U.S. Argo National Report to AST-26, April 14th 2025

Organization of U.S. Argo:

The U.S. Argo Program consists of a seven-institution consortium that includes principal investigators from Scripps Institution of Oceanography (SIO), Woods Hole Oceanographic Institution (WHOI), the University of Washington (UW), the Atlantic Oceanographic and Meteorological Laboratory (AOML), the Pacific Marine Environmental Laboratory (PMEL), Monterey Bay Aquarium Research Institute (MBARI), and presently the Naval Research Laboratory (NRL/Monterey). Float technology development, production, acquisition, logistics, deployment, array monitoring, and data management functions are distributed among these institutions on a collaborative basis. The program is supported by two primary funding sources. The National Oceanic and Atmospheric Administration (NOAA) primarily funds the Core, Deep and some BGC floats and supports the US DAC. The U.S. National Science Foundation supports the U.S. BGC float program through the Global Ocean Biogeochemistry Array (GO-BGC) and Southern Ocean Carbon and Climate Observations and Modeling (SOCCOM) programs.

In addition to the float-providing and data management activities, the U.S. Argo Consortium works collaboratively with closely related programs, including:

- Argo New Zealand is the largest deployer of U.S. Argo floats through designed deployment voyages of RV Kaharoa (jointly supported by Argo USA, New Zealand, and Australia) and deployment opportunities on RV Tangaroa.
- A NOPP project for validation and improvement of the Deep Argo SBE-61 CTD.
- National Academy of Sciences Gulf Research Program's support for 25 Argo floats in the Gulf of Mexico.

The contributions of these and other Argo partner projects are gratefully acknowledged.

The NOAA support for U.S. Argo Consortium is in its final year of a 5-year cycle, beginning in July 2020 and extending through June 2025. The next 5-year cycle is proposed to start in July 2025. The next Work Plan for U.S. Argo includes milestones and growth of the U.S. contribution toward a unified Core/BGC/Deep international Argo Program termed *OneArgo*.

The NSF GO-BGC funding is also approaching its final year of a 5-year cycle, ending November 2026. A GO-BGC II follow-on to continue deploying ~125 BGC floats a year has been proposed to NSF.

Objectives:

The U.S. Argo Consortium is funded by NOAA on a year-to-year basis. There is uncertainty in the level of funding that will be available to support the next 5-year Work Plan for 2025 to 2029. The projections included in this plan starting in July 2025 are optimistic, in that they involve a ramp-up to full One Argo implementation over the length of the proposal as quickly as thought

feasible by each partner institution, generally approaching full strength by year 3. The plan proposes that all float-providing institutions will participate in both Deep and BGC Programs, and the U.S. Argo consortium will carry out data management. Actual funding levels are likely to be less than the ideal scenarios, in which case the highest priority will be sustaining the Core Argo array.

Status of U.S. Core Argo implementation:

