Argo National Data Management Report (2021) – India

1. Status

- **Data acquired from floats**
  India has deployed 01 new floats between November 2020 and November 2021 in the Indian Ocean taking its tally to 494 floats so far. Out of these 83 floats are active. All the active floats data are processed and sent to GDAC.

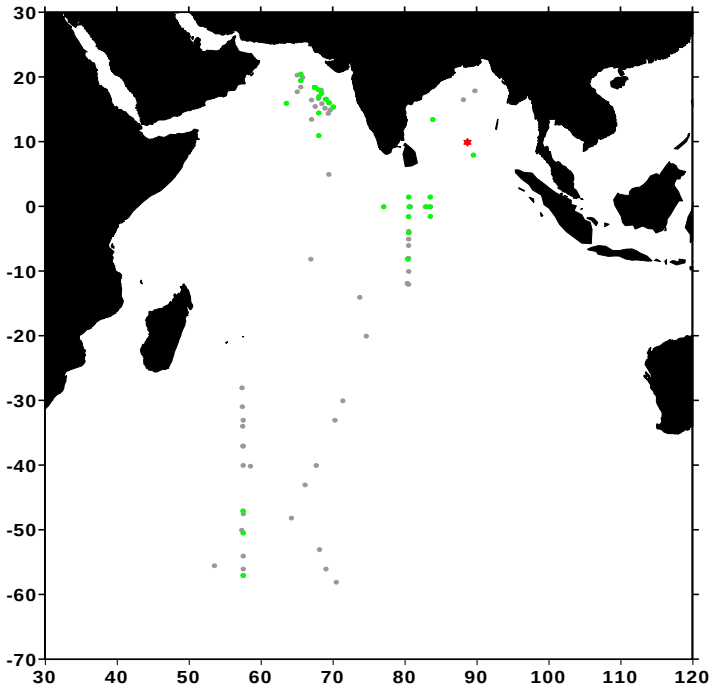


Fig. Status of Argo floats deployed (red) by India, Active BioArgo (green) and CoreArgo (grey) floats in the Indian Ocean.

- **Data issued to GTS**
  All the active floats data is being distributed via RTH New Delhi. Processing time schedules are changed to minimize the time difference in dissemination to GTS and GDAC.

- **Data issued to GDACs after real-time QC**
  All the active floats (83) data are subject to real time quality control and are being successfully uploaded to GDAC.

- **Data issued for delayed QC**
  In total ~55% of the eligible profiles for DMQC are generated and uploaded to GDAC. Some of the old DMQCed floats with old version 2.3 are converted to V 3.1 and uploaded to GDAC. Also floats identified to be having problem and audit report shared is reworked and uploaded.

- **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. Apart from the floats deployed by India, data from floats deployed by other nations in the Indian Ocean are received from the Argo Mirror and made available in the INCOIS website. User can download the data based on his requirement.

- Statistics of Indian and Indian Ocean floats are generated and maintained in INCOIS web site. The density maps for aiding people for new deployments are made available on a monthly basis. For full details visit http://www.incois.gov.in/Incois/argo/argostats_index.jsp.

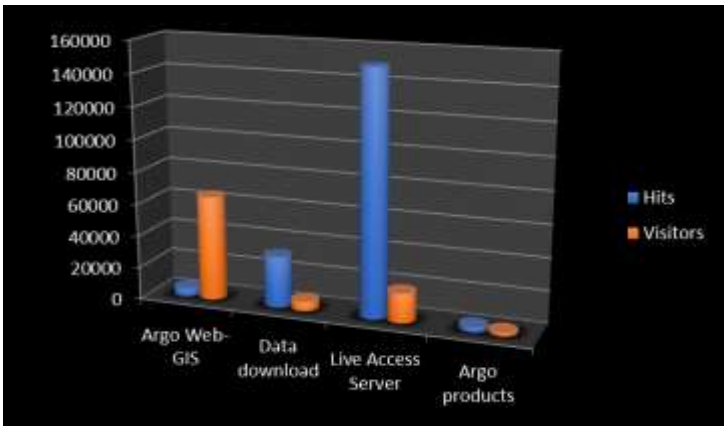
- **Trajectory**

  INCOIS Ver 3.1 trajectory files for all APEX Argo and Iridium floats are still found to be having issues and are being rejected. The problem is still being worked out.

- **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.

  - Argo data is assimilated in ROMS model using LETKF and product names RAIN is being generated and made available to users.
  - Continued to use BGCArgo data for validation of Biogeochemical model like ROMS.



