Argo National Data Management Report (2019) – India

1. Status

- **Data acquired from floats**
  India has deployed 28 new floats (including 8 Apex-BioArgo [1 with Nitrate Sensor), 20 Arovor-L floats) between January 2019 and September 2019 in the Indian Ocean taking its tally to 482 floats so far. Out of these 149 floats are active. All the active floats data are processed and sent to GDAC.

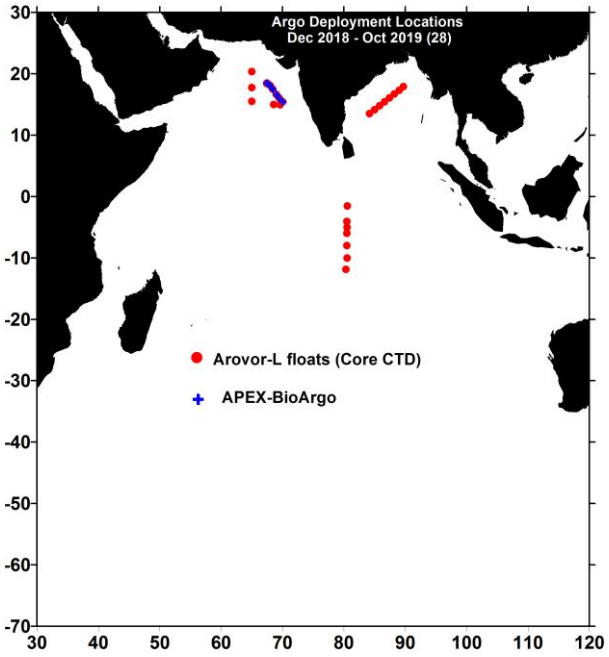


Fig. Location of Argo floats deployed by India

- **Data issued to GTS**
  All the active floats data is being distributed via RTH New Delhi. Previously identified problems are rectified and data are pushed regularly.

- **Data issued to GDACs after real-time QC**
  All the active floats (149) data are subject to real time quality control and are being successfully uploaded to GDAC. Few old floats with old version (Ver 2.3) are being converted to Ver 3.1 and uploaded to GDAC.

- **Data issued for delayed QC**
  In total ~50% of the eligible profiles for DMQC are generated and uploaded to GDAC. Old DMQCed floats with old version 2.3 are converted to V 3.1 and uploaded 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. 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.

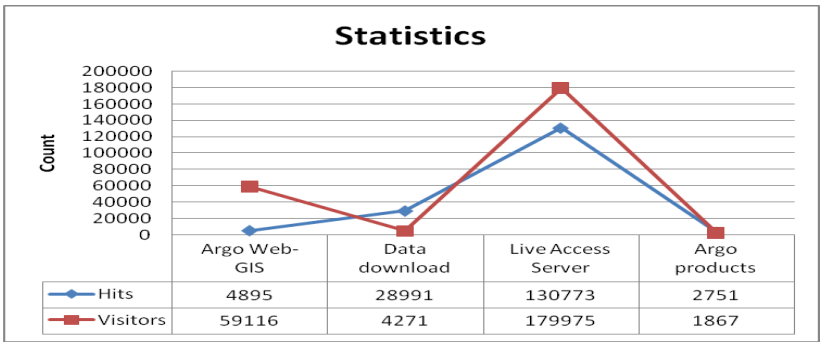
- **Trajectory**

  INCOIS started generating Ver 3.1 trajectory files for all APEX Argo and Iridium floats and uploading them to GDAC. Provor, Arvor floats data will be uploaded shortly.

- **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. More and more BioArgo floats are being deployed in the Indian Ocean. Simultaneous cruises are also being planned.
  - This data is continued to be used for validation of Biogeochemical model outputs like ROMS with Fennel module.



