

Japan National Report

(Submitted by Toshio Suga)

1. The Status of implementation (major achievements and problems in 2014)

1.1 Floats deployed and their performance

The current positions of all the active Japanese Argo floats are shown in Fig.1.

Japan Agency for Marine-Earth Science and Technology (JAMSTEC) deployed 61 Argo and Argo equivalent floats from January to December 2014: 23 ARVOR, 30 Navis and 8 Deep NINJA floats. All the floats were deployed with the aid of R/Vs of 7 domestic organizations.

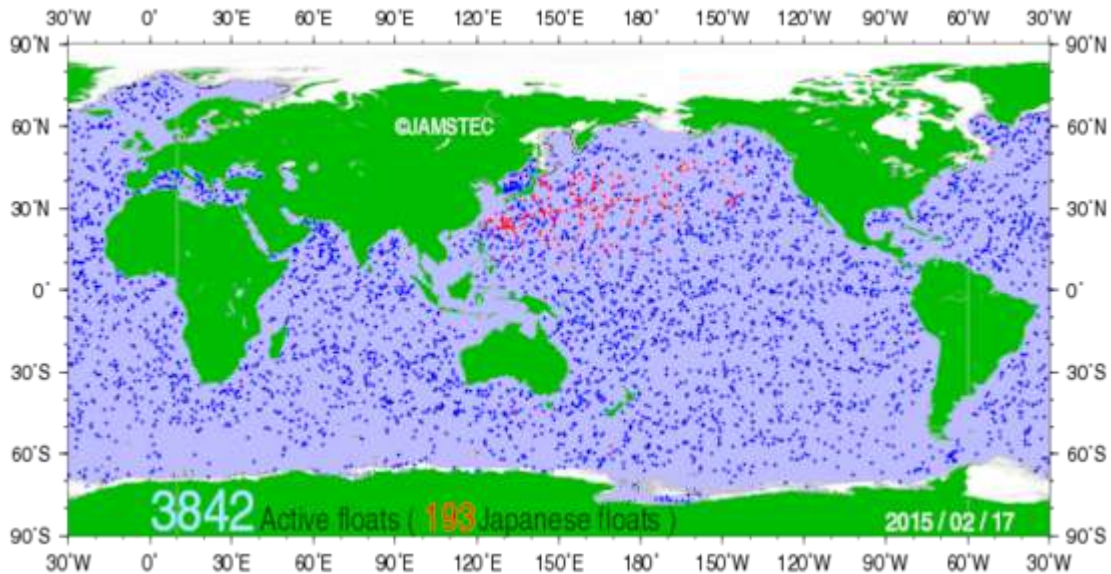


Figure 1: The distribution of active Argo floats. The red dots represent active Japanese floats.

While JAMSTEC planned to deploy one float by a voluntary cargo ship owned by a Japanese merchant ship company, NYK Line, during 2014, the deployment has not been done yet due to ship scheduling matter. The deployment will be done by the end of March 2015. The arrangement of the semi-regular float deployment by cargo ships was made under the cooperative relationship between JAMSTEC and NYK line, which was established in 2011 to increase float deployment opportunities. NYK Line has a lot of cargo shipping routes covering the global ocean, which is very useful to deploy Argo floats in the area of sparse float density. This is also part of environment conservation efforts of NYK Line through optimal routing owing to improvement of ocean current prediction that is benefitted from Argo.

From 1999 to the end of December 2014, JAMSTEC deployed 1076 (1109) Argo and Argo equivalent floats (the number in parenthesis includes floats deployed as non Argo floats; most of their data are to be released as Argo data later) in the Pacific, Indian and Southern Oceans: 739

(764) APEX, 141 (143) PROVOR, 104 (104) ARVOR, 33 (39) NEMO, 30 (30) Navis, 11 (11) NINJA, 12 (12) Deep NINJA and 6 (6) POPS floats. As of the end of December 2014, 152 (173) floats [7 (25) APEXs, 16(18) PROVORs, 90 (90) ARVORs, 29 (29) Naviss, 0 (1) NEMO, and 10 (10) Deep NINJAs] are in normal operation. The other 828 (862) floats terminated their missions, including 9 floats transmitting on the beaches after stranding or being captured by ships, 12 floats drifting at the sea surface and 10 floats recovered. JAMSTEC deployed 4 floats (Navis) in February 2015.

The Japan Meteorological Agency (JMA) deployed 26 Argo equivalent floats (26 APEX floats) in the seas around Japan from January to December 2014. All the floats get 2,000 dbar T/S profiles every 5 days for operational ocean analysis and forecast.