INCOIS Argo web page statistics (for the past one year) are as shown below

Page	Hits	Visitors
Argo Web-GIS	5001	65117
Data download	32005	5804
Live Access Server	150225	18297
Argo products	3027	2014

- **Products generated from Argo data**

1. 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 see in the RDAC functions.
2. Version 2.2 of DVD on "Argo data and products for the Indian Ocean" is released to public for use with data corresponding to Dec 2020 updated. This DVD consists of ~ 3,75,000 profiles and products based on the Argo T/S. A GUI is provided for user to have easy access to the data. DVD product is discontinued and it is being made available via INCOIS and UCSD web sites.
3. To cater to many users of INCOIS LAS, it is enhanced in term of capacity. New Server is procured and new products viz., model outputs, new wind products (OSCAT), fluxes are made available. New products as per the request received from the users in future are being made available. For further details visit http://las.incois.gov.in.
4. The Argo and value added products derived from Argo data are also alternatively made available through ERDDAP. Here the provision for individual data and the derived products is also enabled for users.

2. Delayed Mode QC

- INCOIS started generating and uploading D files to GDAC form July 2006, and as of today, profiles belonging to all eligible floats have been subjected to DMQC.
- DMQC S/W obtained from Cecil, IFREMER is being used. Using this s/w all the eligible floats are reprocessed to tackle pressure sensor offset problems, salinity hooks, thermal lag corrections, salinity drifts. COW S/w is mainly used for performing DMQC of Provor/Arovor floats.
- 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 55% 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.

3. GDAC Functions

INCOIS is not operating as a GDAC.

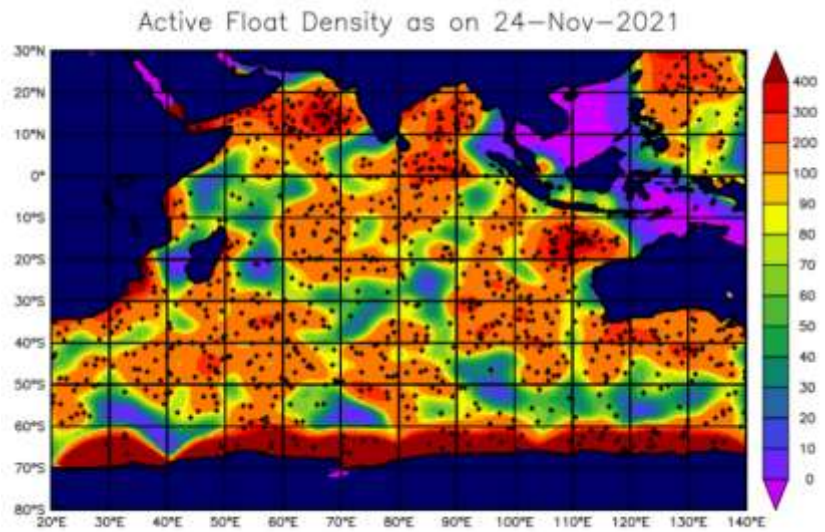
4. Regional Centre Functions

- Acquisition of Argo data from GDAC corresponding to floats other than deployed by India and made them available on INCOIS web site.
- 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.
- Additionally SST from TMI, AMSRE and Wind from ASCAT, Chla from MODIS and OCM-2 are also made available on daily and monthly basis.
- Global wind products from OSCAT is also generated and made available on LAS along with TROP flux data sets.
- 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 http://www.incois.gov.in/Incois/argo/products/argo_frames.html

- Regional Co-ordination for Argo floats deployment plan for Indian Ocean. The float density in Indian Ocean as on 24 Nov, 2021 is shown below.



Publications:

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 resulted from Argo data which includes scientists from INCOIS are given below:

