting of key note lectures, 5 min presentations by the participants and discussion break-out groups will take place. During the second part of the day (13:00-16:15 GMT) the actual training will take place. Each day will cover one observational method: BGC-Argo, moored observations, ship-board and glider observations.

5 min presentations

All of you will have 5 minutes to present your research and how you use/would like to use BGC observations for it. You can accompany your presentation with max 2 slides using the following google template. Please copy the two slides at the beginning and add your content to it **by Tuesday, 13 June**:

https://docs.google.com/presentation/d/171lKGXoDlwuIh7EG05mq1mhEqVDl1Foq/edit?usp=sharing&ouid=106918381861256963794&rtpof=true&sd=true

Zoom

The workshop will be streamed via zoom. For each day we will use a new zoom link:

Wed., 15th June: https://us06web.zoom.us/j/82282027017?pwd=cUdDN0hUcVAyTit5Qlg4NHlWclNnZz09
Thu., 16th June: https://us06web.zoom.us/j/87198111971?pwd=bFZlRDR5MFArVk5XWlJrc1UzZ21WZz09
Fri., 17th June: https://us06web.zoom.us/j/89988115930?pwd=VWRRNnF3cXMxVjRmTUlPcEZJRnZCZz09

Slack

In addition to the live sessions, we will use slack as a communication tool during the workshop. In-person and online participants can post questions there before, during and after the workshop. Please use the following link to create and account and join our slack group:

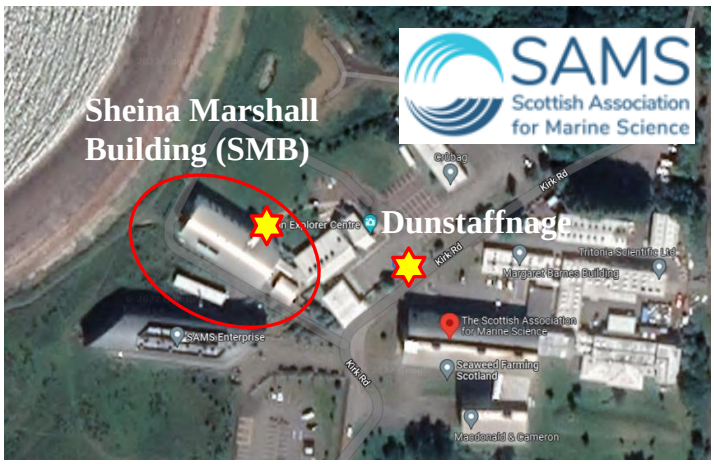
https://join.slack.com/t/bestpractices-rfy7304/shared_invite/zt-19pipe45z-c2stsMOhzek0qKIM5uVX2g

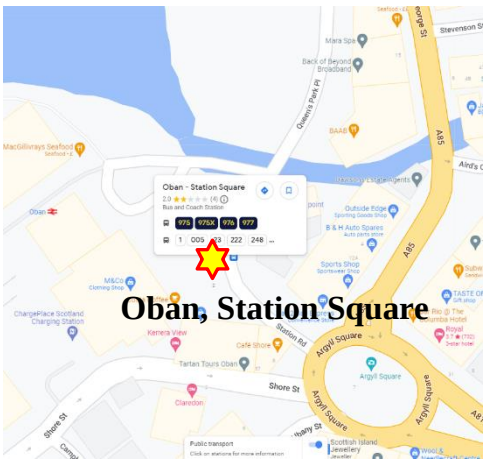
To keep an overview we initially provided the following channels which you can join:

- **general** (This is the one channel that will always include everyone. It's a great spot for announcements and team-wide conversations but also for any question you might have with respect to the workshop in general.)
- **mini-conference** (This channel is for questions and discussion with respect to 5 min presentations, breakout groups of key lectures.)
- **bgc-argo** (This channel is to distribute information and to discuss anything about BGC-Argo observations.)
- **moored-sensors** (This channel is to distribute information and to discuss anything about moored BGC observations.)
- **ship-and-glider-observations** (This channel is to distribute information and to discuss anything about ship-board and glider BGC observations.)
- **networking** (This channel is for any networking activity among workshop participants and trainers.)
- **random** (This channel is for... well, everything else. It's a place for team jokes, spur-of-the-moment ideas, and funny GIFs. Go wild!)

Workshop Venue

The workshop will take place in the Sheina Marshall Building (SMB) of the Scottish Association for Marine Science, Oban, UK.





Getting there:

A bus (005/405) is operating between Oban (Station Square) and SAMS (Dunstaffnage) twice a day. Please make sure to be at the bus station 5min earlier as the bus may departure earlier:

From Oban to SAMS:

- Bus 405, departure from Oban, Station Square at 08:24 (BST); Arrival at Dunstaffnage at 08:36 (BST)

From SAMS to Oban:

- Bus 005; Departure from Dunstaffnage at 17:38 (BST); Arrival at Oban, Station Square at 17:53 (BST)

See also: https://www.westcoastmotors.co.uk/services/WCMO/405

On Wednesday, 15th June, Kristin will be at Oban, Station Square at 8:15 am to accompany you.

Informal Walk Through Oban, Tuesday, 14th June at 6:30pm (BST)

For anyone arrive on Tuesday we will meet at Oban, Station Square at 6:30pm for an informal walk through Oban.

