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Argonautics

Newsletter of the international Argo project

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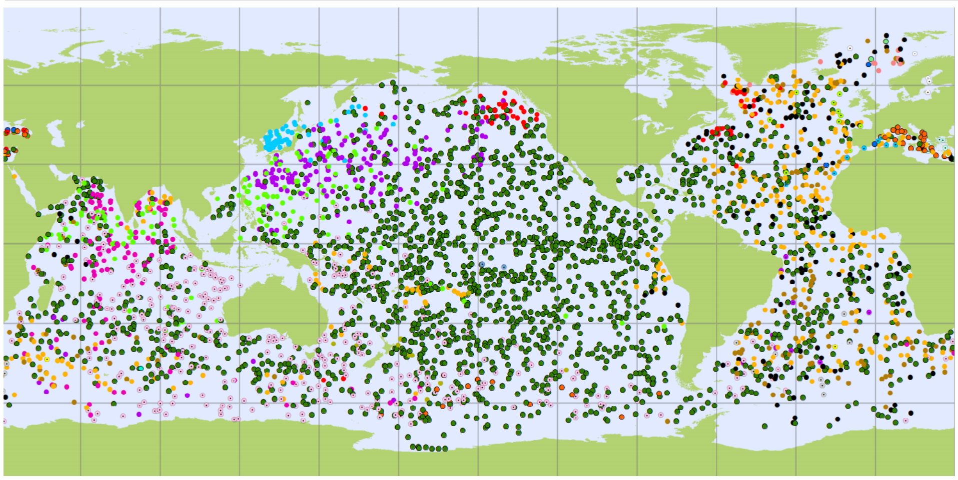

3759 Active Floats **June 2016**

ARGENTINA (2)
AUSTRALIA (377)
BRAZIL (10)
BULGARIA (2)
FINLAND (5)
FRANCE (327)
GERMANY (130)
JAPAN (173)
KENYA (1)
SOUTH KOREA (48)
NORWAY (10)
POLAND (3)
SOUTH AFRICA (1)
SPAIN (8)
TURKEY (3)
CANADA (68)
CHINA (142)
ECUADOR (2)
EUROPEAN UNION (5)
GREECE (5)
INDIA (123)
IRELAND (10)
ITALY (50)
MAURITIUS (3)
MEXICO (2)
NETHERLANDS (11)
NEW ZEALAND (10)
UNITED KINGDOM (129)
UNITED STATES (2099)

Notes from the Editor

The Argo program continues to work on keeping Core Argo healthy and improving platform and sensor technology, data quality and coverage. In addition, Argo is reviewing the status and progress of its enhancements. At the recent AST meeting in JAMSTEC in Yokohama, Japan this past spring, the AST noted that the original global Argo array was limited by technical reasons in the seasonal sea-ice zones and in marginal seas. With the advent of two-way communication and ice-sensing algorithms, these technical limitations are mostly gone. Since the Argo concept is a spatially complete global array, the AST agreed to include seasonal sea-ice zones and marginal seas. Please see the AST-17 meeting highlights article for more information. This Argonautics features articles on two of Argo's extensions, several articles on outreach, highlights from recent Argo meetings, updates on the new Argo DOI and the Argo citation lists.

The team at the Argo Information Centre recently revealed the new JCOMMOPS Argo website (http://argo.jcommops.org/) and have described it in an article in the Newsletter. The new site automatically produces the monthly maps which can be downloaded in various formats for the current month and all previous months. Users now have the ability to use the Argo metadata to search for the specific groups of floats by program, PI, float type, sensor type, etc. and easily download the results or look at plots with statistics on the selected group.

The two enhancement updates featured in this newsletter are the Deep Argo Pilot Array in the Pacific and recent developments in Biogeochemical Argo. The status of the remaining enhancements are described in the AST-17 meeting report soon to be found here (http://www.argo.ucsd.edu.iast17.pdf).

As always, education and outreach remain important to Argo and there are several articles on these topics in this Newsletter. Many of the efforts continue to have a local focus, but Argo is considering holding an education workshop to provide a venue for the various groups to come together and discuss what is working and what else can be done.

The Southern Ocean Carbon and Climate Observations and Modeling project (SOCCOM) contributes an article about the education outreach effort by graduate students and a post-doc as part of SOCCOM. The article describes each budding scientist as they went on a cruise to deploy SOCCOM floats, blogged about it and fielded questions from different classrooms in the US. In the future, SOCCOM hopes to continue inspiring young scientists through outreach efforts.

Following the AST meeting in Japan, an Argo education workshop titled "Measuring the Ocean – Ocean observations and our life" was held in Sendai and attracted an audience of children to adults. There were several talks given by Argo scientists, including one given by the Argo director Howard Freeland, followed by time to examine Argo floats, Cartesian divers, etc. and ending with a discussion panel. The event was very successful.

Another article on outreach efforts describes updates that will be completed this summer on the Global Argo Marine Atlas. More plotting options are available along with a couple more datasets. This tool, designed to be downloaded to computer and updated monthly based on gridded Argo data, allows users not familiar with NetCDF to see plots of Argo data quickly.

There are two final short articles on Argo outreach including a review of the Argo in Schools webpage on the AST website and the possibility of Argo data being added to the earth.nullschool.net application. Argo has had several papers published in Nature Climate Change so far in 2016 including the Argo review paper that was led by S. Riser and H. Freeland. The other articles are highlighted in the Argo bibliography article in the Newsletter, along with some new plots showing how Argo data are used in the papers on the list. The Argo thesis citation list is also featured and I continue to ask for submissions of theses using Argo data since that remains an important way of finding theses. Please email argo@ucsd.edu with any Argo citation submissions.

Megan Scanderbeg

The Deep Argo Pilot Array in the Southwest Pacific Ocean

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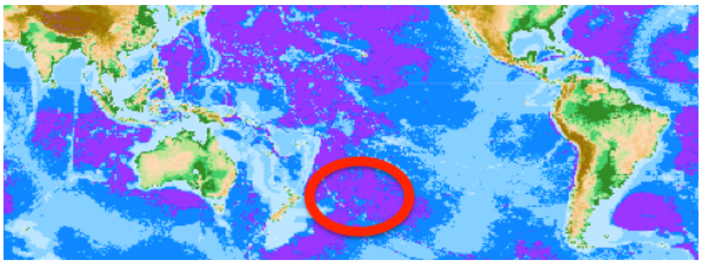
Dean Roemmich, Scripps Institution of Oceanography, USA, [droemmich@ucsd.edu]

The Southwest Pacific Basin was chosen for the pilot Deep Argo Array because it has a significant decadal warming signal in abyssal layers (Purkey and Johnson, 2010), the eddy noise is not excessive, and the bottom is relatively flat over a large area with depths between 5000 and 6000 m. Also, the region is easily accessible from New Zealand, and New Zealand Argo provides joint sponsorship of the voyages on NIWA's vessels. Oceanographically, the Deep Western Boundary Current flows northward along the Tonga/Kermadec Ridge just to the west of the pilot array, feeding the transport through the Samoan Passage that renews the deep layers of the North Pacific.

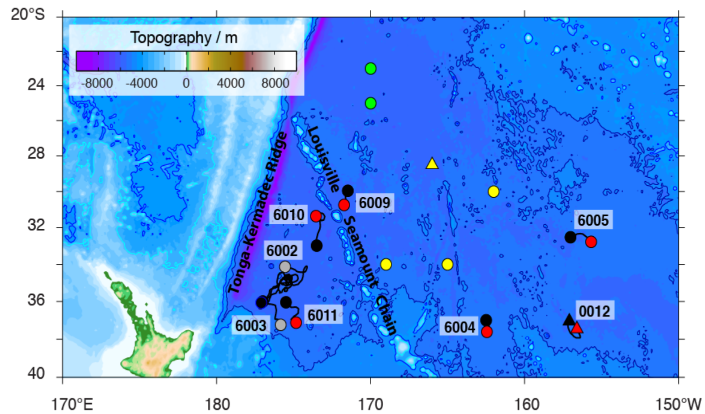


The red circle shows the location of the Deep Argo array in the Southwest Pacific Basin. Light blue areas indicate bottom depths shallower than 4000 m, darkest-blue areas indicate 4000-5000 m, and magenta areas indicate bottom depths exceeding 5000 m.

Mission parameters for the Deep SOLO floats include profiling during descent, mixed continuous and spot sampling to the ocean bottom, parking on ascent at about 5000 m, and a cycle time of 10 days (at present). Deep APEX floats in the regional pilot array cycle to 5200 m every 5 days, park during descent at 3000 m, and profile continuously during float ascent. Temperature and salinity for Deep SOLO and Deep APEX floats are measured using the SBE-61 CTD developed by Sea-Bird Electronics.

Two prototype Deep SOLO floats (WMO ID#6902341 and WMO ID#590234) that were deployed in the Southwest Pacific Basin in June 2014, were recovered during a joint U.S./New Zealand voyage on *RV Kaharoa* in September 2015, having completed about 110 profiles each. Recovery of the prototype Deep SOLO floats is for CTD re-calibration and possible recycling, and for assessment of wear and tear on the pump, glass ball, and electronics.

A pilot Deep Argo array consisting of seven Deep SOLO and two Deep APEX floats was deployed in the same basin during a joint U.S./N.Z voyage on *RV Kaharoa* in January 2016. A GO-SHIP cruise (P15S, Australia) through the pilot array in June 2016 will provide additional high quality CTD data for comparison with the SBE-61 CTD, and the deployment of two additional Deep SOLO floats. Deployment of four Deep Argo floats, including three Deep SOLO and one Deep APEX, during a joint U.S./N.Z. voyage on *RV Kaharoa* in July, will bring the Deep Argo regional array to about 12 floats.



Present location of active Deep SOLO (red spots) and APEX (red triangle) floats in the Southwest Pacific Basin. Deployment locations are indicated in black. Gray spots show recovery of the two Deep SOLO prototypes in September 2015. Locations of planned Deep SOLO float deployments in June 2016 (green spots), and July 2016 (yellow spots), and Deep APEX float deployment in July 2016 (yellow triangle) are indicated. The contours indicate 3000-m (cyan), 4000-m (blue), and 5000-m (dark blue) depth.

Objectives of the Deep Argo SW Pacific regional pilot experiment are: (i) to demonstrate the feasibility and capability of Deep Argo arrays in profiling to the sea bottom, (ii) to validate the accuracy of SeaBird-61 temperature/salinity/pressure profiles, and (iii) to observe interannual variability in deep ocean properties in the SW Pacific.

