AST-14 Meeting, Wellington, New Zealand, 19-21 March 2013

Progress on China Argo

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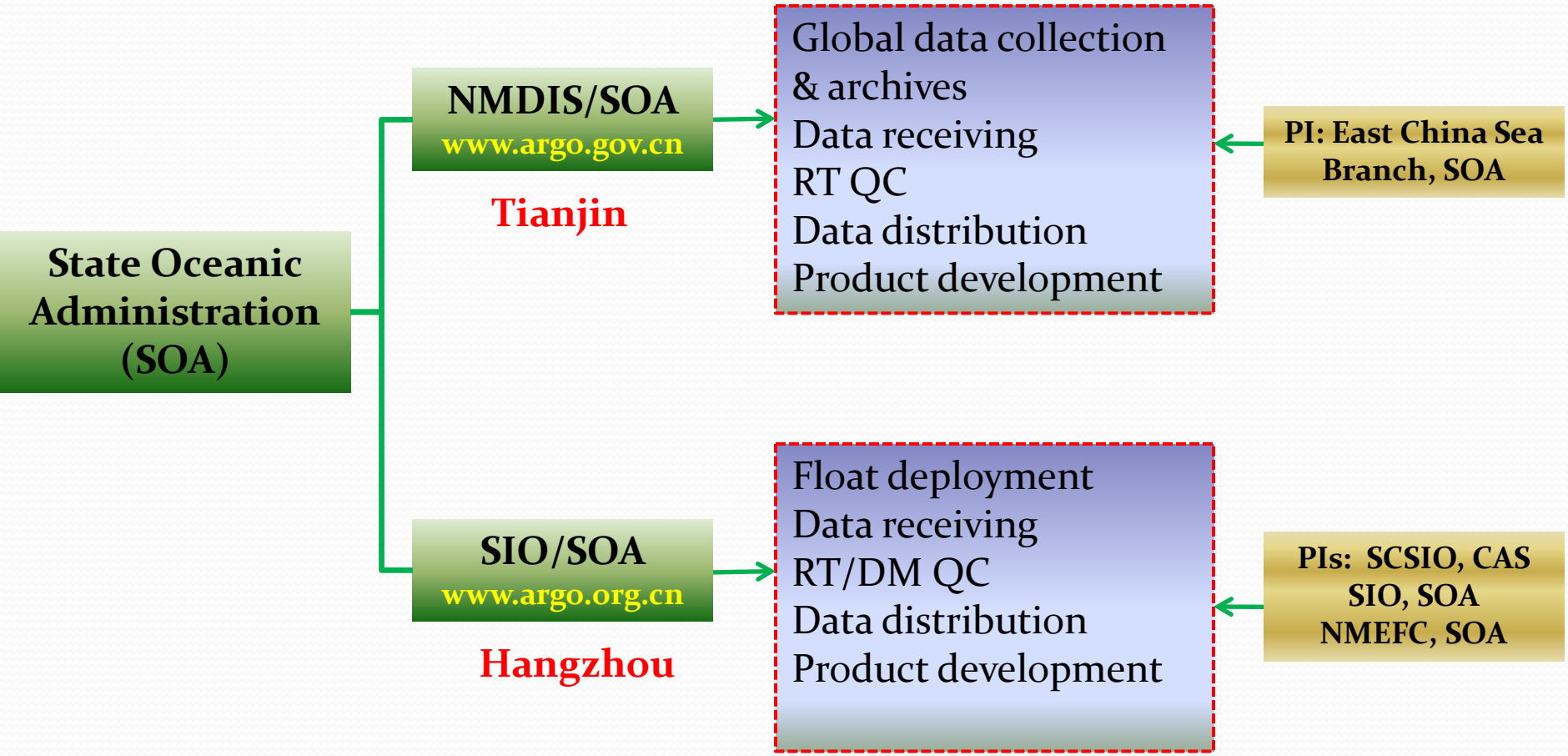
19 March 2013

Outline

1. Organization of China Argo, and source of funding
2. Float deployment and float recovery
3. Application of Argo data
4. Development of profiling float
5. Prospect of China Argo