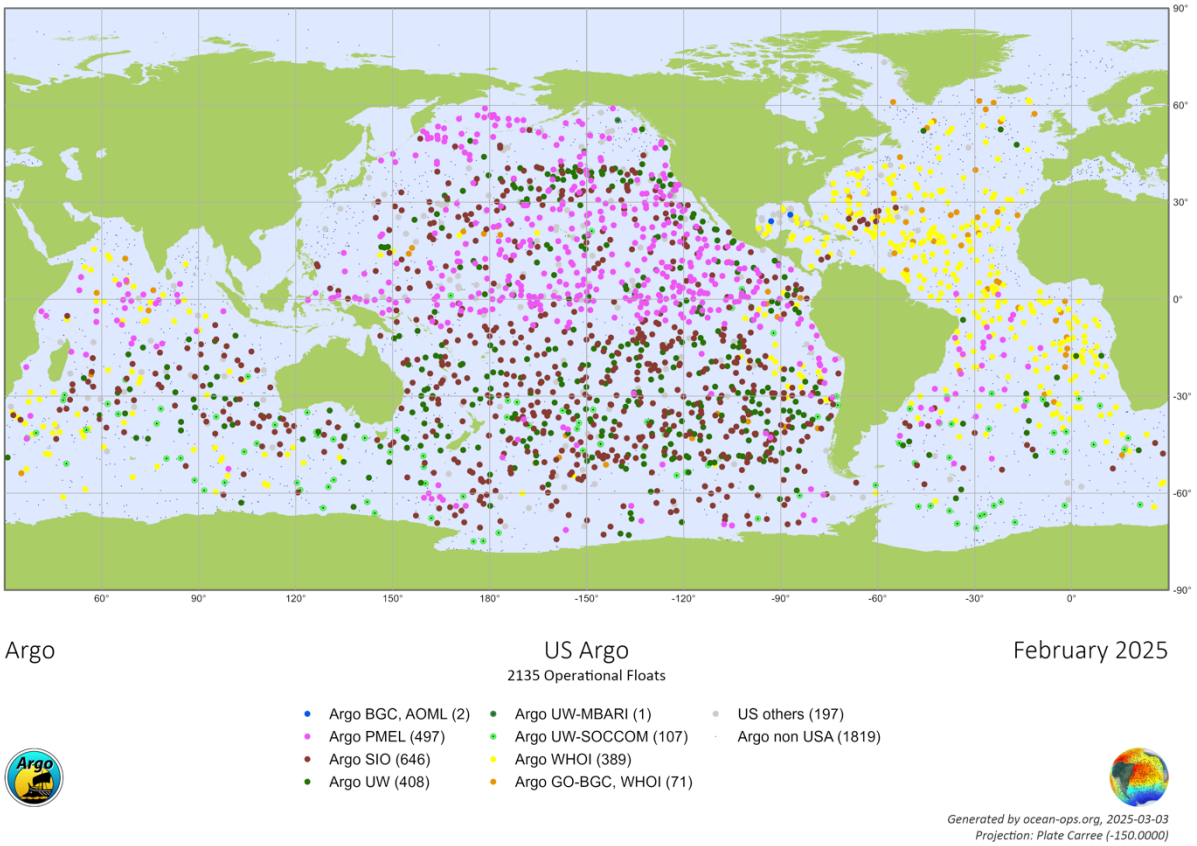

Fig. 1*: Location of operational U.S. Argo Program, SOCCOM, GO-BGC, and other U.S. Argo equivalent floats as of February 2025 (Source: OceanOPS).*

As of April 2025, there were 2299 operational U.S. Argo floats (see Fig. 1 for February 2025 locations), including 385 BGC and 122 Deep. Support levels for U.S. Core Argo floats, provided primarily through NOAA, have remained relatively flat since 2004, with some recent augmentations. Inflationary losses have been offset by increases in float lifetimes, with over 83% of floats deployed in 2018 still operational as of April 2025, and an increase in BGC float deployments funded by NSF.

Further increases in lifetime are expected through the continuing identification of short-term and long-term failure modes and improved battery technologies. However, the present number of

yearly deployments may not be sufficient to sustain the level of U.S. Argo floats, especially if NSF funding does not continue.

Year deployed	Number deployed	Number operational (3/2024)	% operational (3/2024)
2014	236	2	1%
2015	258	27	10%
2016	293	80	27%
2017	308	186	60%
2018	243	196	80%
2019	246	201	81%
2020	249	207	83%
2021	257	180	70%
2022	231	201	87%
2023	177	165	93%
2024	303	277	91%

Table 1: *Number of U.S. Core Argo floats deployed in each year from 2014 through 2025 and the number still operational as of April 2025 (Source: OceanOPS). A major focus of the U.S. Argo Consortium is extension of float lifetimes and reduction of early float failures.*

Impacts of the Covid-19 pandemic included limitations on all institutional laboratory activities for physical distancing, a substantial reduction in available deployment opportunities by the research fleet, supply chain difficulties that have adversely affected float manufacture, sea freight delays, and inflation. Nonetheless, the relatively long life of Argo floats mitigated the Covid-19 reduction in activities, as evidenced by the small decline in numbers of operational US Argo floats over the past several years. Furthermore, as noted below, deployments were catching up in 2024.

In 2024, the US Argo Program deployed 448 Argo floats, in support of all 3 missions (Fig. 2). This year, there was an increase in Core Argo floats deployed due to two Kaharoa II cruises, including the delivery voyage of the Kaharoa II, allowing for the deployment of a surplus of floats from 2023 (Table 1). US Argo also deployed 115 BGC floats, mostly funded by NSF's GO-BGC and SOCCOM, and 22 Deep floats, mostly funded by NOAA.

