10 years of Indian Argo

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Outline

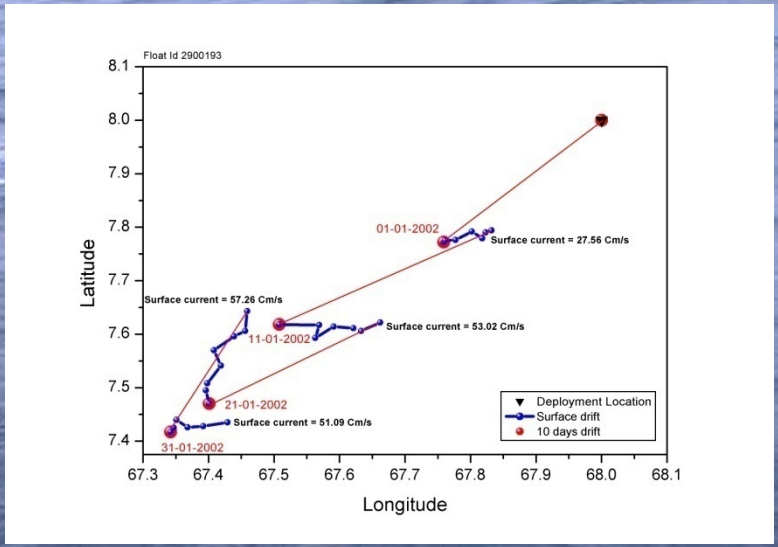
- Present status of Floats deployed by India
- Status of floats in the Indian Ocean
- Utilization of Argo data
  - New in-sights (Science)
  - Operational (Products and services)
  - Catalyst for other *in-situ* observing system
- Capacity building
- Deployment opportunities

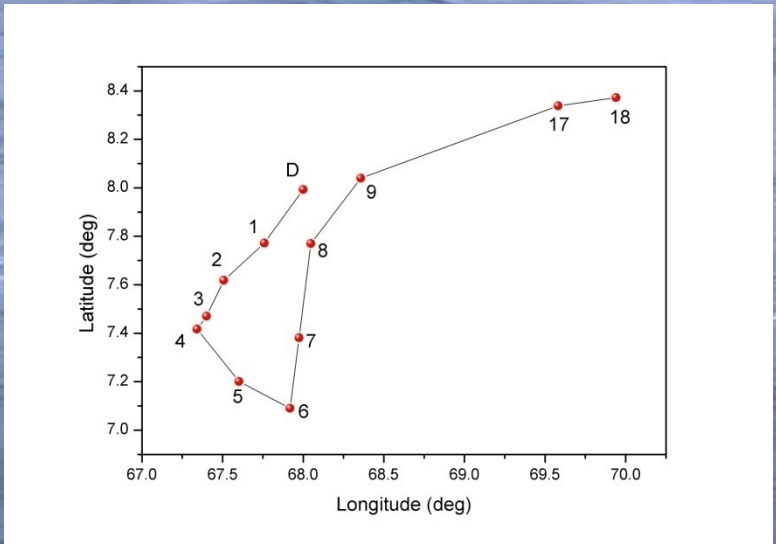
Argo India - start

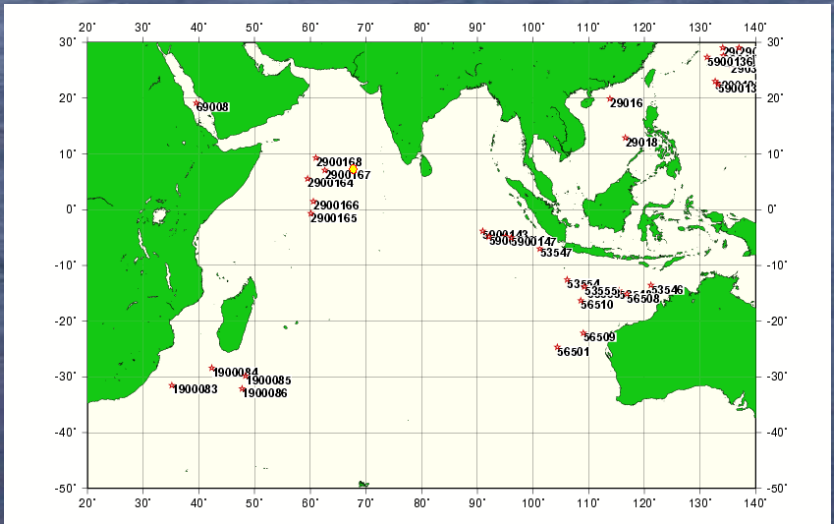
- Implementation planning meeting held at Hyderabad (July 2001)
- Dr. Howard Freeland provided a float to deploy in the Arabian Sea