Organization of China Argo

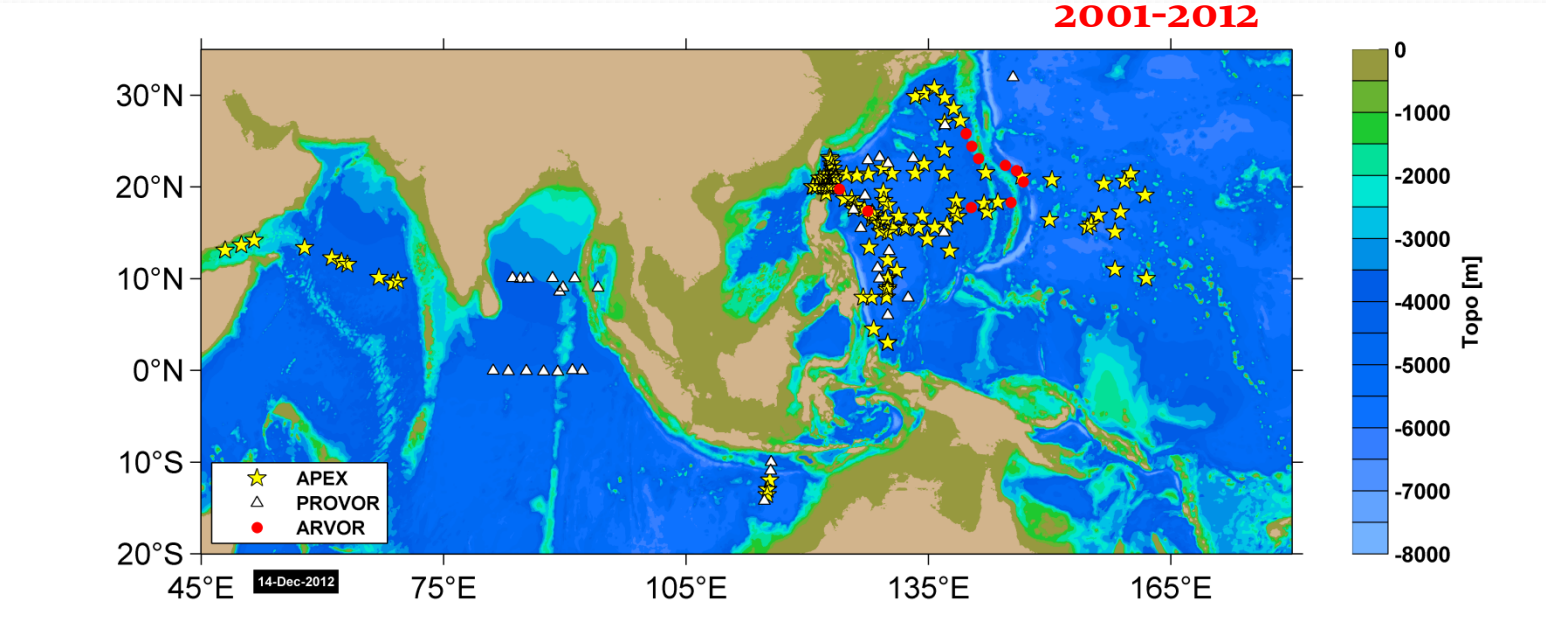


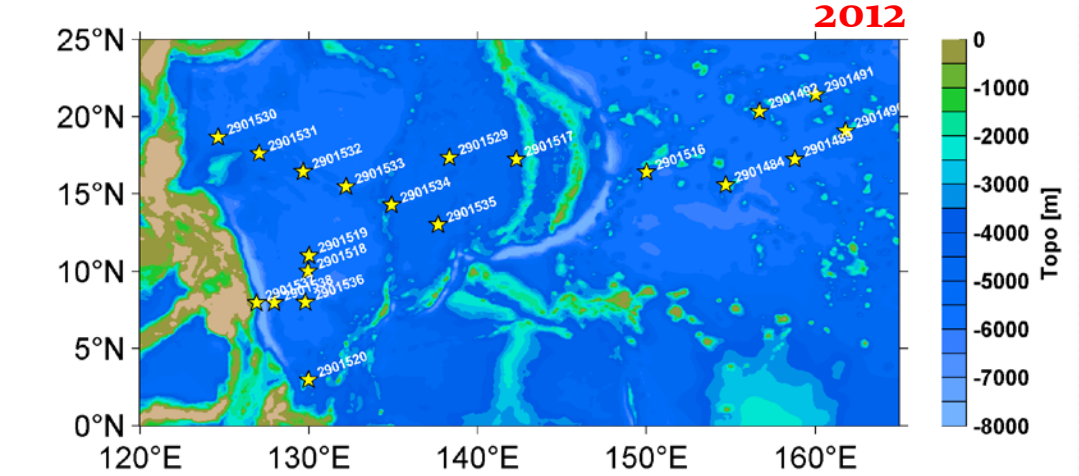
Source of funding

Most of the floats were deployed by research programs!!

MOST: Ministry of Science and Technology
NSFC: National Natural Science Foundation of China

Float deployment





153 floats, 84 active

34 PROVOR

10 ARVOR

21 Iridium APEX

88 standard APEX

Deployment plan in 2013

SCSIO: **2** floats in Indian Ocean (March 2013), confirmed.

TIO: **3** floats in Indian Ocean (March 2013), confirmed.

SIO: **19** floats stocked, **20** floats will be ordered, cruise unconfirmed. (**39**)

ECS: over **20** floats stocked, unknown deployment plan.