Conference Dinner, Wednesday, 15th June at 6:30pm (BST)

Meet interesting communities in Oban and join us for a free conference dinner at Hope Kitchen in Oban (https://www.hopekitchen.org.uk/). Taste of Argyll Kitchen (https://www.facebook.com/people/Taste-of-Argyll-kitchen/100063449546685/) will serve us a local, vegetarian dinner and the civil science Seaweed Gardens project (https://www.facebook.com/groups/491242249207436/) will entertain us with self-made seaweed snacks and interactive activities about climate, oceans gardens, art and science.

Time zones

The workshop times are indicated in the time zone UTC and BST. The table below indicates the corresponding local times of the beginning of the online workshop 8:15 UTC.

Country	UTC (8:15am)/BST (9:15am)	Your time
Nigeria	+1/+0	9:15am
Italy	+2/+1	10:15am
Spain	+2/+1	10:15am
Germany	+2/+1	10:15am
India	+5/+4	13:15pm
China	+8/+7	16:15pm
Japan	+9/+8	17:15pm

Partnership for Observation of the Global Ocean

Program Schedule

Best practices for biogeochemical ocean observation: instrumentation, operation, quality control.

Wed, 15th to Fri, 17th June 2022

Program

UTC	BST	Tuesday	Wednesday	Thursday	Friday
	08:24		08:24 Bus to SAMS	08:24 Bus to SAMS	08:24 Bus to SAMS
08:00	09:00		8:45-9:15 Arrive on side	8:45-9:15 Arrive on side	8:45-9:15 Arrive on side
08:15	09:15		Start of Workshop	Start of Workshop	Start of Workshop
08:30	09:30		Welcome (Mark Inall)	5min talks block	Structured and self-organised breakout groups
09:00	10:00		Ice Breaker	5min talks block	
09:30	10:30		5min talks block	5min talks block	break
10:00	11:00		break	break	Collaborative discussion.
10:30	11:30		5min talks block	Key lecture (Clare Johnson)	
11:00	12:00		5min talks block	5min talks block	MRF Tour (Robotics and Sensors)
11:30	12:30		5min talks block	5min talks block	
12:00	13:00		Lunch		
12:30	13:30				
13:00	14:00		TRAINING BLOCK: BGC-Argo (incl. 30min break)	TRAINING BLOCK: BGC Ship-board and glider observations (incl. 30min break)	TRAINING BLOCK: Moored sensors (incl. 30min break)
13:30	14:30				
14:00	15:00				
14:30	15:30				
15:00	16:00				
15:30	16:30				
16:00	17:00				
16:30	17:30		Wrap up	Wrap up	Wrap up
	17:38		17:38 Bus to Oban	17:38 Bus to Oban	17:38 Bus to Oban
17:00	18:00				
17:30	18:30	Informal tour through Oban (optional)	Free conference dinner at Hope Kitchen in Oban		
18:00	19:00				
18:30	19:30				

Breakout groups on Friday,17th June

On Friday morning we will breakup into self-organised groups. Each group will have a member of the organising committee in case there are any questions. You will organise the discussion within your group by yourself. Make sure everyone contributes and you note down the main results of your group in a jamboard (link will be provided).

Questions to be discussed in the breakout groups:

1. Do we need to standardize calibration and quality control of biogeochemical sensors? Will this differ depending on observational methods?
2. What do you want from the international community?
3. What is a good approach to test new BGC sensors (Ship-board, Mooring, Argo)?

Abstracts

Wednesday, 15th June

BST	Nigeria	Italy/Spain/Germany	India	China	Japan
10:30am	10:30am	11:30am	14:30am	17:30am	18:30am

10:30am-11am (BST)

Mr. Jack Williams (National Oceanography Centre)

Particle size has been widely held as the key determinant of particle sinking velocity, but in recent years, the strength of the size-sinking velocity relationship has been questioned. We review empirical evidence for a size-sinking velocity relationship, and find that for in situ studies the relationship between size and sinking velocity is far weaker than that in ex situ experiment, emphasizing the need for caution when extrapolating ex situ results to natural systems. This finding underlines the need for considering multiple size-scaling relationships when generating particulate fluxes from particle size spectra, necessitating the development of in situ optical methods.

Ms. Sarah Rautenbach (CCMAR)

I am working for the European Multidisciplinary Seafloor and water column Observatory (EMSO-ERIC) as Data Manager for the Iberian Margin as well am engaged in the operational side of managing the moored platform in the south of Portugal. EMSO-ERIC is a consortium of 15 observatories all over Europe, which collects physical, biochemical and seismic parameters of the ocean. The Portuguese platform is composed of two systems; 1) EGIM: Compact framework equipped with ADCP, BGC-Sensors, CTD and more, 2) Wirewalker: CTD profiler + BGC Sensors. This training can surely benefit me and my team on the data handling and operational side.

