

Japan National Report (Submitted by Toshio Suga)

1. The Status of implementation (major achievements and problems in 2011)

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 84 floats from January to December 2011: 30 APEXs, 52 PROVORs, 1 NEMO and 1 POPS (Polar Ocean Profiling System). All the floats except POPS were deployed with the aid of R/Vs of 9 domestic organizations.

POPS is an ice-based drifting buoy with a PROVOR float moving up and down along a 580m cable. The observed data (temperature-salinity profiles of every day, hourly GPS position, atmospheric temperature and pressure) are transmitted to Iridium Satellites and distributed to GTS via JMA. One POPS was deployed in the Arctic Sea in April 2011. Unfortunately, this POPS terminated the mission in August 2011. Another POPS with NOVA is planned to be deployed near the North Pole in April 2012.

One NEMO float was deployed in the tropical Indian Ocean in September 2011 in order to investigate oceanic mixed layer structure and tropical air-sea interaction, as part of Cooperative Indian Ocean Experiment on intraseasonal variability in the year 2011 (CINDY2011). The float uses the Iridium transmitter, measuring temperature and salinity from 500 dbar depth to the sea surface every day.

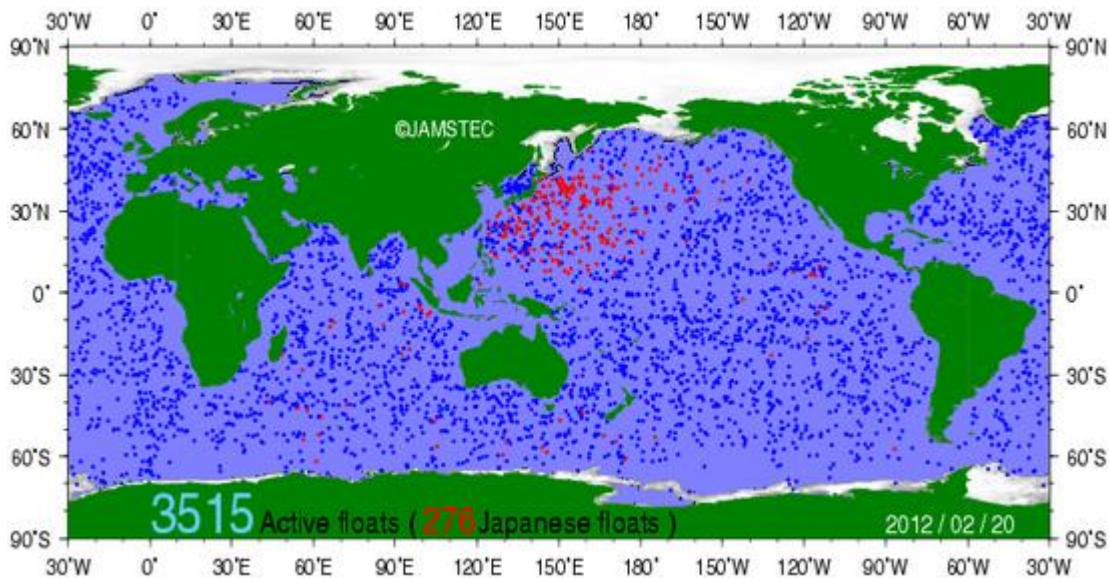


Figure 1: The distribution of active Argo floats. The red dots represent active Japanese floats.

On March 11 2011, a huge earthquake occurred off the east coast of Honshu, Japan, which is known as the Great East Japan Earthquake. Huge tsunami associated with this earthquake hit nuclear power plants in Fukushima and radioactive materials were released from the plants to the

ocean. As a contribution to monitoring efforts for the radioactive material spreading, JAMSTEC deployed 9 floats off Fukushima in March-April 2011, to measure temperature, salinity and surface current above 100m every day. The observed data are opened via web site in real time and used for the data assimilation by the JCOPE (Japan Coastal Ocean Predictability Experiment) team, etc..