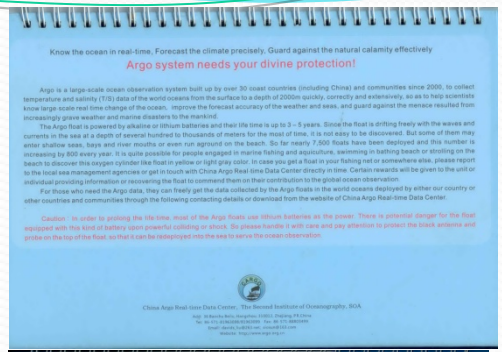
SCSIO: The South China Sea Institute of Oceanology, Chinese Academy of Sciences
TIO: The Third Institute of Oceanography, SOA
ECS: East China Sea Branch, SOA

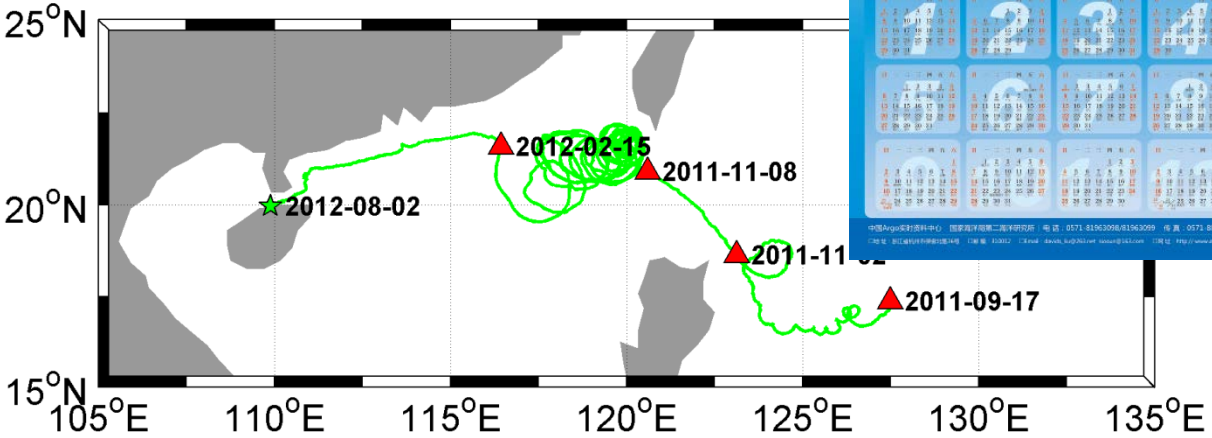
Float recovery

6 floats have been recovered by SIO since 2007.

The knowledge about Argo was educated to local fishermen and persons in connection with seas, through printed calendar or poster since 2004. Proper rewards were given to the finders.

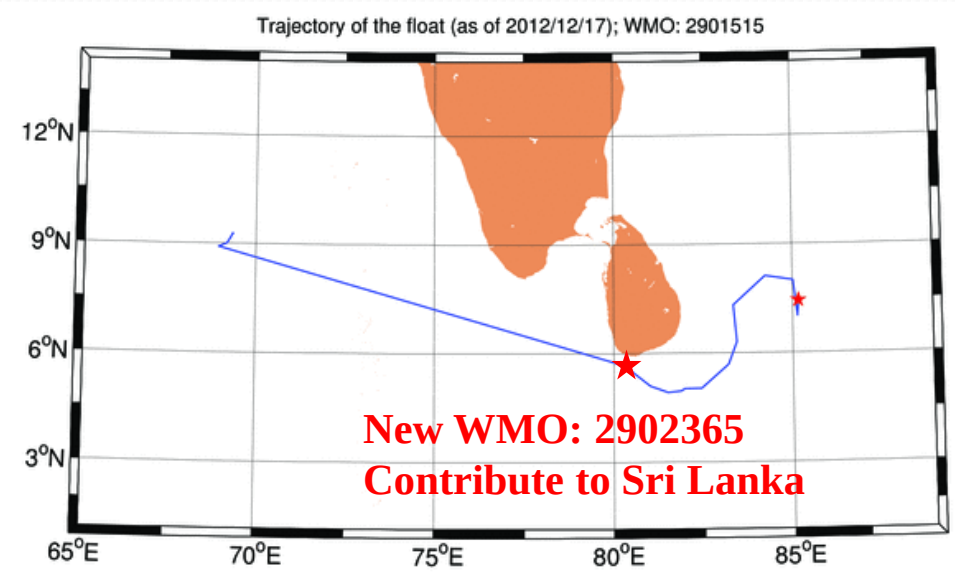
3 floats were changed batteries and redeployed.

