U.S. Argo National Report to AST-19, March 2018

Organization of U.S. Argo:

The U.S. Argo Program is supported with major funding provided by the National Oceanic and Atmospheric Administration (NOAA), and additional participation of the U.S. Navy. It is implemented by a U.S. Float Consortium that includes principal investigators from six institutions: 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), and the Naval Research Laboratory (NRL/Monterey). Float technology development, production, deployment, array monitoring, and data system functions are distributed among these institutions on a collaborative basis.

In addition to U.S. Argo floats, Argo-equivalent floats have been provided from a number of U.S. float groups, programs, and principal investigators. A notable U.S. Argo-equivalent program is Southern Ocean Carbon and Climate Observations and Modeling (SOCCOM). SOCCOM is a regional pilot array for Biogeochemical Argo, with support from the National Science Foundation and NASA, and in partnership with U.S. Argo. SOCCOM has 91 operational floats at present (as tracked by the AIC) equipped with biogeochemical sensors, in the Southern Ocean, and has plans to increase the size of its array to 200 floats in the coming years. The contributions of all Argo-equivalent partners are gratefully acknowledged.

The present 5-year cycle of U.S. Argo implementation began in July 2015, and extends through June 2020.

Objectives:

During the present 5-year cycle, U.S. Argo will sustain its contribution of half of the Core Argo array, while enhancing coverage on a regional basis (high latitudes, western boundary and equatorial regions, marginal seas) as recommended through sustained ocean observing system community activities and endorsed by the AST. These coverage enhancements will only be implemented if sufficient resources are available to maintain the original Argo coverage and the data quality of the Argo array. Further improvements in data quality, timeliness, and resolution are planned, along with ongoing extensions to float lifetimes and cost-effectiveness.

A major enhancement to Argo is the implementation of Deep Argo to extend sampling to the ocean bottom (to pressures as high as 6000 dbar). As a key component of the Deep Ocean Observing Strategy (DOOS), Deep Argo is needed to close regional and global budgets of heat, freshwater, and steric sea level, and for exploration of deep ocean circulation. Deployment of several regional Deep Argo pilot arrays is being undertaken to test floats and sensors, to aid in global array design, and to demonstrate the capability to deploy on a regional basis. U.S. Deep Argo deployments are integrated with planned contributions of international partners.

Status:

The support level for U.S. Argo is determined on a year-to-year basis. Support levels for Core U.S. Argo have remained relatively flat since 2004, with some recent yearly augmentations. Inflationary losses have been offset by increases in float lifetime, so the number of operational U.S. floats remains approximately 2000, equal to the high levels achieved since 2008. Further increases in lifetime are expected through a changeover in SIO and WHOI Argo floats to hybrid lithium batteries to mitigate passivation losses. However, the present number of yearly deployments may not be sufficient to sustain the level of U.S. Argo floats.

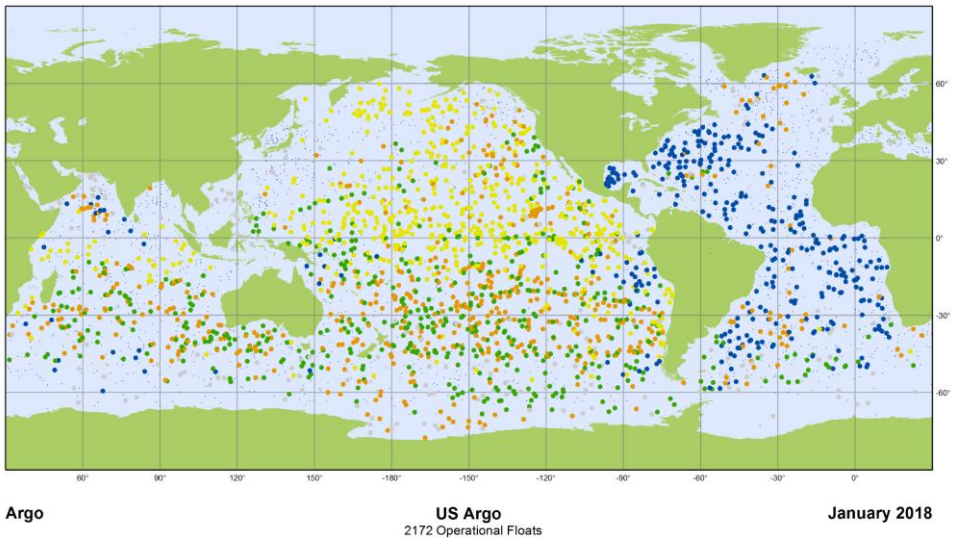

Fig. 1*: Location of 2172 operational U.S. Argo Program and U.S. Argo Equivalent floats as of January 2018. (Source: AIC)*

