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Argo Chinese National Report 2013

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1. The status of implementation

- floats deployed and their performance

From March 2013 to January 2014, China deployed 18 APEX floats in the northwestern Pacific and Indian Ocean. Among these floats, 16 were deployed by the Second Institute of Oceanography, SOA (CSIO), and 2 were deployed by the South China Sea Institute of Oceanology, Chinese Academy of Sciences (SCSIO, CAS). All these floats were manufactured by Teledyne Webb Research, in which 6 floats have the capability of two-way communication with Iridium satellites, and the other 12 floats use Argos satellites. All of the floats are installed SBE41 or SBE41 CP CTD sensors, in addition, 7 floats have the capability of sampling near-surface temperature. These floats were deployed through three cruises, i.e., 2 floats (purchased by SCSIO) were deployed by R/V "Shiyan-3" in last April; 6 floats (purchased by CSIO) were deployed by R/V "Haiyang-6" during 31 May-3 June 2013; 10 floats (purchased by CSIO) were deployed by R/V "Kexue" during December 2013-January 2014. One Iridium float (WMO number: 2901539) deployed during the second cruise failed to get GPS positions since its first cycle, the other floats can receive data and location information normally.

China Argo has deployed 171 profiling floats since 2002, and 83 floats were still active as of 5 Feb 2014.

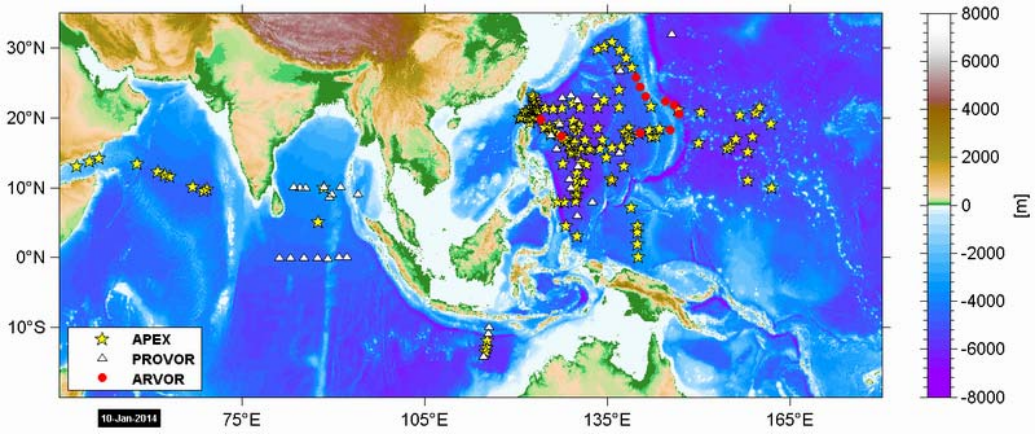

Fig.1 Launch positions of China Argo floats as of February 2014.

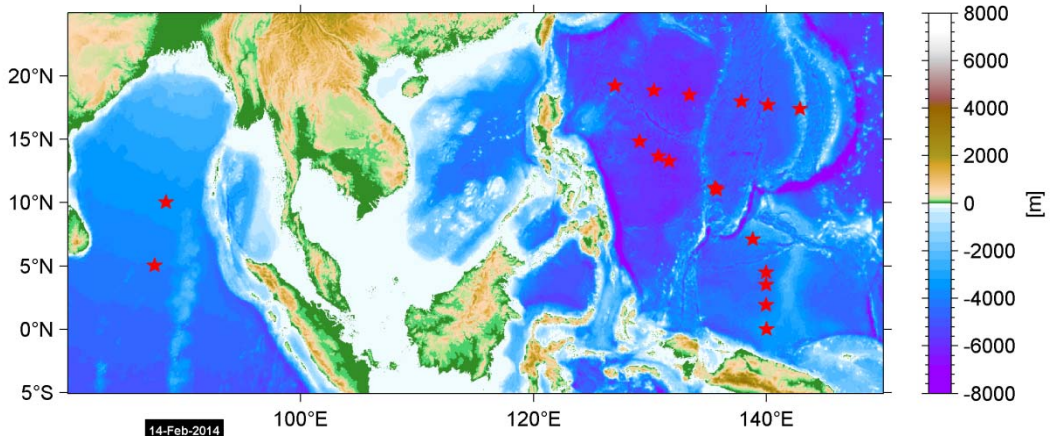

Fig.2 Launch positions of China Argo floats from March 2013 to January 2014.