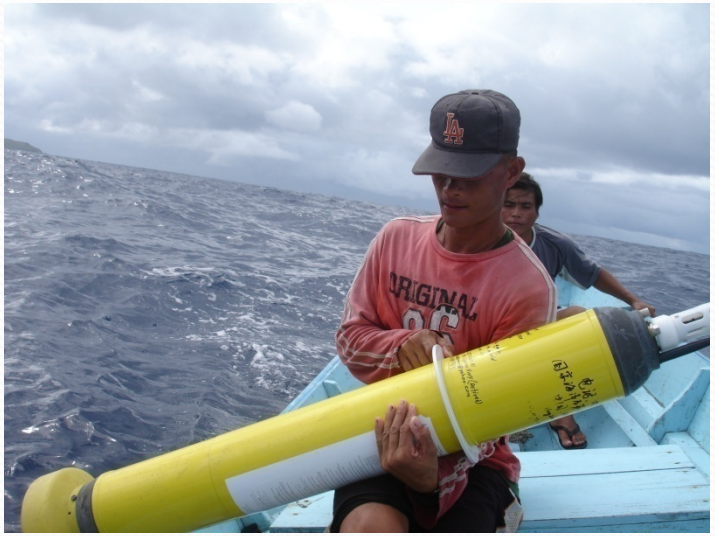




Float recovery

In 2012 two floats (WMO number: 2901515 and 2901617) were redeployed near Galle, Sri Lanka by National Aquatic Resources Research and Development Agency (NARA) after they were captured by local fisherman of Sri Lanka. Float 2901515 reported good data upon redeployment, while 2901617 didn't survive. We thank Dr. K. Arulanthan and Dr. R.M.R.M. Jayathilaka from NARA for their sincere help.





Redeploy a float by the Philippine fisherman in August 2009.

Lithium battery installation

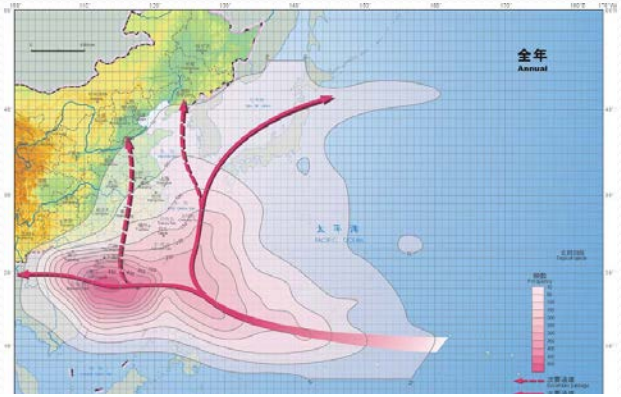
44 APEX floats have been installed Li battery packs since 2009 (SIO).

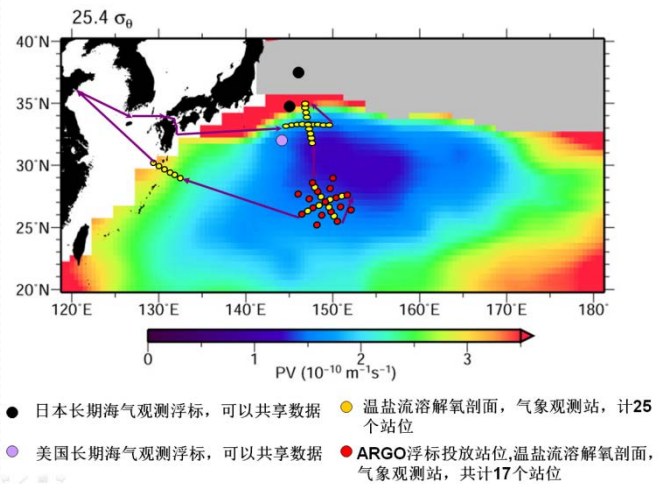
We thank Prof. Steve Riser and Mr. Dana Swift for their technical helps.

Application of Argo data

MOST

The great scientific research program on global changes was launched in July 2010.





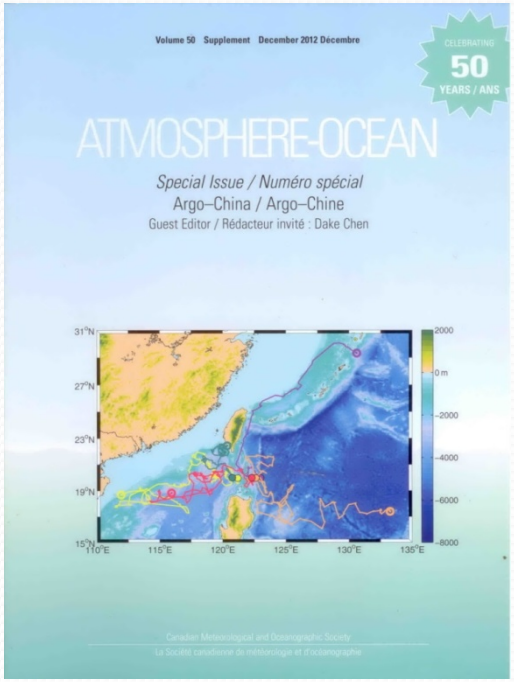
Argo data

1. **Tropical Pacific, warm pool**
2. **Tropical Indian-Pacific**
3. **Upper ocean response to Typhoon**
4. **Subtropical circulation of the north Pacific**

NSFC and SOA reinforced the support to research on ocean and climate changes. Data!!!