Among 192 floats (16 PROVORs, 149 APEXs and 27 ARVORs) which JMA has deployed from 2005 to 2014, 46 floats (46 APEXs) are active as of the end of December 2014, while 16 floats (7 APEX and 9 ARVOR floats) terminated the transmission in 2014. JMA deployed 6 APEX floats in January 2015.

A profiling float for deep ocean observation, Deep NINJA, was developed by JAMSTEC and Tsurumi Seiki Co. Ltd. and has been available for public since April 2013. In 2013/14 austral summer, seven Deep NINJA floats were deployed in two regions off the Antarctica (five off the Budd Coast by R/V Umitaka-maru in January 2014 and two off the Adelie Coast by Shirase in March 2014). In 2014/15 austral summer, one Deep NINJA was deployed off the Budd Coast. Four floats off the Antarctic coasts lost contact from the end of March 2014, probably due to sea ice extension there. Two floats survived Antarctic winter and resumed data transfer in February 2015. We confirmed that they have observed the Antarctic deep layer under sea ice throughout the winter. Recently, the data measured by these Deep NINJA floats have begun to be transferred to GDAC.

Okinawa Institute of Science and Technology Graduate University (OIST) has deployed 4 NEMO floats near Ishigaki Island and 1 NEMO float near Ogasawara Islands as Argo equivalent floats during 2014. The floats deployed near Ishigaki Island measure P, T, and S from 1000 dbar to surface every 30 days, and the float deployed near Ogasawara Islands measure P, T, and S from 1000 dbar to surface every 3days.

1.1.1 Floats deployment for synchronous array observation

JAMSTEC also deployed 7 NAVIS floats along 170W line in the central North Pacific to observe formation and dissipation process of central mode water (CMW). Since the formation region of CMW is to be under strong influence of PDO activity and corresponds to one of important regions for monitoring decadal heat content change by Argo floats (Masuda and Hosoda, 2014), the goal of the observation is to understand effects of variation in Aleutian low, quantifying contribution of CMW on decadal heat content change. Also, it will contribute to understanding of the role of CMW on dynamics of ocean circulation and its variability. The arrayed 7 NAVISs synchronize sampling interval and use deeper parking depth to minimize drift, which were deployed every 2.5 degrees in meridional direction observing from a depth of 2000m to the surface every 10 days. After the deployment in August, the array observation is ongoing through this winter season when mixed layer is deepened, although some NAVIS floats suffered technical trouble and then became uncontrollable.

1.2 Technical problems encountered and solved

1.2.1 Float hardware troubles

Fifty five APEX floats equipped with alkaline batteries, purchased by JAMSTEC in 2010 and 2011 (52 APEX floats) and by JMA in 2008 (15 APEX floats), had terminated their missions before 100 cycles, which were clearly shorter than the specification (150 cycles). The manufacturer,

Teledyne Webb research inc., reported that the trouble was probably caused by energy flu because of troubles in some battery cells. While the manufacturer recommended us to use lithium batteries for future purchasing float to avoid energy flu, JAMSTEC asked further investigation and information for this problem. However, they have not provided any comments yet.

JAMSTEC also purchased 65 PROVOR manufactured by nke instrumentation in FY2009 but suffered some hardware/software troubles on the almost all of the PROVORs. Since the troubles were due to multiple causes such as pump, sensor and software, then we stopped to deploy for a while and influenced to our deployment plan, which had been reported previously. Although the floats were repaired and took back until 2011, 14 of them terminated data transmission within 20 cycles, which is far shorter than expected lifetime (150 cycles). Also, 51 Arvors were purchased in FY2012 and FY2013 but 14 of 65 Arvors terminated data transmission within 20 cycles. Since the two situations are very similar, JAMSTEC asked further information and report on cause of trouble to nke. However, the cause is still unknown.

1.2.2 Deep Ninja and Rinko sensor on S3A

It is worth to report a salinity bias found in Deep NINJA measurements. Comparisons with shipboard CTD measurements showed that float salinity is less saline at deeper depth besides having a constant bias, which means the bias possibly depends on pressure linearly. The pressure dependency of the bias was verified in all of the 11 floats in which the CTD measurements at float deployment were available for the comparison. And in some cases, the pressure dependency was changed in time.