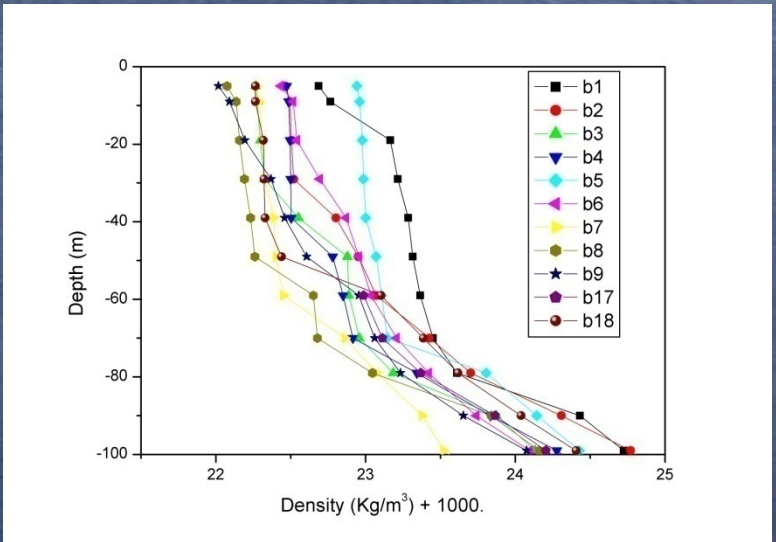
Canadian Argo Float deployed by India in Dec. 2001

(A Typical Case in South Arabian Sea)





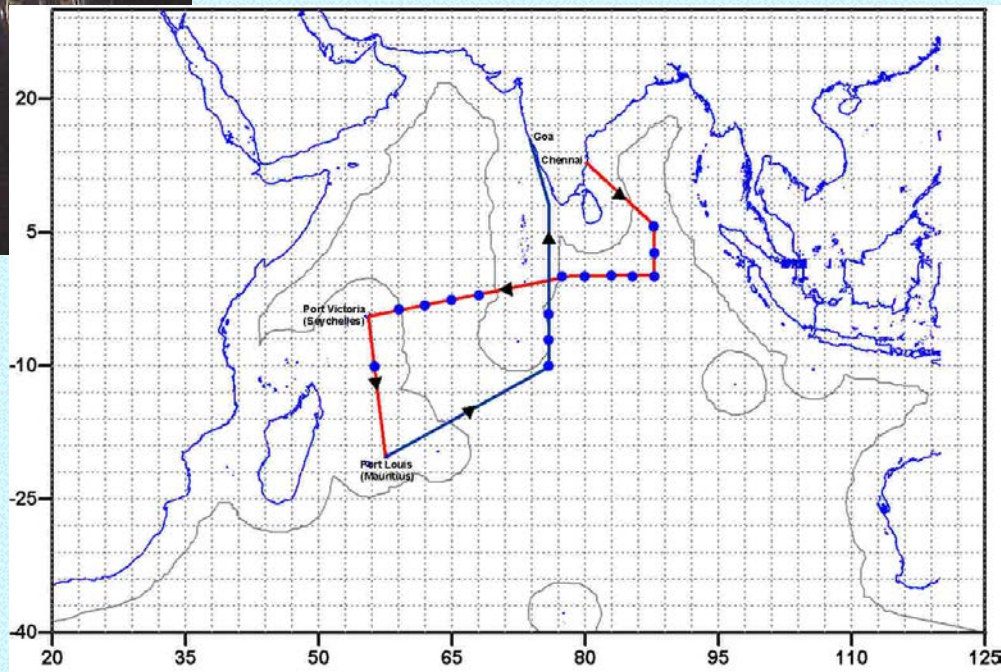




APEX Float with Sea Bird Sensors , Parking Depth of 1200 metre, 180 cc Fluid, 10 day cycle