Application of Argo data

In the past year, China Argo published a special issue named ‘Argo-China’ in Atmoshpere-Ocean (Volume 50, Guest Editor: Dake Chen). 10 papers related to Argo were published in this special issue.



nature geoscience LETTERS

PUBLISHED ONLINE: 22 MAY 2011 | DOI: 10.1038/NGEO1156

Seasonal and spatial variations of Southern Ocean diapycnal mixing from Argo profiling floats

Lixin Wu[1]*, Zhao Jing[1], Steve Riser[2] and Martin Visbeck[3]

The Southern Ocean is thought to be one of the most energetic regions in the world's oceans. As a result, it is a location of vigorous diapycnal mixing of heat, salt and biogeochemical properties[1,2]. At the same time, the Southern Ocean is poorly sampled, not least because of its harsh climate and remote location. Yet the spatial and temporal variation of diapycnal diffusivity in this region plays an important part in the large-scale ocean circulation and climate[4–9]. Here we use high-resolution hydrographic profiles from Argo floats in combination with the Iridium communications system to investigate diapycnal mixing in the Southern Ocean. We find that the spatial distribution of turbulent diapycnal mixing in the Southern Ocean at depths between 300 and 1,800 m is controlled by the topography, by means of its interaction with the Antarctic Circumpolar Current. The seasonal variation of this mixing can largely be attributed to the seasonal cycle of surface wind stress and is more pronounced in the upper ocean over flat topography. We suggest that additional high-resolution profiles from Argo floats will serve to advance our understanding of mixing processes in the global ocean interior.

The Southern Ocean is an important source of bottom water in the world's oceans and is a key upwelling site of deep water, pointing to diapycnal mixing (that is, mixing across surfaces of equal density) in the region as an important controlling factor of the global meridional overturning circulation (MOC; refs 7,8). Modelling studies have demonstrated that the global strength of the MOC depends critically on the details of the representation of mixing processes in the Southern Ocean interior[9]. A few existing observations[10–14] in this region have revealed dramatic spatial heterogeneity in diapycnal mixing, with values of diffusivity over smooth topography comparable to those in the mid-latitude ocean interior (of the order of 10^{-5} m^2 s^{-1}), and enhanced mixing (of the order of 10^{-4} m^2 s^{-1} or larger) extending far from rough topography. However, discerning the nature of diapycnal mixing over the entire Southern Ocean is still a formidable challenge because of the very limited sampling of the necessary parameters in the region. Furthermore, in general the temporal variability of diapycnal mixing remains poorly assessed and understood throughout most of the world's oceans, but in some cases the causes of such variability might be reasonably straightforward to document. As an example, recent analysis of historical hydrographic data reveals that the subsurface turbulent diapycnal mixing in the Northwestern Pacific displays a pronounced seasonal variability stirred by surface wind stress[15].

The International Argo Program has created the first global array for observing the subsurface ocean. A subset of Argo floats deployed are designed to use the Iridium communications system (henceforth referred to as Argo Iridium floats), and are able to provide high-resolution (2 m) profiles that are able to resolve fine-scale (tens to hundreds of meters) strain. These floats provide an unprecedented opportunity to determine the geographic distribution of upper ocean turbulent diapycnal mixing worldwide, especially in locations with unfavourable weather and logistical limitations. Furthermore, these long-term floats with high temporal coverage also have the potential ability to access the temporal variations of diapycnal mixing over a vast region. Here we will make the first attempt to demonstrate the ability of these high-resolution profiles from Argo Iridium floats to map both the seasonal and spatial distribution of diapycnal mixing in the upper Southern Ocean by employing a fine-scale parameterization method[12,16] (see Methods for details), which displays the capability to estimate diapycnal mixing in the upper ocean[15,17,18].

The Southern Ocean contains a wide range of topographic features (Fig. 1a). Although Argo Iridium floats do not cover the entire Southern Ocean, the water column over the roughest topography (except the Pacific Antarctic Ridge) has been well sampled, making it possible to capture most hotspots of turbulent diapycnal mixing in the Southern Ocean (Fig. 1a). The diapycnal diffusivity derived from Argo Iridium floats shows significant spatial variability (Fig. 1b). Whereas low and moderate mixing rates (on the order of 10^{-5} m^2 s^{-1}) are found over the abyssal plains in the southeast Pacific and to the south of Australia, enhanced mixing (on the order of 10^{-4} m^2 s^{-1} or larger) is found over rough topography, including the Scotia Sea, the Drake Passage, east of the Kerguelen Plateau, the Mid-Atlantic and Southwest Indian ridges, and the edges of the Campbell Plateau and Antarctica (Fig. 1b). This enhanced mixing along topographic features can be further inferred from the vertical map of the diapycnal diffusivity and dissipation rate (Fig. 2a–c), where most of the enhanced mixing corresponds to the large roughness values (variance of bottom height). This is also demonstrated by the significant correlation between the values of diapycnal diffusivity and bottom roughness (Fig. 3a). A notable exception occurs in the region 58°–70° E, where the dissipation rate is much stronger in the depth range from 300 to 800 m, even though the topography is relatively smooth. The enhanced mixing here is possibly owing to the great amount of work done by the wind on inertial motions[19] in the region.