Mr. Carlos Sousa (IPMA)

Within EMSO-ERIC (European Multidisciplinary Seafloor and water column Observatory - European Research Infrastructure Consortium), IPMA and CCMAR are responsible for the implementation of the Iberian Margin regional facility, an oceanographic infrastructure that adds observational capabilities to Portugal. This infrastructure includes a EGIM (European Generic Instrumentation Module), a deep-sea bottom multi-instrument structure; and a wave powered water column profiler (Wirewalker), capable of high-resolution observations from the surface to 150 m depth. Acquired data meets standard Essential Ocean Variables (EOV) requirements, namely: conductivity, temperature, pressure, dissolved oxygen, turbidity, ocean currents, total chlorophyll, and passive acoustics.

Dr. Houssem Smeti (University of Tunis / MIO)

Monitoring of essential oceanographic variables in Tunisia's largest coastal lagoon: towards a long-term observation of met-ocean and biogeochemical processes

In the frame work of the NF-POGO funded project: "Monitoring and numerical modelling of nearshore hydrodynamics and coastal erosion in Africa (2012-2017)", the Boughrara lagoon and adjacent Mediterranean Sea has been the location of met-ocean observations (sea level, wave, wind), since 2015. The lagoon has been highly contributing to the Tunisian fisheries production and provides a variety of other services (e.g. aquaculture, tourism). Although there is a relatively sustained monitoring of physical parameters, observation of biogeochemical variables are severely lacking, which is crucial for a comprehensive evaluation of the ecological state of the lagoon.

BST	Nigeria	Italy/Spain/Germany	India	China	Japan
11:30am	11:30am	12:30pm	15:30pm	18:30pm	19:30pm

11:30am-12pm

Miss Nouhaila ERRAJI CHAHID (University Chouaib Doukkali)

The lagoon of Oualidia, located on the Atlantic coast between El Jadida and Safi is one of the coastal sites in Morocco where develop several activities especially socio-economic.

The objective of this study is to contribute to the understanding of the impact of freshwater resurgences on the Oualidia lagoon, by describing the physicochemical parameters, the temperature and the salinity of the water, measured in 14 main sources and 11 at low tide with 3 reference zones at the channel level, were studied during the month of May 2018.

Temperature and salinity indicate a clear influence of tide and current (flood and ebb) where marine water influence downstream of the lagoon and the salinity is reduced progressively upstream, due to continental/underground freshwater seepages inside the lagoon which play a dominant hydrological role.

And since it is essential to ensure a qualitative and quantitative management, the idea was to measure the flow of its sources to have an idea about the average quantity of fresh water which returns to the lagoon and to make a connection between these parameters in order to have the impact of these sources on the lagoon system of Oualida.

The adapted methodology allowed to establish the typology of this site, this environment is subdivided into three zones: a) the downstream zone, is clearly influenced by the sea (contribution of phosphatic elements, small variations of temperature and salinity); b) the intermediate zone, undergoing both the marine influence and the continental influence; (c) the upstream zone which is very confined and has a reservoir of nitrogenous elements, suspended matter and organic matter.

Dr. Bieito Fernández Castro (University of Southampton)

Sub-Antarctic Mode Waters (SAMW) form in areas of deep mixed layers to the North of the Antarctic Circumpolar Current (ACC) in the Southern Ocean and play a key role in the overturning circulation. SAMW sequester vast amounts of heat and carbon into the ocean interior and transfer nutrients towards low latitudes sustaining primary production there. Seasonal dynamics leading to SAMW formation are investigated with BGC-Argo floats, revealing that SAMW have an important contribution from subtropical waters advected along the ACC. This influx increases salinity and

decreases nutrient concentrations in SAMW with respect to Antarctic waters crossing the ACC northward due to Ekman transport.

Miss Mengyu Li (East China Normal University)

Particulate Organic Carbon (POC) is in high dynamic with the highest turnover rate of any organic carbon pool on the planet, playing a key role in the biological carbon pump in shelf seas. Compared with the open ocean waters, the turbid coastal oceans in China are affected by large world-class rivers' inputs, complex hydrodynamic and biogeochemical processes along the coast, resulting in optical complex particle types including inorganic mineral particles, algal particles, and detritus, which contribute to POC differently. Therefore, it is essential to develop optical identification algorithms for complex particle types and compositions, and subsequently approach POC.

Mrs. Hellen Joseph Kizenga (University of Dar es Salaam)

The Weddell gyre in the Southern Ocean is one of the important features in the ventilation and distribution of important biogeochemical parameters to the deeper parts of the global oceans. Our research focused on investigating the variability of biogeochemical parameters in different water masses of the eastern Weddell gyre using long-term observations. Three decades of ship data from the Global Ocean Data Analysis Project (GLODAP) retrieved mainly from the Atlantic sector of the Southern Ocean were used to investigate the characteristics of four prominent water masses plus the temporal and spatial variability of these variables across the gyre.

BST	Nigeria	Italy/Spain/Germany	India	China	Japan
12pm	12pm	13:00pm	16:00pm	19:00pm	20:00pm

12pm-12:30pm

Dr. Ahmed Mandour (Oceanography Department - Alexandria University)

I am an assistant professor and a post-doc researcher affiliated with Alexandria University (Egypt). My field is crucial in egypt's development and I am self-motivated to participate and collaborate on the international level. Recently, I acquired my Ph.D., which focused on geochemistry and pollution in coastal sediments. My research interest involves sediments geochemistry and coastal policy in Egypt. I have 3 publications and working on another three. My current research topic is the biogeochemistry of nutrients and metals in the mangrove environment of Egypt. I am very interested in expanding my network and working on cross-border collaboration projects.