Watch the recovery video at:
http://www.argo.ucsd.edu/Argo_movies.html

Link to high-res version:
Part 1: https://www.youtube.com/watch?v=KBLXorKQe-4
Part 2: https://www.youtube.com/watch?v=XiC55P2QyrA

Recovery of a prototype Deep SOLO float in September 2015 onboard *RV Kaharoa*

Global Marine Atlas Updates

Megan Scanderbeg, Scripps Institution of Oceanography, USA, [mscanderbeg@ucsd.edu]
Jenny Li, Scripps Institution of Oceanography, Intern

As of August 2016, the Global Argo Marine Atlas will have new products and options available.

Updates to the Atlas will include two new data sets: Alison Gray and Stephen Riser's AGVA (Absolute Geostrophic Velocities from Argo) and Jamie Holte and Lynne Talley's Mixed Layer Depth climatology.

The AGVA data set (for more information, see http://flux.ocean.washington.edu/agva/) will offer plots of the zonal velocity, meridional velocity, and geostrophic velocity. These will each be placed into the map view, vertical section, time series, and line drawing sections of the Atlas. The line drawing graphs will include four options: AGVA vs. time, AGVA vs. depth, AGVA vs. latitude, and AGVA vs. longitude. In all of the sections, each plot will also include options for the average, monthly anomaly, and yearly anomaly plots.

The plots include pressure data from 5 db to 2000 db, with a geographic range from 75 S to 69 N, and from 0 E to 359 E. The data is monthly and spans from December 2004 to November 2010.

The second data set, the Holte Mixed Layer Depth climatology (see http://mixedlayer.ucsd.edu/ for more information), will go in the "Derived products" section of the Atlas. It currently incorporates data from January 2000 to May 2016 and has twelve average months of data. Holte's product has mixed layer calculations from his density algorithm, as well as calculations using de Boyer Montegut et al.'s 2004 threshold value method.

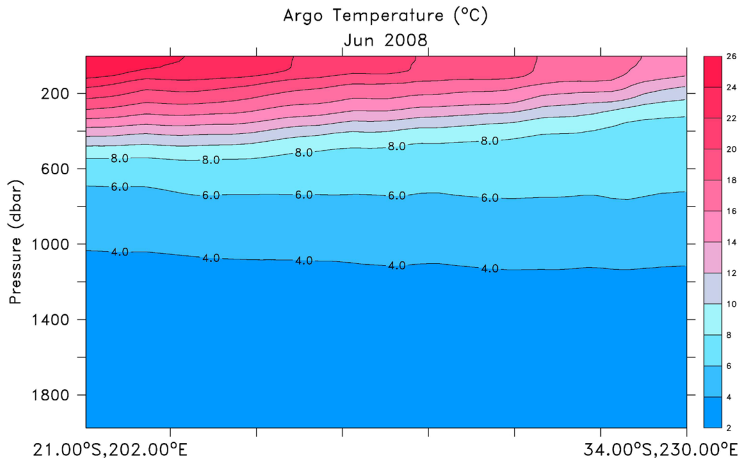
For each mixed layer, the plot will be including a mean, maximum, and median calculation from both the density algorithm and the density threshold, for a total of six types of graphs. The mixed layer average temperature will also be plotted on each of these graphs as a contour.

The geographic range of these plots spans from 89.5 S to 89.5 N, and from 179.5 W to 179.5 E.

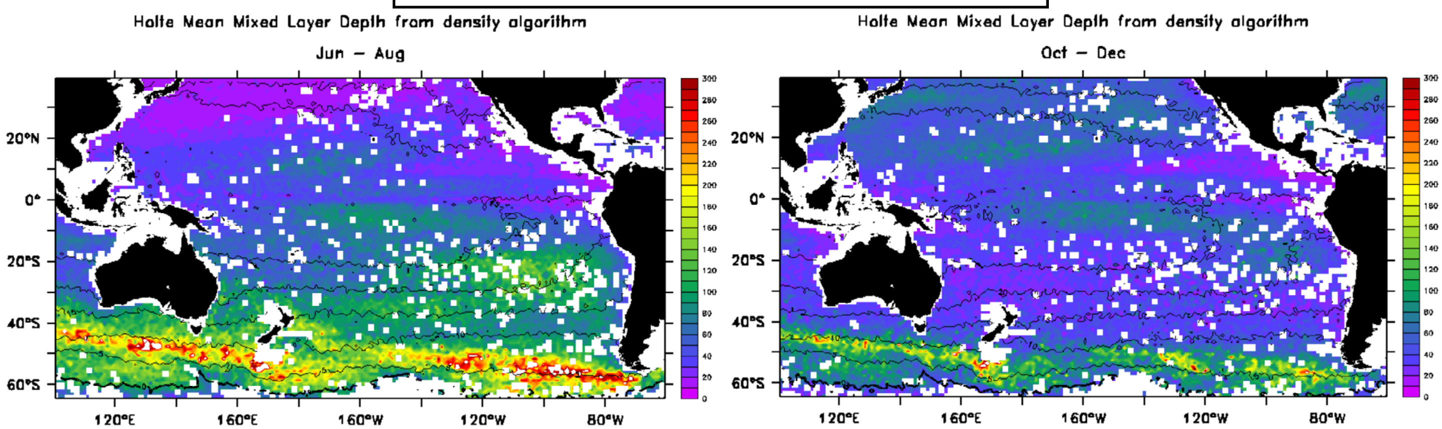
Also, point-to-point section plots will be available for the Argo data grid and the AGVA grid in the vertical section part of the Atlas. The AVISO data set has also been updated through December 2015.

Changes to the Atlas were made using the graphing program Ferret. The Atlas user interface has almost been updated and will soon be ready for public use.

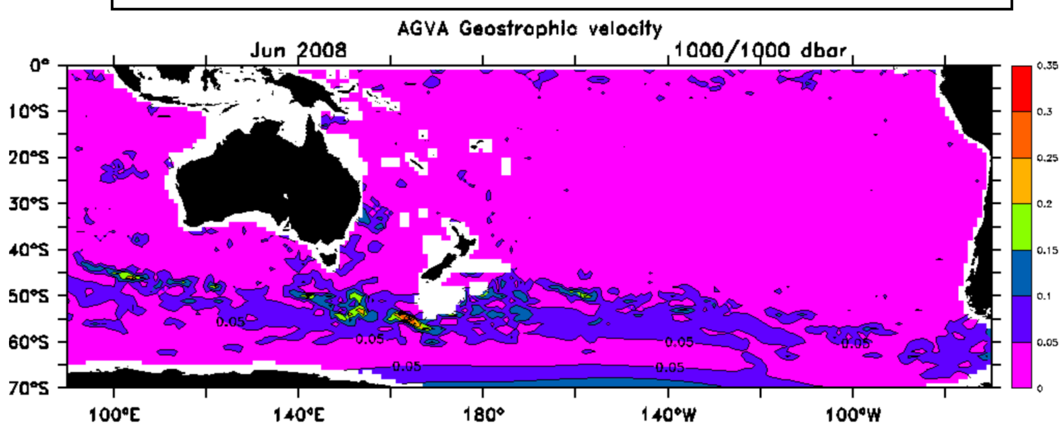
Screenshot of point-to-point vertical section



Screenshots of the new mixed layer depth plots (m)



Screenshot of the geostrophic velocity AGVA plot (m/s)



Argo's New Single DOI

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Fred Merceur, IFREMER, France, [Frederic.Merceur@ifremer.fr]
Megan Scanderberg, Scripps Institution of Oceanography, USA, [mscanderbeg@ucsd.edu]

Argo has moved to a single DOI for the Argo dataset which is closer to the RDA recommendation for dynamic data citation. This DOI has been developed with SEANOE and allows users to add an extra key to the end of the generic Argo DOI to specifiy the month the Argo data was taken from the GDACs.

This is the new single DOI citation:

Argo (2000). **Argo float data and metadata from Global Data Assembly Centre (Argo GDAC).** SEANOE. http://doi.org/10.17882/42182

The landing page (page that appears when you click the above link and is shown to the right), gives information about Argo and links to the User's manual, the data itself and then the three most recent monthly snapshots of Argo data created at the GDACs.

To cite data from a particular month, the key is added to the end of the Argo DOI:

Argo (2016). **Argo float data and metadata from Global Data Assembly Centre (Argo GDAC)-Snapshot of Argo GDAC of February, 8th 2016.** SEANOE. http://doi.org/10.17882/42182#42350

Argo float data and metadata from Global Data Assembly Centre (Argo GDAC)

Publication date	2000-09-12
Author(s)	Argo
DOI	10.17882/42182
Publisher	SEANOE
Keyword(s)	float, Argo, global ocean observing system, ocean circulation, in-situ, ocean pressure, sea water salinity, sea water temperature, multi-year, weather climate and seasonal observation, global-ocean, Installations de suivi environnemental
Abstract	Argo is a global array of 3,000 free-drifting profiling floats that measures the temperature and salinity of the upper 2000 m of the ocean. This allows, for the first time, continuous monitoring of the temperature, salinity, and velocity of the upper ocean, with all data being relayed and made publicly available within hours after collection. The array provides 100,000 temperature/salinity profiles and velocity measurements per year distributed over the global oceans at an average of 3-degree spacing. Some floats provide additional bio-geo parameters such as oxygen or chlorophyll. All data collected by Argo floats are publically available in near real-time via the Global Data Assembly Centers (GDACs) in Brest (France) and Monterey (California) after an automated quality control (QC), and in scientifically quality controlled form, delayed mode data, via the GDACs within six months of collection.
Licence	CC BY
Utilisation	A user of Argo data is expected to read and understand this manual and the documentation about the data contained in the "attributes" of the NetCDF data files, as these contain essential information about data quality and accuracy. A user should acknowledge use of Argo data in all publications and products where such data are used, preferably with the DOI and following standard sentence:"These data were collected and made freely available by the international Argo project and the national programs that contribute to it."

Screenshot of landing page for Argo DOI

Previous Argo DOIs will be redirected to the new ones so the link will remain (See www.argodatamgt.org/Access-to-data/Argo-DOI-Digital-Object-Identifier for more details).

J. Buck, who has been working with the data citation community to find the best solution for an Argo DOI, informed the Argo Steering Team that this new single DOI should allow for the Argo data set to be cited in the ***references*** rather than the main body of the text once a paper is published describing the Argo data set and its DOI. This will make both citing the data set and tracking its papers easier. Please cite the appropriate DOI when needed.