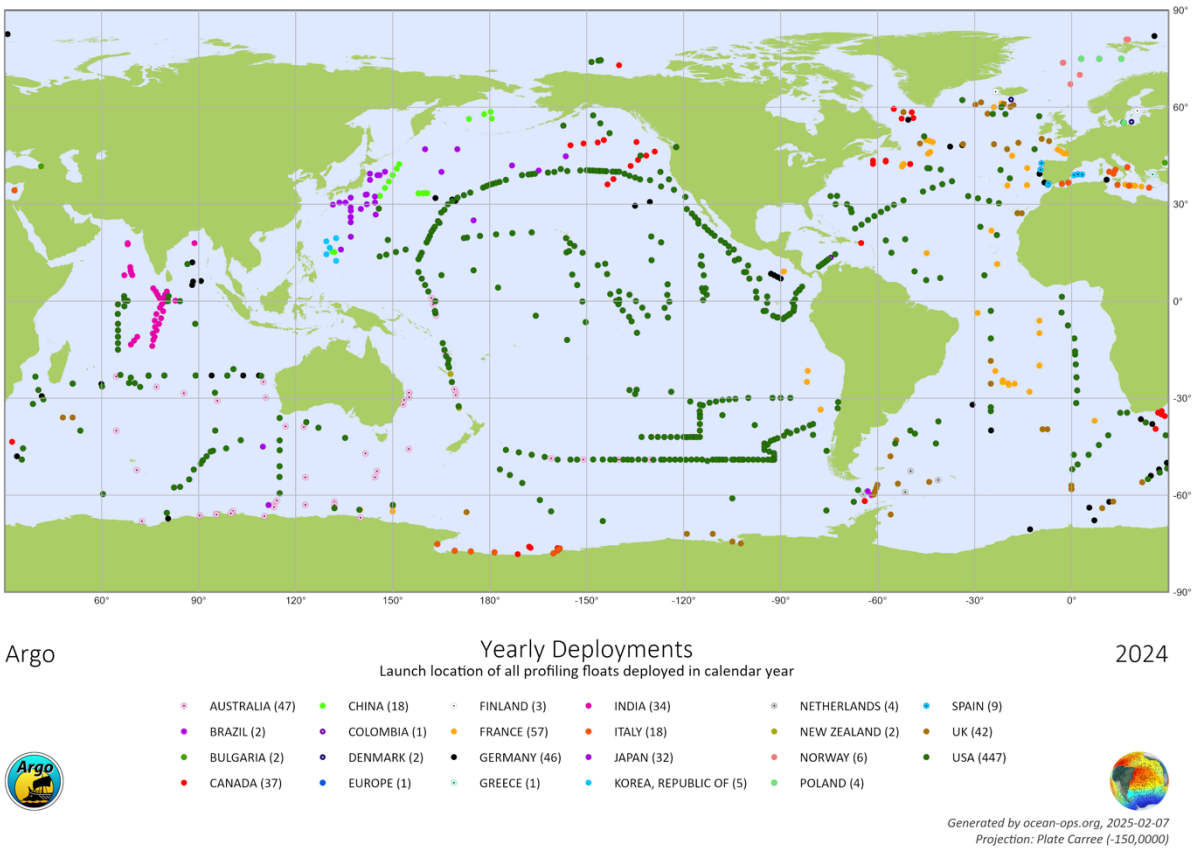

Fig. 2: *Locations of US Argo floats deployed in green during 2024 and still operational as of February 2025. This year, the US Argo funded two Kaharoa II cruises to deploy floats, including the delivery voyage from Spain to New Zealand (Source: OceanOPS).*

Support for the U.S. Argo Consortium includes float production and deployment; technology improvement; communications; data system development and implementation for real-time and delayed-mode data streams; participation in international Argo coordination, technical workshop, and science workshops; contributions to Regional Centers; and outreach activities. Work is ongoing to assess the accuracy of CTD data used for the core Argo mission. Salinity drift in recent cohorts of Argo floats is being closely monitored collaboratively with the CTD manufacturer. An alternative Core CTD manufacturer is entering pilot status with the intent of limiting risk to the Argo Program. The U.S. Argo Consortium is actively involved in testing, quantifying sensor biases, and contributing to the pilot array of RBR CTD equipped floats.