- technical problems encountered and solved

No technical problems encountered except that two APF9a floats equipped with SBE41 CTD sensor (WMO number: 2901512 and 2901489) which were deployed in the Indian ocean in November 2011 and in the Pacific ocean in September 2012, respectively, were still reporting bad salinity measurements from their first profile. One Iridium float above mentioned (WMO number: 2901539) failed to get GPS positions. It seems that these faults of missing positions and bad salinity data are resulted from the problem of hardware. We hope that these problems could draw more attentions from the float or sensor's manufacturers. It's expected that the manufacturers could looking for and solve the problem in order to improve the use effect of the float.

In addition, different profiling floats have different encoding formats, which make us spend a lot of times to develop corresponding decoding software. Furthermore, it's easy to cause incorrect decoding problems and reduce the quality of observations. For example, the 17 Iridium PROVOR-DO-I floats (with O2 sensor) purchased by Ocean University of China (OUC) from NKE Instrumentation deliver data via SBD files (binary file) to user, so the user is forced to develop the appropriate software to decode those messages. Meanwhile, the SBD files are sent to user via email, which is bound to increase the difficulty and workload when user processes the data, and make it difficult to submit data to GDACs and GTS in real time. In addition, although ARVOR float that also developed by NKE uses hexadecimal encoding format, but it has a quite different and complicated format with PROVOR float from Metocean. Currently, the data decoding for those two types of float has got help from the technicians at Coriolis DAC. We take this opportunity to thank them all.

-status of contributions to Argo data management (including status of pressure corrections, technical files, etc)

In 2013, China Argo submitted 3573 TS profiles (including 207 O2 profiles) to GDAC. Coriolis still helped us decode Argos messages from 8 active ARVOR floats because we haven't corresponding decoding software. All data were distributed on GTS by CLS.

From January 2014, CSIO updated most of the technical files and started to submit new version (format version 3.0) of profile files. The DOXY and near-surface temperature data

have been incorporated into new profile files. CSIO also started to carry out real-time pressure adjustment from December 2013.

- status of delayed mode quality control process

Last October, China submitted 5,107 D-files to GDACs, and a total number of 11,673 D-files have been submitted from the beginning of China Argo. The DMQC operator of China carries out DMQC for all Argo data generally once per year. The surface pressure, CTM and OW corrections have been applied in our DMQC system. The lack of historical CTD data in the western boundary current region (e.g. Kuroshio) is the largest difficulty we encountered when we carry out DMQC.

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

China Argo is still funded by research programs from Ministry of Science and Technology (MOST), State Oceanic Administration (SOA) and National Natural Science Foundation of China (NSFC). In 2013, some funds from China Academy of Sciences (CAS). So the number of yearly deployment is unstable because the purchase funding is depended on the actual allocated funding, usually in the 20-30. There are two groups maintained by CSIO and NMDIS, respectively. The China Argo Real-time data centre at CSIO is in charge of float purchasing, data receiving, processing and donating to AIC. Currently, there are 5 staffs working for this group. The China Argo data centre at NMDIS is in charge of processing data from floats deployed by East China Sea Branch, SOA, and data archives from Chinese floats.

In recent years, one problem that who will pay the satellite communication fee for the active floats after the research programs were finished was encountered. We are discussing solutions to the problem with the related operating division of SOA. The primary solution is that the operating division will allocate special funding each year used for continuing to receive and process data from those active floats.

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

We estimate that about 30 floats will be deployed in 2014. Of these floats, 17 floats are provided by a national basic research program from MOST undertaken by OUC, and the other 13 floats are provided by a national special key program for basic work from MOST undertaken by CSIO. One cruise has been confirmed, and will be undertaken by R/V "Dongfanghong-2" from OUC. It is scheduled that 17 PROVOR Iridium DO floats will be deployed in the North Pacific Ocean during March-April. In addition, CSIO will also deploy about 8 standard APEX floats through this cruise. All the data from these floats will be received and processed by CSIO, and shared with other countries.

4. Summary of national research and operational uses of Argo data as well as contributions to Argo Regional Centers. Please also include any links to national program Argo web pages to update links on the AST and AIC websites.

In order to prompt the research on ocean data assimilation and its operational use, as well as the application of the Argo data in oceanic and atmospheric sciences, CSIO held the 8th

workshop of Chinese ocean data assimilation & the 2nd Argo science workshop at Zhoushan, Zhejiang from 5 to 8 November 2013. 106 representatives from the 26 organizations participated in the workshops. Focused on the development of ocean data assimilation system, the study on theoretical methods and techniques of ocean data assimilation, the operational use of ocean data assimilation techniques, the progress on Argo ocean observing system, the application use of Argo data in the basic research, ocean data assimilation system and operational predicting and forecasting system, the development of Chinese autonomous profiling float, etc., the participants made conferences through oral presentations and posters. Among them, 23 representatives gave speeches. About 40 conference papers were submitted to the workshop, and more than 10 posters were put up. Abundant results acquired from the study on ocean data assimilation techniques and application use of Argo data in recent years were fully exhibited in this workshop.