User's manual http://dx.doi.org/10.13155/29825

Data

File	Size	Format	Processing	Access	Key
2016-03-08	9 GB	NC, NetCDF	Quality controlled data	Open access	42382
2016-02-08	8 GB	NC, NetCDF	Quality controlled data	Open access	42350
2016-01-08	8 GB	NC, NetCDF	Quality controlled data	Open access	42349

More snapshots

Data ftp://ftp.ifremer.fr/ifremer/argo
ftp://usgodae.org/pub/outgoing/argo

Screenshot of Argo DOI showing the 'Key' to add to specify the time period the Argo data was retrieved

AST-17 Meeting Highlights

Megan Scanderberg, Scripps Institution of Oceanography, USA, [mscanderbeg@ucsd.edu]
Brian King, National Oceanographic Centre, UK, [bak@noc.ac.uk]

The 17th Argo Steering Team Meeting took place at JAMSTEC in Yokohama, Japan on March 22 – 24, 2016. The objectives of the meeting were as follows:

- Ensure that Core Argo remains healthy and that platform and sensor technology, data quality, coverage, and utility continue to improve
- Review the status and progress of Argo enhancements (Deep Argo, BGC-Argo, Equator, western boundary regions, marginal seas, high latitudes)

The entire meeting report will be available on the AST website at: http://www.argo.ucsd.edu/iast17.pdf. This article will include a few highlights from the meeting that are not already featured elsewhere in the Newsletter.

One focus of the AST meeting was the difficulties that the Argo Data Team are experiencing due to the increasing number of novel floats and sensors. The Argo Data Management Team requested feedback from the AST on how to limit the demands put on DACs/DMQC operators, and how to enable them to secure adequate resources for any extra tasks they may be asked or expected to carry out.

AST group photo -- Photo credit: Y. Morohashi

One step that would help DACs would be to limit future growth in the complexity of the Argo data system. The conversion to V3.1 NetCDF files allows for a very wide range of Biogeochemical variables to be included. The system now needs several years of stability while DACs consolidate their capability and catch up with tasks that have been neglected during the transition.

Limiting the new tasks that might be asked of DACs has several aspects, each of which attracted some discussion. These include: (1) what steps do we take to ensure DACs have adequate resources to accept extra floats that already conform to Argo requirements? (2) What is the procedure for having new sensors and parameters accepted into the Argo data system? (3) How should data be handled that fall outside the Argo data system, to ensure they are transparently available in an acceptable form?

To address questions (1) and (2), King and Wong drafted a series of points summarizing requirements for new floats or new data types to be accepted into Argo. These were shown at the meeting and will be posted on the Argo websites shortly. Question (3) generated a lot of discussion. The AST does not wish to see the Argo data system expand in an uncontrolled way. The inclusion of new parameters must first be discussed and approved. There is a very considerable overhead in adding parameters, including additions to the documentation and to the file checking system. Equally, Argo does not want to exclude the possibility of such floats, which could stifle innovations or remove a significant number of floats form the global array. The idea of a hard gateway requiring such floats to be refused by Argo was thought to be too severe. Instead, it was agreed that so long as all parameters were publically and transparently available somewhere, this would satisfy Argo obligations. B. King has drafted some documents discussing and describing options, that will be circulated around AST and the GDACs for comment. Discussion should ideally be completed in time for endorsement at ADMT-17.

Another point of discussion was on float survival rates. B. King analyzed float survival and compared float types and PI groups in order to see if there was any evidence that float performance was dropping over time or if there was clear evidence that different groups have different performances. Certain known failure modes showed up clearly, most strikingly the pressure micro leak. Apart from that, there was no obvious trend in performance across the fleet or across groups. All groups improved between 2000 and 2005, and have been generally steady since then, with 90, 80, 70, 60 percent of floats surviving 1,2,3 or 4 years.

However, there are clear differences between float types and between float deployment groups. The most successful sets of floats have an expectation (in the probability sense) of 180 to 190 cycles, compared with a fleet average of 145, and some groups managing significantly less than that. If all groups could match the best performing groups the global array would grow as float longevity increases. B. King would be happy to develop the statistics for any group that AST members might find helpful.

At the meeting, the AST noted that the original global Argo array was limited by technical reasons in the seasonal sea-ice zones and in marginal seas. Thanks to both two-way communication and ice-sensing algorithms, these technical limitations are largely mitigated. The Argo concept is of a spatially complete global array. Inclusion of seasonal sea-ice zones and marginal seas moves the target number of Argo floats to 3800. At present, sampling of the high latitude Southern Ocean is progressing, and in some marginal seas, such as the Mediterranean, regional Argo programs are fully operational.

In addition to the globalization of Argo, the additional enhancements include Deep Argo, Biogeochemical Argo, and increased density of sampling in western boundary current regions and in equatorial regions. For each of these, one or more regional pilot arrays is already in place, and others are pending. (See the article on BGC Argo and the Deep Argo Pilot Array in the Southwest Pacific in this Newsletter for more details.) The process for reviewing these pilots and approval as enhancements to Argo should parallel that of original Argo and should include consideration by the OOPC, GODAE Ocean View, and the CLIVAR Global Synthesis and Observations Panel (GSOP). In the case of the equatorial Pacific, the specialist panel TPOS 2020 will have an important voice. The timetable leaves several years that will be needed to study outcomes of pilot deployments, leading to OceanObs'19.

Overall, the meeting was successful from the Steering Team's point of view and the hosts did an excellent job. The AST thanks Japan Argo for hosting the meeting and for all the hospitality provided during the week.

Development of Biogeochemical-Argo and a Mini-Review of Recent Research

Kenneth S. Johnson[1], Hervé Claustre[2], Stephen C. Riser[3], Jorge L. Sarmiento[4], Lynne D. Talley[5]

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[2]Laboratoire d'Océanographie de Villefranche, Villefranche-sur-Mer, France
[3]School of Oceanography, University of Washington, Seattle, WA, USA
[4]Princeton University, Princeton, NJ, USA
[5]Scripps Institution of Oceanography, University of California, San Diego, CA, USA

Development of a global, Biogeochemical-Argo program is moving forward rapidly. Regional-scale arrays of floats with biogeochemical sensors are being deployed around the world (Fig. 1). The operation of these float arrays has enabled refinement of biogeochemical sensors and data handling. The amount of biogeochemical data being generated by these systems now exceeds that being collected from ships in the open ocean (Fig. 2) and will be an essential component for global studies. The regional-scale programs have enabled significant improvements in operation of the sensors.

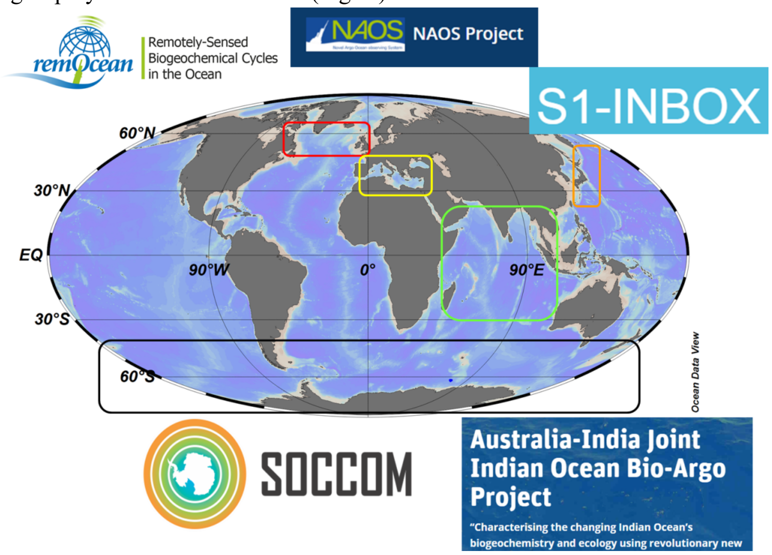

Figure 1: Regional Biogeochemical-Argo programs

For example, work in these systems has validated the potential for significant improvements in the accuracy of oxygen sensors through air oxygen measurements (Bittig and Körtzinger, 2015; Bushinsky et al., 2016; Johnson et al., 2015). This work has also demonstrated the synergies that result when profiling float deployments with biogeochemical sensors are closely coordinated with basin-scale hydrographic programs such as GO-SHIP (Williams et al., 2016) and global-scale remote sensing by satellites (Sauzède et al., 2016; Westberry et al., 2016). A variety of papers have been published using bio-optics, oxygen, nitrate, and pH sensors that show the scientific potential for a global system.

This work has culminated with planning for a global array. A meeting was held 11 to 13 January 2016 in Villefranche-sur-Mer, France to organize the development of a global system. The goal of the meeting was to develop a science and implementation plan for the global array. That plan has now been released for public comment (Biogeochemical Argo Task Team, 2016; http://www3.mbari.org/chemsensor/BGCArgoPlanJune21.pdf). In addition, a short article that summarizes the plan will be published in Eos (Johnson and Claustre, 2016). A program website will be released in September 2016 (biogeochemical-argo.org).

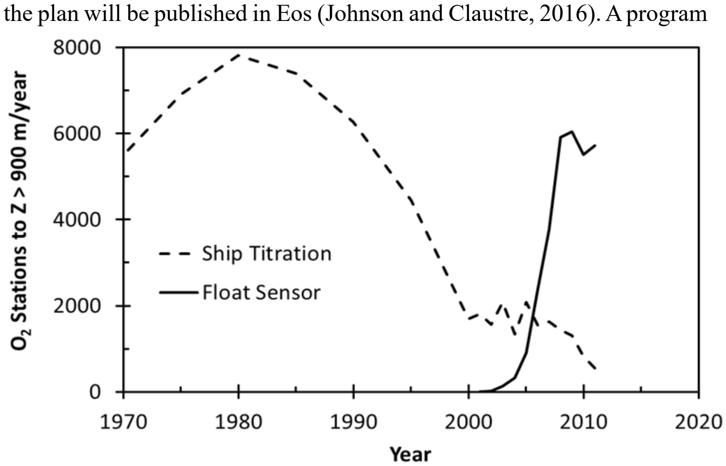

Figure 2. Number of oxygen profiles to a depth (Z) of at least 900 m per year in the US NODC World Ocean Database 2013. "Ship Titration" denotes the Winkler titration measurements made on board ship, while "Float Sensor" values are data reported by profiling floats. Reproduced from Johnson et al., 2015. In 2015, the number of float O2 profiles approached 12,000.