1. Ganguly, D., K. Suryanarayana, and M. Raman, 2021: Cyclone Ockhi Induced Upwelling and Associated Changes in Biological Productivity in Arabian Sea. Marine Geodesy, 44, 70-89, https://doi.org/10.1080/01490419.2020.1838675.
2. Jayaram, C., T. V. S. U. Bhaskar, N. Chacko, S. Prakash, and K. H. Rao, 2021: Spatio-temporal variability of chlorophyll in the northern Indian Ocean: A biogeochemical argo data perspective. Deep Sea Research Part II: Topical Studies in Oceanography, 183, 104928, https://doi.org/10.1016/j.dsr2.2021.104928.
3. Jayaram, C., J. Pavan Kumar, T. V. S. Udaya Bhaskar, I. V. G. Bhavani, T. D. V. Prasad Rao, and P. V. Nagamani, 2021: Reconstruction of Gap-Free OCM-2 Chlorophyll-a Concentration Using DINEOF. Journal of the Indian Society of Remote Sensing, https://doi.org/10.1007/s12524-021-01317-6.
4. Kuttippurath, J., N. Sunanda, M. V. Martin, and K. Chakraborty, 2021: Tropical storms trigger phytoplankton blooms in the deserts of north Indian Ocean. npj Climate and Atmospheric Science, 4, 11, https://doi.org/10.1038/s41612-021-00166-x.
5. Maneesha, K., D. H. Prasad, and K. V. K. R. K. Patnaik, 2021: Biophysical responses to tropical cyclone Hudhud over the Bay of Bengal. Journal of Operational Oceanography, 14, 87-97, https://doi.org/10.1080/1755876X.2019.1684135.
6. Mathew, T., S. Prakash, L. Shenoy, A. Chatterjee, T. V. S. Udaya Bhaskar, and B. Wojtasiewicz, 2021: Observed variability of monsoon blooms in the north-central Arabian Sea and its implication on oxygen concentration: A bio-argo study. Deep Sea Research Part II: Topical Studies in Oceanography, 184-185, 104935, https://doi.org/10.1016/j.dsr2.2021.104935.
7. Pradhan, M., A. Srivastava, S. A. Rao, D. S. Banerjee, A. Chatterjee, P. A. Francis, O. P. Sreejith, M. Das Gupta, and V. S. Prasad, 2021: Are ocean-moored buoys redundant for prediction of Indian monsoon? Meteorology and Atmospheric Physics, 133, 1075-1088, https://doi.org/10.1007/s00703-021-00792-3.
8. Prakash, K. R., T. Nigam, V. Pant, and N. Chandra, 2021: On the interaction of mesoscale eddies and a tropical cyclone in the Bay of Bengal. Natural Hazards, https://doi.org/10.1007/s11069-021-04524-z.
9. Pramanik, S. and S. Sil, 2021: Assessment of SCATSat-1 Scatterometer Winds on the Upper Ocean Simulations in the North Indian Ocean. Journal of Geophysical Research: Oceans, 126, e2020JC016677, https://doi.org/10.1029/2020JC016677.
10. Prasanth, R., V. Vijith, V. Thushara, J. V. George, and P. N. Vinayachandran, 2021: Processes governing the seasonality of vertical chlorophyll-a distribution in the central Arabian Sea: Bio-Argo observations and ecosystem model simulation. Deep Sea Research Part II: Topical Studies in Oceanography, 183, 104926, https://doi.org/10.1016/j.dsr2.2021.104926.
11. Raju, N. J., M. K. Dash, P. K. Bhaskaran, and P. C. Pandey, 2021: Numerical Investigation of Bidirectional Mode-1 and Mode-2 Internal Solitary Wave Generation from North and South of Batti Malv Island, Nicobar Islands, India. Journal of Physical Oceanography, 51, 47-62, https://doi.org/10.1175/JPO-D-19-0182.1.
12. Sabu, P., M. P. Subeesh, J. V. George, N. P. Anilkumar, and M. Ravichandran, 2021: Enhanced subsurface mixing due to near-inertial waves: observation from Seychelles-Chagos Thermocline Ridge. Ocean Dynamics, https://doi.org/10.1007/s10236-020-01430-z.
13. Seelanki, V., T. Nigam, and V. Pant, 2021: Upper-ocean physical and biological features associated with Hudhud cyclone: A bio-physical modelling study. Journal of Marine Systems, 215, 103499, https://doi.org/10.1016/j.jmarsys.2020.103499.
14. Udaya Bhaskar, T. V. S., V. V. S. S. Sarma, and J. Pavan Kumar, 2021: Potential Mechanisms Responsible for Spatial Variability in Intensity and Thickness of Oxygen

Minimum Zone in the Bay of Bengal. Journal of Geophysical Research: Biogeosciences, 126, e2021JG006341, https://doi.org/10.1029/2021JG006341.
15. Valsala, V., M. G. Sreeush, M. Anju, P. Sreenivas, Y. K. Tiwari, K. Chakraborty, and S. Sijikumar, 2021: An observing system simulation experiment for Indian Ocean surface pCO2 measurements. Progress in Oceanography, 194, 102570, https://doi.org/10.1016/j.pocean.2021.102570.
16. Vidya, P. J., M. Balaji, and R. Mani Murali, 2021: Cyclone Hudhud-eddy induced phytoplankton bloom in the northern Bay of Bengal using a coupled model. Progress in Oceanography, 197, 102631, https://doi.org/10.1016/j.pocean.2021.102631.
17. Vijay, A., K. Munnooru, G. Reghu, A. Gera, R. R. Vinjamuri, and M. V. Ramanamurthy, 2021: Nutrient dynamics and budgeting in a semi-enclosed coastal hypersaline lagoon. Environmental Science and Pollution Research, https://doi.org/10.1007/s11356-021-15334-y.