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

Page	Hits	Visitors
Argo Web-GIS	4895	59116
Data download	28991	4271
Live Access Server	130773	179975
Argo products	2751	1867

- **Products generated from Argo data**

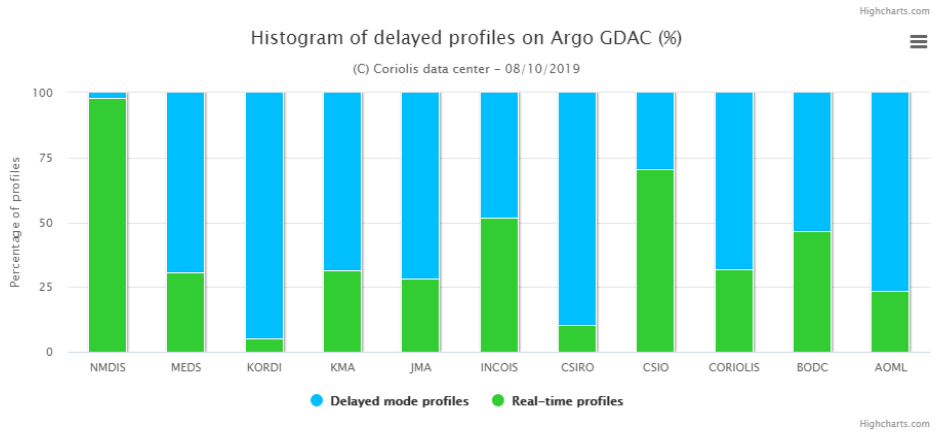
  1. Value added products obtained from Argo data are continued. Continued to variational analysis method while generating value added products. Many products are generated using Argo temperature and salinity data. The Argo T/S data are first objectively analysed and this

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 2018 updated. This DVD consists of ~ 3,50,000 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.
- Advanced Delayed Mode Quality Control s/w developed by CSIRO is being put to use successfully. Also the modified DMQC S/W obtained from Cecil, IFREMER is also 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 51% 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.