Given the availability of these documents, we focus here on some of the recent scientific accomplishments in Biogeochemical-Argo and their relationship to the major science questions that have been outlined in the Science and Implementation Plan. The following highlights a few of the papers published since 2014 using biogeochemical sensors on profiling floats that are intended to operate in an Argo mission with profiles to 1000 m over multiple years. The studies are organized by the primary sensor used in the analyses. This review is only intended to give a flavor of the types of work being done and that could be scaled up through a global array. It is certainly not comprehensive.

Bio-optical sensors

Bio-optical sensors for chlorophyll fluorescence, suspended particles (backscatter sensors), and downwelling irradiance are being used to study ocean ecology, bio-physical coupling, and carbon export. In the Norwegian Sea, Dall'Olmo and Mork (2014) have used backscatter data from the surface to 1000 m to study coupling between particle production in the euphotic zone and export into the mesopelagic. Westberry et al. (2016) have combined profiling float and satellite remote sensing data from the North Atlantic and North Pacific to examine changes in the chlorophyll and phytoplankton carbon biomass during spring. Although the North Atlantic has a large increase in chlorophyll each spring, while the North Pacific does not, the changes in phytoplankton carbon are similar in each system. This is a remarkable finding.

Xing et al. (2014) demonstrate anomalies in bio-optical properties in the North Atlantic, particularly backscatter, that may result from coccolithophore blooms. Grenier et al. (2015) used a small array of profiling floats with chlorophyll fluorescence and backscatter sensors to study impacts of island derived iron on phytoplankton biomass near Kerguelen Island. They conclude that arrays of floats, rather than single platforms, will often be required to understand processes. Itoh et al. (2015) used profiling floats with bio-optics to examine competing hypotheses for the processes that regulate phytoplankton bloom dynamics. Sauzède et al. (2016) have used a neural network method to merge >8000 profiles of backscatter observed by floats with satellite remote sensing fields to produce a climatology for the vertical distribution of backscatter by suspended particles

Continued on page 7

Continued from page 6

throughout the global ocean. Organelli (2016) used downwelling irradiance data from 65 profiling floats in various open ocean waters and marginal seas to develop protocols that produce high quality profiles required to derive light attenuation versus depth. Such protocols will be needed to utilize data from even larger arrays.

Dissolved oxygen

Dissolved oxygen sensors have now been deployed on hundreds of profiling floats. Hennon et al. (2016) used profiles from more than 100 of these floats to determine respiration rates in the mesopelagic zone of the ocean on a global scale. They find results for carbon export and subsequent respiration that are generally consistent with Net Community Production (NCP) in the surface ocean. Direct estimates of NCP in the surface ocean from dissolved oxygen require an exquisitely well calibrated sensor. Bushinsky and Emerson (2015) pushed this capability forward by using oxygen sensors that are recalibrated in the air on each profile to determine annual NCP at Ocean Station Papa in the North Pacific.

One of the essential applications of biogeochemical sensor data on profiling floats will be to provide background information for targeted, shipboard studies. Fiedler et al. (2016) demonstrate the potential for this approach by using data from Argo floats equipped with physical and chemical sensors to guide a shipboard study of low oxygen eddies in the North Atlantic. Gao et al. (2016) demonstrate the synergies that can result when high resolution chemistry data observed on floats can be used as an additional tracer in physical oceanographic studies of North Pacific mode water. A series of papers from the INBOX regional program (Inoue et al., 2016; Kouketsu et al., 2016) demonstrate the synergies that can result in biogeochemical studies when operating a relatively dense float array equipped with oxygen sensors to study carbon production and export and the influence of eddies.

Nitrate

An array of profiling floats, which were deployed at Ocean Station Papa, have produced 12 float years of data that have been used to assess NCP at this station and to assess gas exchange rates from oxygen sensor data on the same floats (Plant et al., 2016). D'Ortenzio et al. (2014) demonstrated for the first time, using nitrate sensors on profiling floats, the sequence of events that occur in the northwestern Mediterranean as mixing to >1000 m depth injects nitrate into the surface ocean to levels rarely seen from ships. Large phytoplankton blooms result in some, but not all, cases. Pasqueron de Fommervault et al. (2015) have extended this work with an array of similar floats throughout the Mediterranean to examine regional variability in nitrate. Omand and Mahadevan (2015) use the relatively high resolution data observed by nitrate sensors on profiling floats to study the structure of the nitracline in the open ocean.

pH

pH sensors are a relatively new sensor addition to profiling floats. Johnson et al. (2016a) report on the design of the sensor and use data from profiling floats deployed at the Hawaii Ocean Time-series station to validate sensor operation. Williams et al. (2015) demonstrate how high quality shipboard data can be used to validate sensor operation in the Southern Ocean and, if necessary, correct sensors for drift in much the same way that profiling float salinity sensors are corrected for drift. An example showing four years of pH data from near Hawaii was reported in Johnson and Claustre (2016). The SOCCOM program, which has deployed 38 floats with pH sensors, is using these systems to study aspects of carbon cycling that range from air-sea carbon dioxide flux to carbon-based estimates of NCP.

Summary

A diverse body of work is being published using data generated by biogeochemical sensors on profiling floats. This work has been done by research groups from laboratories around the world. The work demonstrates both the value of operating a few sensors for long periods of time, and the value that derives when large numbers of sensors are operated. It also demonstrates the broad access to these systems and acceptance of the data they produce. This is an important validation of the Biogeochemical-Argo concept and an essential step towards implementation of a global system.

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SOCCOM's Broader Impacts: Inspiring Young Scientists

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The Princeton-affiliated and NSF-sponsored Southern Ocean Carbon and Climate Observations and Modeling Project, or SOCCOM, has been inspiring the next generation of young scientists by involving them in their most recent cruises to the Southern Ocean. Two SOCCOM graduate student scientists and one postdoctoral fellow were paired with local Princeton or Seattle middle schools as they deployed SOCCOM floats, which will continue to collect biogeochemical data in the Southern Ocean over the course of the next five to six years.

Veronica Tamsitt, a PhD candidate at Scripps Institution of Oceanography at the University of California in San Diego (UCSD), embarked on the *R/V Palmer* in December 2015 to deploy three SOCCOM biogeochemical floats. Before boarding the ship, she partnered with three classes at Princeton Day School, located in Princeton, NJ. They followed her trip aboard the Palmer, via her online blog (floatsonboats.blogspot.com), which she updated daily. The students were able to "adopt" three of the SOCCOM floats that were released on the trip, tracking their trajectories and plotting the data collected. The students' teachers, Jack Madani and Ron Banas, taught the students about the importance of the Southern Ocean and its role in regulating the Earth's climate, developing a curriculum specific to the SOCCOM project to be used in future years and at other schools. The children helped name the three floats Huey, Dewey and Louie after the robots in the 1972 science fiction film, Silent Running, and the Walt Disney cartoon duckling triplets.

Tamsitt's fellow scientist, Isa Rosso, was also paired with Princeton middle school students at John Witherspoon Middle School. She communicated with teacher Steve Carson's 7th grade science classes during and after her Indian Ocean cruise, answering questions about the deployed floats' data and oceanographic processes. In her cruise blog (floatsherder.blogspot.com), Rosso describes the SOCCOM floats and their scientific importance, plus gave short profiles of her companions aboard the *R/V Investigator*. Rosso was born in Italy and is currently a postdoctoral candidate at Scripps. She and Tamsitt participated in one of SOCCOM's public Google Hangout webinars before embarking on their voyages.

Earle Wilson, a graduate student at the University of Washington (UW) and a scientist aboard the I08S cruise, was paired with teacher Jamie Monkkonen's 5th and 8th grade science classes at Lakeside Middle School in Seattle. Wilson and the classes kept in communication throughout the cruise and the students followed the data collected from the SOCCOM floats deployed. Monkkonen's students gave Wilson creative names for the floats he deployed, including "Pi", "Tator Tot", "X-Pod", and "Kaia", among others. Wilson chronicled their deployments, daily life aboard the ship, and scientific concepts (floatdispenser.blogspot.com). At UW, Wilson's research takes place in the Argo lab, where the floats are constructed. As a result, he was able to include a post about the lab where the floats were "born." After returning to Seattle, Earle visited the middle school classroom and described his experiences face-to-face with the students, explaining the mysteries of the Southern Ocean and why the data collection from the SOCCOM floats is so pivotal to oceanographic research. Wilson is from Jamaica, and this cruise was his first voyage to the Southern Ocean.

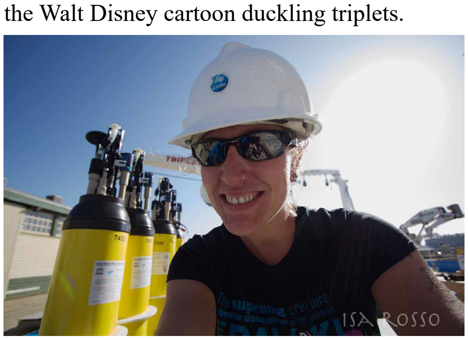

Figure 1: Scripps Postdoc Isa Rosso with SOCCOM float

Figure 2: Floats Huey, Dewey, and Louie to be deployed from the *R/V Palmer* by Veronica Tamsitt

Figure 3: Earle Wilson visiting Lakeside Middle School

SOCCOM director and Princeton professor Jorge Sarmiento also took this partnership as an opportunity to teach the middle schoolers about SOCCOM. He visited the classroom one morning after Tamsitt's return and explained the importance of studying the Southern Ocean, as well as how far oceanographic research has come as a result of the Argo and SOCCOM programs. Prior to pursuing his PhD, Sarmiento taught middle school science, which is where he developed his interest in oceanography. Tamsitt, who hails from Australia, writes in her blog about her dreams of becoming a marine biologist when she was young, but it wasn't until she traveled to the U.S. for college that she discovered her passion for oceanography.

Speaking during an outreach panel at SOCCOM's annual meeting at Scripps in May, all three scientists were enthusiastic about their experiences partnering with middle school classrooms over the course of their Southern Ocean cruises. As a program, SOCCOM continues to make this connection a priority for their scientific cruises in the hopes that it will inspire the next generation of young scientists.