The origin of the mixing may be inferred from the energy budget. Over relatively smooth topography, the turbulent kinetic dissipation rate decreases with depth throughout the sampled water column (300–1,800 m; Fig. 3b) and the vertically integrated dissipation rate is about 1.8×10^{-3} W m^{-2}, comparable in magnitude to regional estimates of the energy flux from the wind to near-inertial motions[19]. On the other hand, over rough topography, the dissipation rate in the upper 300–1,200 m also decreases with depth, and deviates from that over smooth topography by a factor of only two. However, below 1,200 m, over rough topography the depth trend of dissipation rate is reversed and the deviation is a factor of more than five (Fig. 3b). These enhanced dissipation rates are probably owing to the breaking of internal

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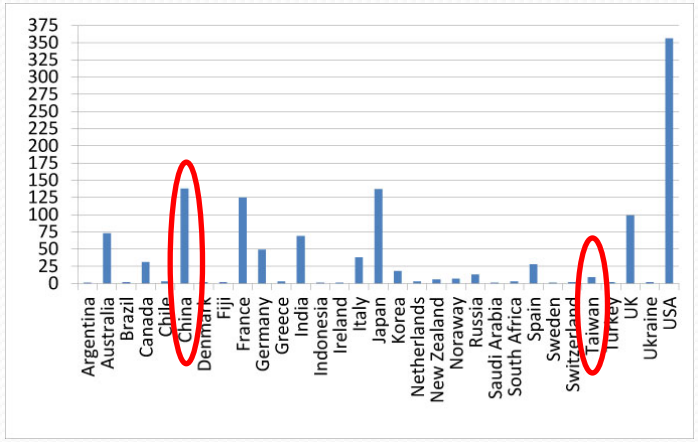
Argo bibliography since 1998



Taiwan?

Here we use high-resolution hydrographic profiles from Argo floats in combination with the Iridium communications system to investigate diapycnal mixing in the Southern Ocean. (Nature, Lixin Wu)

Application of Argo data

"China Argo Ocean Observation Array, its data assimilation and short-term climate forecasting" awarded Science and Technology Prize from the China Association of Oceanic Engineering in March 2012 (First Prize).

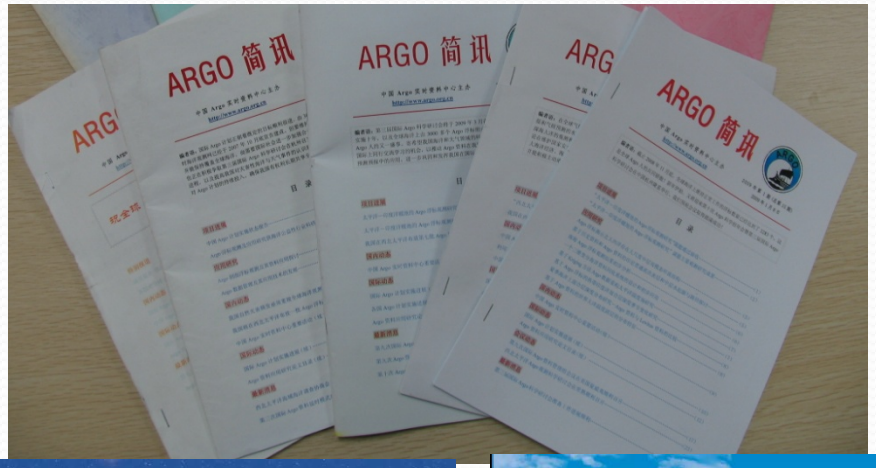
"China Argo ocean Observation, its data assimilation and improvements in short-term climate forecasting" awarded National Award for Science and Technology Progress in January 2013 (Second Prize).

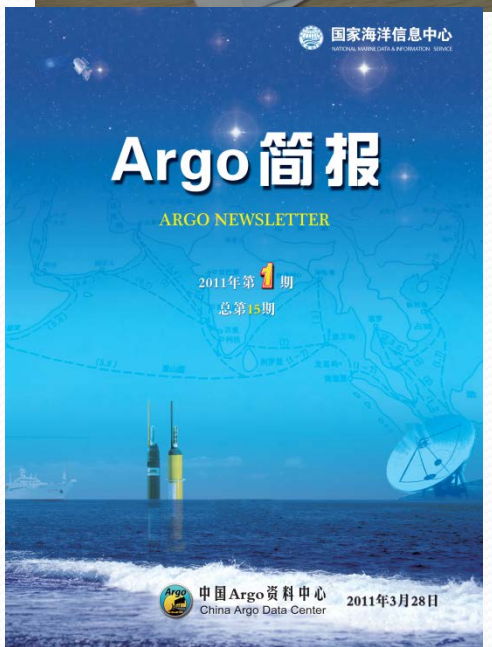
Chinese Argo newsletter

CSIO: **28** editions of Argo newsletter have been published since 2003.