The voluntary float deployment from cargo ships owned by a Japanese merchant ship company (NYK Line) succeeded in 2011. 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. This wide coverage is very useful to deploy Argo floats in the area of sparse float density. In 2011, 5 floats were deployed in the central North Pacific Ocean as a deployment test, and profiles were successfully received. This deployment opportunity contributes to not only maintain the global Argo array, but also environment conservation efforts of merchant ship companies through improvement of ocean current prediction.

Among JAMSTEC's 893 floats (735 APEXs, 131 PROVORs, 10 NEMOs, 11 NINJAs, and 6 POPSs) deployed in the Pacific, Indian and Southern Oceans, from 1999 to the end of January 2012, 246 floats (194 APEXs, 50 PROVORs, and 2 NEMOs) are now in normal operation. The other 647 floats (541 APEXs, 81 PROVORs, 8 NEMO, 11 NINJAs, and 6 POPSs) terminated their missions, including 9 floats (8 APEXs and 1 PROVOR) transmitting on the beaches after stranding, 2 floats drifting at the sea surface (1 APEX and 1 NEMO) and 12 floats (9 APEXs, 2 PROVORs, and 1 NINJA) recovered.

The Japan Meteorological Agency (JMA) deployed 24 Argo equivalent floats (12 APEXs, 11 ARVORs and 1 PROVOR) in the seas around Japan from January to December 2011. All the floats except 3 APEXs get 2,000 dbar T/S profiles every 5 days for operational ocean analysis and forecast. Three APEX floats were deployed in the western North Pacific in June 2011 in order to observe daily changes in the structure of the oceanic mixed layer that occur with typhoon passages. These floats use an Iridium transmitter and measure temperature and salinity profiles from the sea surface down to the 500 dbar depth every day from July to September.

Among 113 floats (15 PROVORs, 71 APEXs and 27 ARVORs) which JMA has deployed from 2005 to 2011, 40 floats (16 APEXs and 24 ARVORs) are active as of the end of December 2011, while 19 floats (15 APEXs and 4 ARVORs) terminated the transmission in 2011. JMA deployed 8 APEXs in January 2012.

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) in the Kuroshio-Oyashio mixed water region in the North Pacific in 2011.

All of Tohoku University's 8 floats deployed during 2008 as Argo equivalent floats (3 NINJAs having a ECO FLNTU (Fluorometer and Turbidity Sensor) manufactured by WET Labs and an anti-biofouling shutter with the parking depth of 40 dbar and 5-day cycle, 4 APEXs having a Sea-Bird oxygen sensor and an ECO FLNTU with 3-day cycle, and an APEX with an AANDERAA oxygen sensor with 3-day cycle) terminated their missions by early 2011. Two APEXs, out of the 8 floats, recovered in 2008 had been repaired, equipped with a new sensor, ECO FLbb-AP (Combination Fluorometer-Scattering Sensor) and were deployed in March 2011 for Lagrangian observation of larval fish along the Kuroshio with daily profiling of the upper 500 m. One of them terminated the mission by May 2011. The other was recovered after its one-week mission and has been redeployed in the subtropical front region of the western North Pacific in December 2011 for a physical-biogeochemical survey with daily profiling of the upper 500 m, which is active as of the end of December 2011.

A new implementer of Argo equivalent floats came in during 2011. Okinawa Institute of Science and Technology(OIST), which is located in the Ryukyu Islands (Nansei Islands) of Japan, deployed one NEMO with Iridium telecommunication system in the Kuroshio in July 2011 and

another in December 2011. While their purpose of the deployment was to measure current velocity of Kuroshio from surface to the mid-depth for the investigation of the environment of coral reef, they agreed to the Argo data policy, providing real time temperature and salinity data from their float.