Earth.nullschool.net to Add Argo Data

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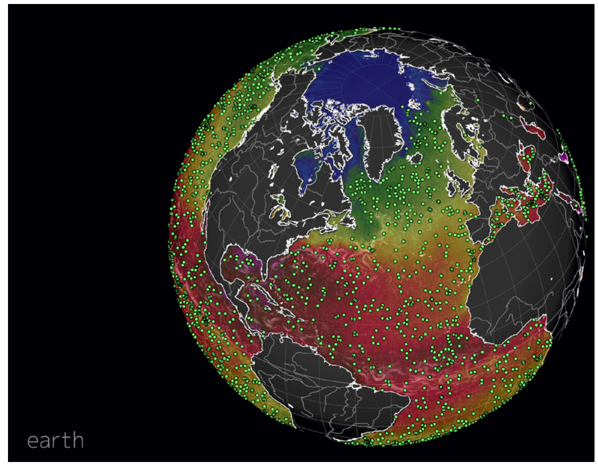
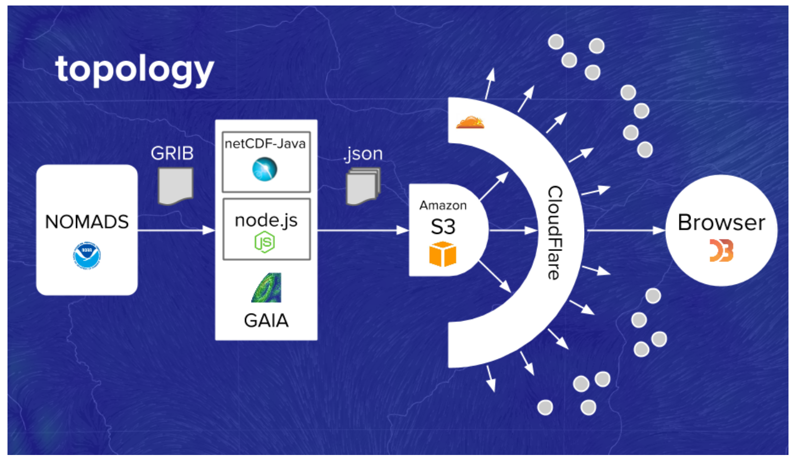


What is earth.nullschool.net? A platform to visualise data on Earth in a data browser. Right now, it contains global weather conditions, ocean surface current estimates, ocean waves, and other datasets. It was built by Cameron Beccario and it starts with a dataset (let's say NOMADS from NOAA), puts it in the correct format for the website, stores the data on Amazon S3 and then uses CloudFlare to show it on individual browsers around the world. See the flowchart figure to the right.

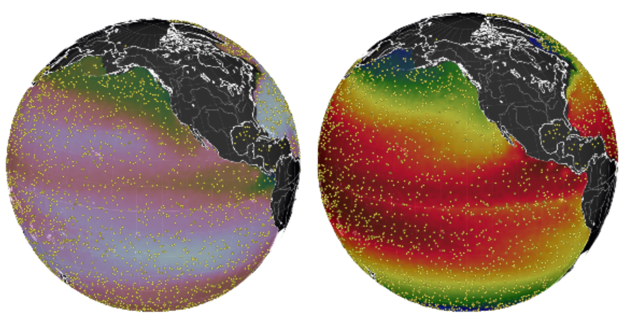
The user can manipulate the globe to turn it around to the desired angle, similar to NASA World Wind or Google Earth. Curiosity is rewarded when the user clicks the menu at the bottom right hand corner which allows users to pick from different general data groups: air, ocean, chem, particulates. Under each group are more variables that can be displayed. The source and time of the data are noted and time can be manipulated.

Mr. Beccario is working with Steve Diggs to investigate incorporating Argo data into earth.nullschool.net. See the screenshots from the prototype made showing Argo float locations with Argo temperature data from the Roemmich and Gilson grid (RG grid) contoured underneath. The possible plan is to add Argo temperature and salinity data from the 1/6th degree RG grid at the various levels, over the available time period.

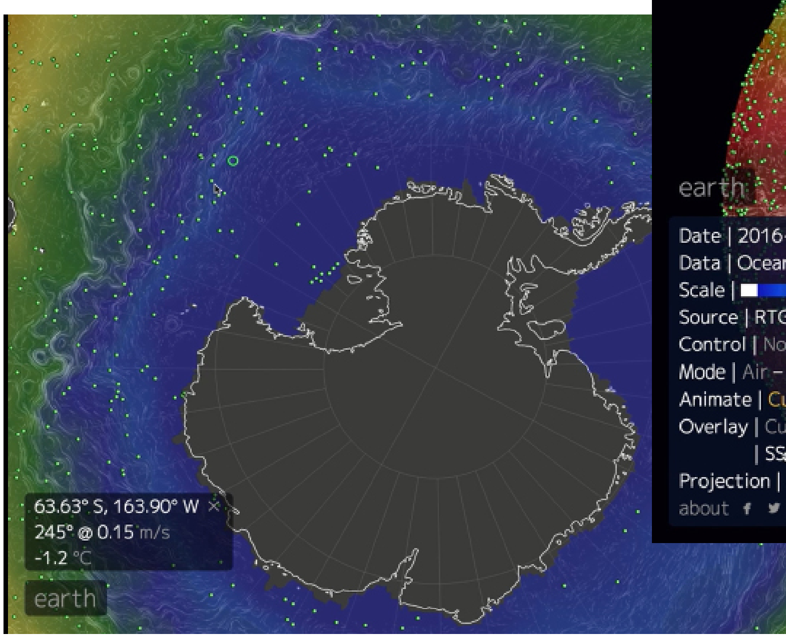
This platform is exciting since it runs quickly in a browser which makes it very easy to use when giving talks or demonstrations. It does not have a lot of specific numbers associated with it, but it makes a huge visual impact and could be very useful when interfacing with the public.

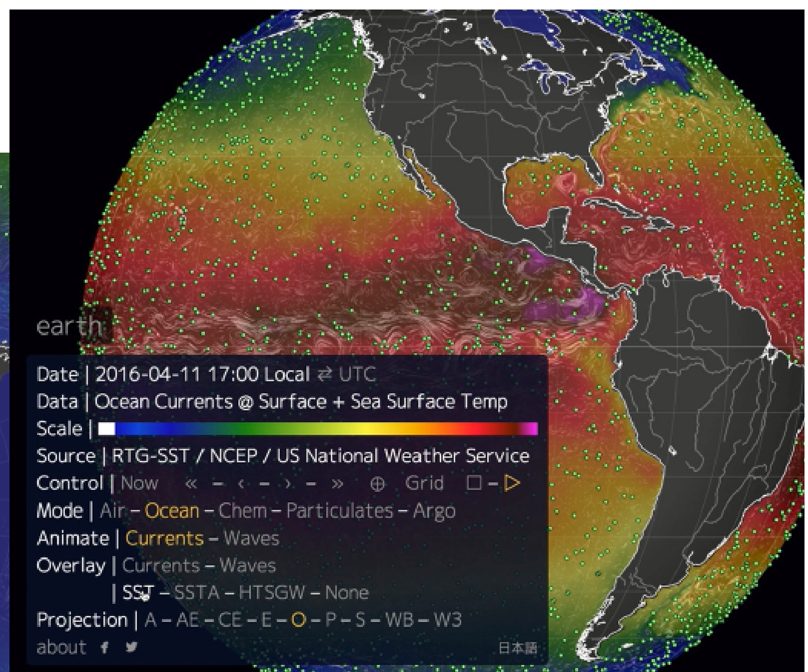


Flowchart (above)



Two globes from earth.nullschool.net displaying Argo salinity (left) and temperature (right)





Screenshots from a prototype earth.nullschool.net showing Argo temperature data at 1/6° grid resolution

The Sendai Argo Education Workshop

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Toshio Suga introducing the Sendai Education Workshop

Part of Howard Freeland's presentation

Exploring the insides of an APEX float

On Saturday March 26th, a workshop was held at Tohoku University, Sendai. The event was extremely successful with very positive comments from the audience. In the following we will outline how this was organised and advertised, we will outline how we felt it was received and what the audience was like and how we interacted with them.

The workshop had the title "Measuring the Ocean – Ocean observations and our life."

The workshop was sponsored by the Graduate School of Science and the International Research Institute for Disaster Science, both at Tohoku University.

It was co-sponsored by the Sendai Headquarters of JMA and the Tohoku National Fisheries Research Institute.

It was supported by the boards of education for Miyago prefecture and Sendai City, and by the Oceanographic Society of Japan and the Meteorological Society of Japan.

The event took place on one day only in the Aoba Science Hall at Tohoku University, 09:30 to 15:00.

Presentations included four talks:

1) Robots measuring the world ocean – Howard Freeland, Argo Director
2) Ocean and climate/weather – ocean and our life – Tatsuo Nakamura, JMA
3) Gifts from the Ocean – Ocean ecosystems – Takeshi Okunishi – Tohoku Natl. Fisheries Res. Inst.
4) Demonstration of Argo Web Sites – Shigeki Hosoda, JAMTEC

We took a slow pace to the presentations and allowed lots of time for questions. The lunch break was between talks 3) and 4). After talk 4) we created an impromptu discussion panel. Suga-san did not present a talk; rather he served as an intermediary between the audience and the speakers regularly interjecting material to encourage spirited discussions. There was also time to see specimen floats, including one cut-away float, for children to play with Cartesian Divers, to see a display on a Gakken World Eye Projector (see photo below) and to engage with the speakers.

The audience was about 50 people. The event had been advertised through the local school boards, local newspapers and distributed posters. The audience was what one could call "eclectic". The age range was roughly 7 to 70. There were 10 teachers interested in using Argo for teaching purposes. There was considerable interest in demonstrations of the Argo Marine Atlas and I'd like to know if there was a spike in downloads immediately following the meeting. There were students of elementary school age, secondary school age and university students. Further there were random people off the streets in Sendai who were just keen to pursue their interest in the ocean.

Talks 2), 3) and 4) were all presented in Japanese. Howard Freeland prepared his talk 1) in English but when the content was finalised all text on all slides was translated into Japanese. I spoke in English but tried hard to keep the pace down and to use simple English. I have seen too many occasions when audiences are destroyed by what my Russian colleagues call "machine-gun English". Suga-san was available to translate if needed but, in fact, not much translation was needed. Care is required, but talks can be presented in a language that is not spoken by most of an audience.

The audience received several pieces of paper. One invited them to write questions that they might have for the final discussion panel. The other sheet requested feedback from the audience about the workshop, the responses were gratifyingly positive.