Dr. Shiye Zhao (Japan Agency for Marine-Earth Science and Technology)

Although hundreds of studies have surveyed plastic debris in surface ocean gyre and convergence zones, depth profile data detailing microplastics (MP) throughout the water column beneath these surface accumulation areas are lacking, impeding a better understanding of plastic behavior and fate in ocean systems. This is largely due to the difficulty and enormous expense and technicality of deep-water sampling. Employing a convergence of biogeochemical approaches, we profiled and explained the characteristics and distribution of small MP in the water column of the South Atlantic Subtropical Gyre, improving our knowledge of the deep-ocean plastic pollution to some extent.

Miss Sophy Oliver (National Oceanography Centre)

I am using oceanic observations (such as from Argo floats, CTDs, marine snow catchers, etc.) from three different projects (CUSTARD, GOCART and COMICS) to inform parameterisations within global ocean biogeochemical models.

Dr. Sadaf Nazneen (Jamia Millia Islamia)

The biogeochemical process in shallow coastal ecosystems contribute to rich ecological diversity and blue carbon production and storage. Healthy nutrient cycling in coastal ecosystems is important to maintain the resources in the long run for sustainable future. Nutrient enrichment caused by nitrate and phosphate is a major issue in tropical coastal ecosystems. It is important to monitor real time nutrient concentrations in water and sediments of these ecosystems.

BST	Nigeria	Italy/Spain/Germany	India	China	Japan
12:30pm	12:30pm	13:30pm	16:30pm	19:30pm	20:30pm

12:30pm-1pm

Mr. Md. Shahin Hossain Shuva (Eutech Systems Limited)

The study determined the spatial, and temporal distributions of Chlorophyll-a (Chl-a) concerning environmental factors in the Bay of Bengal (BoB) from 2003 to 2020. Three regions of interest (A, B and C) were selected by considering a 2.5° × 2.5° grid for each in the BoB. Chl-a data had retrieved from MODIS-Aqua and the environmental factors (SST, POC, NPP, SSHA, Wind, Wind Vector, Current) data had been retrieved from satellites, whereas the in-situ Chl-a and nutrients data were retrieved from WOD, and the river discharge data were collected from BWDB for this study. This research will aid in the knowledge of marine ecosystem health.

Mr. Valerio Caruso (CNR – ISMAR)

The aim of the project of my Institute is to monitor the air-sea CO2 fluxes and the parameters of the carbonate system in a ICOS (Integrated carbon observation system) marine station in the Gulf of Trieste (named "Paloma"); thanks to its central position in the gulf, it represents an ideal site where to study air-sea CO2 fluxes and interactions. My primary task is carrying out laboratory analysis of sea water (sampled at four different depths), mainly of pH, alkalinity and dissolved oxygen, collect data and sharing them with the work group to conduct a long-term study of the carbonate system dynamics in the gulf. The marine station provides meteorological and marine data, transmitted and available in near real time. The institute would like to improve future observation on the monitoring station, with physical and chemical sensor, so I would like to learn more about how to manage them and other BGC instruments, in this way I could help better my research group in the future.

Miss Andrea Rochner (University of Exeter)

Data assimilation is a technique to modify a model simulation to better match observations while maintaining the dynamical links between variables and regular spatial/temporal coverage. I will present early results of assimilating biogeochemical observations into a physical-biogeochemical ocean model in the Southern Ocean and the impact on the simulation of air-sea CO2 flux. The aim is to investigate the influence of assimilating different sources and combinations of data sets, from in situ data as well as satellite-based observations.

Dr. Amii Usese (University of Lagos)

The importance of ocean observing technologies in enhancing our understanding and mitigating the effects of the changing marine environment and the global climate cannot be over emphasised. Despite the various achievements and research output in coastal nations like Nigeria, there is currently inadequate capability for ocean science and observations. To enhance research-led education and aid the sustainable use of ocean resources, there is need for capacity building in self-sustaining ocean science and observational communities. This has the potential to generate multiple benefits that may not be achievable due to unavailability of technologies and expertise in these regions.

Dr. Anthony Ndah (Alfred Wegener Institute for Polar and Marine Research)

We analyzed the concurrent effects of temperature, light, salinity, river discharge, mixed layer depth, upwelling, nutrients, and El Nino, on the abundance, temporal variability and spatial segregation of phytoplankton functional groups (diatoms, coccolithophores, chlorophytes and cyanobacteria) in the South China Sea (SCS). The objective was to gain a holistic understanding the effects of simultaneous stressors on phytoplankton communities in the broader SCS. Changes in temperature and NO3 jointly explained up to 51% of the total community variability. El Nino was the dominant driver of inter-annual phytoplankton variability responsible for lowering primary production by inducing physical conditions that modulate nutrient availability.