Launching Indian Argo Programme

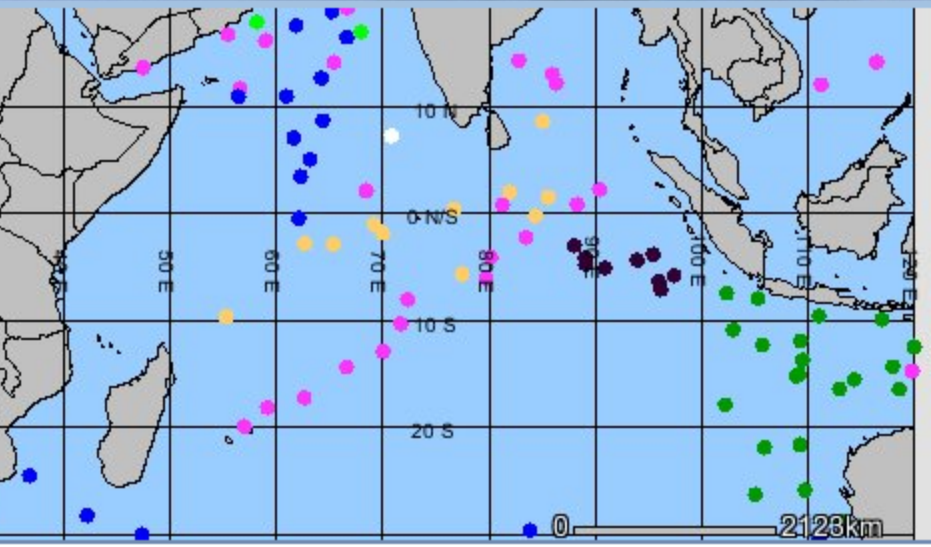
Oct 2002



Edit View Favorites Tools Help

http://www.incois.gov.in/website/argoht/viewer.htm

ARGO FLOATS IN INDIAN OCEAN



Select Floats by WMO ID

Choose Multiple Argo Floats
Q2900092
Q2900093
Q2900094
Q1900050
Q5900031
Q5900029
Q5900033
Q5900026
Q5900030

Display TS Profiles

Layers

- Current Location of Argo Floats
- Argo Trajectory

Select By Country

Nationality

India

Select

Display Cursor Location in Degree Minutes and Seconds

62.82 Y -65.63

Data Updated on every Monday

der to avoid congestion of points in the map, Argo Trajectory shows the most recent 10 locations on which it appeared at the ocean surface

Legend

ND(10)	UK(38)	USA(38)	FRA(2)
AN(1)	JAP(9)	AUS(21)	

Clicking on the map would

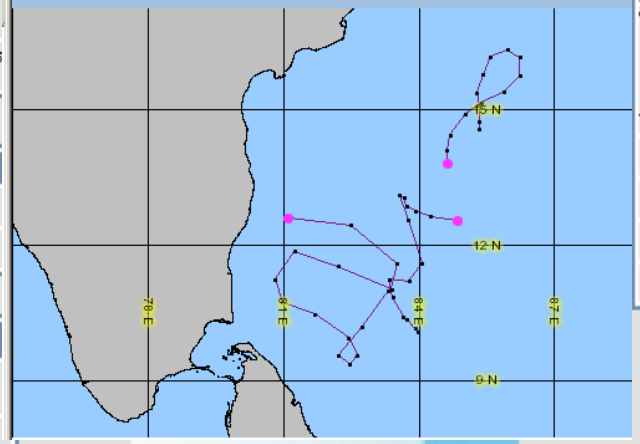
Zoom In | Zoom Out | Pan | Full View

Info Tool | Rectangle Select | Measure Distance

Map Refresh

Argo - Microsoft Internet Explorer

ARGO FLOATS IN INDIAN OCEA



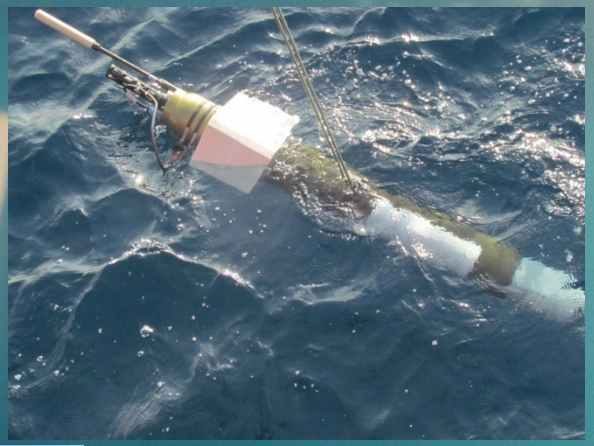
Help Me!