NMDIS: **16** editions of Argo newsletter have been published since 2003.

About **150** hardcopies of each edition are sent to the scientists and administrative persons from **41** agencies.

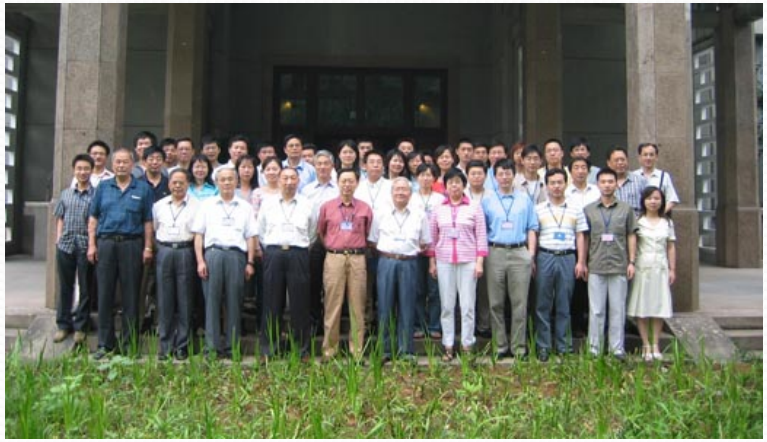




Argo workshop

2003: The first ocean data assimilation workshop, hosted by CSIO and IAP/CAS (Changshu).
2006: The first China Argo Science Workshop hosted by CSIO (Hangzhou).
2009: The 3rd ASW was held at Hangzhou.
2013: The 8th ocean data assimilation & the 2nd China Argo Science Workshop will be held at Zhoushan, Zhejiang, in November. (CSIO)

1st ASW-China (June 2006, Hangzhou)

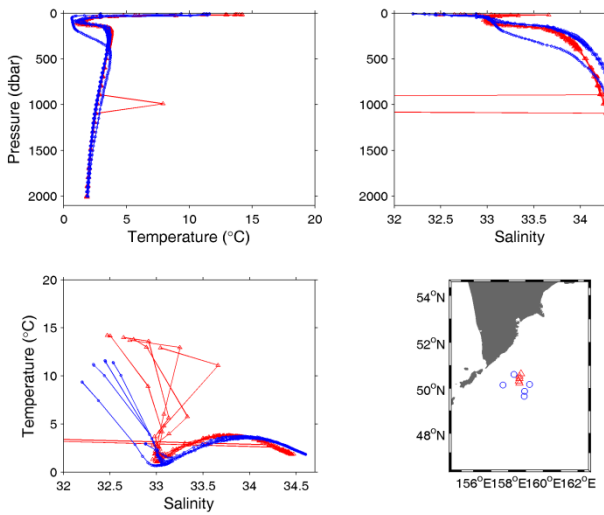


2nd ASW-China (Nov 2013, Zhoushan)

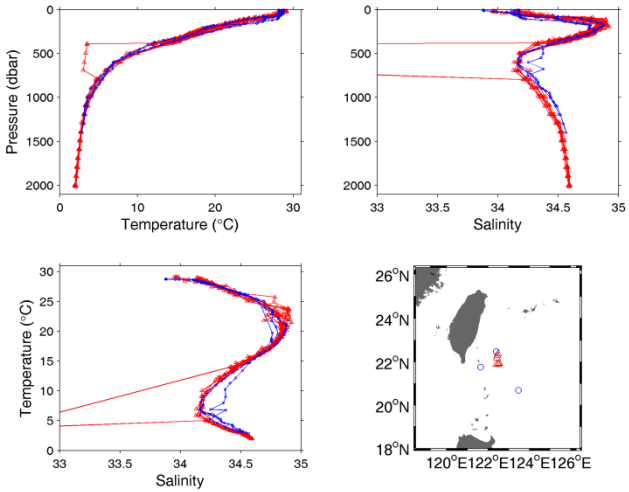
3rd ASW (March 2009, Hangzhou)

Development of profiling float

COPEX: developed by National Ocean Technology Center (Tianjin) in 2003.



