

**Report from the 1<sup>st</sup> Argo Regional Center (ARC) Meeting  
CSIRO, Hobart, Tasmania  
13 November 2007**

Representatives from each of the five Argo Regional Centers (ARCs; list of participants given in Appendix 1) met in Hobart just prior to the 8<sup>th</sup> Argo Data Management Team (ADMT) meeting. The ARC meeting was designed to enhance regional center activities by sharing experiences, identifying successes and impediments, and perhaps leveraging existing capabilities. The role of ARCs is given in Appendix 2, and the stated objectives for the meeting were:

- Review the status of the various ARCs
- Discuss mandatory functions of ARCs (mainly related to quality control)
- Discuss optional functions of ARCs (products, etc.)
- Discuss possibilities of DM QC by ARCs for small programs that don't have the resources to do it
- Identify challenges (mainly funding)
- Identify ways for ARCs to help each other (e.g., software exchange)

The meeting was chaired by Drs. Claudia Schmid (AOML) and Jim Potemra (UH/IPRC) and ran from 8:30AM to about 4:00PM. Ann Thresher (CSIRO) provided logistical support for the meeting. This document provides a brief summary of the meeting as compiled by Claudia, Jim and Sylvie Pouliquen.

**1. Welcome and objectives**

Ann Thresher welcomed the meeting participants and provided some logistical details. Jim Potemra then opened the meeting and reminded the participants about the objectives of the meeting and the tasks for each ARC (Appendix 2). It was suggested that the meeting proceed more as a working group, with open discussion encouraged, rather than a more formal meeting.

**2. Presentations by each ARC (chairs)**

Each ARC was asked to prepare a brief overview of their activities over the past year.

**a. North Atlantic Ocean (Sylvie Pouliquen)**

The North Atlantic ARC activities are related to two main topics: facilitating the delayed mode assessment of the Argo data set and the generation of products merging Argo with other data sources.

In 2007 the European contributors to Argo submitted the EURO-ARGO proposal to the European Commission, and it was accepted. This project will in particular organize the European contribution to the ARCs and also provide some funds to speed up the development of the Atlantic ARC.

Recent activities at the N. Atlantic ARC regarding quality control activities include:

- Strong contribution to the development/organization of the Argo reference database (including addition of recent CTD profiles)
- A prototype to check for data consistency on the basin level was developed in 2006. This work will be pursued in 2008.
- Plan to start DM QC in the Med Sea.
- Organize DM QC processing for 'orphan' floats (see below).

For product development, yearly reanalysis of weekly temperature and salinity fields are performed with three resulting data sets: the Argo profiles, the Argo Profiles on interpolated depths, and the weekly analysis. For the 2001-2006 reanalysis, a new climatology for the North Atlantic has been developed and is under validation. There is plan to develop climate indicators from the reanalysis.

#### **b. Indian Ocean (Uday Bhaskar)**

The Indian Ocean ARC is being maintained by INCOIS, and they have developed a web-based interface to access Indian floats. CTD data collection is done and will be transferred to GDAC. For quality/control functions, INCOIS is using objective analysis to detect outliers.

At present, the Indian Ocean ARC has products for temperature, salinity and derived quantities. An atlas for the Indian Ocean based on "neural networks" is currently underway. This project generated much interest and questions, including: How will this be done? Will it include more than just Argo? What will be distributed? The Indian Ocean Hydrobase will continue, and there are plans to build a climatology.

#### **c. Pacific Ocean (Jim Potemra)**

The Pacific region is large with several floats from many countries and eight different DACs: most are from the USA and Japan, the rest from Korea, China, Canada, Australia, Russia, and others. The Pacific ARC, therefore, has a big challenge in organizing such a wide array.

Most of the DACs are already producing Argo-based. JAMSTEC started the consistency checking work (float QC against WOA01 climatology), and they developed a reference dataset called SeHyD. The IPRC at the University of Hawaii contributes to PARC, among other things, by developing Argo-based products (trajectory and derived quantities in gridded fields). The Argo data are necessarily q/c'd during the product development stage, and problems are catalogued.