Welcome! Download the zipped files to find help on using the various features in this site

- How to start?
- Zoom In,Out,Pan,Full view
- TS Profiles by WMO ID
- Rectangle Select

Internet

Deployment of different types of floats



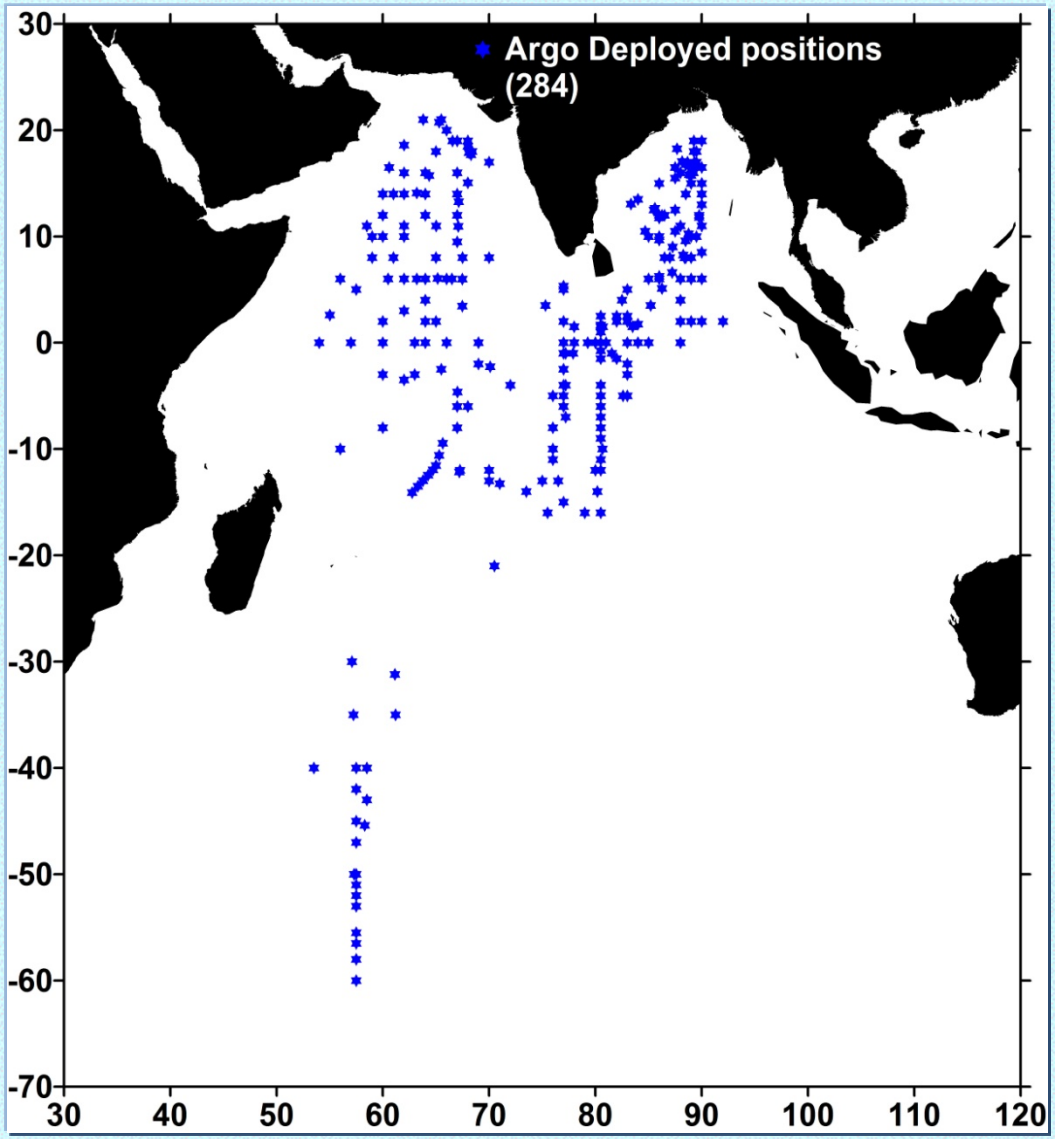
Five year plans

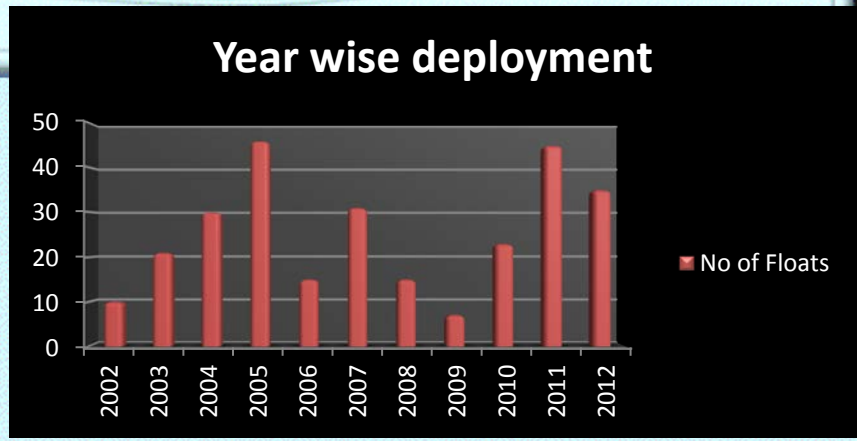
- First five year plan (2002-2007)
  - To deploy 150 floats (30 floats per year)
- Second five year Plan (2007-2012)
  - To deploy 150 floats (30 floats per year)
- Third five year Plan (2012-2017)
  - To deploy 200 floats (40 floats per year)
  - 50 floats are Bio-Argo (10 floats per year)