Dissolved oxygen derived from the first profile of S3A floats were compared with high-quality shipboard CTD and discrete water sampled data obtained at deployment of the S3A floats. The first oxygen profiles from the S3A were quite similar between the two floats (Fig. 2). Also, the oxygen profiles from the S3A represent relatively small scale vertical oxygen structure such as subsurface minimum and maximum near the surface (Fig. 2a). Time difference between the first profile of S3A and the shipboard CTD profile was about 12 hours. Since a depth of the pycnocline (and also oxycline) may change largely in time due to mesoscale variability, the oxygen profiles were compared on the same density surface (Fig. 2b). However, dissolved oxygen from the S3A was slightly smaller than the discrete water sampled data (Fig. 3). The comparison shows that a span correction is appropriate for the S3A RINKO sensors. The correction factor was estimated to be 1.035 for the two S3A RINKO sensors. Standard deviation of the difference between the S3A and the discrete water sampled Winkler data was about 4 $\mu\text{mol/kg}$.

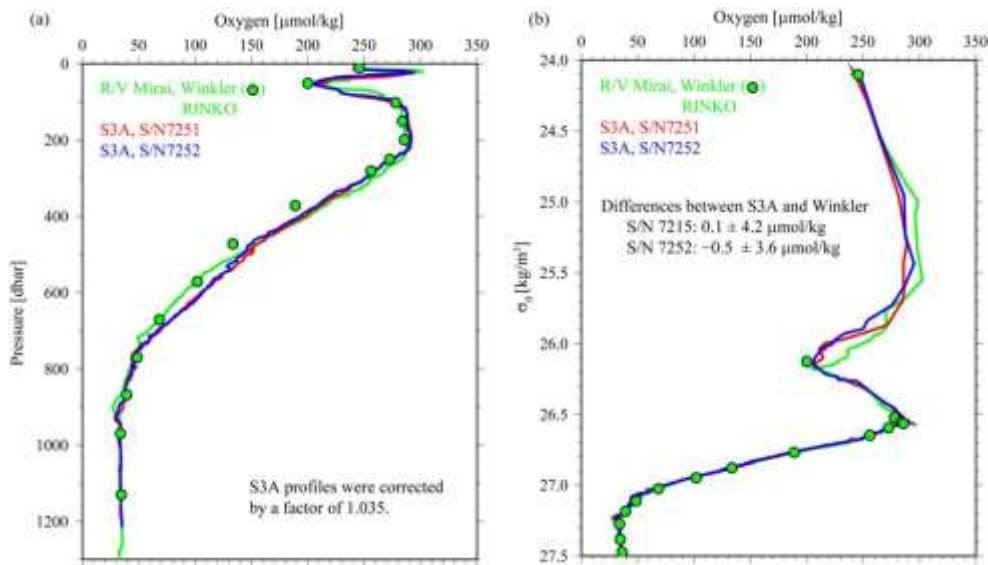


Figure 2. Comparison of dissolved oxygen profile derived from S3A and high-quality shipboard CTD measurements plotted against (a) pressure and (b) potential density (σ_θ). The S3A data were corrected by a factor of 1.035 to correspond with the discrete sampled Winkler data.

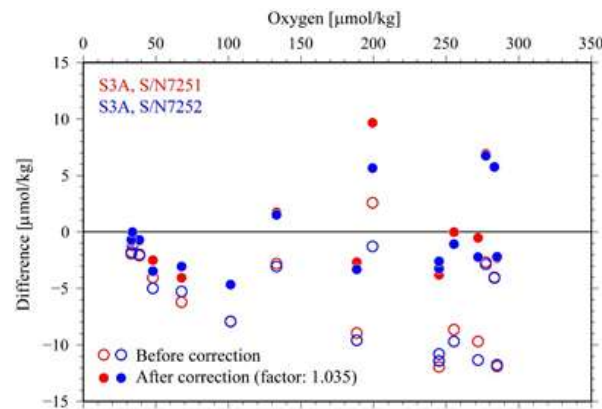


Figure 3. Difference between the S3A oxygen and the discrete sampled Winkler data. The S3A oxygen data were interpolated onto the same potential density as the Winkler data for comparison. Mean with standard deviation of the difference after correction of the S3A was $0.1 \pm 4.2 \mu\text{mol/kg}$ and $-0.5 \pm 3.6 \mu\text{mol/kg}$ for S/N 7251 and 7252, respectively.

1.3 Status of contributions to Argo data management

The Japan DAC, JMA has operationally processed data from all the Japanese Argo and Argo-equivalent floats including 193 active floats as of February 15, 2015. Ten Japanese PIs agree to provide data to the international Argo. All the profiles from those floats are transmitted to GDACs in the netCDF format and are also issued to GTS using the TESAC and BUFR codes after real-time QC on an operational basis. Argo BUFR messages have been put on GTS since May 2007.