The first question from the audience. I think this 10-year-old young woman asked 8 questions! (top)

Emi's first question was "where can I get a Lego model of a float," I gave her my business card and asked her to send her street address and I'd send her a Lego float. This has been done. (left)

Students exploring Argo floats projected onto a Gakken World Eye. That was a very popular item. Also visible are two APEX floats, and two Cartesian divers. (left)

Tatsuo Nakamura (JMA) presenting (left)
Takeshi Okunishi (Fisheries Research Agency) presenting (middle)
Shigeki Hosoda presenting his guide to Argo web sites. (right)

Argo in Schools

www.argo.ucsd.edu/Argo_in_schools.html

Argo wants to showcase outreach efforts in schools around the world. Students are excited to learn about Argo floats, how they work and what they can tell us about the world ocean. Their enthusiasm can be seen in the different features below.

Sarah Gille — December 2015

Revelle College, which is one of the undergraduate colleges with UC San Diego, runs an Honors Seminar each quarter for high achievers among Revelle Freshmen. The theme for fall quarter 2015 was "Science and Society", with different guest presenters each week. In the final week (December 1), Sarah Gille brought along the Scripps demonstration version of a SOLO-II float (top right) to talk about the ocean, climate, and how we measure temperature changes in the ocean.

Carol Brieseman — November 2015

Carol Brieseman regularly discusses Argo floats in her classroom and wrote an article in New Zealand Science Teacher about how to incorporate science related to Argo in the classroom. Here is a picture of a student making a cartesian diver to explore buoyancy of floats (right).

The YouthMobile Initiative — October 2015

Within its YouthMobile Initiative, in 2015 UNESCO supported the organization of a YouthMobile Ocean App Competition between schools in the city of Oulu in Finland. Argo data and on-line resources were used by the competition to encourage students to interact with mobile App technologies and environmental sciences. The winning App, called "Aaro's Adventure" was conceptualized and designed by 17-year-old students from the Laanila High School, Oulu. The application concept, which was not fully implemented, in view of its complexity, aims at sensitizing people on the fragility and preservation of oceans. It consists of five different mini games in which the data from the world oceans' Argo buoys, reporting on the salt levels, temperatures and water pressures, are combined with other data sources in an attempt to stimulate the user in interactive activities, such as boat-fishing or garbage collection. With the help of this mobile app, students hope that "the spreading of information on the condition of the world oceans will be both informative and fun". Working at the design of this App, they said, "unites information technology, game design and open data resources for a more sustainable future on our planet".

The school competition was organized by the Arctic City of Oulu, in cooperation with the Finnish Meteorological Institute, to draw national and international attention to the unique sea area of the Baltic and the Arctic areas covered by sea and ice as climate change has a major impact on the Arctic region. The City of Oulu has challenged the six largest cities in Finland through shared development strategy (6Aika) to combine open data, marine ecosystems and sustainability.

UNESCO's YouthMobile Initiative aims at engaging young women and men to develop mobile apps and address issues linked to sustainable development, especially those related to poverty reduction, climate change and youth unemployment. http://en.unesco.org/youthmobile

Picture of the Grossmont high school students holding a float, taken by Nathalie Zilberman

If you want to contribute to this page, email **argo@ucsd.edu**

Dr. Zilberman — September 2015

Dr. Nathalie Zilberman visited a French high school class in Grossmont, CA during September 2015 (here is where Grossmont is located). Dr. Zilberman spoke to the French class about Argo floats and brought one in to demonstrate how a SOLO-II float worked.

New JCOMMOPS/Argo Website

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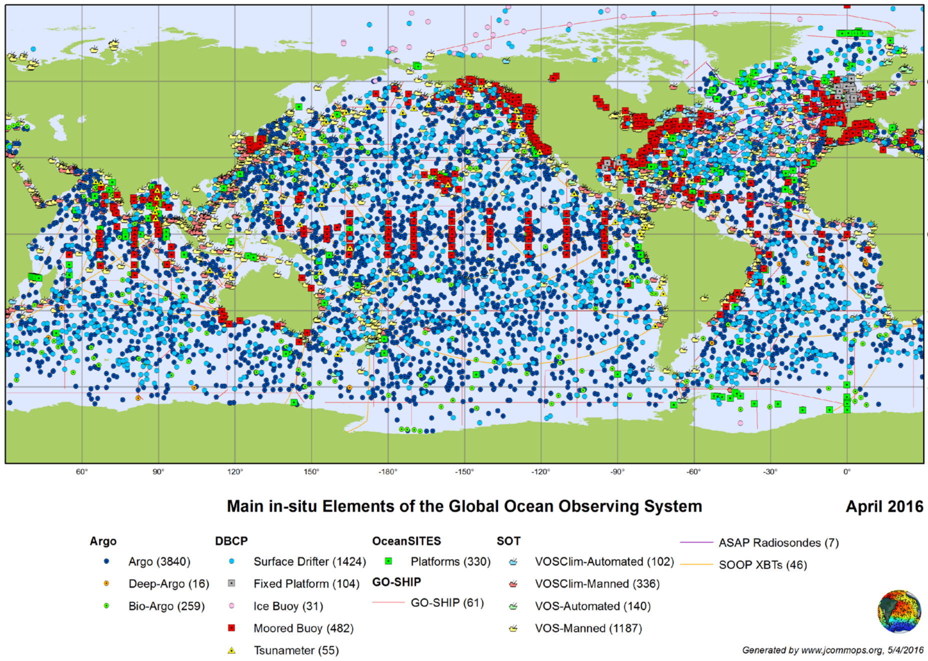

Fig1: JCOMMOPS view of the Global Ocean Observing System

The Joint WMO-IOC Technical Commission for Oceanography and Marine Meteorology in situ Observations Programme Support Centre (JCOMMOPS) is the monitoring and controlling centre of the ocean observing networks. Since 2001, JCOMMOPS manages about 10,000 ocean observing platforms such as, floats, buoys and ships equipped with instruments measuring the key ocean parameters for climate research and operational oceanography, in addition to satellites, contributing to the Global Ocean Observing System (Figure 1).

In March 2016, JCOMMOPS introduced its new website to the Argo community after many years of development. Improvements are made every day by two I.T. engineers under the Argo Technical Coordinator's direction. The new web system represents a big step forward for the integrated monitoring of the ocean observing networks. The main objective of the new website is to provide harmonized web based services for individual international programmes (Argo, DBCP, OceanSITES, SOT and GO-SHIP) and for an integrated perspective, through the same web application.

The website was originally designed as on-line software for network implementers taking into account, different users' needs and perspectives. In this context, before the website launched, JCOMMOPS asked key groups to participate in a survey with the aim of finalizing the new website based on their feedback and wish list. A new survey, based on the recent tool developments, is open to all users.

The new JCOMMOPS website is a real-time information system synchronized with the GTS, GDACs and satellite telecommunications data providers. Program managers, platform operators, data managers, and cruise operators, provide metadata directly on the website or through machine to machine mechanisms. The information system automatically updates the status of platforms and routinely controls and enriches the metadata set.

Operators can register and update their platforms and cruises in the system through different planning and editing interfaces (form, file loader, interactive map).

The core concept of the website is a dashboard fueled by platform samples and displaying different widgets (Figure 2) for maps, statistics, and metadata grids. When the user changes the platform sample, all widgets automatically update. The platform samples and preferred widgets can be saved in the preferences so that everyone can configure their own dashboard and switch from one sample to another at any time.

It is recommended to use Chrome or Firefox and open only one instance of the website in the same browser. If any issues arise, empty the cache, and close and reopen the browser.

After having selected the program of interest (Argo, DBCP, SOT, OceanSITES, GO-SHIP, or all through JCOMMOPS), the first step to use the website is to do a "search" on samples (floats mainly but also cruises, contacts or programs). The search can be done using different criteria based on Argo metadata including a constraint on observations available (space/time). Hence a sample of observation is always linked to a sample of platforms. Some interesting criteria allow intersecting platform locations within basins or maritime zone polygons through GIS processing.

Hence users can set up a permanent and real-time dashboard to monitor a specific group of platforms according to metadata or area of operation.

Once the sample is defined, user can explore the metadata through a grid and export its list. A number of analysis widgets can be open to exploit these metadata and provide many interactive charts in different categories: summary (overview of the sample through different grouping), implementation (statistics on deployments, growth of the sample in time), instrumentation (float performance),

Fig2: JCOMMOPS website dashboard

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and operations (critical ship used).

Charts and underlying data can also be easily exported in different formats.

A key widget is the interactive map (Figure 3a and b). The current float sample initializes the "Operational Layers" and displays four types of geographic information: deployment location, latest location, trajectory and individual observations. Each layer can be customized according to different symbols and metadata, and "pinned" in the work layers for further customization. A set of other layers is available for cruises, analysis maps (design, platform density, observations coverage) and common layers (maritime zone, basins, ports, ice extent, etc). Beyond classic zoom functions, the interactive map comes with a toolbox to change the projection, get information on layers, make selections, make intersections between points and polygons, make on-the-fly heat map calculations, and print.

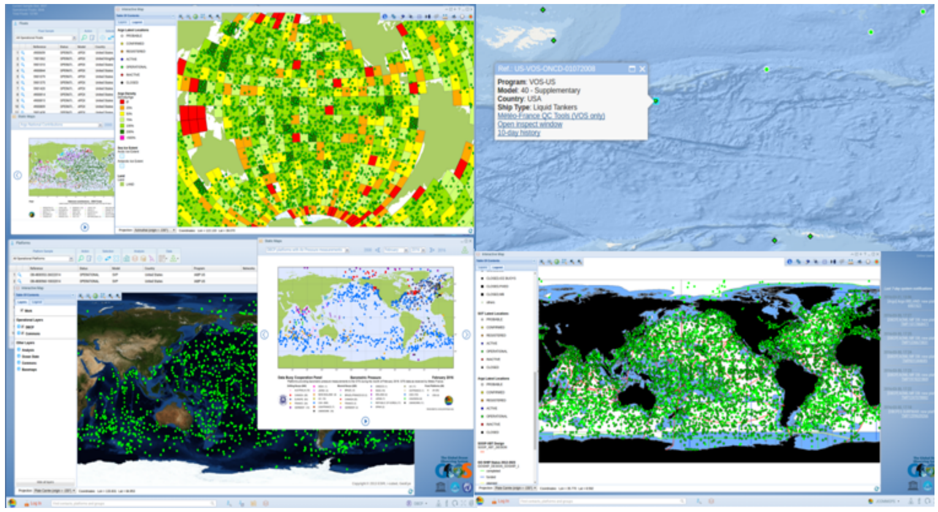

Fig3a: JCOMMOPS analysis snapshot

The interface is also made to facilitate and optimize deployment and cruise planning.