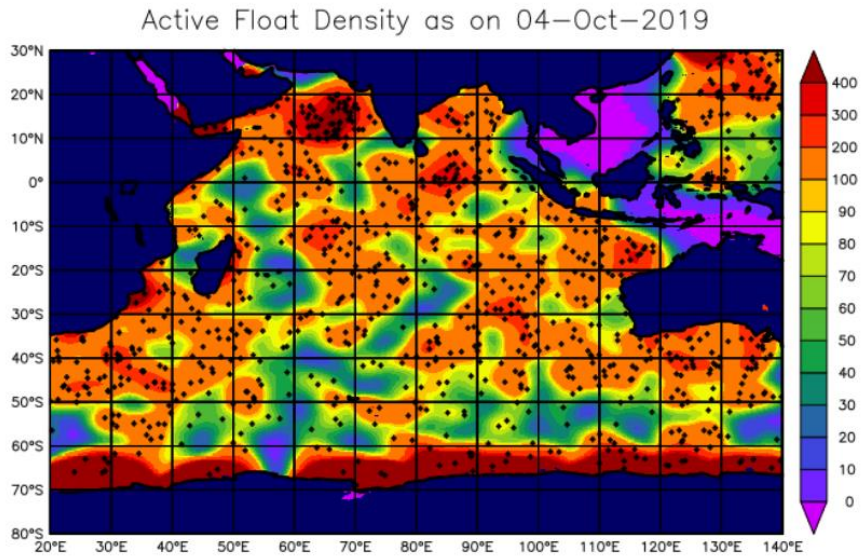
3. GDAC Functions

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 21 Nov, 2018 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. Bhowmick, S. A., N. Agarwal, M. M. Ali, C. M. Kishtawal, and R. Sharma, 2019: Role of ocean heat content in boosting post-monsoon tropical storms over Bay of Bengal during La-Niña events. *Climate Dynamics*, 52, 7225-7234, https://doi.org/10.1007/s00382-016-3428-5.
2. Chakraborty, K., N. Kumar, M. S. Girishkumar, G. V. M. Gupta, J. Ghosh, T. V. S. Udaya Bhaskar, and V. P. Thangaprakash, 2019: Assessment of the impact of spatial resolution on ROMS simulated upper-ocean biogeochemistry of the Arabian Sea from an operational perspective. Journal of Operational Oceanography, 1-27, https://doi.org/10.1080/1755876X.2019.1588697.
3. Chakraborty, K., A. A. Lotliker, S. Majumder, A. Samanta, S. K. Baliarsingh, J. Ghosh, P. P. Madhuri, A. Saravanakumar, N. S. Sarma, B. S. Rao, and P. Shanmugam, 2019: Assessment of model-simulated upper ocean biogeochemical dynamics of the Bay of Bengal. Journal of Sea Research, 146, 63-76, https://doi.org/10.1016/j.seares.2019.01.001.
4. Chatterjee, A., B. P. Kumar, S. Prakash, and P. Singh, 2019: Annihilation of the Somali upwelling system during summer monsoon. Scientific Reports, 9, 7598, https://doi.org/10.1038/s41598-019-44099-1.
5. Chaudhuri, D., D. Sengupta, E. D'Asaro, R. Venkatesan, and M. Ravichandran, 2019: Response of the Salinity-Stratified Bay of Bengal to Cyclone Phailin. Journal of Physical Oceanography, 49, 1121-1140, https://doi.org/10.1175/JPO-D-18-0051.1.
6. Girishkumar, M. S., V. P. Thangaprakash, T. V. S. Udaya Bhaskar, K. Suprit, N. Sureshkumar, S. K. Baliarsingh, J. Jofia, V. Pant, S. Vishnu, G. George, K. R. Abhilash, and S. Shivaprasad, 2019: Quantifying Tropical Cyclone's Effect on the Biogeochemical Processes Using Profiling Float Observations in the Bay of Bengal. Journal of Geophysical Research: Oceans, 124, 1945-1963, https://doi.org/10.1029/2017JC013629.
7. Goni, G. J., J. Sprintall, F. Bringas, L. Cheng, M. Cirano, S. Dong, R. Domingues, M. Goes, H. Lopez, R. Morrow, U. Rivero, T. Rossby, R. E. Todd, J. Trinanes, N. Zilberman, M. Baringer, T. Boyer, R. Cowley, C. M. Domingues, K. Hutchinson, M. Kramp, M. M. Mata, F. Reseghetti, C. Sun, U. Bhaskar TVS, and D. Volkov, 2019: More Than 50 Years of Successful Continuous Temperature Section Measurements by the Global Expendable Bathythermograph Network, Its Integrability, Societal Benefits, and Future. Frontiers in Marine Science, 6, https://doi.org/10.3389/fmars.2019.00452.
8. Hermes, J. C., Y. Masumoto, L. M. Beal, M. K. Roxy, J. Vialard, M. Andres, H. Annamalai, S. Behera, N. D'Adamo, T. Doi, M. Feng, W. Han, N. Hardman-Mountford, H. Hendon, R. Hood, S. Kido, C. Lee, T. Lee, M. Lengaigne, J. Li, R. Lumpkin, K. N. Navaneeth, B. Milligan, M. J. McPhaden, M. Ravichandran, T. Shinoda, A. Singh, B. Sloyan, P. G. Strutton, A. C. Subramanian, S. Thurston, T. Tozuka, C. C. Ummenhofer, A. S. Unnikrishnan, R. Venkatesan, D. Wang, J. Wiggert, L. Yu, and W. Yu, 2019: A Sustained Ocean Observing System in the Indian Ocean

for Climate Related Scientific Knowledge and Societal Needs. Frontiers in Marine Science, 6, https://doi.org/10.3389/fmars.2019.00355.
9. Jena, B., M. Ravichandran, and J. Turner, 2019: Recent Reoccurrence of Large Open-Ocean Polynya on the Maud Rise Seamount. Geophysical Research Letters, 46, 4320-4329, https://doi.org/10.1029/2018GL081482.
10. Jyoti, J., P. Swapna, R. Krishnan, and C. V. Naidu, 2019: Pacific modulation of accelerated south Indian Ocean sea level rise during the early 21st Century. Climate Dynamics, https://doi.org/10.1007/s00382-019-04795-0.
11. Kakatkar, R., C. Gnanaseelan, J. S. Chowdary, J. S. Deepa, and A. Parekh, 2019: Biases in the Tropical Indian Ocean subsurface temperature variability in a coupled model. Climate Dynamics, 52, 5325-5344, https://doi.org/10.1007/s00382-018-4455-1.
12. Prasad C, A. and P. Kumar, 2019: On the Possible Mechanisms for Saltening of the Bay of Bengal. Defence Science Journal, 69, 93-103, https://doi.org/10.14429/dsj.69.12220.
13. Gulakaram, V. S., N. K. Vissa, and P. K. Bhaskaran, 2018: Role of mesoscale eddies on atmospheric convection during summer monsoon season over the Bay of Bengal: A case study. Journal of Ocean Engineering and Science, 3, 343-354, https://doi.org/10.1016/j.joes.2018.11.002.