Japan National Report

(Submitted by Toshio Suga)

1. The Status of implementation (major achievements and problems in 2012)

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 58 Argo and Argo equivalent floats from January to December 2012: 5 APEXs, 14 PROVORs, 38 ARVORs and1 NEMO. All the floats were deployed with the aid of R/Vs of 10 domestic organizations.

One NEMO float was deployed near the northwest coast of Papua New Guinea in order to make quasi stationary observation of New Ireland Coastal Undercurrent (NICU) in August 2012, as part of the JAMSTEC contribution to CLIVAR/SPICE. The float used the Iridium transmitter, measuring temperature and salinity, and was supposed to stay in the NICU for a long time by controlling parking depth in the NICU and the opposite flow just below it. Unfortunately, the float observed two profiles and then stopped communication due to technical failures.

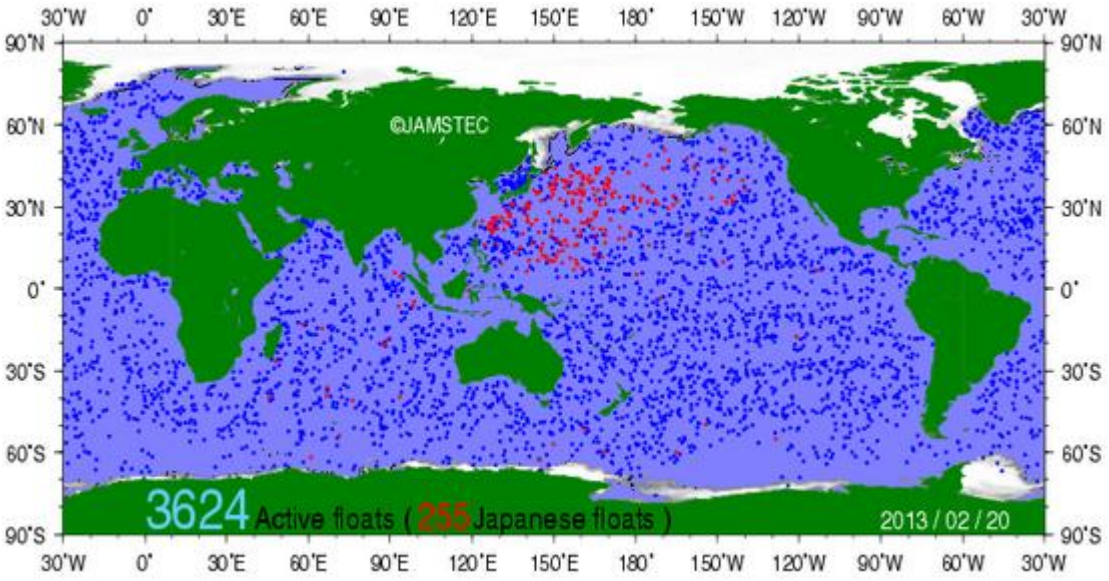

Figure 1: The distribution of active Argo floats. The red dots represent active Japanese floats.

Four floats were deployed voluntarily from cargo ships owned by a Japanese merchant ship company (NYK Line) in 2012. In order to increase float deployment opportunity, JAMSTEC has developed cooperative relationship with NYK Line, which has a lot of cargo shipping routes covering the global ocean from 2011. This wide coverage is very useful to deploy Argo floats in the area of sparse float density. This deployment opportunity contributes to not only maintain the global Argo array, but also environment conservation efforts of merchant ship companies through optimal routing owing to improvement of ocean current prediction.

Among JAMSTEC's 990 Argo and Argo equivalent floats (756 APEXs, 143 PROVORs, 38

ARVORs, 36 NEMOs, 11 NINJAs, and 6 POPSs) deployed in the Pacific, Indian and Southern Oceans, from 1999 to the end of January 2013, 198 floats (112 APEXs, 43 PROVORs, 37 ARVORs, and6 NEMOs) are now in normal operation. The other 792 floats (644 APEXs, 100 PROVORs, 1 ARVOR, 30 NEMO, 11 NINJAs, and 6 POPSs) terminated their missions, including 15 floats transmitting on the beaches after stranding or being captured by ships, 12 floats drifting at the sea surface and 16 floats recovered.

The Japan Meteorological Agency (JMA) deployed 27 Argo equivalent floats (27APEXs) in the seas around Japan from January to December 2012. All the floats get 2,000 dbar T/S profiles every 5 days for operational ocean analysis and forecast.

Among 141 floats (16 PROVORs, 98 APEXs and 27 ARVORs) which JMA has deployed from 2005 to 2012, 52 floats (31 APEXs and 21 ARVORs) are active as of the end of December 2012, while 17 floats (15 APEXs and 2 ARVORs) terminated the transmission in 2012. JMA deployed 3 APEXs in January 2013.

