

Argo Steering Team Meeting (AST-9)

National Report – India (Submitted by M. Ravichandran)

A. Organization of Indian Argo Project

- a) The Indian Argo Project, fully funded by the Ministry of Earth Sciences (MoES), Government of India is implemented by the Indian National Center for Ocean Information Services (INCOIS) of MoES at Hyderabad. From this year, National Centre for Antarctic and Ocean Research (NCAOR) is taken up the responsibility of deployment of Argo floats.
- b) The Indian Argo Project for the year 2007-2012 envisages (a) Deployment of 200 Argo floats in the Tropical Indian Ocean, (b) Argo Data Management Activities, (c) Regional Coordination for Deployment in the Indian Ocean, (e) Development of Ocean Data Assimilation System, (f) Analysis and utilization of Argo data and (g) Capacity Building at National level.
- c) Several R&D Institutions including the National Institute of Oceanography at Goa, NCAOR, Goa, Space Applications Centre at Ahmedabad, National Remote Sensing Agency at Hyderabad, Indian Institute of Tropical Meteorology at Pune, National Centre for Medium range Weather Forecasting (NCMRWF) at New Delhi, Centre for Mathematical Modelling and Computer Simulation (C-MMACS) at Bangalore participate in the utilization of Argo data. Efforts are underway to encourage and enable academic institutions in this endeavour. National level Argo utilization meeting is planned in July 21-23, 2008.

1. Floats deployed and their performance

a. Float deployment

During the year 2007-08, 38 floats have been deployed with 10 floats with Oxygen sensors. Another 30 floats are planned to deploy in North Indian Ocean during October-Dec 2008.

Financial Year	Floats deployed
2002-03	10
2003-04	21
2004-05	33
2005-06	43
2006-07	15 (4 Oxygen Sensor)
2007-08	38 (12 Oxygen sensor)
TOTAL	160

During the year 2007-08, 10 floats were deployed with Oxygen sensors in Bay of Bengal and two floats were deployed in Western equatorial Indian Ocean.

b. Performance Analysis of the Floats deployed so far

Out of 160 floats deployed by India so far, 89 floats are active. Out of 89 active floats, 70 floats are less than two year old.

One Argo float beached in Srilanka was retrieved by Srilankan fishermen with NARA. Presently this float is with NARA. There was no damage in this float and it is in working condition. Highest appreciation to Srilankan fishermen, Argo Information Center and NARA their help in retrieving this float.

c. Status of contributions to Argo data management

- **Data acquired from floats**
India had deployed 160 floats so far. Out of these 89 floats are active. All the active floats data are processed and sent to GDAC.
- **Data issued to GTS**
Presently we do not have GTS access and hence we are not able to send Indian floats data to GTS. Up on our request CLS ARGOS is still continuing to send Indian floats data in TESAC format to GTS.
- **Data issued to GDACs after real-time QC**
All the active floats (89) data are subject to real time quality control and are being sent to GDAC.
- **Web pages**
INCOIS is maintaining Web-GIS based site for Indian Argo Program. It contains entire Indian Ocean floats data along with trajectories. Further details can be obtained by following the link http://www.incois.gov.in/incois/argo/argo_home.jsp.
- **Statistics of Argo data usage**
Argo data is widely put to use by various Organisations/ Universities/ Departments. INCOIS Argo web page statistics (for the past one year) are as shown below

Page	Hits	Visitors
Argo Web-GIS	3842	603
Data download	7367	244
Live Access Server	310	57
Argo products	510	52

- **Delayed Mode QC:**

INCOIS started generating and uploading D files to GDAC from July 2006, as of today 93 eligible floats(as of July 2007) were subjected to DMQC and only 81 of them were uploaded. More than 70% of the eligible Indian Floats are DMQCied and are available on GDAC.

Major bottle necks identified for DMQC are

- Lack of CTD profiles from North Indian Ocean is still a critical problem when decision is to be taken for the complicated cases. As per the suggestion following the previous DMQC meeting, if the data other than CTD is omitted from the reference database, the number of profiles for DMQC reduces significantly in many regions.
- The second major issue is the Manpower.

- **Trajectory data:**

- A total of **140 trajectory** netcdf files were processed and uploaded to the GDAC. The process of generation of trajectory netcdf files undergoes quality checks like position, time, cycle number, etc., and corresponding quality status is assigned to each parameter. Finally a visual check is performed to verify that there are no missing cycles without cycle numbers and to check the surface time intervals.
- For 8 new floats deployed in 2007, trajectory files are also processed for surface time and uploaded to GDAC.

The proposals of ATW-2 and status of implementations is given in the following tables.

