SCOR Working Group 168

4D-BGC: Coordinating the Development of Gridded Four-Dimensional Data Products from Biogeochemical-Argo Observations

1. Brief summary with the main highlights (200-300 words)

The 4D-BGC working group (WG 168) was established this year, bringing together 21 members from 14 different countries, who are experts in ocean biogeochemistry, from the perspective of both direct observations and numerical modeling. The stated purpose of WG 168 is to enhance access and utility of BioGeoChemical-Argo (BGC-Argo) observations through four-dimensional (4D) data products. These advanced data products aim to refine our understanding of ocean biogeochemistry, improve biogeochemical models and reanalysis products, and provide valuable insights for policy-making. In 2024, the WG made notable progress towards achieving these objectives. The WG hosted multiple group-wide meetings (one online and one in-person) and a conference session during Ocean Sciences Meeting in February 2024, bringing together interested researchers together to share ideas about 4D-BGC products. These activities were instrumental in shaping a strategic plan to achieve the group's objectives and deliverables.

2. Activities since previous report to SCOR (e.g., virtual or in-person meetings, email discussions, special sessions). Limit 1000 words

Feb. 2024: WG 168 held its initial in-person meeting in New Orleans, LA, in association with the Ocean Sciences Meeting. This meeting allowed members to discuss their motivation and objectives in depth. Attendees included both members of the working group and invited guests, who delivered several lightning presentations showcasing a range of observation-based data products related to ocean chemical and bio-optical properties. The presentations highlighted current advancements and challenges in mapping these properties, fostering an initial exchange of ideas and setting the stage for collaborative efforts.

Feb. 2024: The co-chairs of WG 168 also chaired a session at the Ocean Sciences Meeting titled *Observation-Based Data Products of Ocean Biogeochemistry and the Importance of Standardized Measurement and Uncertainty Estimation Protocols in Marine Science* that included both posters and oral presentations. By bringing together researchers interested in the topic of the WG, the session facilitated discussions and fostered the emergence of key ideas and collaborative opportunities.

Apr. 2024: The co-chairs of WG 168 presented at a weekly BGC-Argo seminar hosted by the Southern Ocean Carbon and Climate Observations and Modeling (SOCCOM) program. This presentation provided an update to the SOCCOM community on WG 168's activities and objectives.

May 2024: Working group member Xiaogang Xing (assisted by J. Sharp and A. Mignot) gave a presentation titled *Synergy of BGC-Argo and Marine Ecosystem Modeling* discussing the motivation

and objectives of WG 168 at the Scoping Workshop on Synergy of Ocean Observations and Biogeochemical Models in Xiamen, China.

May 2024: WG 168 held its second official meeting (virtually). During this meeting, the group discussed model assimilation of observation-based data products, the formation of breakout groups to make progress on different goals, the writing of a synthesis paper, and the creation of a data product archive. The group also deliberated on meeting frequency, communication channels, and potential in-person meetings in 2025 and 2026, along with ideas for capacity development activities and effective ways to engage external members.

3. Documents published since previous report to SCOR (e.g., peer-reviewed journal articles, reports, Web pages) and should be limited to publications that resulted directly from WG activities and which acknowledge SCOR support

The working group has established a dedicated web page (https://4d-bgc.github.io) to post updates about the group's activities and accomplishments.

4. Progress toward achieving group's terms of reference. List each term of reference separately and describe progress on each one. Limit 1000 words

T1. Establish connections among 4D-BGC product developers, observational communities and data synthesis efforts, and end-user communities.

WG members have initiated formal and informal interactions with community groups and organizations (including SOCCOM, OceanOPS, BGC-Argo data management team, NOAA NCEI) to raise awareness about the WG goals to ensure connections in the chain from data collection to product creation to analysis.

T2. Compile an inventory of 4D-BGC products that highlights the original data and methodology used to create each one, provides data access information, and suggests relevant applications.

The WG has developed an online form to collect information from product developers and has connected with the BGC-Argo website manager to compile and curate a product repository hosted by the BGC-Argo website.

T3.Synthesize available estimates of global to regional magnitudes, variabilities, and trends of key biogeochemical processes that can be refined by 4D-BGC products, and identify actions that can be taken to achieve those refined quantifications.

The WG has discussed, outlined, and begun writing a synthesis paper that will explore the potential for observation-based 4D-BGC products to address uncertainties in key global ocean processes, inventories, and fluxes.

T4. Develop recommendations for methods to create, distribute, and dynamically update 4D-BGC products, as well as strategies to estimate uncertainties from grid-cell to global scales.

The group has begun to discuss these issues and to document ideas in meeting notes, with plans to build out these expert opinions into a recommended practices document for 4D-BGC product construction within the next couple years.

T5. Build capacity within the oceanographic community, especially among early career researchers and within underrepresented groups, to ensure 4D-BGC product development and usage is sustained and supported.

The WG has is planning a webinar series to advertise 4D-BGC products and their use cases, with a goal of encouraging early career researchers and those in underrepresented nations to use freely available data (e.g., BGC-Argo) to develop new data products and to analyze publicly available 4D-BGC products to develop new insights into ocean biogeochemical processes.

5. WG activities planned for the coming year. Limit 500 words

October 2024: Publish the data product archive online on the BGC-Argo website and present it at the Argo Data Management Team (ADMT) meeting at the end of October. Moreover, WG will present an update on its activities to the Argo Data Management team at this meeting.

November 2024: Begin webinar series on 4D-BGC data products and uses.

March 2025: Submit synthesis paper (likely to *Biogeosciences*) for peer review.

April 2025: Hold in-person group meeting associated with the European Geosciences Union (EGU) annual meeting in Vienna, Austria.

6. Is the group having difficulties expected in achieving terms of reference or meeting original time schedule? If so, why, and what is being done to address the difficulties Limit 200 words

At the moment, we are on track with our original schedule. Over the next year, it will be important to ensure wide participation from WG members and beyond, and to distribute responsibilities among different members to lead specific topic areas. This will ensure we continue progressing toward our goals and achieve our stated deliverables.

7. Any special comments or requests to SCOR. Limit 100 words.

Additional information can be submitted and may be posted at the SCOR Annual Meeting webpage at the discretion of the SCOR Executive Committee Reporter for the WG and the SCOR Secretariat.