Note that the addresses of following web pages have been changed due to the address change of the JMA website last fall.

JAPAN ARGO Real Time Data Base : <http://ds.data.jma.go.jp/gmd/argo/data/index.html>

Float Status : <http://ds.data.jma.go.jp/gmd/argo/data/status/statusE.html>

1.4 Status of delayed mode quality control process

JAMSTEC has submitted the delayed-mode QCed data of 95,423 profiles to GDACs as of December 2014.

JAMSTEC will have converted D-profile files of Japanese ARGOS floats and meta-files of our ARGOS floats from v2 to v3.1 by the end of March 2015.

2. Present level of and future prospects for national funding for Argo including a summary of the level of human resources devoted to Argo.

Japan Argo had been conducted in a 5-year program from FY1999 to FY2004, as a part of Millennium Project implemented under cooperation among the Ministry of Education, Culture, Sports, Science and Technology (operation: by JAMSTEC), the Ministry of Land, Infrastructure and Transport, JMA and Japan Coast Guard. After the Millennium Project terminated in March 2005, JAMSTEC has continued the operation until FY2013 nearly in the same scale (about 80 floats to be deployed every year and associated delayed-mode data management) under its two consecutive mid-term programs for FY2004-2008 and FY2009-2013. JAMSTEC continues the operation but in the scale somewhat lower than ever before (less than 50 floats to be deployed every year with delayed-mode data management) under its new mid-term program FY2014-2018. In FY2015, since their fund for research activity including Argo is cut >20% based on the fund in FY2014, the number of deployment/purchase of Argo floats should decrease. Due to this budgetary situation, the number of technical staff devoting for delayed mode QC and PARC will decrease from 5 to 4 after FY 2015. Additional research fund for enhancement of Argo, including competitive research funding, should be sought. JMA allocates operational budget for 27 floats every fiscal year.

3. Summary of deployment plans (level of commitment, areas of float deployment) and other commitments to Argo (data management) for the upcoming year and beyond where possible.

In FY 2015, JAMSTEC will deploy about 23 floats in total in the North Pacific and Indian Oceans for the Argo core mission. The main purposes of deployment is to fill the blank of 3x3 degree bins in the global Argo array. Two to four Deep Argo floats will be deployed as Argo equivalent floats in FY2015 mainly in the Indian Ocean. To investigate response of physical/biogeochemical oceanic processes to explosive cyclones, four NAVIS floats with CTD sensor (SBE Inc.) will be deployed as Argo equivalent floats along winter-time storm track in the western North Pacific, based on competitive research funding. Since several Japanese scientists are applying for competitive research funding to purchase Argo floats, deep floats and bio Argo floats, the number of floats to be deployed in FY2015 may be increased.

JMA plans to deploy 27 Argo equivalent floats around Japan in FY2015 and in the coming years. All the JMA floats are identical with the core Argo floats except that they are operated in a 5-day cycle, synchronized with JMA's real-time ocean data assimilation and forecast system.

JMA continues serving as the Japan DAC. JAMSTEC continues running the Pacific Argo Regional Center for the upcoming year.

4. Summary of national research and operational uses of Argo data as well as contributions to Argo Regional Centers.

Many groups in JAMSTEC, JMA, FRA and Japanese universities are using Argo data for oceanographic researches on water mass formation and transport in the Pacific Ocean, the mid-depth circulation, the mixed layer variation, the barrier layer variation, and tropical atmosphere-ocean interaction in the Pacific and Indian Ocean and so on. Japanese fisheries research community is conducting their biogeochemical studies using Argo floats equipped with chlorophyll and/or oxygen sensors.

The global Argo TESAC messages are used for operational ocean analysis and forecast by JMA. Daily and monthly products of subsurface temperatures and currents for the seas around Japan and western North Pacific, based on the output of the real-time ocean data assimilation system (MOVE/MRI.COM-WNP), are distributed through the JMA web site (in Japanese). Numerical outputs of the system are available from the NEAR-GOOS Regional Real Time Data Base (<http://ds.data.jma.go.jp/gmd/goos/data/database.html>) operated by JMA. Monthly diagnosis and outlook of El Nino-Southern Oscillation based on the outputs of the Ocean Data Assimilation System and the El Nino Prediction System (an ocean-atmosphere coupled model) are also operationally distributed through the JMA web site (in Japanese) and the Tokyo Climate Center (TCC) web site (<http://ds.data.jma.go.jp/tcc/tcc/products/elnino/>). JMA has introduced the ocean-atmosphere coupled model, which is the same as that for El Nino prediction, into seasonal forecast of climate in Japan since February 2010. The model products for seasonal forecast are available from the TCC web site (<http://ds.data.jma.go.jp/tcc/tcc/products/model/>).