Deep Argo:

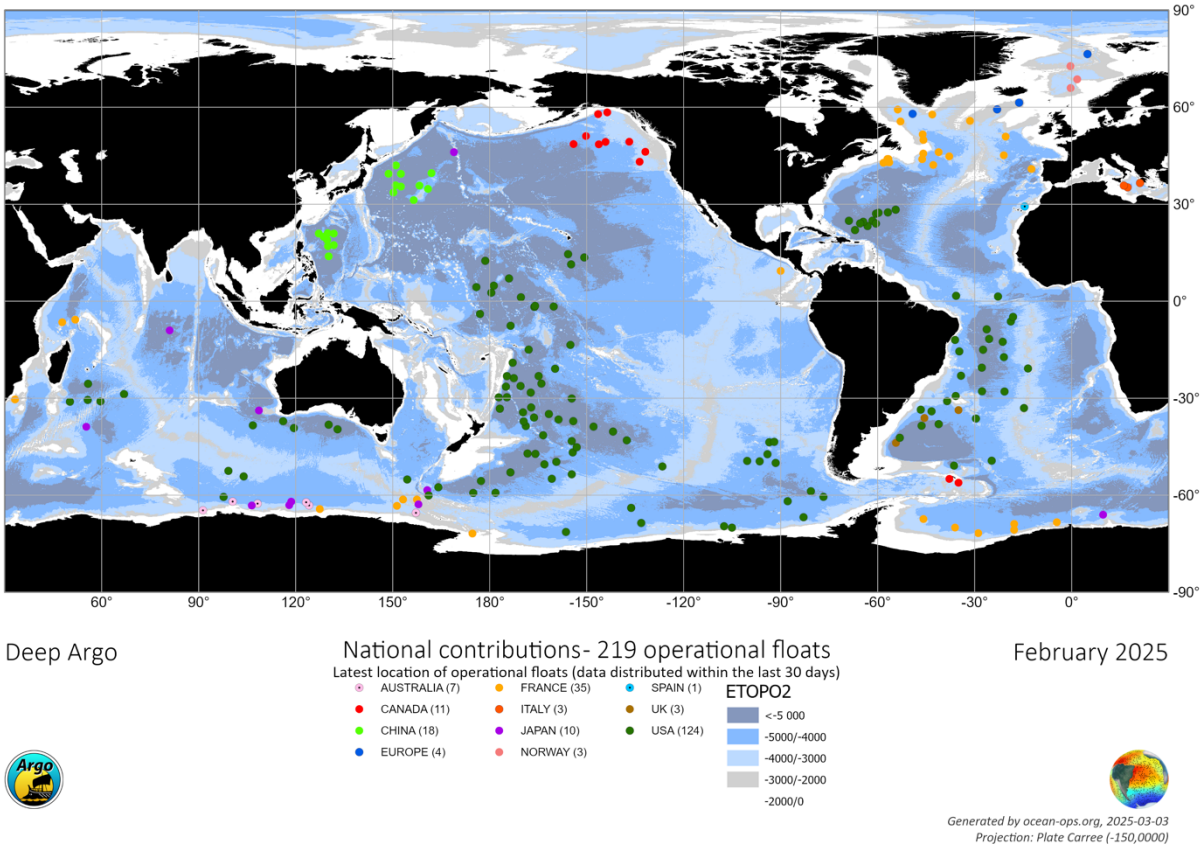

Fig. 3*: Location of all 219 operational Deep Argo floats, as of February 2025, by National Program, with the 124 operational U.S. Deep Argo floats indicated by dark green filled circles (Source: OceanOPS).*

In 2011–2015, the U.S. Argo Consortium carried out development and testing of Deep Argo floats, with successful prototype float deployments in 2013–2015. U.S. Deep Argo floats profile to pressures as great as 6000 dbar, and recent versions with hybrid lithium batteries are capable of more than 250 cycles. Deployment of U.S. Deep Argo regional pilot arrays began in the SW Pacific Basin in 2016, in the South Australian Basin in 2016, in the western North Atlantic in 2017, in the Australian Antarctic Basin in 2018, in the western South Atlantic in 2019, in the SE Pacific Sector of the Southern Ocean and western Indian Ocean in 2023, with operational US Deep Argo floats in all of those regions (Fig. 3).

Testing of Deep Argo float models continues as well as testing of SBE-61 CTD accuracy and stability. The SBE-61 has not yet achieved its aspirational goals of ± .001°C, ±.002 psu, and ± 3 dbar, but is progressing relative to them. In partnership with U.S. Argo, a 3-year National Ocean Partnership Program award is funded for improvement of the SBE-61. A collaborative U.S./New Zealand/SeaBird Scientific cruise on RV Tangaroa took place in April 2023 for testing/validation of new SBE-61 conductivity and pressure sensors.

