A Proposal for a Joint OCB-CLIVAR Scoping Workshop on the Major Expansion of BGC-Argo and the Use of Profiling Floats

Dr. Ken Johnson, MBARI
Dr. Roberta Hotinski, Princeton
Dr. Andrea Fassbender, NOAA/PMEL
Prof. Stephen Riser, University of Washington
Prof. Lynne Talley, Scripps Institution of Oceanography
Dr. Susan Wijffels, Woods Hole Oceanographic Institution

Summary
The Global Ocean Biogeochemistry (GO-BGC) Array is a new US-based program that aims to produce and deploy 500 profiling floats equipped with biogeochemical (BGC) sensors throughout the world's oceans as a major component of BGC-Argo. GO-BGC has been recommended by the US National Science Foundation (NSF) for funding through its Mid-Scale Research Initiative-2, with final negotiations concerning the scope and funding profile now underway. This large (approximately $53 million) initiative and the infrastructure associated with it represent a major expansion of BGC-Argo (BGC-Argo Planning Group, 2016), which is one of the three mission components (e.g., Core, Deep, and BGC) of the unified Argo program that has been widely discussed in recent years. The GO-BGC program is multi-institutional and will be based at the Monterey Bay Aquarium Research Institute (MBARI). Other participating institutions include Princeton University, Scripps Institution of Oceanography, the University of Washington, and Woods Hole Oceanographic Institution; there will also be a separate component of the program supported through NOAA. It is anticipated that this effort will officially begin in autumn 2020, with the first float deployments taking place in mid-2021. GO-BGC is likely to shape much of the direction of large-scale biogeochemical ocean and carbon research in the coming decade, and it is essential at this early stage of GO-BGC to gain input from the biogeochemical and climate communities concerning the use of this resource and the infrastructure associated with it.

Background
The international Argo program began in 2000, after several years of meetings, discussions, planning reports, and test deployments. By 2007 the program had achieved its primary target, the deployment and maintenance of an array of 3000 floats in the global ocean. By 2010, the array had produced over 1 million temperature and salinity profiles, with the data available in near real-time to anyone with internet access (Riser et al., 2016). To date the data produced by the Argo program have been used in over 4000 scientific papers and nearly 300 PhD theses. By essentially any measure Argo has been a major success.

After the first few years of Argo, interest in adding additional sensors to floats began to grow. The University of Washington group added dissolved oxygen sensors to a few floats as early as 2003, and around the same time the first *Autonomous Lagrangian Platforms and Sensors* (ALPS) meeting (Rudnick and Perry, 2003) fostered an extended discussion on what types of biogeochemical (BGC) measurements might be possible and desirable in the future from profiling floats and other platforms. The results from early efforts to add BGC sensors to floats (Riser and Johnson, 2008; Johnson et al., 2010) showed the degree to which this technology could usefully observe the seasonal carbon cycle in the ocean in a cost-effective manner. The white paper of Gruber et al. (2010) outlined a long-term strategy for measuring dissolved oxygen in the ocean from floats. By 2013, floats equipped with dissolved oxygen, nitrate, and chlorophyll sensors were being successfully deployed in the Pacific, and the addition of ice-avoidance software allowed these floats to be deployed in the Antarctic. This capability lead to observations of the variability of BGC parameters throughout the annual cycle in the Southern Ocean, both in and out of the seasonal ice zone. A few years later most floats began carrying pH sensors. The success of these BGC float deployments led to the NSF-funded SOCCOM program, which since 2015 has deployed over 200 BGC-equipped floats in the Southern Ocean. Nearly 120 papers and 10 PhD dissertations have used the SOCCOM data and associated model results to better understand the carbon cycle in the Southern Ocean. As an example, using data from SOCCOM floats the regional variation and magnitude of the Southern Ocean atmosphere-ocean CO_2 flux has been much better bounded, thanks to the pioneering paper of Gray et al. (2018).

With the success of SOCCOM and evidence that BGC float technology has developed to the point that successful operation is the norm, NSF has agreed to fund the GO-BGC float array, essentially a global version of SOCCOM. Model studies show that about 1000 BGC floats are required for successfully estimating the necessary global oceanic carbon parameters, and NSF will provide 500 of these floats. The remainder will come from other international partners, many of whom already participate in Argo. There is clearly a great deal of interest in the implementation of GO-BGC and BGC-Argo both in the US and internationally. A forum is needed to collectively discuss these efforts, the technology available, and the scientific questions that might be addressed.