1.1.1 Floats deployed as part of INBOX

Besides 84 floats deployed in 2011 as reported above, JAMSTEC deployed twenty-five floats (22 NEMOs and 3 APEXs) equipped with dissolved-oxygen sensors (Aanderaa Optode3830) in 2011 spring-summer seasons around the biogeochemical observation mooring site S1 (30N, 145E) maintained by JAMSTEC (Fig. 2). The deployment was done as part of Western North Pacific **IN**tegrated **Ph**ysical-**B**iogeochemical **O**cean **O**bservation **E**xperiment (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 and mooring observations. The floats measure temperature, salinity and dissolved oxygen from surface to 2000 dbar in a square area of 150 km x 150 km with 30 km of horizontal resolution, synchronizing every 2 days. The floats are sending lots of good measurement data to us, although the most of the floats were drifted westward from S1 in a few months. The time series data are being analyzed with other observed data. During the deployment of 25 floats, high-quality ship observation data of temperature, salinity and dissolved oxygen were obtained at five stations for the post-deployment sensor calibration. JAMSTEC is conducting calibration of Optode sensors by fitting those data to ship observation data.

JAMSTEC plans to deploy 23 floats with Optode4330 dissolve oxygen sensor to observe physical-biogeochemical process around an air-sea flux buoy (named JKEO mooring, 38N, 147E) in the Kuroshio-Oyashio Extension region in 2012. JAMSTEC has been preparing the Optode4330 sensor pre-deployment calibration 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.

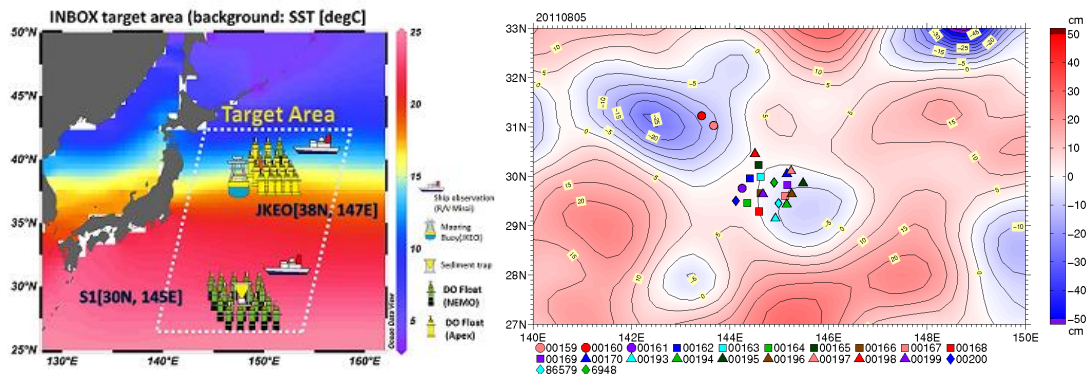


Figure 2. (Left panel) Study area of INBOX. In 2011, 25 floats with Optode3830 were deployed around the S1 mooring site (30N, 145E) in the Kuroshio recirculation gyre. In 2012, 22 floats with Optode4330 will be deployed around JKEO mooring (38N, 147E) to study physical-biogeochemical processes associated with mesoscale eddy. (Right panel) Positions of 25 floats just after deployment (August 5, 2011) around the S1 mooring. 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

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, 3 floats have the extreme negative surface pressure drift, exceeding -10 dbar. The floats repaired and sent back or those purchased after the problem was fixed have either a Kistler pressure or a Druck pressure sensor. The Kistler sensors show slight positive drift smaller than 1dbar; the Druck sensors show no drift.

Some NEMO-Iridium floats of JAMSTEC miss GPSs very often at the rate exceeding 50%, because they have troubles about their air bladders. At ADMT#12, JAMSTEC proposed the method to estimate position when GPS is missed, and it was agreed that a weighted average of all Iridium fixes should be included in profile file if no GPS is available.

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. The first prototype was tested in Sagami Bay, a coastal/shallow region near Tokyo, with R/V Kaiyo in 2011 summer. The field test for deep ocean observation will be carried out this summer, and then a (small) fleet of Deep NINJAs will be deployed in the Southern Ocean during R/V Mirai cruise in 2012/13 austral summer. Deep NINJA is planned to be available for public in 2 – 3 years.