BGC Argo:

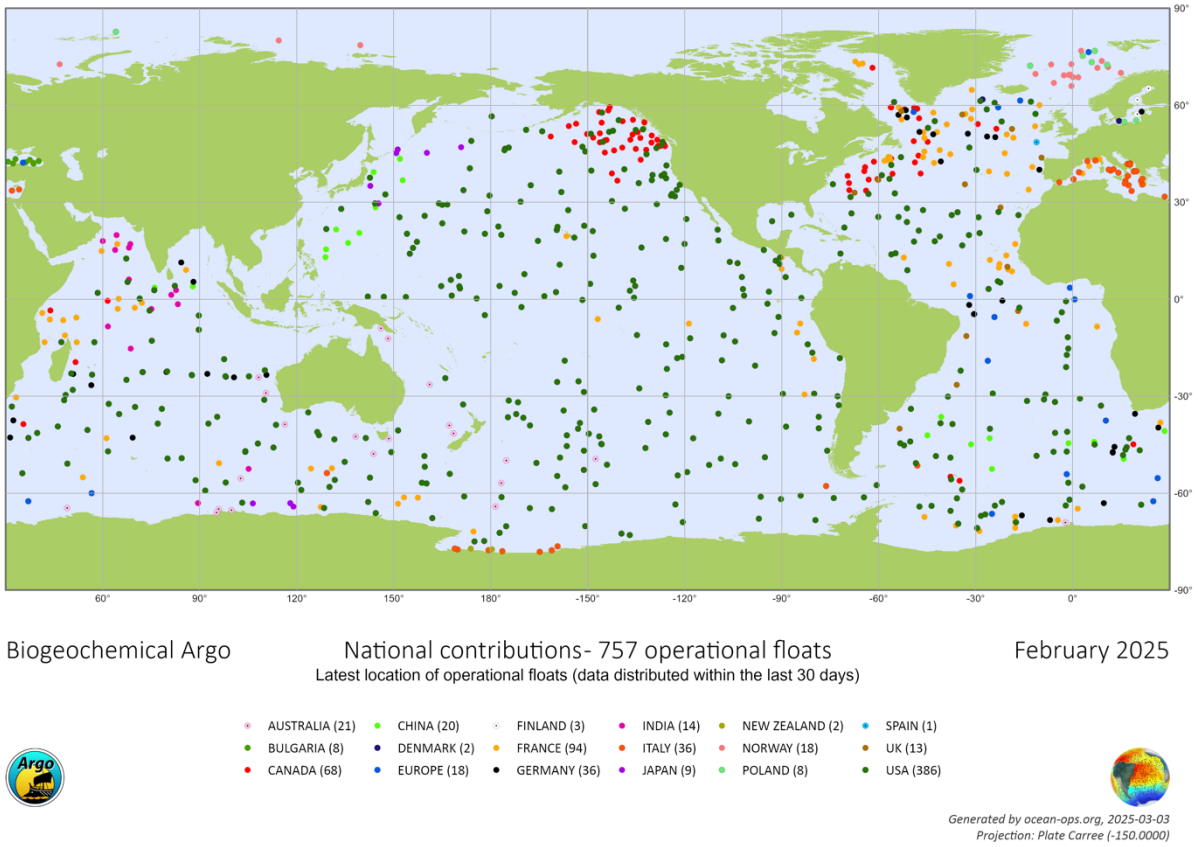

Fig. 4: *Locations of 757 operational BGC-Argo floats as of February 2025, including 386 US Argo floats, mostly from SOCCOM and GO-BGC. US BGC floats are indicated as dark green filled circles (Source: OceanOPS).*

Since 2012 the U.S. Argo Consortium has carried out testing and deployment of Biogeochemical (BGC) Argo floats. The present versions of these floats cycle 0–2000 m at 10-day intervals and, in addition to the CTD, carry sensors for dissolved oxygen, nitrate, pH, chlorophyll fluorescence, and particulate backscatter. A major NSF proposal (SOCCOM) started in 2014 to deploy a 200-float array of BGC floats in the Southern Ocean. A second major NSF proposal (GO-BGC) was funded in 2020 for global deployments of up to 500 BGC floats over a 5-year period. Two funded NOPP proposals between 2020-2023 have implemented technology improvements to the BGC SOLO and BGC NAVIS Argo float models and have deployed 15 BGC floats in the equatorial Pacific. As of January 2025, US BGC floats, mostly from SOCCOM and GO-BGC, with several US Argo Consortium contributions, number 386 of the total 757 operational BGC Argo floats (Fig. 4), with 335 of the US's 386 BGC floats measuring at least five BGC variables.