Thursday, 16th June

BST	Nigeria	Italy/Spain/Germany	India	China	Japan
9:30am	9:30am	10:30am	13:30pm	16:30pm	17:30pm

9:30am-10am

Dr. Sudheesh Valliyodan (Central University of Kerala)

I am an early career researcher working on Indian Ocean Biogeochemistry. I work on the field measured dataset with a particular interest in nutrient cycling, oxygen minimum zone (OMZ) and their impact on ecosystem dynamics. I have expertise in high precision field measurement of dissolved oxygen, pH (spectrophotometric method using MCP), nutrient and other related parameters. I hope the opportunity to be part of the programme will be an added advantage of my research career. I can impart my understanding to my colleague in the workshops and I am very much learn from the experts of topic of the programme.

Mr. Johan Viljoen (University of Exeter)

Exploring phytoplankton dynamics below the eyes of the satellite using BGC-Argo: Understanding how phytoplankton are responding to climate change is essential. Satellite remote sensing of ocean colour is a main method for assessing changes in global phytoplankton abundance. However, satellites can only observe the surface layer (<40 m). A forest of phytoplankton exists below the surface. Ocean robotics such as BGC-Argo floats, with Chl-a sensors (fluorometers), can be used to explore the subsurface at temporal and spatial scales that surpass ship operation. The objective is to produce an in-situ record of water column Chl-a using vertical profiles of Chl-a including BGC-Argo

profiles. Ultimately, quantify the influence of climate change on subsurface phytoplankton abundance.

Dr. Katrin Schroeder (CNR ITALY)

I will present the MedSHIP programme, which is meant to be the Mediterranean component of GO-SHIP, a programme of high quality repeat oceanographic surveys along predefined transect to measure physical properties of water masses, but also biogeochemical properties, with a focus on carbon, as well as transient tracers.

Mr. Lorenzo Pasculli (Ca' Foscari University of Venice)

The Strait of Sicily is an important threshold for communication between the Western and Eastern Mediterranean and regulates the passage of the deeper water masses, such as the Intermediate Levantine Water. By allowing a low recirculation of deep water across the two basins, the Strait has an essential regulatory function on the nutrient budget in the two basins.
In my PhD project, the goal is to analyze the flows of water and nutrient masses through this Strait, through in situ observations (moorings) and numerical modelling (ROMS), for time series reconstruction and future scenarios analysis in consequence of climate change.

BST	Nigeria	Italy/Spain/Germany	India	China	Japan
10am	10am	11am	14:00pm	17:00pm	18:00pm

10am-10:30am

Mx. Ben Cala (NIOZ)

In my project, I investigate drivers of carbonate mineral dissolution other than the seawater's saturation state. One such driver could be the ratio of carbonate to calcium ions. To better understand how this ratio behaves with depth in different parts of the ocean, I used a machine learning approach to cluster data trends. This method can be helpful when dealing with large amounts of data to get a better feel for global distributions or to identify locations with interesting or changing trends to focus on in future studies.

Mr. Thiago Monteiro (Universidade Federal do Rio Grande)

I am now investigating various biogeochemical processes in the Northern Antarctic Peninsula and how these processes respond to ocean dynamics, such as how the mixing of distinct water masses influence ocean acidification and nutrient availability. As these processes are very dynamic and often ocean-atmosphere-land coupled, the availability of a wide variety of biogeochemical parameters is critical to better understanding them. Therefore, utilizing the biogeochemical data that are available on these platforms will significantly broaden the scope of my studies and help me to deepen our understanding of the processes I am studying.

Dr. Zonghua Liu (National Oceanography Centre)

The project I will participate in is named “Advancing novel imaging technologies and data analyses in order to understand interior ocean carbon storage”, abbreviated as ANTICS. This project aims to mechanistically understand ocean carbon storage across the Atlantic by using an innovative

synthesis of cutting-edge in situ imaging, machine learning and novel data analyses. To complete the project, much data on the size, distribution and composition of organic matter particles will be collected and their sinking velocity will be measured. A framework based on neural networks will also be designed which allows the conversion of in situ images into carbon fluxes.

BST	Nigeria	Italy/Spain/Germany	India	China	Japan
10:30am	10:30am	11:30am	14:30pm	17:3pm	18:30pm

10:30am-11am

Miss Margot Debyser (University of Edinburgh)

Stable isotope datasets of major nutrients are presented to elucidate the impact climate change will have on nutrient cycles in the Arctic and sub-Arctic regions, and predict knock-on effects on nutrient availability for Arctic and Sub-Arctic ecosystems. This work contributes to closing the gaps in our understanding of nutrient pathways in Fram Strait and the Eurasian Arctic.

Dr. Zoi Kokkini (CNR-ISMAR)

This research is separated into two branches. The first refers to the Red Sea. Glider data are analyzed to answer questions regarding the seasonal and interannual variability. The bibliography has underlined the importance of biogeochemical data in water-mass characterization in that area.
The second part refers to water-mass exchanges through the Sicily Channel. ADCPs and CTs installed on moored buoys support this ongoing research. Future use of gliders equipped with biogeochemical sensors is planned; thus, implementing best practices procedures on these data is essential.

Dr. Francesco Paladini de Mendoza (CNR-ISMAR)

My research focus on hydrodynamic and sedimentary processes trough the analysis of data collected by mooring placed along the continental slope in the southern Adriatic Sea. In this context dense water cascading is a relevant process. The moorings provide from 2012 unique observatory of deep water dynamic and are are part of EMSO-ERIC network.