Finally, a "Metrics" module is available to present the performance indicators for Argo in various categories. Each metric shows the current percentage of the current year's or month's target along with a time series of the metric from 2000 to today. KPIs can be filtered by basin or network such as BioGeoChemical Argo. The system will automatically update all these indicators every month or year.

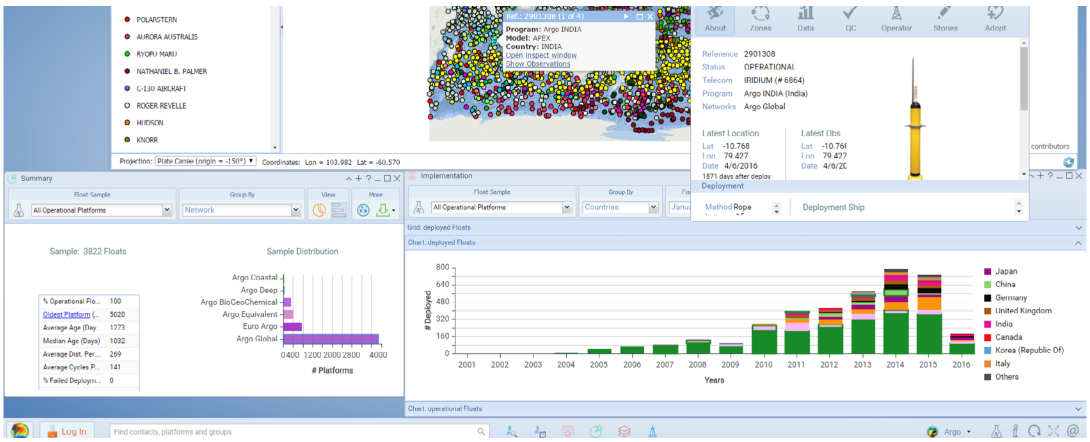

Fig3b: JCOMMOPS maps snapshot

Users will find easily the classic features proposed by JCOMMOPS websites including monthly maps (now automatically produced, with permalinks), key presentations, news, gallery, contact points and user groups details.

One of the last advanced services developed and included in the JCOMMOPS website is the new Warning System for maritime zones, to notify coastal states when Argo floats approach their Exclusive Economic Zone. The development and improvement of new tools and features, such as the QC feedback and performance indicator tools for all networks within JCOMM/GOOS and individual networks context, is also in preparation.

Lastly, JCOMMOPS will soon offer a mobile application (Figure 5) that will allow status checks on networks in real-time (if connected), registering deployment plans (from the ship using the GPS position and adding photos) and sharing marine meteorological observations.

Before the last official integrated website release, scheduled in the next months, JCOMMOPS encourages all Global Ocean Observing System players to look at the website and provide opinions and wish lists, in the dedicated section of the website, without forgetting that it is a very sophisticated engine and requires

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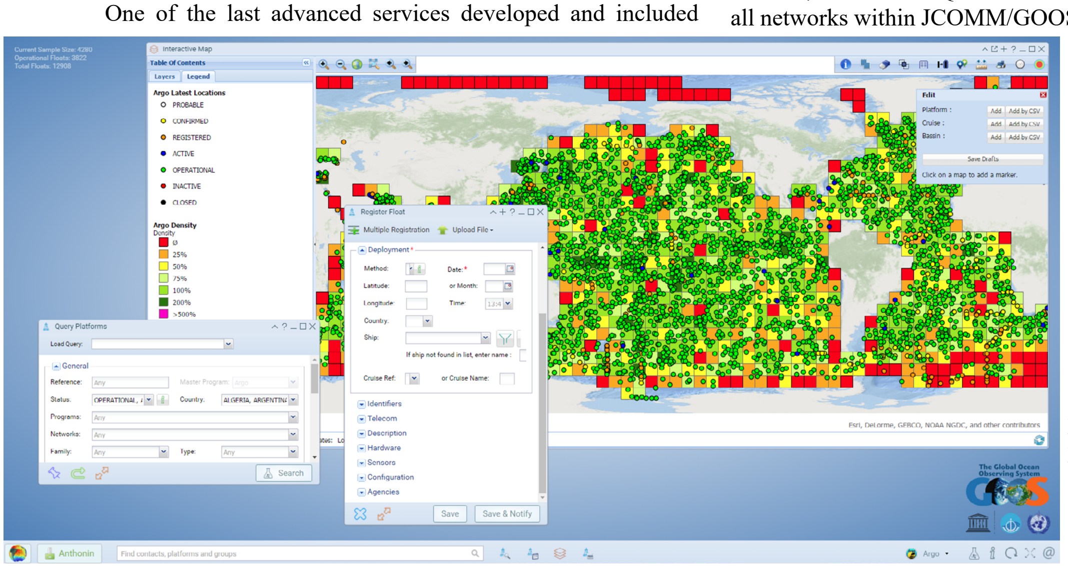

Fig4: JCOMMOPS register and deployment plans snapshot

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some experience and training from JCOMMOPS Technical Coordinators to discover its full capabilities.

The website is indeed original and seems complex at the first visit. JCOMMOPS is preparing a set of tutorials and short videos to facilitate its discovery and will keep on simplifying access to key features. In any case, the team can be contacted at support@jcommops.org and will be pleased to help.

The website offers all monitoring tools set up and tested in the last decade for Argo international coordination, and new ones. It will keep addressing the growing needs of large observing programmes like Argo. But the highest potential is when the integrated perspective will be finalized, which is not a simple task.

The website and its underlying information system is now ready to interact with the community, to build up the tools we will be using in the next decade, and also to share them beyond this interface through an API development.

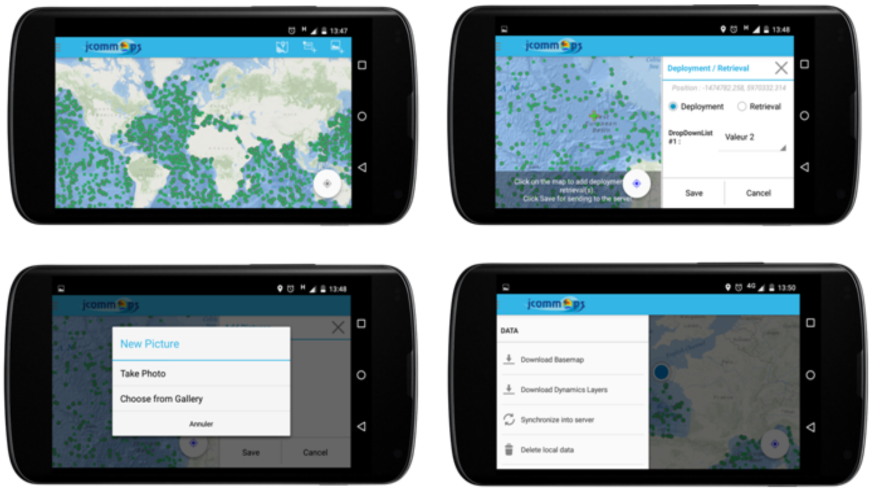

Fig5: JCOMMOPS Mobile application

ADMT-16 Meeting Highlights

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ADMT 16 was held in Bermuda in conjunction with a Bio-Argo meeting, in November 2015. Discussion was diverse but one theme was repeated over and over again. The DACs are struggling with the complexity of the data system and core activities such as DMQC are suffering because of the requirements of coding to produce version 3.1 files, handle ever increasing Biogeochemical data and variables, and maintaining the quality of the real time and delayed mode data.

Version 3.1 was designed so the Argo data system could handle floats with changing missions, manage near surface measurements and other variables that require a 'secondary' axis for pressure, and carry data from Argo extensions and in particular Biogeochemical Argo (BGC Argo). As a result of this, there can now be multi-profiles in one profile file and there is now an approval process for new BGC, Tech, Traj and Configuration parameters.

Progress on conversion to format version 3.1, however, is not consistent or complete, either across DACs or across file types. This is a difficult process and requires significant effort by all DACs. This has had a major impact on DQMC – all DACs are now between 12 and 18 months behind. The DACs have been working on this format conversion for more than 2 years, but as you can see from the table, the meta file conversion is 84% and the tech file conversion is 78%. For profile files in real time, some work has been done, but more is needed to reach V3.1. The majority of dmode profile files are in V3.1. Hopefully more progress will be made before ADMT17.

Creation of version 3.1 files has allowed more rigorous checking by the GDACs for file contents as well as formats. This relies on tables with well defined vocabularies for variables but table updates have been slow and relied on only one person. We have now identified two who will be responsible for each table, with the tables on line and edited only by these people. Each parameter or variable name will have a status associated with it indicating whether it is ready for use ('active') as opposed to under development. Updating of the file checker will hopefully be faster using this scheme and it is in the process of being implemented.

Several action items came out of the meeting. The Real Time data delivery had some problems and the ADMT proposed to investigate this by monitoring all TESAC and BUFR messages that arrive at various nodes during a specific time period. DACs will be asked to send lists of the messages submitted during that time period to identify any blockages in the system. Issues with BUFR formats have been solved by distribution of updated Perl scripts provided by Japan that convert version 3.1 files directly to BUFR.

The use of two-way communication and the delivery of BGC data have focused attention on the expansion of timing information now provided by the floats. It is now possible to decode a 'profile' of time for the core and Bio data, as well as increased 'sparse' time data within the cycle. The questions is whether there is a need to store and deliver this within the existing data system, whether this is necessary information for DMQC of variables or whether it can be stored only when a PI requests it. And if it is needed, where will it be stored?

The ADMT and AST concluded that this would probably not be useful for QC of core variables and so the profile of times would not be mandatory. Some BGC variables need this information and so it becomes optional and will reside in the B files with a new parameter name (to be defined) if a DAC reports it. Sparse data will be carried in the trajectory file.

Despite the complexities introduced by the expansion of BGC Argo, this has been a very useful collaboration, made easier because the BGC Argo meeting is held in conjunction with ADMT. The ADMT recommends this continue.

Finally, ADMT Co-Chair Ann Thresher will retire at the end of this year and Megan Scanderbeg has been selected to replace her. Megan was warmly welcomed by AST.