Objectives

We propose to hold a workshop to discuss the state of biogeochemical (BGC) profiling float technology and the use of BGC floats in future experimental efforts in the world ocean, including GO-BGC. We hope to hold this workshop online during the first half of 2021. The costs of such an online workshop are minimal, yet the sponsorship of OCB (along with US CLIVAR) is essential to publicizing the workshop throughout the global ocean BGC community and ensuring its

success. [We have submitted a similar proposal to the US CLIVAR Program in hopes of making this a joint US CLIVAR-OCB activity to further amplify advertising and community engagement.]

The workshop will be planned and organized by scientists affiliated with the NSF-sponsored SOCCOM (Southern Ocean Carbon and Climate Observations and Modeling) project and the soon-to-be announced NSF-funded GO-BGC program. Both of these programs are centered around the deployment of arrays of BGC profiling floats (SOCCOM in the Southern Ocean; GO-BGC globally) that provide real-time water column data that can be used to examine various aspects of the carbon cycle, including ocean-atmosphere gas exchange and the biological pump, both analytically and in models on a variety of space and time scales. The data will also be used by the operational community. The goal of the workshop is to reach a global community of prospective users of the presently existing and future BGC float data and to make this community aware of these new resources and how they might be employed. We anticipate holding the workshop over portions of 3 days, with invited presentations from new and experienced users and input from the community on how these resources might best be employed. There are two main objectives for the workshop:

Objective 1 is to educate potential BGC float users as to the present state of BGC float technology and data management, so that this technology can be employed in planned and proposed scientific experiments. We will discuss nascent plans for GO-BGC, the 500 global BGC float array soon to be funded by NSF. This project will produce an unprecedented quantity of global, high quality, near real-time, publicly available BGC data, beginning in 2021. We hope to prepare the US and global BGC community for engagement with the large database that will result from this project and to stimulate interest in the use of the data from the array. Additionally, the meeting will examine the use of moorings and gliders equipped with BGC sensors and their use in conjunction with BGC profiling floats.

Objective 2 is to coordinate international planning for the future global BGC float deployments as part of BGC-Argo (that include both GO-BGC and other efforts) and to examine scientific questions that might be addressed with the data that result from these projects. Some groups are already engaged in field experiments and have committed resources to purchase and use such floats, while other groups are at an earlier stage, planning for potential future work and learning about the technology that is available to address their scientific interests. It is planned that there will be discussions concerning the steps needed to achieve a global 1000 float array and the numerous scientific problems that can be addressed with the resulting data as well as the use of this technology in more local experiments. The use of the data in conjunction with state estimation and associated scientific and operational modeling efforts will also be addressed.

Tentative Workshop Plan

The meeting will be held over portions of 3 days, with a few keynote talks each day, invited talks by international experts and users of data from BGC floats, and contributed talks from existing and potential users of such data. We plan to set aside a substantial amount of time in the schedule for questions and discussion of various topics by meeting participants, including in breakout rooms. A general plan for each day is

(1) Day 1: An outline of GO-BGC; float technology to be used; basic scientific questions;

(2) Day 2: Data management and availability; scientific questions to be explored and approaches;

(3) Day 3: Discussion of topics from days 1 and 2; plans from other groups; community input.

We note that early-career scientists will be encouraged to present their work and to provide input on each day. We are committed to furthering diversity and inclusion of underrepresented groups in all facets of the proposed meeting.

Benefit to OCB

The proposed workshop will have direct benefit to OCB by contributing to the establishment of an effective, international, real-time ocean carbon observing system that addresses the major themes and research priorities of OCB. The program will provide data to the community in an open and unrestricted manner that will greatly improve our understanding of ocean processes and our ability to predict future trajectories of ocean change.

Budget

We envision a meeting with approximately 60 attendees, to be held during the first half of 2021. Due to its online-only nature, we believe that no funds from OCB are necessary for this meeting. We seek the sponsorship of both OCB and US CLIVAR in order to ensure broad US and international participation. Adequate video conferencing resources for handling up to 100 participants are available at both MBARI and Princeton, and we plan to utilize these for holding the meeting. Staff at these institutions have experience in overseeing recent large, successful online conferences for Argo and SOCCOM.

Other funding

The US National Science Foundation will fund the GO-BGC work that will be one of the main topics to be discussed at this meeting. NSF, NOAA, and NASA have for a number of years collectively funded the SOCCOM project, which has deployed over 200 BGC floats in the Southern Ocean and developed and refined the technology and data management that will be used in GO-BGC.

References

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