Mr. Solomon Mordi (Nigerian Institute for Oceanography and Marine Research)

I am presently working on the enrichment of metal concentration in sediment of the Gulf of Guinea (GoG). Sediment samples have been collected during an oceanographic cruise and analysed for about 30 metals using ICP-OES. To further assess the ecological status of the GoG using physiochemical parameters, the use of Biogeochemical Observing system will be of great importance, as it will provide information for rational exploitation and sustainable management of the water body and its resources.

BST	Nigeria	Italy/Spain/Germany	India	China	Japan
12pm	12pm	13:00pm	16:00pm	19:00pm	20:00pm

12pm-12:30pm

Miss Louise Delaigue (NIOZ Royal Netherlands Institute for Sea Research)

Variability in the biological pump in the South Atlantic Ocean

The South Atlantic Ocean is a key feature in carbon cycling through the ocean. With distinct water stratification and enhanced productivity, this region is also the interface between the North Atlantic and the Southern Ocean, both crucial in the marine sink for anthropogenic CO2. But natural changes in biogeochemical properties and the consequences for the carbon cycle remain poorly understood. Here, we explore a timeseries of discrete carbonate chemistry observations to address intriguing shifts in water mass compositions in the South Atlantic Ocean that reflect changes in the biological carbon pump.

Mr. Bruno Pereira (Oceanographic Institute, University of Sao Paulo)

The time-series (01/01/1998 and 06/30/2021) of Copernicus Marine Service data is used to imagery the annual climatology of Colored Dissolved Organic Matter (CDOM, m-1) across southeast Brazilian continental inner shelf (22 ° – 28°S). Hovmoller diagrams for CDOM, chlorophyll concentration (Chl, mgm-3), sea surface temperature (SST, C°), wind stress magnitude (N/m²) and mixing depth laye (m) show the role of continental sources of CDOM drive by La Plata River plume dispersion and coastal upwelling of deep south atlantic ocean water.

Dr. Joseph Nkwoji (The University of Lagos, Nigeria)

Dissolved nutrients are essential for primary production and food web. The bioavailability of these nutrients are essential for optimal ecosystem function. Some models have been used to study fluxes of dissolved nutrients from adjourning water into the coastal seas. However, information regarding biogeochemistry, nutrient composition and fluxes in many coastal waters of West Africa is limited, especially in Nigeria. The Lagos lagoon, located in the south western Nigeria, is the largest coastal lagoon in the Gulf of Guinea and a depository of last resort for over 70% of surface runoffs containing both solid and liquid wastes generated around the coast.

Mr. Juan Camilo Torres Lasso (Federal University of Rio Grande)

We will analyze how carbon fluxes in the Southern Ocean around the Northern Antarctic Peninsula are influenced by freshwater input from melting of sea ice and glacier, considering:
(i) variability and trends of the cryosphere around NAP;
(ii) freshening and stability of the mixed layer;
(iii) biogeochemical disturbing due nutrients supply from melting and consequences in the biological carbon pump.
For that, we will analyze data from reanalysis and ocean state estimates, looking to understand the relation between climatic change and the Southern Ocean response.

BST	Nigeria	Italy/Spain/Germany	India	China	Japan
12:30pm	12:30pm	13:30pm	16:30pm	19:30pm	20:30pm

12:30pm-1pm

Mr. William Major (National Oceanography Centre)

Biogeochemistry is a flourishing field and data is becoming far more readily available as a result of

technological innovation. My work covers the gravitational flux of carbon in the mesopelagic using imaging techniques, modelled upper ocean extremes in temperature and dissolved oxygen, and long-term dissolved oxygen trends at mooring sites. Most recently, I have been heavily involved with a project that aims to use citizen science to boost plankton sampling capacity by providing a low-cost imaging microscope and sample collection net to volunteers.

Mr. Lisandro Ariel Arbilla (UBA/CONICET/SHN)

The main objective of my PhD is to analyze sea-atmosphere CO2 fluxes and to determine the trend in ocean acidification in the Drake Passage. To do so, I am using biogeochemical variables from two global databases derived from field observations. I use CO2 fugacity and CO2 molar fraction from SOCAT and pH, total alkalinity and dissolved inorganic carbon from GLODAP. I have acquired experience in data processing but not in their acquisition. In this sense, I will participate in future oceanographic cruises to be carried out within the SAMOC project. In addition, my home institution, the SHN, has recently acquired a pCO2 monitoring system which will be used to moored-observations. Consequently, this training is fundamental to learn how to operate and maintain the equipment and how to handle the output data.

Miss Malek Belgacem (CNR-ISMAR)

Ocean life relies on the loads of dissolved inorganic nutrients (nitrate, phosphate and silicate) and other micro-nutrients into the euphotic layer. They fuel phytoplankton growth that maintains the equilibrium of the food web. Ocean circulation and physical processes continually drive the large-scale distribution of chemicals toward a homogeneous distribution (Williams and Follows, 2003).