Besides in the basic research of oceanic and atmospheric sciences, the Argo data and its products are also operationally used in the ocean and atmosphere predicting and forecasting models. Argo data has been used to a global ocean four-dimensional variational data assimilation system (NCC-GODAS) developed by National Climate Centre, as well as the Ocean Variational Analysis System (OVALS) developed by Institute of Atmospheric Physics, CAS, which provided more realistic ocean initial fields to the global air-sea coupling modeling for seasonal climate predicting, and played an important role in improving the level of predicting. OVALS system has also been operationally applied in National Marine Environment Forecasting Centre (NMEFC), SOA, and also played an important role in operational El Nino monitoring and analyzing system. In October 2013, in China first global operational oceanographic forecasting system developed by NMEFC, the main data source of Argo data is assimilated into the system.

China Argo hasn't taken part in the activities of Pacific Argo Regional Center (PARC) until now. Currently, it looks like PARC didn't hold any meetings and activities.

There are two websites routinely maintained by China, one is maintained by NMDIS (www.argo.gov.cn) at Tianjin (China Argo data center), and another is maintained by CSIO (www.argo.org.cn) at Hangzhou (China Argo Real-time data center). Through them, the implement status of China Argo, real-time data display including T/S/O2 profiles, float trajectory, profile data, the derived products and status of global Argo are presented. Meanwhile, GDACs, related international organizations and member's Argo websites can be accessed through these two websites.

5. Problems encountered during the operation of international Argo and suggestions

In November 2013, the AIC TC asked for comments about how to correctly use Argo label through email, and hoped to reach an agreement as soon as possible and drew up an implementation plan. We highly agreed with the opinion that "the Argo label should be used in agreement with the Argo programme". It's necessary to restate the principle and purpose of an earlier design Argo programme, so that the programme can be always along the right track for its sustainable development, this requires the efforts from all participating countries and PIs. Earlier, we have suggested China float producers not to call profiling float in development simply as "C-Argo". Only those floats purchased and used by China Argo

project or the international Argo program participants are eligible to called "Argo profiling float". In other words, the floats that haven't participated in the Argo programme or haven't promised to share their data with the other member states are not allowed to paste Argo labels. As for the Argo label is pasted by the float suppliers, or by the manufacturers, we estimate that they are difficult to understand the real intention of purchasers. Therefore, we suggest that the PIs are responsible for the allocation of these labels, and supervise the float observations on which Argo label is stuck to be shared with all members. In order to help PIs and AIC coordinator effectively monitor the labeled floats, we suggested that a serial number should be printed on each label, and allocated to each member country in accordance with segmentation. As for the seven basic “best practices for Argo” TC mentioned that Argo operator should adhere to, it is very important for Argo’s sustain in a long term. For this reason, we suggest that not only the float operator who doesn’t adhere to the seven basic “best practices for Argo” is not allowed to paste Argo label, but also treated differently in terms of purchasing float and paying for satellite service in order to attract more countries and PIs to joining the Argo community.

In addition, considering the status of different data format used for different types of float, and confused use of hexadecimal and binary encoding, we suggest AST could urge float manufacturers to use the same data format, or use hexadecimal encoding at least, with adequately considering the limited human resource at each DAC.

6. To continue improving the number of CTD cruise data being added to the reference database by Argo PIs, it is requested that you include the number and location of CTD cruise data uploaded by PIs within your country to the CCHDO website in the past year.

In the past year, we didn’t obtain any CTD casts because all of the float deployments were carried out by the opportunity ships. In 2014, we plan to conduct CTD observing during the North Pacific Ocean cruise which will be implemented by R/V "Dongfanghong-2". We will also take water samples, and measure water salinities using Lab salinometer to verify the reliabilities of CTD and conductivity sensors of the floats. All the CTD data will be timely submitted to CCHDO.

7. Keeping the Argo bibliography

Argo related academic papers:

(1) Han, G., H. Fu, X. Zhang, W. Li, X. Wu, X. Wang, and L. Zhang, 2013: A global ocean reanalysis product in the China Ocean Reanalysis (CORA) project, *Adv. Atmos. Sci.*, **30**(6), 1621-1631,**http://dx.doi.org/10.1007/s00376-013-2198-9**

(2) Han, G., W. Li, X. Zhang, X. Wang, X. Wu, H. Fu, X. Zhang, L. Zhang, and D. Li, 2013: A new version of regional ocean reanalysis for coastal waters of China and adjacent seas, *Adv. Atmos. Sci.*, **30**(4), 974-982,**http://dx.doi.org/10.1007/s00376-012-2195-4**

(3) Hu, R., and M. Wei, 2013: Intraseasonal oscillation in global ocean temperature inferred from Argo, *Adv. Atmos. Sci.*, **30**(1), 29-40, **http://dx.doi.org/10.1007/s00376-012-2045-4**

(4) Liu, Z., J. Xu, C. Sun, 2013: Combining sea surface height data with temperature profile data to estimate global upper ocean heat content anomaly, Journal of Tropical Oceanography (in Chinese), **32**(6), 9-15.