Blue: Nearby Argo
Red: COPEX

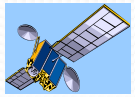


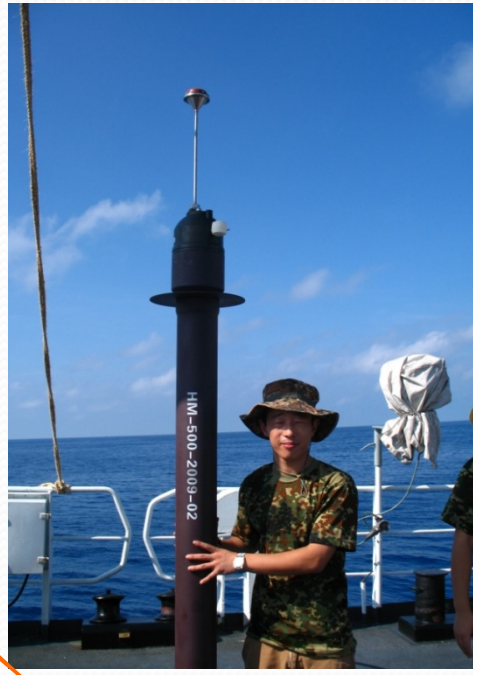
Erroneous salinity data

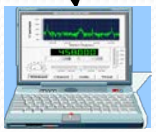
Development of profiling float

Another float developed by Institution of testing technology, China Shipbuilding Industry Co. (CSIC) from 2007.

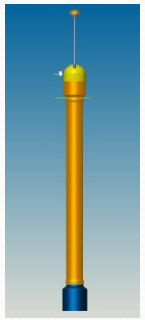
- ➢BeiDou (Compass) navigation satellite system
  2-way communication
- ➢Recover mode







PC

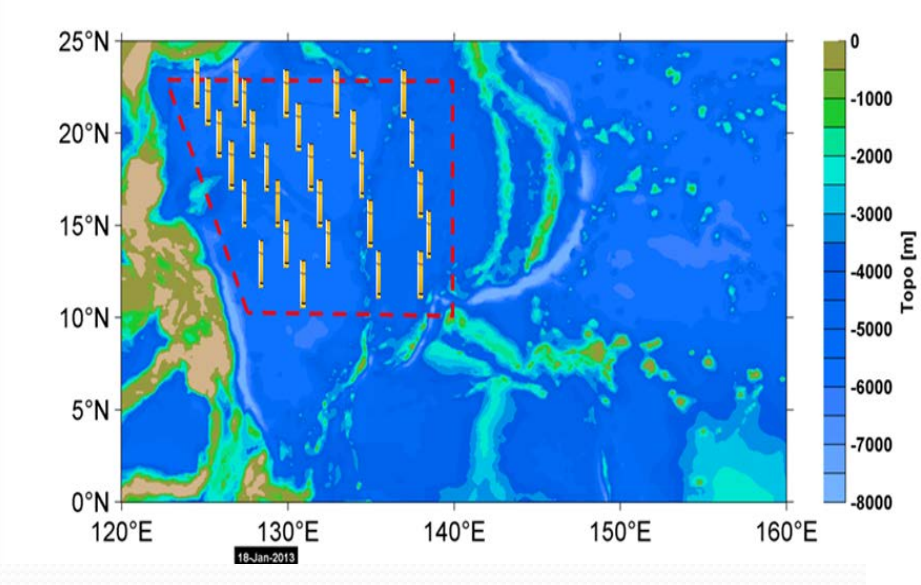


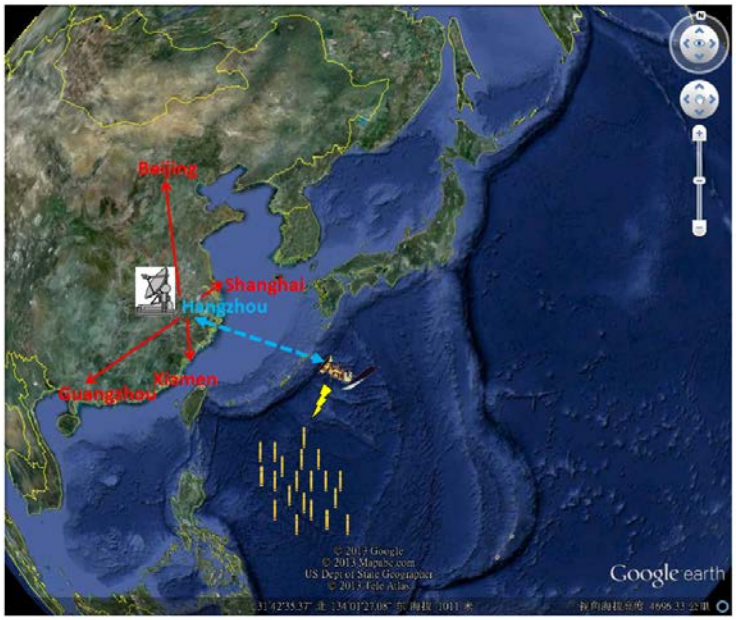
Command center

Development of profiling float

NSFC: Special program for the major scientific equipment research and development.

Autonomous profiling float and real-time ocean monitoring system based on BeiDou satellite system. (A proposal prepared by Jianping Xu, collaborate with Institution of testing technology, CSIC)





Prospect of China Argo

"**Planning on National ocean observing network**" drafted by SOA, pointed out the construction of Argo local-region observing network and operational float deployment will be dramatically sponsored. It's expected that China Argo will be brought into operational ocean system.

Thank you for your attention.