JAMSTEC is providing a variety of products including objectively mapped temperature and salinity field data (Grid Point Value of the Monthly Objective Analysis using Argo float data: MOAA-GPV: http://www.jamstec.go.jp/ARGO/argo_web/MapQ/Mapdataset_e.html), objectively mapped velocity field data based on YoMaHa'07 (version September 2010) (http://www.jamstec.go.jp/ARGO/argo_web/G-YoMaHa/index_e.html), and gridded mixed layer depth with its related parameters (Mixed Layer data set of Argo, Grid Point Value: MILA-GPV http://www.jamstec.go.jp/ARGO/argo_web/MILAGPV/index_e.html). JAMSTEC have released Argo temperature and salinity profile data put through more advanced automatic checks than real-time quality controls (Advanced automatic QC Argo Data version 1) since October 2014. We add our own new flag to real time profile data which tells whether it passed each check or not. Users can select profiles even if they have bad flags of our checks. The dataset is provided not only netcdf but also ascii formats for users who are unfamiliar with netcdf format. JAMSTEC has also provided scientifically quality controlled data of Deep NINJA for convenient use on scientific or educational purposes (<http://www.jamstec.go.jp/ARGO/deepninja/>). The QC is based on comparisons with high accurate shipboard CTD observations conducted nearby float observations.

JAMSTEC is also providing information about consistency check of float data related to delayed-mode QC for the Pacific Argo Regional Center (PARC) web site as a main contributor. JAMSTEC will support the activities of the Southern Ocean ARC (SOARC) in the Pacific sector.

ESTOC (Estimated state of ocean for climate research) is a JAMSTEC product; an integrated dataset of ocean observations including Argo data by using a four dimensional variational (4D-VAR) data assimilation approach. ESTOC is the open data that consists of not only physical but also biogeochemical parameters for 55 years during 1957-2011 (See the web site in JAMSTEC, <http://www.godac.jamstec.go.jp/estoc/e/top/>).

JCOPE2 (Japan Coastal Ocean Predictability Experiment 2) is the model for prediction of the oceanic variation around Japan which is operated by Application Laboratory of JAMSTEC. JCOPE2 is the second version of JCOPE1, developed with enhanced model and data assimilation

schemes. The Argo data are used by way of GTSP. The reanalysis data 20 years back and the forecast data 2 months ahead are disclosed on the following web site: <http://www.jamstec.go.jp/frcgc/jcope/>. More information are shown in

http://www.jamstec.go.jp/frcgc/jcope/htdocs/jcope_system_description.html.

FRA-ROMS is the nowcast and forecast system for the Western North Pacific Ocean developed by Fisheries Research Agency (FRA) based on the Regional Ocean Modeling System (ROMS). Instead of FRA-JCOPE, which was the previous system of providing the hydrographic forecast information around Japan, FRA started the FRA-ROMS operation in May 2012. Argo has been one of important sources of in-situ data for the FRA-ROMS data assimilation system. The forecast oceanographic fields are provided every week on the website <http://fm.dc.affrc.go.jp/fra-roms/index.html/>.

5. Issues that our country wishes to be considered and resolved by the Argo Steering Team regarding the international operation of Argo.

As reported in 2011, EEZ clearance procedure for Argo float deployed by Japanese PIs has been simplified following IOC Resolution XLI-4. This change reduced our time and effort for the process of EEZ clearance significantly. However, the traditional EEZ clearance is still needed for some key countries because Argo national focal points (NFPs) of those countries are not registered on the listed at AIC. Since the procedure following IOC Resolution XLI-4 is applied only to the coastal nations whose Argo NFP is registered. Japan Argo has a strong desire for NFPs especially of nations in and around the Pacific Ocean to be registered to facilitate more timely and optimal deployment of Argo floats. This could be also helpful for smooth implementation of any future extension of Argo.

6. Summary of the number and location of CTD cruise data to the CCHDO website.

Data of 710 CTD casts conducted by JMA in the western North Pacific from January 2013 to January 2014 were uploaded to the CCHDO website.

7. Argo bibliography

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