(5) Pan, J., and Y. Sun, 2013: Estimate of Ocean Mixed Layer Deepening after a Typhoon Passage over the South China Sea by Using Satellite Data, *J. Phys. Oceanogr.*, **43**(3), 498-506, **http://dx.doi.org/10.1175/JPO-D-12-01.1**
(6) Wang, X., G. Han, W. Li, X. Wu, and X. Zhang, 2013: Salinity drift of global Argo profiles and recent halosteric sea level variation, *Glob. Planet. Change*, **108**(0), 42-55,**http://www.sciencedirect.com/science/article/pii/S0921818113001471**
(7) Wang, F., Y. Li, Y. Zhang, and D. Hu, 2013: The subsurface water in the North Pacific tropical gyre, *Deep Sea Research Part I: Oceanographic Research Papers*, **75**(0), 78-92,**http://www.sciencedirect.com/science/article/pii/S0967063713000228**
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(9) Zhang, C., J. Xu, X. Bao, and Z. Wang, 2013: An effective method for improving the accuracy of Argo objective analysis, *Acta Oceanol. Sin.*, **32**(7), 66-77, **http://dx.doi.org/10.1007/s13131-013-0333-1**
(10) Zhang, H., G. Chen, C. Qian, and H. Jiang, 2013: Assessment of Two SMOS Sea Surface Salinity Level 3 Products Against Argo Upper Salinity Measurements, *Geoscience and Remote Sensing Letters, IEEE*, **10**(6), 1434-1438, **http://dx.doi.org/10.1109/lgrs.2013.2259792**
(11) Zhang, Z., D. Yuan, and P. C. Chu, 2013: Geostrophic meridional transport in tropical Northwest Pacific based on Argo profiles, *Chinese Journal of Oceanology and Limnology*, **31**(3), 656-664,**http://dx.doi.org/10.1007/s00343-013-2169-0**.
(12) Zhang, Z., Y. Zhang, W. Wang, and R. X. Huang, 2013: Universal structure of mesoscale eddies in the ocean,*Geophys. Res. Lett.*, **40**(14), 3677-3681, **http://dx.doi.org/10.1002/grl.50736**
(13) Zhang R., J. Zhu, J. et al., 2013: Argo global ocean data assimilation and its applications in short-term climate prediction and oceanic analysis, Chinese Journal of Atmospheric Sciences (in Chinese), **37** (2), 411–424.
(14) Zhang, W., R. Zhang, Y. An et al., 2013: Diagnostic calculation of three dimensions sea flow in the Pacific by P vector method on isopycnal surface, Chinese Journal of Hydrodynamics (in Chinese), **28**(1), 72-80.

Some Argo related doctoral dissertations:

(1) CHEN Lijing, 2014. Estimation on global ocean heat content in the past 45 years and the tropical cyclone's impact on ocean energy budget, Chinese Academy of Sciences, Beijing, China.
(2) AN Yuzhu, 2013. Study on the Upper Ocean Temperature and Salinity Characteristics Based on Argo Data, PLA University of Science and Technology, Nanjing, Jiangsu, China.
(3)ZHANG Weitao, 2013. Three-dimensional current field reconstruction based on Argo float data and satellite remote sensing data, PLA University of Science and Technology, Nanjing, Jiangsu, China.
(4)ZHANG Chunling, 2013. The research of reanalysis method and three-dimensional grid data reconstruction on the Argo data, Ocean University of China, Qingdao, Shandong, China.

(5)WANG Huizan, 2011. Global temporal-spatial salinity variability, gridded salinity reconstruction and freshwater flux retrieval based on Argo network, PLA University of Science and Technology, Nanjing, Jiangsu, China.
(6)XIE Jiping, 2008. Analyzing and Assimilating Argo Data, Institute of Atmospheric Physics, Chinese Academy of Sciences, Beijing, China.
(7)ZHOU Hui, 2006. A study of some characteristics and variability of the North Pacific Western Boundary Current System, Ocean University of China, Qingdao , Shandong, China.
(8)CHEN Yide, 2006. Application Researches of Argo Data, PLA University of Science and Technology, Nanjing, Jiangsu, China.
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