Plans:

The highest priority in 2025 for the U.S. Argo program is to (1) sustain the Core Argo array, (2) continue to build out the global BGC array, and (3) maintenance of regional pilot arrays for Deep. Specific plans for float deployments in 2025, as they evolve, are posted on the AIC

deployment planning web page. Funding levels for the U.S. Argo Consortium in FY2025 are not yet finalized but planning is based on a roughly match with FY2024 levels.

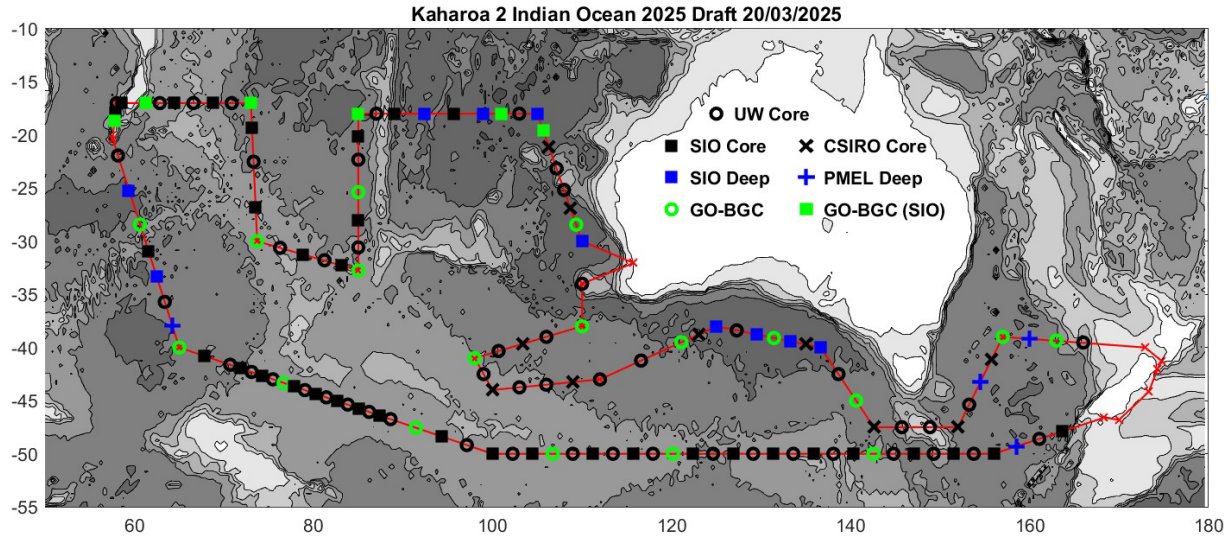

Fig. 5: *Cruise track and deployment plan for the 2025 Kaharoa II voyage with planned core (black), BGC (Green) and Deep (Blue) locations indicated.*

Data management

The U.S. Argo Data Assembly Center (DAC) is based at NOAA/AOML. Real-time data from all U.S. Argo floats are distributed via the GTS and to the Global Data Assembly Centers (GDACs). The systems developed at AOML are operational on a primary server housed at AOML and also run on AOML's Argo mirror server at a cloud service provider. These systems apply internationally-agreed Argo-specific quality control tests and generate data files for the user communities that comply with the Argo standards. The U.S. Argo DAC has expanded its decoding and quality control capabilities to include the full suite of BGC data, currently able to accept BGC data from APEX, NAVIS and SOLO-family floats. Delayed-mode quality control and other data management functions of the core parameters are carried out by the float-providing institutions. The real-time and delayed mode adjustment of the BGC parameters for GO-BGC and SOCCOM floats are performed at MBARI. The AOML data center serves as the national focus for data management and is the conduit for delayed-mode data to pass between the PIs and the GDACs.

In addition to the national DAC, a GDAC is presently run as part of the GODAE server, located at the Naval Research Laboratory, Monterey. The two GDACs at NRL/Monterey and IFREMER/Brest are mirror images in their assemblies of Argo data from all international partners, and are responsible for dissemination of the data. A GDAC refresh by another U.S. provider is in an early stage of development. Several U.S. institutions participate in Argo Regional Center activities.