JAMSTEC and JMA suffered severe experiences of Iridium telecommunication trouble of floats in 2011. The troubles occurred in both dial up type service for APEX and short burst mode service (SBD) for NEMO. 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. On the other hand, while the trouble in the SBD type service occurred for just a few tens of minutes in a single event, the observed data were lost because it occurred at the time when the data transmission to the satellite had just started. Replying to JAMSTEC and JMA's inquiry about the troubles, Japanese agent of Iridium telecommunication system replied that the troubles may be caused by data server error and/or damaged telecommunication line. To our knowledge, these troubles occurred only in Japan. The troubles will affect glider operation more seriously. We made a request to the agent for improvement of the Iridium telecommunication system. At the same time, we notified Japanese Iridium float users and potential users about these troubles.

In 2011, EEZ clearance procedure for Argo float deployed by Japanese PIs was changed following IOC Resolution XLI-4. This change reduced our time and effort for the process of EEZ clearance. Before this change, we needed to inform all of coastal states, whose EEZ our floats may enter with certain possibility, in advance (about 6 months before deployment) in the same manner as that for ship observations. We now need to notify only an appropriate Argo national focal point (NFP), whose EEZ our float is about to enter. Since the new procedure 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 278 active floats as of January 27, 2012. 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.

1.4 Status of delayed mode quality control process

JAMSTEC has submitted the delayed-mode QCed data of 76,855 profiles to GDACs as of January 2012. Among these data, 23,513 profiles were provided within a year.

According to the new definition of APEX Truncated Negative Pressure Drift decided at the 12th Argo Data Management Team Meeting, JAMSTEC has been re-creating D files of target floats.

CSIRO has monitored and checked progress on pressure correction both real time and delayed mode profile files. It has also reported the result of each DAC on its web site. JAMSTEC has provided feedback to CSIRO about the anomalies, and modified delayed mode profile files if needed.

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 FY2012, it has been proposed that JAMSTEC will deploy about 70 floats in total in the Pacific Ocean for the Argo core mission. Twenty two Argo equivalent floats with dissolved oxygen sensor Optode3830/4330 will be deployed near the station S1 (30N, 145E) and in a cyclonic eddy in the mixed water region off the east coast of Honshu as part of INBOX. JAMSTEC will also deploy one EM-APEX in a cyclonic eddy in the mixed water region. One Deep-NINJA, which JAMSTEC and Tsurumi-Seiki Co. Ltd. are developing, is planned to be deployed in the Southern Ocean in December 2012. One POPS is planned to be deployed as an Argo equivalent float near the North Pole in April 2012. This POPS is equipped with NOVA. One NEMO-Iridium float is planned to be deployed as Argo equivalent float. It will be deployed near the northwest coast of Papua New Guinea in order to make Lagrangian observation of New Ireland Coastal Undercurrent. JMA plans to deploy 27 Argo equivalent floats around Japan in FY2012 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. Tohoku University will deploy one Argo equivalent floats equipped with oxygen sensor in or near the Kuroshio-Oyashio Extension region.

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) and 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). JAMSTEC released a new data set of gridded mixed layer depth with its related parameters in October 2011, named MILA GPV (Mixed Layer data set of Argo, Grid Point Value: http://www.jamstec.go.jp/ARGO/argo_web/MILAGPV/index_e.html). This consists of 10-day and monthly average data and monthly climatology data in the global ocean using Argo temperature and salinity profiles (Fig. 3).