Trajectory - Format checks		Status
1	Introduce missing cycles and CYCLE_NUMBERS with CYCLE_NUMBER starting from zero.	Done
2	Julian day (JULD) to be made monotonic.	Done
3	Position_QC and JULD_QC to be made consistent with Table2 of ATW-2.	Done
4	Increment in JULD to be consistent with CYCLE_NUMBER	Done

Trajectory - Scientific challenges		Status
5	Estimation of times at end of ascent and start of descent	Done for Floats deployed in 2007
6	Estimation of position at those times by extrapolation of reported surface positions	Code for the module is under process

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

Indian Argo Project is a 5 year Program from April 2002 to March 2007 fully funded by MoES, Govt. of India. For the next five year plan (2007 to 2012), Ministry of Earth Sciences has approved funding for deploying 40 floats per year (200 floats for 5 year term) with few floats will have additional sensors. Funding is secured upto 2012 for deployment of 200 Argo floats, Data management activities, Data analysis, etc.

2 Permanent and 1 temporary scientific/technical personal are working under Indian Argo project, which include personal for deployment of Argo floats, Data system, Analysis of Data, etc. in three different institutions. Efforts are underway to get more manpower.

3. Summary of deployment plans and other commitments to Argo for the upcoming year and beyond where possible.

India committed to deploy floats in North Indian Ocean wherever gap exists. Also plans to deploy few tens of floats in the Southern Indian Ocean.

INCOIS, India will continue to serve data management activities including Regional Data center and deployment co-ordination.

4. Summary of national research and operational uses of Argo data as well as contributions to Argo Regional Centers

Presently, Argo data are used by India Meteorological Department for their operational use. During the last few years many scientific users from different Organization (INCOIS, NIO, SAC, C-MMACS, NRSA, IITM, NCMRWF, IISc, etc) have started analyzing data for different applications. Efforts are underway in assimilating argo data in OGCM.

The data are being used for:

- To study the structure and variability of the Indian ocean
- To study the response of the North Indian Ocean to the summer monsoon
- Heat content variability of Indian Ocean
- Barrier layer studies in Bay of Bengal and Arabian Sea
- To study short-term variability of Sound Velocity
- Assimilation of Argo float data in OGCMs
- Validation of Ocean models

One of the main Objectives for the forthcoming year is to assimilate Argo and other satellite data in OGCM and deliver operational nowcast/ forecasts on the seasonal time scale for the Indian Ocean region.

National Level Argo user meet workshop is planned during July 21-23, 2008, mainly to take stock of the research going on in National level using Argo data.

Regional Centre Functions

- Acquisition of Argo data from GDAC corresponding to floats other than deployed by India and made them available on INCOIS web site.
- Delayed Mode Quality Control (Refer 2.0 above)
- Data from the Indian Ocean regions are gridded into 3x3 box for monthly and 10 day intervals. These gridded data sets are made available through Live Access Server (LAS). Users can view and download data/images in their desired format.
- Additionally SST from TMI and Wind from Quikscat are made available on daily and monthly basis. SSHA merged product is provided on ten day basis on INCOIS Live Access Server.
- Data Sets (CTD, XBT) have been provided to CORIOLIS, IFREMER for integration into the Reference Data Sets, used for Delayed Mode Quality Control.
- Value added products:

Two types of products are currently being made available to various user from INCOIS web site. They are:

1. Time series plots corresponding to each float (only for Indian floats). This include the following plots:
 - Water fall plots
 - Surface pressure
 - Bottom most pressure
 - Surface temperature
 - Bottom most temperature
 - Surface salinity
 - Bottom most salinity
 - Trajectory of float

- T/S plots.
2. Spatial plots using the objectively analysed from all the Argo floats data deployed in the Indian Ocean. This includes:
- Temperature (at 0, 75, 100, 200, 500, 1000 meters)
 - Salinity (at 0, 75, 100, 200, 500, 1000 meters)
 - Geostrophic Currents (at 0, 75, 100, 200, 500, 1000 meters)
 - Mixed Layer Depth, Isothermal Layer Depth
 - Heat Content up to 300 mts
 - Depth of 20 deg and 26 deg isotherms

These valued added products can be obtained from the following link http://www.incois.gov.in/Incois/argo/products/argo_frames.html

Efforts are underway in updating Indian Ocean reference data sets using high quality CTD data collected using Indian Research Vessels. Some of the CTD data were submitted to CCHDO through Coriolis Data Center and soon these data will also made available from ARC-Indian Ocean webpage. A separate study has been initiated with National Institute of Oceanography and Indian Institute of Technology for making Reference data base for DMQC, Indian Ocean Atlas and validation of profile data (Real-time and Delayed mode) with CTD and recent Argo profiles.

TVS Udaya Bhaskar, D. Swain and M. Ravichandran (2007), Mixed layer variability in Northern Arabian Sea as detected by an Argo float, *Ocean Science Journal*, Vol. 42, No. 4, Dec, 2007.

Anitha, G., M. Ravichandran, and R. Sayanna, (2008), Surface buoyancy flux in Bay of Bengal and Arabian Sea, *Annales Geophysicae.*, in press