Regional analysis and inter-comparison work has started with the development of a climatology at JAMSTEC. Documentation and feedback to the PIs needs to be improved.

So far, it seems that Korea is the only one doing data assimilation at the regional level (MOM-based modeling effort at KMA).

In summary, the following were listed as outstanding issues at the PARC:

- communication is critical due to the scope of institutes involved
- resources are still problematic
- product development is moving forward, perhaps not optimally
- need a better mechanism for providing feedback to PIs (or maybe directly to the DACs)

**d. South Atlantic Ocean (Claudia Schmid)**

A prototype on consistency check is currently underway at the S. Atlantic ARC: comparison with nearby profiles (floats, XBTs, CTDs) and climatology (currently WOA 2001).

A need for efficient ways of communication with PIs in case of detected problems was identified.

Web site with links and information on:

- International collaboration (deployment, float donation and capacity building)
- Products coming out of other projects (e.g.): Monthly mixed layer properties. Seasonal Climatology of temperature and salinity

**e. Southern Ocean (Lesley Rickards)**

The Southern Ocean web site is up and running with maps (from FOAM). Partners include BODC, University of Washington (Annie Wong), CSIRO, and JAMSTEC.

Delayed-mode q/c was given a priority over the past year, so the ARC development was deferred. However, there was an effort to collect CTD from UK PIs. It was noted that EURO-ARGO funding is being used to help set up the ARC. One concern was a lack of feedback from operational models that are using the Argo data. This feedback, for example a list of rejected floats (and reasons for rejection) could help the ARC in its q/c efforts.

**3. Quality Control (Claudia Schmid)**

The discussion began with an inventory of the methods used for consistency checking of Argo data:

- Check of real time data to detect anomalies that were not detected by the DACs or the GDACs
  - Low-level consistency check of netcdf files (US DAC: compare with real-time files to make sure no variable was corrupted in d-mode file)
  - Profile duplications and similar problems (see separate PARC list)

- Comparison with climatology (on depth levels or otherwise)
  - WOA from US NODC
  - Argo-based climatology
  - Others regional climatology
  - Temporal evolution in North Atlantic
  - Potential for global climatologies to have limitations on the regional scale
- Statistical analysis :
  - Comparison with buddies on depth levels, comparison of salinity on potential temperature levels
  - Comparison of salinity on potential temperature levels
  - Objective analysis to detect bulls-eyes
- Near-real-time consistency check, e.g., map of difference between climatology and float profiles

Finally, Dean Roemmich suggested using an Argo climatology in order to determine statistics. For the purposes of consistency it should be enough for most areas, and we should not hold from moving ahead. It was also pointed out that consistency checking should be done both in near real time (within 1-3 months) and in delayed mode to be able to detect anomaly before the users do.

#### **a. Software exchange**

This topic was intended for two purposes. First, ARCs were asked if software, or lack thereof, was a limiting factor in making progress. This does not seem to be the case. Second, several institutes have made impressive progress in developing software to interact with Argo data. It was thought some of this could be shared among the group. This second aspect was not followed-through during the discussions, however, the following list was proposed and could be helpful in future discussions:

- What software is at a stage where it could be shared?
- What language are they based on?
- Develop systems that allow application to real-time files.
- How portable is the software?
- Software should start from netcdf files.
- This should include web tools/scripts as well.

#### **b. Reporting to PIs**

The question to whom to report the anomalies detected was raised. The group agreed that ARCs should report to the DACs because it is the fastest link to the PIs and/or delayed mode operators. It is another issue for users as they are not always aware of the specific DAC. It was suggested to better advertise the AIC help desk [support@argo.net](mailto:support@argo.net).

Finally for users (often students) that do not feel comfortable posting questions to the Argo mailing list or help desk, it was suggested to set up a user group forum in the form of a web-based site (including FAQs). This

would be helpful for users that have any sort of question and encourage communication between users.

**c. Time/resource issue**

It was pointed out that the ARC are really starting their activities this year as they needed to have enough delayed mode data processed to really progress on the methods.