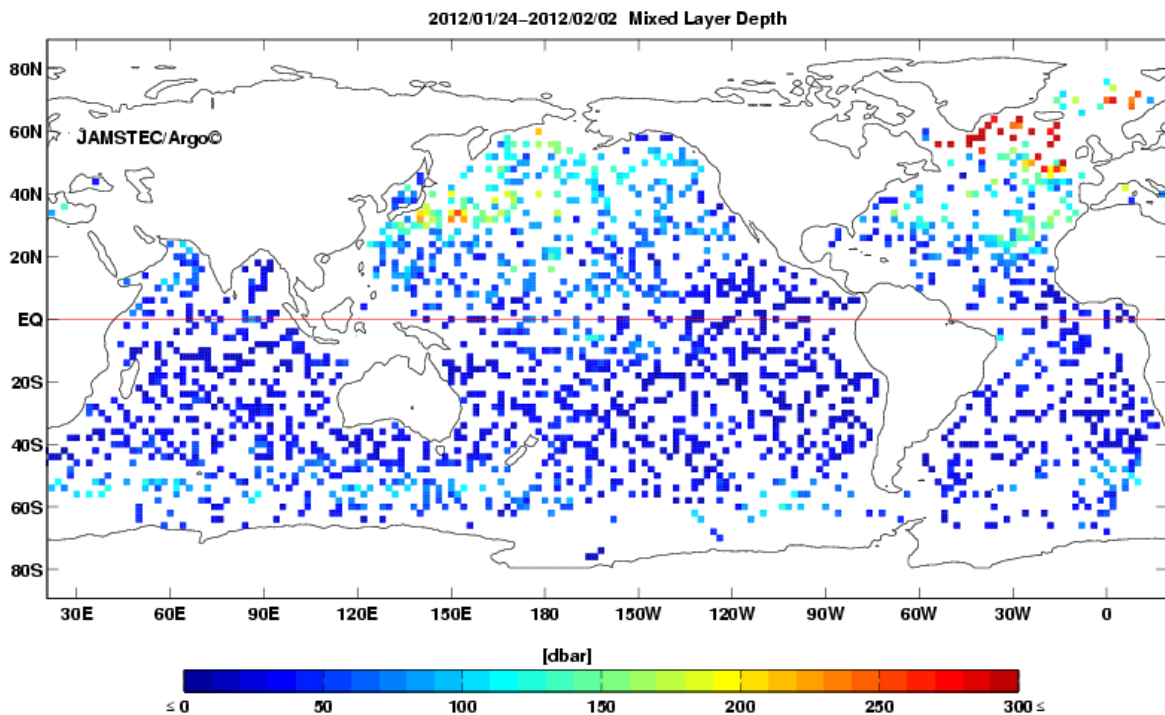


Figure 3. Map of mixed layer depth (dbar) averaged for 10 days, from 24th January 2012 to 2nd February 2012. Mixed layer depth is defined as the smaller value of isothermal layer thickness and isopycnal layer thickness. They are calculated using the finite difference method based on the temperature and potential density values at 10 dbar with threshold values of 0.03kg/m^3 for $\Delta\sigma_\theta$ and 0.2°C for ΔT .

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.

Based upon the accomplishment of the JAMSTEC research project “Japan Coastal Ocean Predictability Experiment (JCOPE)”, Forecast Ocean Plus, INC (FOP) was established as a JAMSTEC venture in March 2009. FOP has been providing the ocean current forecast information over the global ocean based on the state of the art ocean models, including real time forecasts for the shipping companies, offshore industries, coastal engineering works, and the weather information company. Argo is one of important sources of in-situ data for the FOP data assimilation system.

Following the accomplishment of the FRA-JAMSTEC joint research project “A new operational ocean prediction system with hydrographic data of coastal repeated observation lines and its linkage for ecosystem problems”, FRA started operating the ocean prediction system FRA-JCOPE in April 2007, providing the hydrographic forecast information around Japan both to the fisheries research/management community and the general public. Argo has been one of important sources of in-situ data for the FRA-JCOPE data assimilation system. FRA has terminated the service using the FRA-JCOPE system in March 2011; a new prediction system is being developed.

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

Data of 988 CTD casts conducted by JMA in the western North Pacific from spring 2010 to summer 2010 were uploaded to the CCHDO website.

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