All of 9 floats deployed by the Fisheries Research Agency (FRA) in 2005 and 2008 terminated their missions by mid 2011. FRA conducted research survey using a Slocum glider (1-km model; manufactured by Webb Research) and a Sea Glider (manufacturerd by i-Robot inc.) in the Kuroshio-Oyashio mixed water region in the North Pacific in 2012. The Sea glider was successfully operated for about two months, and measured detailed vertical structures of temperature and salinity above1000 m.

1.1.1 Floats deployed as part of INBOX

Besides 58 floats deployed in 2012 as reported above, JAMSTEC deployed 13APEX floats and one NEMO float equipped with dissolved-oxygen sensors (Aanderaa Optode4330) byl December 2012. The deployment was done as part of Western North Pacific **IN**tegrated Physical-**B**iogeochemical Ocean **O**bservation E**x**periment (INBOX); its purpose is to investigate physical-biogeochemical processes associated with mesoscale variability by constructing an integrated physical and biogeochemical ocean observation system in collaboration with ship, satellites and/or mooring observations. The floats measure temperature, salinity and dissolved oxygen from surface to 2000 dbar, telecommunicating by iridium transmitter. Two target areas are set: one is around the biogeochemical observation mooring site S1 (30N, 145E) maintained by JAMSTEC where 25 oxygen floats were deployed in 2011 in a square area of 150 km x 150 km with 30 km of horizontal resolution, synchronizing every 2 days; another is warm core mesoscale eddies in Kuroshio-Oyashio mixed water region (Left panel of Fig. 2).

Around S1, two floats (APEX) were sequentially deployed to extend time series data around S1 with high temporal and vertical density. The obtained data were analyzed with mooring, ship and satellite data to clarify the relationship between mesoscale physical process and bio-geochemical process.

In the warm core eddies, 12 (11 APEXs and one NEMO) floats were deployed in two cruises (Right panel of Fig. 2). First deployment for the eddy observation was done around the eastern warm core eddy off southeastward of Hokkaido (42 N, 147 E); 8 floats were deployed in June 2012. Second was around the western warm core eddy off south of Hokkaido (41 N, 144 E); 4 floats were deployed in September 2012. In each of the two observations, some surface drifters were also deployed, and high-quality ship observation for temperature, salinity and dissolved oxygen (CTDO) were carried out.

JAMSTEC conducted pre-deployment calibration of the Optode4330 sensors in the laboratory. With the pre-deployment calibration along with the comparison with shipboard CTDO observation, the accuracy of dissolved oxygen data will be greatly improved. Data from the INBOX floats will be opened with delayed-mode calibration after completion of dissolved oxygen calibration within 2 years from the deployment.

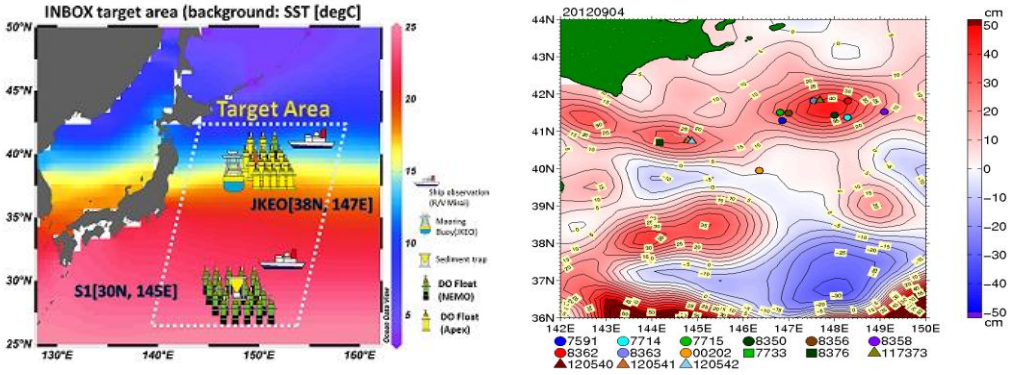

Figure 2. (Left panel) Study area of INBOX. In 2011 and 2012, 25 floats with Optode3830 and 2 floats with Optode4330 were deployed respectively around the S1 mooring site (30N, 145E) in the Kuroshio recirculation gyre. In 2012, 14 floats with Optode4330 were deployed in the Kuroshio-Oyashio mixed water region to study physical-biogeochemical processes associated with mesoscale eddy. (Right panel) Locations of the floats on September 4, 2012. Background colors and contours show the sea surface height anomaly based on the merged altimeter satellite product distributed by AVISO (http://www.aviso.oceanobs.com).

1.2 Technical problems encountered and solved

A lot of APEX floats equipped with alkaline batteries, purchased by JAMSTEC in 2010 and 2011 and by JMA in 2008, terminated their missions within 70 cycles. The life time as Argo floats were clearly shorter than the specification (150 cycles). The manufacturer, Webb research inc., reported that the trouble is probably caused by energy flu. That is, the battery voltage of those floats rapidly decreased because some of the battery cells were gradually broken. While they recommended us to use lithium batteries to avoid energy flu, JAMSTEC requires further investigation for this problem.