The biological and biochemical processes counteract this tendency. Therefore, describing nutrient dynamics is important to understand the overall ecosystem functioning. At global scale, most of the biogeochemical descriptions are based on model simulations and satellite data, since nutrient in situ observations are generally infrequent and not homogeneously distributed in space and time. Climatological mapping is often used to understand the biogeochemical state of the ocean representing monthly, seasonally or annual averaged fields. Within this context, the western Mediterranean Sea climatology (BGC-WMED) presented here is a product derived from in situ observations, derived from various data sources: in total, 2253 in-situ inorganic nutrient profiles over the period 1981-2017 have been used. Annual mean gridded nutrient fields for the period 1981-2017, and sub-periods 1981-2004 and 2005-2017, on a horizontal 1/4° × 1/4° grid have been produced. The biogeochemical climatology is built on 19 depth levels and for the dissolved inorganic nutrients nitrate, phosphate and orthosilicate. To generate smooth and homogeneous interpolated fields, an advanced Ndimensional version of DIVA, DIVAnd v2.5.1 (Barth et al., 2014), which is based on the variational inverse method (VIM) (Brasseur et al., 1996), has been used. A sensitivity analysis was carried out to assess the comparability of the data product with the observational data. The BGC-WMED has then been compared to other available data products, i.e. the medBFM biogeochemical reanalysis and the biogeochemical component of WOA18.

Miss Emily Hammermeister (University of Southampton / National Oceanography Centre)

The development of marine autonomous platforms provides higher spatiotemporal access to the ocean and can be used to further the understanding of anthropogenic CO2 effects on the climate and marine ecosystem. As a part of the pioneering OCEANIDS programme, biogeochemical sensors were integrated on the Autosub Long Range (ALR) and recently deployed for trial missions in the

Celtic Sea. Preliminary results show a successful integration and data acquisition from multi-day autonomous missions. The data collected by the novel sensors on the ALR will be validated via discrete water samples taken from the mission locations and depths.

Miss Ana Carolina Sala Sousa Santos (Federal University of Bahia)

I am conducting research on the rare earth elements, along the food web in a tropical estuary. In addition to biological samples, we will analyze sediment and suspended particulate matter. The natural concentrations of REE in ecosystems have been changing over the years and their demand tends to grow even more increasing the anthropogenic input. Understanding the sources, sinks and mobilization of REE in coastal systems and their transfer along food chains has important implications for quantifying their global geochemical cycles, assessing their potential risks and their application as tracers of various natural and anthropogenic processes.

From where do you join the workshop?

Mentimeter

30

Where are you from?

Mentimeter

28

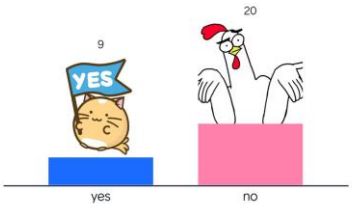
What do you expect from the workshop?

Mentimeter

- a better understanding of how we treat the BGC data (preparation, QC, international standards)
- To learn more on the biogeochemical observing systems and how to validate the BGC data
- To improve knowledge in biogeochemical cycles and observations
- Improve my skills in analising data and share knowledge with colleagues
- to use BGQ data
- proficiently use a more diverse range of biogeochemical data
- Focus and learn more about Ocean observation
- handling/data quality of large BGC datasets
- Transferrable skills and best practices that will be applicable to a wide range of sensors+/sampling methods
- Lots of inspired oceanographers!
- How to download and use autonomous BGC data
- How to use BGC data
- Critical analysis from biogeochemical raw & simply processed data
- Meet researchers in different fields
- what observations are actually measuring
- Coding experience to access/process different types of autonomous BGC data
- learn about data processing and quality control of different sensors
- Learn and communicate your research
- Learn about quality control
- access new tools and protocols to get and process samples of ocean biogeochemical data
- standard calibration procedure
- how to initiate and participate in constructing local and BGC observation sys
- I am expecting to learn from the best, get expert guidance on obtaining and processing satellite, quality control and possibly get some collaborations for the future

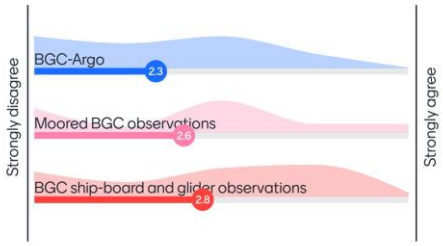
Do you know how to download BGC-Argo data?

Mentimeter



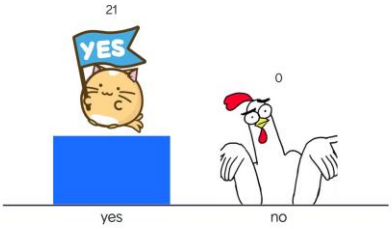
I feel confident to use the following BGC ocean observation for my research?

Mentimeter

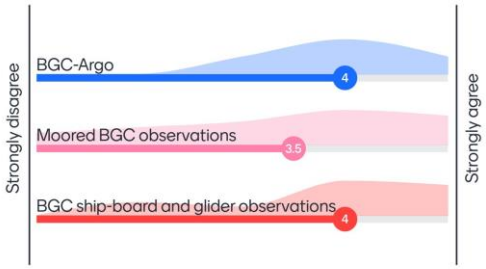


APPENDIX Wrap-Up

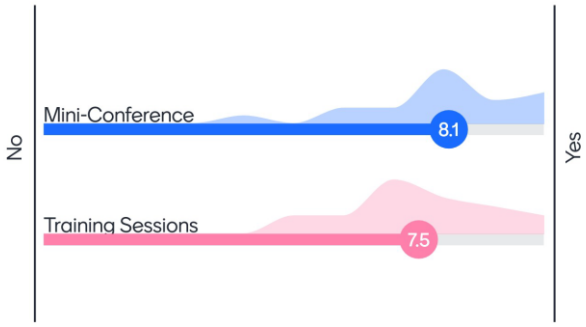
Do you know how to download BGC-Argo data?