Since many of these issues addressed on this topic could not be fully handled, a working group was formed (see Appendix 3, Action items). This group will have one representative from each ARC.

**4. Products (Jim Potemra)**

It was decided to attempt a catalog of available Argo products already being provided by ARCs (and possibly others). Jim started and updated a table on products presently distributed by the ARCs with input from the group (Appendix 4). Dean wants to advertise a table like that on the AST web site with description paragraph and contacts.

It was pointed out that it is difficult at this point to know what users want. It was suggested to have a forum, possible at the AIC. An Argo user group could be formed to make use of this forum. This will be a recommendation to the ADMT and then this action could be taken on board by AIC, moderated by AIC, and used by the ADMT to detect problems.

**5. Reference Data Set (Sylvie Pouliquen)**

It was agreed that the ARCs still have a role to play in the formation of the reference database as some data will only arrive that way. So, ARCs should continue contacting PIs in an effort to increase the amount of CTD data available for QC purposes.

As CCHDO is maintaining a non-public area for Argo, ARCs should encourage PIs to provide the data to CCHDO, and if an ARC gets data from a PI they should discuss with the PI to get the authorization to send it to CCHDO. This can be posted either in the public or non-public area depending on the PI's wish. The data flow goes from there into the Argo database. This topic will also be discussed at the ADMT meeting.

**6. Provide scientific QC to programs that need assistance (Annie Wong)**

The DACs should be the contact point to find out who will do the DM QC. The current list was screened and DM operators were found for most of them (see Appendix 5).

It's wise to notify the PI that the chosen center will do DMQC but as ARGO data are public one can consider that we are making value added products from public data. No need to ask for permission, but it is good to inform them.

## 7. Funding (chairs)

This session involved a discussion about funding issues for maintaining ARCs. Some groups do have funding for ARC activities: AOML, INCOIS and JAMSTEC. In Europe with EURO-ARGO, NA-ARC has funds to organize Argo activities in Europe and develop the missing functions such as consistency checking. Then the operation that relies on national centers such as IFREMER, BODC or BSH, IEO it should be more easily sustained. More specifically,

- AOML: funding for consistency check only. Institutional funding (not national funding)
- CORIOLIS: European funding for consistency check, national funding for reference data set & product development. European funding will be found for operational implementation. Request from operational centers: Building data sets for ocean reanalysis models/data assimilation.
- UH: no funding at national level, year-to-year. Providing community with products (e.g. MJO research proposal to create Argo-based product to increase understanding, found inconsistencies during the work on the project). User requests are mostly from individual PIs.
- BODC: no funding for real-time work. Funding for delayed-mode work, but need to do real-time work first.
- India: funding
- JAMSTEC: funding
- KORDI: not enough funding (or none?)

Can Argo Science Team provide some kind of support, e.g., to make it easier to get funding? The problem is if something is mandatory within Argo, then Argo should pay for it according to funding agencies.

Steve P.: For Argo to go operational a program manager would like to see the QC to be funded through Argo rather than through research projects.

Though there is some funding, manpower issues seem to be a problem at most if not all ARCs.

Some Arc pointed out that they would more easily get funds for product development if product development was a mandatory function. In fact it is and to do good product development, you first need to check consistency.

Steve Pietrowicz stated that in order for NOAA to help with funding issues, the ARCs need to develop Argo-based products that are "uniquely Argo", i.e., demonstrate how Argo gives us something that no other data source can. Some ARC pointed out that it doesn't sound wise to them to not use the CTD data that are also available in these Argo products.

## 8. User and PI feedback (chairs)

Can ARCs help in improving feedback from operation centers? It would be nice to know which Argo data was being withheld from the assimilation and why. This is an issue raised by GODAE, and there is a working group chaired by Jim Cummings

working on this. We should advertise again the Argo help desk in this community. GODAE is storing information about rejected profiles. They are going to do an inter-comparison of the ingested data for their models (with respect to rejected/not rejected).

The issue of reanalysis datasets for Operational Model Reanalysis came up and the question on how to serve these centers with delayed mode Argo dataset was discussed. There is a need to better identify how they will use Argo data and what they would like us to give them.

