Argo Steering Team Meeting (AST-8)

National Report – India

(Submitted by M. Ravichandran)

1. 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 (lead) jointly with the National Institute of Ocean Technology (NIOT) of MoES, Chennai, and the Center for Atmospheric and Ocean Sciences (CAOS) of Indian Institute of Science at Bangalore.

b) The Indian Argo Project envisages (a) Deployment of 150 Argo floats in the Tropical Indian Ocean, (b) Setting up and operation of Argo Data Reception and Processing System at National level, (c) Setting up and operation of Regional Argo Data Centre, (d) 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, 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.

2. Floats deployed and their performance

a. Float deployment

Deployment of Argo floats is the major part of the program and the total commitment of India's contribution is 150 floats for the period 2002-2007. To fulfill the commitment, 122 floats have been deployed so far. Remaining 28 floats have already procured and will be deployed within 2 or 3 months depending upon the availability of ship time. The year-wise break-up of float deployment is given here.

Financial Year	Floats deployed
2002-03	10
2003-04	21
2004-05	33
2005-06	43
2006-07	15 (2 Oxygen Sensor)
TOTAL	122 (28 to be deployed)

During the year 2006-07, six floats were procured with Oxygen sensors and two floats of this type were already deployed in Bay of Bengal

b. Performance Analysis of the Floats deployed so far

Out of 122 floats deployed by India so far, 76 floats are active, 4 floats are providing only near surface information and 42 floats are inactive. Out of 42 inactive floats, 4 floats were beached (2 in Maldives, 1 in Somali coast and other one in Oman coast), 28 floats were failed due to (i) pressure sensor problem, (ii) energy flu and/or (iii) completion of its life cycle. The reasons for the remaining failed floats are not known, but they are Provor type floats.

One Argo float beached in Maldives was retrieved by Maldivian fishermen was handed over to Indian High commission and was brought by Indian Navy to India. There was no damage in this float and it is in working condition. Highest appreciation to Maldivian fishermen, Argo Information Center, Indian High Commission (Maldives), and Indian Navy for their help in retrieving the float.

3. Status of contributions to Argo data management

a. Real time data stream:

One Scientist from INCOIS was trained by Coriolis Data Centre, France for Automatic Quality control procedure, development of Visual QC and generation of Data products. A hand on experience of Coriolis Visual Quality Control (CVQC) was used to correct all INCOIS profiles by eliminating error flags. The profiles with wrong position are changed to the correct position using the surface trajectory information. Three level Quality Control is implemented at INCOIS for generating data with correct quality flags. The three levels include 1. Automatic Quality Control , 2. Visual Quality Control and 3. Using Objective Analysis for Quality Control.

The Automatic Quality Control passes the data to 19 prescribed quality control checks and subsequently the profiles generated are used in Objective Analysis and those profiles which are rejected by the Objective Analysis are checked with Visual QC for further correction of flags.

With the above three tier architecture all the old data starting from October 2002 were reprocessed and NetCDF files are generated and uploaded on to GDAC.

b. Delayed Mode QC:

Out of 122 floats deployed by India, 96 profiles are eligible for DMQC (13 floats were failed before 1 year time frame and another 13 are less than one

year old). Out of 96 eligible floats, DMQC are made only 10 floats and uploaded to GDAC. Remaining floats will be done in 2 to 3 months. The delay is due to some problem in R files, which was corrected recently.

Lack of CTD profiles from North Indian Ocean is still a critical problem when decision is to be taken for a complicated case. It was advised on DMQC-2 to switch off the bottle data for better calibration. It is found that in some cases this strategy is very useful for making meaning full guess about the float sensor behavior but data gaps will be worse in these cases.

c. Trajectory data:

The Argo trajectory files for floats deployed after 2004 are re-processed from raw ADS format. A total of 67 trajectory netcdf files are uploaded to the GDAC. The trajectory files for the rest of the floats are under processing.

d. Argo Regional Data Center and Basin level co-ordination (Indian Ocean)

Indian National Centre for Ocean Information Services (INCOIS), India acts as Argo Regional Data center (ARC) for the Indian Ocean region. The functions of ARC-Indian Ocean are as follows:

- Acquisition of Argo data from GDAC for Indian Ocean region and made available from ARC web.
- Acquiring CTD data from Indian Research Vessel for Updating Indian ocean reference data base
- Comparison of float to float and float to CTD data
- Delayed mode Quality control
- Statistics of floats (deployed, active, drifts, percentage of floats in water from deployment, etc)
- Argo Value added products
- Basin level Deployment Co-ordination

Data from Indian Ocean Argo floats are made available at ARC- Indian Ocean WEB-GIS site http://www.incois.gov.in/argo/arc/present.jsp. Wherein, users can quarry with desired time, depth and parameters and, download the required data in ASCII format for a single float or group of floats. All the active and inactive floats data are made available in this site.

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.

Value-added Products

As a part of ARC activities, products such as Waterfall plot of temperature, salinity and density (to show consistency of the data), sea surface temperature, sea surface salinity, T-S plots, time-series of surface pressure & maximum profile pressure by float type are generated and published in INCOIS web. This information is available from INCOIS website for all the Indian Ocean floats from the date of deployment to present. Also, objectively analyzed monthly products such as spatial variation of Sea surface temperature, sea surface salinity, mixed layer depth, heat content up to 300 m depth, upto thermocline depth and upto 26 deg isotherms, Geostrophic currents, dynamic height, etc are generated. http://www.incois.gov.in/argo/arc/products.jsp

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). (http://www.incois.gov.in/argo/arc/las.jsp) Users can view and download data/images in their desired format.

Basin level Regional Co-ordination for Argo floats deployment plan for Indian Ocean is made available from http://www.incois.gov.in/website/futureextended/viewer.htm

3. 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. During this period, India committed to deploy 150 floats. However, we could deploy only 122 floats as of now and the remaining 28 floats will be deployed within two months.

For the next five year plan (2007 to 2012), Ministry of Earth Sciences has approved funding for deploying 50 floats per year (250 floats for 5 year term) with few floats will have additional sensors.

5 Permanent and 3 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.

4. 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.

5. 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 one year 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.