

# 16 National report of India (2021)

(Submitted by E. Pattabhi Rama Rao)

## 1. The status of implementation

### 1.1a Floats deployment

During the year 2020 - 21, 11 floats were deployed in the Indian Ocean, taking the total contribution to 494. The new deployments in 2020-21 include 05 Bio-Argo floats with additional sensors like Doxy, FLBB, Chl-a.

### 1.1b Performance Analysis of Floats deployed

Out of 494 floats deployed, 110 floats are active and providing profiles.

## 1.2 Technical problems encountered and solved

None

## 1.3 Status of contributions to Argo data management

- **Data acquired from floats**

India had deployed 494 floats so far (till March 31, 2021). Out of these 110 floats are active. All the active floats data are processed and sent to GDAC.

- **Data issued to GTS**

BUFR format messages from these floats are being sent to GTS via RTH< New Delhi RTH.

- **Data issued to GDACs after real-time QC**

All the active floats (110) 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:

<https://incois.gov.in/argo/argo.jsp>

- **Statistics of Argo data usage**

Argo data is widely put to use by various Organisations/ Universities/ Departments. Indian Meteorological Department (IMD) is using Argo data for their operational purpose. Scientists, Students and Researchers from INCOIS, NIO, SAC, C-MMACS, NRSA, IITM, NCMRWF, IISc etc are using Argo data in various analysis. Many paper based on Argo data were also published in reputed journals. See the references below. The demand for Bio-Argo data is increasing and the same is being supplied for research interest by various research institutes and universities.

Products generated from Argo data

- Value added products obtained from Argo data are continued. Continued to variational analysis method while generating value added products. Many products are generated using Argo temperature and salinity data. The Argo T/S data are first objectively analysed

and this gridded output is used in deriving value added products. More on this can be seen in the RDAC functions.

- Value added products from argo floats and many other data (fluxes, winds, satellite data products, model analysis outputs etc) are available through INCOIS Live Access Server (LAS). For further details visit <http://las.incois.gov.in>.

#### **1.4 Status of Delayed Mode Quality Control process**

- INCOIS started generating and uploading D files to GDAC from July 2006, and as of today, profiles belonging to all eligible floats have been subjected to DMQC.
- Advanced Delayed Mode Quality Control s/w developed by CSIRO is being put to use successfully. Using this s/w all the eligible floats are reprocessed to tackle pressure sensor offset problems, salinity hooks, thermal lag corrections, salinity drifts.
- Under the data search and archeology data from our own sister concerns is being obtained and put to use in the delayed mode processing.
- About 44% of the eligible profiles are subjected to DMQC and the delayed mode profiles are uploaded on to GDAC. Majority of the old dead float which are passed through DMQC are converted to Ver 3.1 and uploaded to GDAC

#### **1.5 Trajectory files status:**

Trajectory files in Ver 3.1 format for all APEX floats are being uploaded to GDAC and format errors wrt trajectories of PROVOR and ARVOR floats are being resolved.

### **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 fully funded by Ministry of Earth Sciences, (MoES), Govt. of India. Funding request for the deployment of 40 Argo floats per year including (3:2 Normal and Bio), Data management activities, Data analysis, etc. for the period 2021-2026 is under consideration.

Three Permanent and one temporary scientific/technical personnel are working under Indian Argo project, which include personal for deployment of Argo floats, Data system, Analysis of Data, etc.

### **3. Summary of deployment plans (level of commitment, areas of float deployment) and other commitments to Argo (data management) for the upcoming year and beyond where possible.**

India is committed to deploy floats in the Indian Ocean wherever gap exists. India has committed 40 floats per year during 2021-2026. Out of 40 floats, 17 floats will be bio-argo floats. After ascertaining the gap region and cruise plan of MoES research vessels, these floats will be deployed.

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

**Operational:** All Argo data are being routinely assimilated in Ocean Model for providing Global ocean analysis. This analysis is being used by Indian MET department for initialization of coupled ocean-atmosphere forecast of the Monsoon. From the year 2011, India is providing seasonal forecast of monsoon using dynamical model wherein Ocean analysis (with assimilation of Argo) is an important contribution. The analysis products are being made available through INCOIS live access server ([las.incois.gov.in](http://las.incois.gov.in)).