Among the 73 APEX floats with APF9 controllers deployed by Japan before the SBE41 and 41cp recall due to micro-leak problem, 8 floats have the negative surface pressure drift larger than -2.4 dbar. Among these floats, 4 floats have the extreme negative surface pressure drift, exceeding -10 dbar. The floats recalled or those purchased after the problem was fixed have either a Kistler pressure or a Druck pressure sensor. Both pressure sensors show little drift.

Tsurumi Seiki Co. and JAMSTEC have developed a new profiling float for deep ocean, “Deep NINJA”, which has an ability to measure PTS profiles at the depth of up to 4000 dbar. After a field test in the Japan Sea with R/V Natsushima in May 2012, the field test for deep ocean observation was carried out with 2 prototypes in August-October 2012. Both of them made a success of PTS profiling from the depth of 4000 dbar. However, communication has been lost with one float since the first ascending, probably due to a trouble of its communication module. The other ceased its operation in November. In December 2012, 4 Deep NINJAs were deployed in the Southern Ocean (3 off the Adelie Coast and one in the south of New Zealand) at R/V Mirai cruise to observe variations of Antarctic Bottom Water. All of them have operated well until now. The data measured by Deep NINJAs have not been circulated on the Argo data stream yet, because documents describing its data format is not ready. The data circulation is planned to begin in April 2013. Deep NINJA will be available for public in 2013.

JAMSTEC and JMA suffered again severe experiences of Iridium telecommunication trouble of floats in 2012. The troubles occurred in both dial up type service for APEX. As to the trouble of the dial up type service, telecommunication was stopped several times in one year. Although all the observed data during the troubles could be finally obtained owing to the data logging in the floats, mission commands could not be sent to the floats during the troubles. The trouble during our

INBOX eddy observation caused floats diverging from the eddy to the outside due to long surface-drifting time. JAMSTEC and JMA have been asking for examination of the troubles to Japanese agent of Iridium telecommunication system.

As reported in 2011, EEZ clearance procedure for Argo float deployed by Japanese PIs was changed following IOC Resolution XLI-4, and now in operation in 2012. This change reduced our time and effort for the process of EEZ clearance. However, the EEZ clearance still needs in some key countries because Argo national focal points (NFPs) of those countries are not listed in AIC. Since the procedure in Japan is applied to only the coastal nations whose Argo NFP is registered (listed in AIC) . Japan Argo community has a strong desire for more countries, especially in/around the Pacific Ocean, to register their NFPs.

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 255 active floats as of February 6, 2013. 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 excluding NOVA float of OIST, which has not been determined WMO instrument code yet. Argo BUFR messages have been put on GTS since May 2007.

1.4 Status of delayed mode quality control process

JAMSTEC has submitted the delayed-mode QCed data of 83,652 profiles to GDACs as of December 2012. Among these data, 6,803 profiles were provided within a year.

As of December 2012, according to the new definition of APEX Truncated Negative Pressure Drift decided at the 12th Argo Data Management Team Meeting, JAMSTEC is still re-creating D files for some APEX floats.

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 continued the operation until FY2008 nearly in the same scale (about 80 floats to be deployed every year) under its mid-term program. While new mid-term program for FY2009-2013 started in April 2009, JAMSTEC has been trying to continue the operation nearly in the same scale as part of its research activity. 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 FY2013, it has been proposed that JAMSTEC will deploy about 70 floats in total in the Pacific Ocean for the Argo core mission. Three EM-APEX will be deployed near the Kuroshio Extension as part of INBOX. Some Deep-NINJA, which JAMSTEC and Tsurumi-Seiki Co. Ltd. are planned to be deployed in the Southern Ocean in 2013. Two POPSs are planned to be deployed as an Argo equivalent float near the North Pole in April 2013. These POPSs are equipped with NOVA. Three NEMO-Iridium float is planned to be deployed as Argo equivalent float. It will be deployed in the western tropical Pacific Ocean to investigate surface ocean variations associated with atmosphere-ocean interaction. JMA plans to deploy 27 Argo equivalent floats around Japan in FY2013 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. University of Tokyo will deploy two Chl-a/DO APEXs in the Kuroshio-Oyashio mixed water region to investigate physical-biogeochemical processes in blooming period, collaborating with JAMSTEC.

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://goos.kishou.go.jp/) 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 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.

JCOPE2 (Japan Coastal Ocean Predictability Experiment 2) is the model for prediction of the oceanic variation around Japan which is operated by Research Institute for Global Change of JAMSTEC. JCOPE2 is the second version of JCOPE1, developed with enhanced model and data assimilation schemes. The Argo data is used by way of GTSPP. 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. Summary of the number and location of CTD cruise data to the CCHDO website.

Data of 935 CTD casts conducted by JMA in the western North Pacific from January to December 2012 were uploaded to the CCHDO website.

6. Argo bibliography

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