The session was concluded with a presentation by Charles Sun on behalf of Peter Chu, who is deriving surface currents from Argo trajectories. Their approach is to use an Optimal Spectral Decomposition (OSD) method. This method is based on EOFs and doesn't require first guess or auto correlation function. It is an alternative to Objective Interpolation (OI). Peter's web site can be consulted for further information (<http://www.oc.nps.navy.mil/~chu>).

#### **9. Wrap-up (chairs)**

ARCs need to define what is uniquely Argo, and then what needs to be done in operational mode, and what is value added and first put efforts on the first issue. Actions decided are recorded in Appendix 3.

Finally, it was decided that the ARC meeting was a successful forum and should be continued. The next meeting will be one day prior to ADMT9.

## **Appendix 1: Participants at the 1<sup>st</sup> ARC meeting**

Uday Bhaskar	INCOIS
Mathieu Belbeoch	AIC
Tim Boyer	US-NODC
Thierry Carval	IFREMER
Christine Coatanoan	IFREMER
Steve Diggs	CCHDO
Holger Giese	BSH
John Gilson	UCSD
Mark Ignaszewski	FNMOC
Fengying Ji	NMDIS
Brian King	NOC
Birgit Klein	BSH
Taiyo Kobayashi	JAMSTEC
Tomoaki Nakamura	JAMSTEC
James Potemra	Hawaii University
Loic Petit de la Villéon	IFREMER
Steve Piotrowicz	NOAA
Sylvie Pouliquen	IFREMER
Lesley Rickards	BODC
Dean Roemmich	UCSD
Claudia Schmid	AOML
Jang-Won Seo	METRI/KMA
Nobie Shikama	JAMSTEC
Lin Shaohua	NMDIS
Joseph Sudheer	INCOIS
Moon-Sik Suk	KORDI
Charles Sun	US-NODC
Jim Swift	CCHDO
Tseviet Tchen	CSIRO
Ann Gronell Thresher	CSIRO
Anh Tran	ISDM
Esmee Van Wijk	CSIRO
Xiang Wenxi	NMDIS
Annie Wong	University of Washington
Joon-Yong Yang	NFRDI
Liu Zenghong	Second Institute of Oceanography China

## **Appendix 2: The role of ARCs**

(NOTE: from <http://www.argo.ucsd.edu/FrARC.html>)

Argo supports five Argo Regional Centers (ARCs) that are divided mostly by ocean basin as can be seen in this map. These regional centers are an important part of the Argo program since they help to ensure the quality of Argo data in a more focused manner than the DACs or GDACs, but in a broader sense than the individual PIs. They can also encourage participation and collaboration between more countries working on the same ocean region. Users may find the regularly produced products helpful. The ARCs are in different levels of development, so to find out about each individual ARC, click on the buttons above.

### **What are the essential activities of Argo Regional Centers?**

- Perform regional analysis of all the Argo data in the region to assess its internal consistency as well as its consistency with recent shipboard CTD data.
- Provide feedback to PIs about the results of the regional analysis and possible outliers.
- Facilitate development of a Reference Data Base for delayed mode quality control. This includes assembling the most recent CTD data in their region.
- Prepare and distribute Argo data products on a regular basis. The main data product will be a consistent Argo delayed mode dataset for their region, but other products might include weekly analyses of temperature, salinity and currents calculated from floats. Documentation of these products will also be provided.

### **What are the optional activities of Argo Regional Centers?**

- Coordinating Argo float deployments for the region, including information on ships of opportunity and research vessels and guidance on regional float deployment.
- Develop new quality control tests for their region if appropriate. It may be expected that new procedures will be developed to check data quality and can be implemented earlier in the data system.
- Provide delayed mode quality control to national programs in their region without such capabilities.
- Compare Argo data with model output and with assimilated fields to understand why specific data are rejected by assimilations (e.g. model inconsistencies, systematic data errors).