**Research:** Argo data are being widely used for many applications to understand the Indian Ocean dynamics, cyclone and monsoon system in relation to heat content, thermocline

component of sea level and validation of OGCM by various Indian institutions and university students.

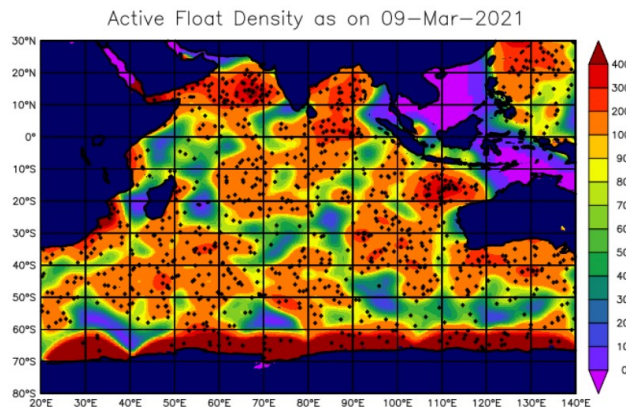
### Argo Regional Centre (ARC) - Indian Ocean

(<http://www.incois.gov.in/argo/ARDCenter.jsp>)

- Acquisition of Argo data from GDAC corresponding to floats other than deployed by India and made them available on INCOIS web site.
- All these data sets are made available to the user through a s/w developed with all GUI facilities. This s/w is made available through FTP at INCOIS and UCSC web sites.
- Delayed Mode Quality Control (Refer 2.0 above)
- Data from the Indian Ocean regions are gridded into 1x1 box for monthly and 10 days and monthly intervals. These gridded data sets are made available through INCOIS Live Access Server (ILAS). Users can view and download data/images in their desired format.
- ERDDAP site was set up for the data and data products derived from Argo floats.
- Data Sets (CTD, XBT, Subsurface Moorings) are being acquired from many principle investigators. These data are being utilized for quality control of Argo profiles.
- Value added products: Two types of products are currently being made available to various user from INCOIS web site. They are:
  - (i) Time series plots corresponding to each float (only for Indian floats).
  - (ii) Spatial plots using the objectively analysed from all the Argo floats data deployed in the Indian Ocean.

These valued added products can be obtained from the following link <https://incois.gov.in/argo/ANDCProducts.jsp>

- Regional Co-ordination for Argo floats deployment plan for Indian Ocean. The float density in Indian Ocean as on 09 Mar, 2021 is shown below.



**5. Issues that your country wishes to be considered and resolved by the Argo Steering Team regarding the international operation of Argo. These might include tasks performed by the AIC, the coordination of activities at an international level and the performance of the Argo data system. If you have specific comments, please include them in your national report.**

None

**6. To continue improving the quality and quantity of CTD cruise data being added to the reference database by Argo PIs, it is requested that you include any CTD station data that was taken at the time of float deployments this year. Additionally, please list CTD data (calibrated with bottle data) taken by your country in the past year that may**

**be added to the reference database. These cruises could be ones designated for Argo calibration purposes only or could be cruises that are open to the public. To help CCHDO track down this data, please list the dates of the cruise and the PI to contact about the data.**

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## **7. Argo bibliography**

INCOIS is actively involved in utilization of Argo data in various studies pertaining to Indian Ocean. Also INCOIS is encouraging utilization of Argo data by various universities by funding them. Some of the publications in 2020 resulted from Argo data which includes scientists from INCOIS and other Indian institutions are given below:

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3. Ali, S. A., Z. Mao, J. Wu, X. Chen, Q. Zhu, H. Huang, F. Gong, and T. Wang, 2020: Satellite Evidence of Upper Ocean Responses to Cyclone Nilofar. *Atmosphere-Ocean*, **58**, 13-24, <https://doi.org/10.1080/07055900.2019.1700097>
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5. Anandh, T. S., B. K. Das, J. Kuttippurath, and A. Chakraborty, 2020: A Comparative Analysis of the Bay of Bengal Ocean State Using Standalone and Coupled Numerical Models. *Asia-Pacific Journal of Atmospheric Sciences*, <https://doi.org/10.1007/s13143-020-00197-z>
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