Profile netCDF files						
	R			D		
	V2	V3.0	V3.1	V2	V3.0	V3.1
Total	175863	220196	220595	305892	13010	666708
Progress%		36	36		1.3	68

File Version broken down by DAC
(20 Jul 2016)

Table 1

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	Trajectory (Core and B) netCDF files		Meta netCDF files		Tech netCDF files		
	R						
	V2	V3.1	V2	V3.1	V2	V3.0	V3.1
Total	4028	7776	1999	10467	1115	1504	9518
Progress%	66		84			12	78

Table 2

Timetable of Argo meetings		
2016-2017		
September 18 - 25, 2016	Qiangdao, China	CLIVAR
September 26 - 27, 2016	Tianjin, China	Biogeochemical Argo Meeting
September 28 - 30, 2016	Tianjin, China	Argo Data Management Team Meeting
November 2 - 13, 2016	San Diego, CA	PICES

Two PMEL Argo floats nestled in knitted cozies held by Falkor lead marine tech Leighton Rolley (left) and artist Michelle Schwengel-Regala (right)

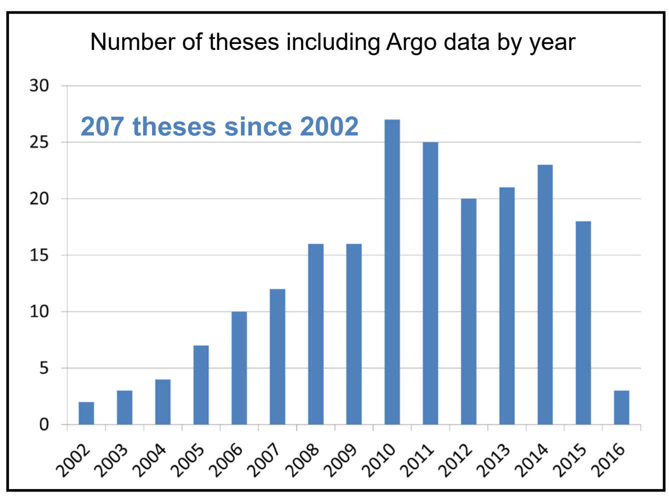
Photo credit: Schmidt Ocean Institute media journalist Monika Naranjo-Gonzales.

Thesis Citation List

To help show the use of Argo in higher education, the thesis citation list is now maintained and has over 200 doctorate theses using Argo data. This list is based on both database searches and contributions from AST members. There are helpful databases for the US, Canada and parts of Europe, but access to the entire dissertation is not always possible and some are in languages other than English, making it harder to verify Argo data usage. For most other areas of the world, it is important for AST members to contribute thesis citations directly to argo@ucsd.edu.

As can be seen in the graph, there is a decrease in thesis citations in recent years and it is thought to be due to a potentially long period of time for theses to reach the databases and even if they reach the database in a timely manner, sometimes there is a hold placed on the entire document for a year to allow time for publication of data. This makes it harder to determine if Argo data was used until the embargo is lifted.

Finally, if you have any citations to add to the list or any thesis database suggestions, please send them to argo@ucsd.edu.



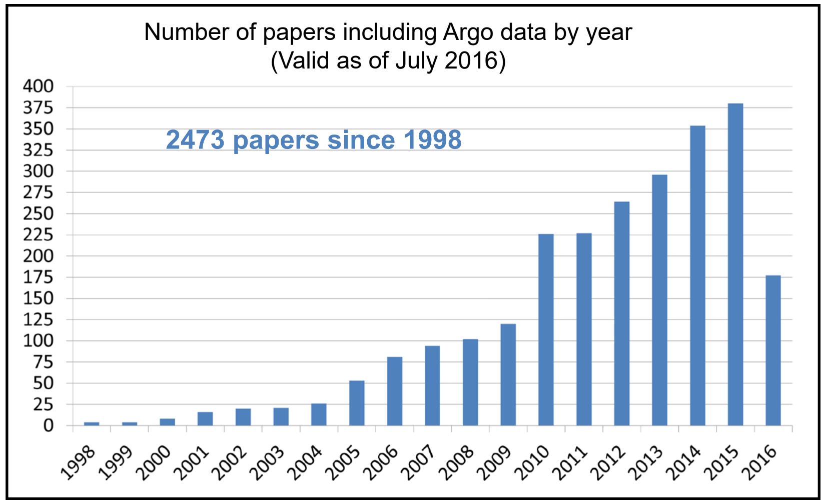
Bibliography Citation List

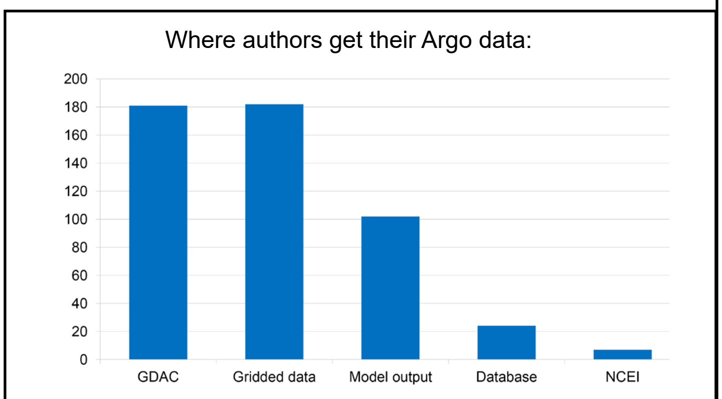
In 2015, 378 papers were published using Argo data – that is more than one a day! So far this year, the total number of Argo papers is 2,473. In addition, articles were published by first authors from three new countries in the past year: Argentina, Pakistan and Sri Lanka. The details can be found online at http://www.argo.ucsd.edu/Bibliography.html.

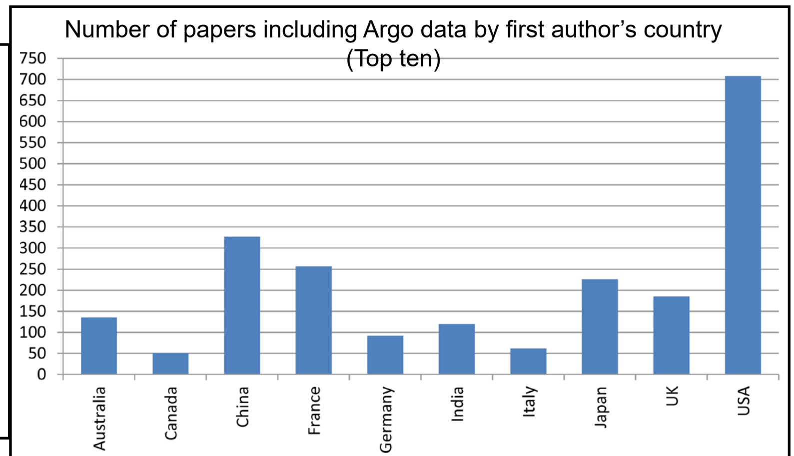
Starting in the past year, additional statistics on the bibliography have been tracked including how many papers are published by an Argo Principle Investigator, the Argo data source and DOI citations. Over the past year, about 25% of papers were published by an Argo PI. This was based on a list of scientists involved in Argo from six countries (Canada, China, France Germany, South Africa, USA) and on AST members from the additional countries. In terms of sources of Argo data used in papers, GDAC data and gridded fields are being used at roughly the same rate. At a lesser rate, model outputs are being used and only a very few papers are using internal databases or NCEI (formally NODC).

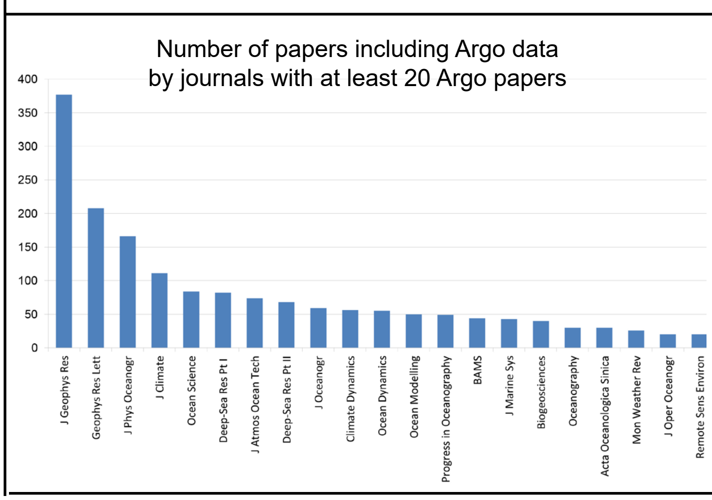
In terms of the Argo DOI, it has only been cited a handful of times, but several papers use the official Argo acknowledgement. See the Argo DOI article for updates on the move to a single DOI and how to cite it in papers. Finally, at the request of the Argo Steering Team, Argo papers will also be categorized by topic to see how and where the data are being used. In addition, special requests for subsets of citations can be created upon demand.

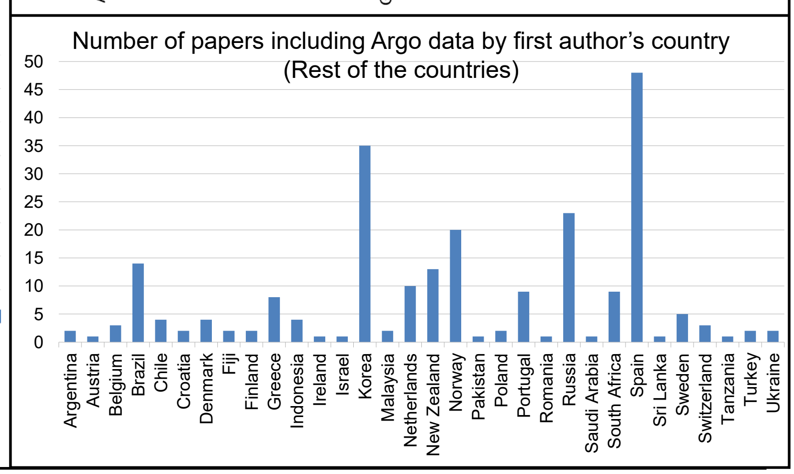
Earlier this year, the Argo review paper lead by S. Riser and H. Freeland was published in Nature Climate Change. Four other Argo articles were published in Nature Climate Change this year including Gleckler et al, Johnson et al, von Schukmann, et al and Wijffels et al.











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Information about Argo can be found at www.argo.ucsd.edu and from the Argo Information Centre at argo.jcommops.org. The AIC site includes information about the present and past distribution of Argo floats. Argo data may be downloaded from the Global Data Centers www.usgodae.org/argo/argo.html and www.ifremer.fr/coriolis/cdc/argo.htm