### **Provide documentation of the procedures being done at the ARC.**

## **Appendix 3: Action items**

### **Consistency check working group:**

- IOARC: Uday Bhaskar, INCOIS
- NAARC: Christine Coatanoan, IFREMER
- PARC: Nobie Shikama, JAMSTEC
- SAARC: Claudia Schmid, NOAA/AOML
- SOARC: Annie Wong (IO sector), University of Washington (Are there any volunteers for other sectors? Please let Claudia Schmid know. Thank you.)

### **Working group will discuss and present results at next ARC meeting:**

- Methods for consistency checks (need to compile what kinds of checks ARCs are currently doing)
- Software exchange (software should start from Argo netcdf files)
- How to get information back to PI (through DACs) & web page with additional details
- ...

### **Reference Database**

- Encourage ARCs to continue collecting data from PIs.
- Ask ARCs to send the data they collected to CCHDO. CCHDO is maintaining a non-public area specifically for Argo reference data
- May need discussion with reluctant PIs through ARCs.

### **Product Inventory: Jim Potemra will coordinate**

- Finish table like and present it to the AST with description paragraph and contacts
- Table will eventually include email addresses and web links
- Table will be put on the AIC web page

### **Delayed-mode QC of Argo floats without a delayed-mode operator and Argo equivalent floats:**

- DM-operators were identified for most of the floats. Follow-up needed for some floats.
- Mathieu needs email addresses for each (batch of?) floats. NAVOCEANO will have more than one DM operator.
- AOML will inform PIs of US-DAC floats about our plans.

### **Float deployments:**

- Coordination of float deployments could be improved. Can AIC help to encourage people to update the plans????

### **User feedback:**

- How to get feedback from operational models? Can ARCs help in improving feedback from operation centers?
- [support@argo.net](mailto:support@argo.net) needs a description that includes reports of problems with data quality (e.g. salinity drift)

- It was suggested to have forum facility (may be at AIC). Also an ARGO user group that would use this forum.... This will be a recommendation to ADMT If approved this action could be implemented at (and probably moderated by) AIC. The forum could be used by ADMT to detect problems.

**AIC:**

- Links to ARC pages will be made more easily to find.



Notes for table:

1. Binary access means users are provided access to the data rather than ready made plots
2. Interpolation is to regular grid either in vertical, horizontal or time
3. Trajectory file means the Argo Trajectory files are used in the product development
4. Interactive search means web site provides such capabilities to interface with data
5. Float location indicates web site provides float location via graphical interface
6. Region is either Global or Regional (G/R)
7. Temporal resolution is Daily, Weekly, Monthly, Seasonal, Annual, Other (D,W,M,S,A,O); Climatology (C), temporal resolution can be given as well.
8. Argo/Mixed means product is either based solely on Argo data or incorporates other data sources (A/M)
9. Web site language (English, Korean, Chinese, Japanese, etc.)

**Appendix 5: Floats/Programs without designated delayed-mode operators**

Argo Programs	
Argentina	WHOI
Brazil	WHOI
Chile?	WHOI?
Costa Rica	Donated by Spain
Denmark	Germany; organized within Europe
IfM-Geomar	IfM-Geomar
JMA	JAMSTEC
KORDI	NFRDI, Southern ocean is problem
METRI/KMA	KORDI?, Southern ocean is problem
MEX-CO-US	PROVOR failed at deployment
Mexico	Donated by Spain
Netherlands	Organized within Europe (Coriolis)
Norway	Organized within Europe (Coriolis)
Russia	MEDS
Argo equivalent	
AOML	No salinity. AOML.
ESP-OMZ	(Chile) MEDS
FSU	AOML, ask them
HNFRI	JAMSTEC
IfM	Germany
JAMSTEC	JAMSTEC
NAVO	Med sea – Europe, Arabian Sea – India, S. China Sea - ? AOML will tell NAVO about the plans.
NDBC	Not at GDACs
NIPR	JAMSTEC
NRIFS	JAMSTEC
ORI	JAMSTEC
SAGE	JAMSTEC
TNFRI	JAMSTEC
TSK	JAMSTEC
UC	empty
UH	IPRC
UW	UW
UW-UA	UW