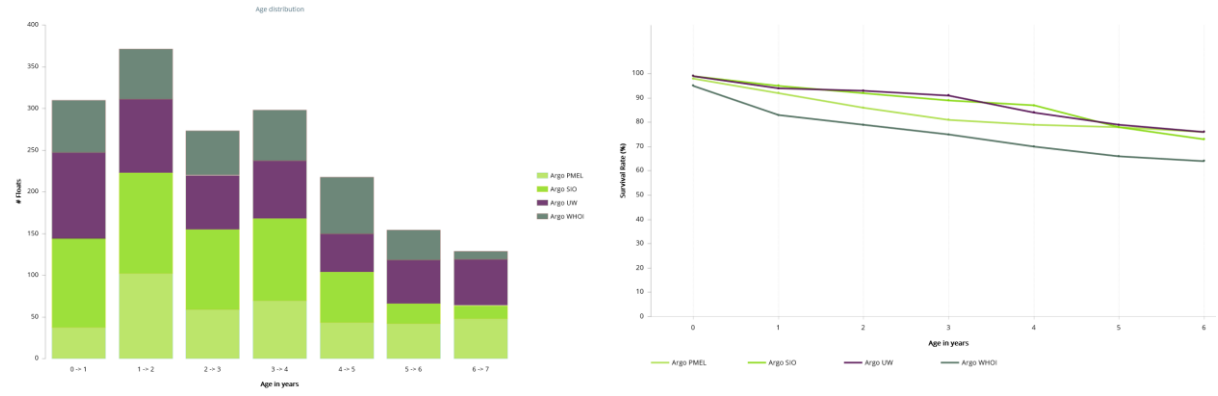

Fig. 2: *Left panel – Age distribution of operational U.S. Argo Program floats deployed since 2011. Right panel: Survival rate of U.S. Argo Program floats deployed since 2011. (Source: AIC)*

There are presently 1995 operational U.S. Argo Program floats (Fig. 1) as of January 2018. The age distribution of operational floats deployed since 2011 is shown in Fig. 2, along with the AIC failure rate for that sample. Of the 329 U.S. Argo Program floats deployed in 2013, 229 (67%) remain operational (AIC). Table 1 indicates the number of U.S. Argo Program floats deployed and operational for each year since 2011 (Source: AIC).

Year deployed	Number deployed	Number active	% active (2/2018)
2011	329	116	34%
2012	341	133	39%
2013	329	221	67%
2014	376	292	78%
2015	356	303	85%
2016	348	334	96%
2017	344	332	97%

Support for U.S. Argo includes float production and deployment, technology improvement, communications, data system development and implementation for real-time and delayed-mode data streams, and participation in international Argo coordination, Regional Centers, and outreach activities.

Deep Argo:

In 2011-2015, U.S. Argo carried out development and testing of Deep Argo prototype floats. Successful prototype float deployments were made 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 200 cycles. Deployment of U.S. Deep Argo regional pilot arrays began in the SW Pacific Basin in 2016 - 2017, in the South Australian Basin in late 2016, in the Australian Antarctic Basin in early 2018, and in the western North Atlantic in early 2017 (Fig 3).

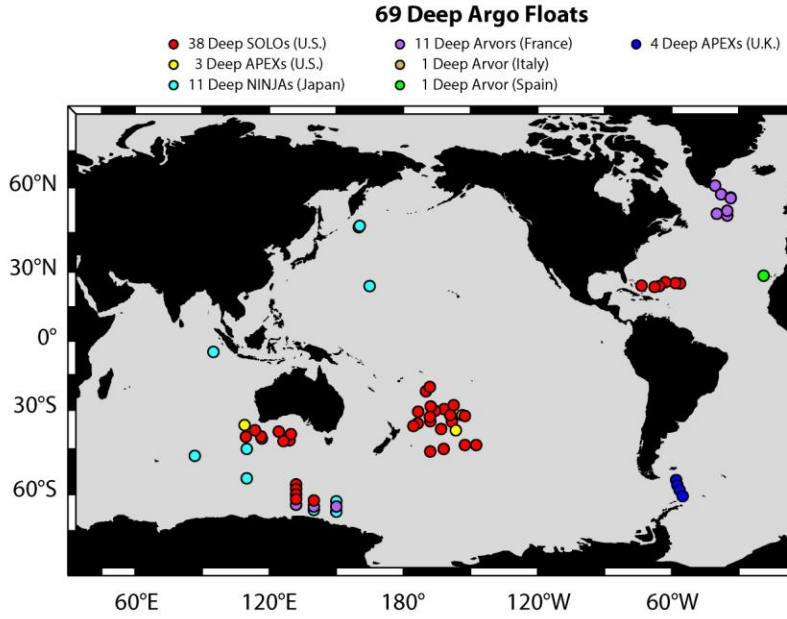

Fig. 3*: Location of all Deep Argo pilot floats, including 20 U.S. Deep Argo floats in the SW Pacific Basin, 9 in the South Australian Basin, 5 in the Australian Antarctic Basin, and 6 in the NW Atlantic. SIO Deep SOLO floats are indicated in red and UW Deep APEX floats in yellow.*

Testing of deep 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 (± .001C, ±.002 psu, and ± 3 dbar) but is progressing relative to those goals (Fig. 4).