I feel confident to use the following BGC ocean observation for my research?



Did the workshop meet your expectiations?



APPENDIX Breakout group feedback

1. Do we need to standardize calibration and quality control of biogeochemical sensors? Will this differ depending on observational methods?

- it is necessary to compare observation data with in situ and lab measurements and document these results as QC data complimentary to the BGC data.
- Standardise calibration and QC with reference documentation. And an effort to keep it common on all the platforms.

- No to globally standardizing methods but yes to standardizing minimum best practice for quality control
- Standardize how to report uncertainty in measurements
- Metadata file format standards
- Careful calibration depending on sampling region
- Yes it will differ depending on BGC methods

- i think it needs to be standardized, maybe develop toolboxes for the different variables
- Yes and yes. Factory calibrated and used within the stated period. Before deployment, a calibration procedure should be used and added to the metadata
- Manufacturer initial calibration & QC not enough
- Yes
- Yes, standardized calibration is needed.

- "Cookbook" of steps on how to calibrate and quality control, that everyone should follow.
- Always provide raw data alongside
- Pre-deployment sensor calibration will be the same regardless of observational method
- Post deployment corrections will be both sensor specific (e.g. spike removal) and observational method specific (e.g. correcting salinity for flow speed in the float data)
- Cross-lab comparisons on their calibrations (e.g. for alkalinity its calibration methods are often compared across most labs)
- Difficult to compare the calibration of different sensors that measure the same variable

2. What do you want from the international community?

- How to access the glider datasets in a specific region? Is there a website for it?
- There is need for frequent global discussions, capacity building initiatives and collaborative effort with experts and international community in order to deploy these sensors to areas that are still lagging like Gulf of Guinea.
- What we need international bottom lines in the form of agreement and MOUs on regional levels to allow for the collection and what kind of data that the parties of interest will allow for. Moerover, collaboration in funding between developing and developed countries is necessary to expand research. .... Means and easy access is key to achieve the best out of these systems
- Easy access to Best Practices documentation, from the initial sensors treatment until the delayed mode QC standards.
- Encourage the scientific community to share BGC data.

- Transparency
- Maybe a big database of labs, and which methods they use
- Just do it
- INCLUSIVITY AND VISIBILITY

- maybe agree about qc for the different sensors by setting guidelines, well could be this the role of the data assimilation centers!
- Capacity building and increase the use of some QC toolbox. like what Copernicus is doing to increase the use of their products!
- Reduce the number of available guidelines (some redundancy). Also focus on platforms (moored, argo, gliders, ...) and available sensors (commercial fact sheets vs real application)

- Create a network of divided geographical areas - within each region the calibration processes are standardized. So within each region researchers have to follow that region's standardized rules.
- Have a regularly sampled station in each geographical region around the global ocean, to provide a range of feasible values for oceanic data in each region
- Have very extensive metadata (sensor precision, internal settings, uncertainties, measurement error)
- Accessible and Transparent. Want to know every step of the process from raw to the finalized dataset. Want merged data into a standardized format, for each step of the quality control process. That way, depending on what you want to use the data for, you can access all the raw data, and all the data after different stages of quality control
- Know which calibration toolboxes were used (e.g. in matlab)
- Communication! e.g. between observationalists and modelers. Cross-discipline communication.

3. What is a good approach to test new BGC sensors (Ship-board, Mooring, Argo)?

- Compare with all the available data (previous data, sensoring remote (if this is calibrated for the region), etc).
- Depending on the available budget, and the possibility of cross-validation with other measurements/platforms, we can deploy them on a mooring and cross-validated with ship campaigns, so we can check depth issues and long-term deployment behaviour.
- Do a laboratory test to check the information provided by the BGC sensor.
- First, we can send test missions of cheaper built devices (for the short-term operational period) that can validate the data of long-term operation devices. Second, if further technology is explored we can find ways of recalibrating and maintaining the sensors while in commission.

- Co-sampling validation + comparison to known methods
- Being critical
- Control environment test
- To understand the dynamics of the associated systems and predict their evolution, particularly in a context of strong human pressure and climate change, it is necessary to rely on long-term observation systems providing robust data

- Lab test with other sensors (if available), followed by "sea" trial. Discrete bottle samples could be used to validate observations.
- Compare with different data platform !
- Intercomparison between groups/projects
- Discrete bottle (Niskin/GoFlo) samples via CTD rosette casts

- Ship-board: for new optical sensors that are quite big, easiest to be done on a ship. Unlike on argo, you can continuously monitor its progress.
- Test in lab first
- Put onto an autonomous platform, but follow it with the ship so have ship data to validate with and/or calibrate to
- Compare against all available data we have
- Depends on budget - maybe float is the cheapest option