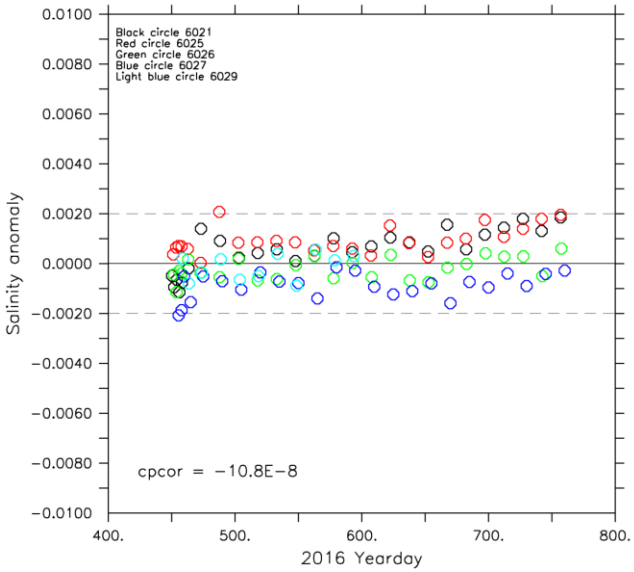

Fig. 4: *Time-series of salinity anomaly at 1.6°C potential temperature from 5 Deep SOLO floats, with SBE-61 CTDs, in the NW Atlantic. A 6th float has a failed CTD. Salinity anomaly is relative to shipboard CTD casts at the place and time of each float deployment. The conductivity cell compressibility is estimated, to remove a fresh bias seen in all floats.*

Plans:

The highest priority for U.S. Argo is to sustain the Core Argo array. Specific plans for float deployments in 2018, as they evolve, are posted on the AIC deployment planning links. A major U.S./New Zealand/Australia Argo deployment cruise from New Zealand to Chile and back on RV Kaharoa was carried out in late 2017 (Fig. 5 yellow symbols). This voyage deployed 107 Core Argo floats in the South Pacific Ocean and 5 Deep Argo floats in the SW Pacific Basin, enlarging the regional pilot array there (Fig. 3). A deployment cruise on RV Kaharoa, from New Zealand to Tahiti, is planned in July 2018 to deploy 10 – 14 Deep Argo floats in the SW Pacific Basin, plus additional Core Argo floats in the South Pacific.

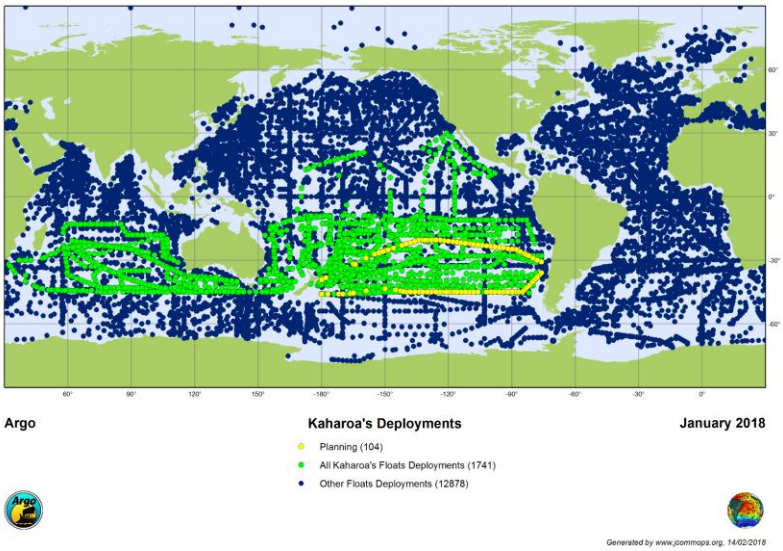

Fig. 5: All 1845 Argo float deployments by RV Kaharoa since 2004 (Green and yellow symbols). Deployment voyages are supported by U.S., New Zealand, and Australia Argo. Argo could not have achieved and cannot sustain global coverage without deployment voyages in the South Pacific and South Indian Ocean.

The U.S. Argo Data Assembly Center (DAC) is based at NOAA/AOML. Real-time data from all U.S. Argo floats are transmitted via the GTS. GTS transmission uses parallel systems developed at AOML and housed at AOML and at Collect Localisation Satellites (CLS), implementing internationally-agreed quality control tests. 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. During 2016, processing of delayed-mode files continued but was slowed somewhat by adoption of new file formats.

In addition to the national DAC, a Global Data Assembly Center (GDAC) is 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. Several U.S. institutions participate in Argo Regional Center activities, including AOML's role as focus for the South Atlantic ARC.