– Argo data center (DAC and ARC)

– Data utilization (Products, analysis and Science)

Deployment locations

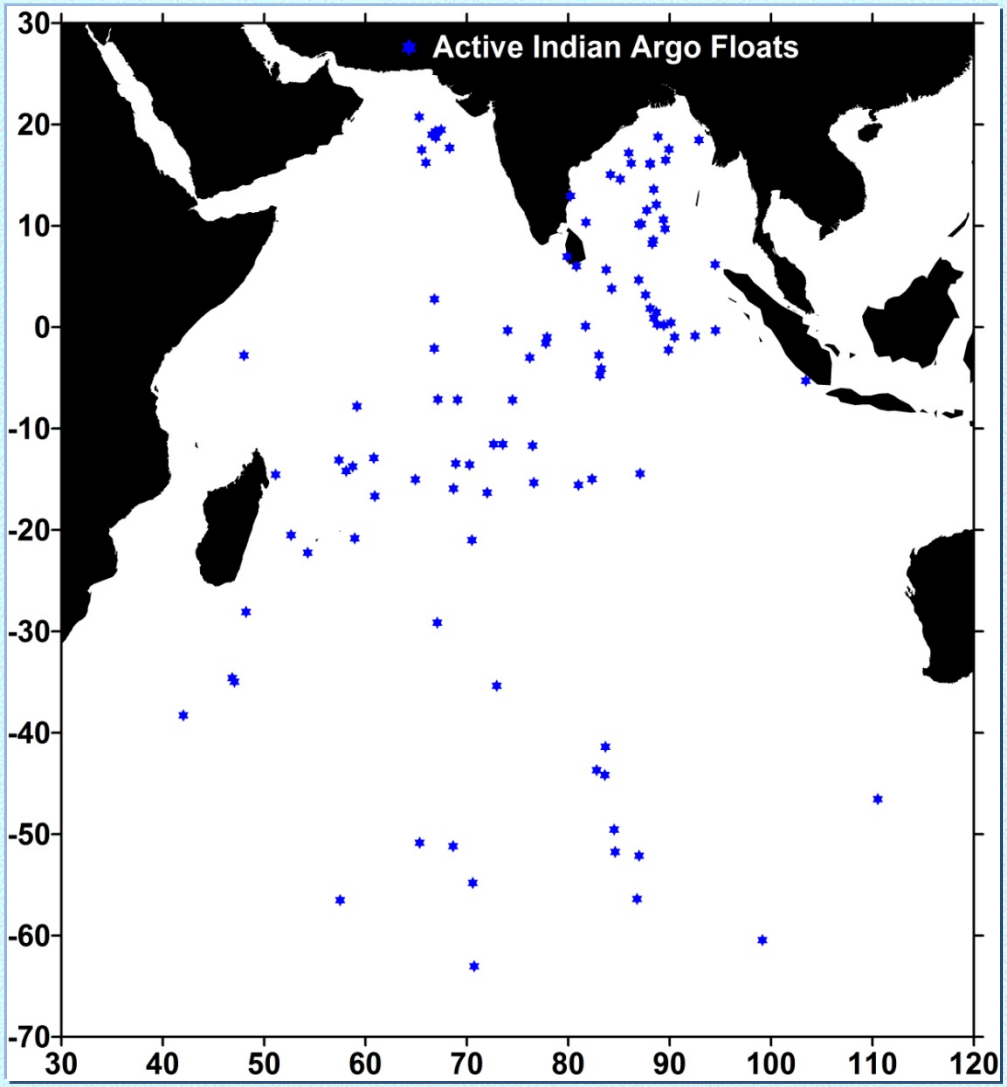




Type of Sensors	No
CTD alone	244
CTD + Near Surface Temperature	15
CTD + Dissolved Oxygen	16
Bio-Argo (CTD + Chla + DO + FLBB)	9

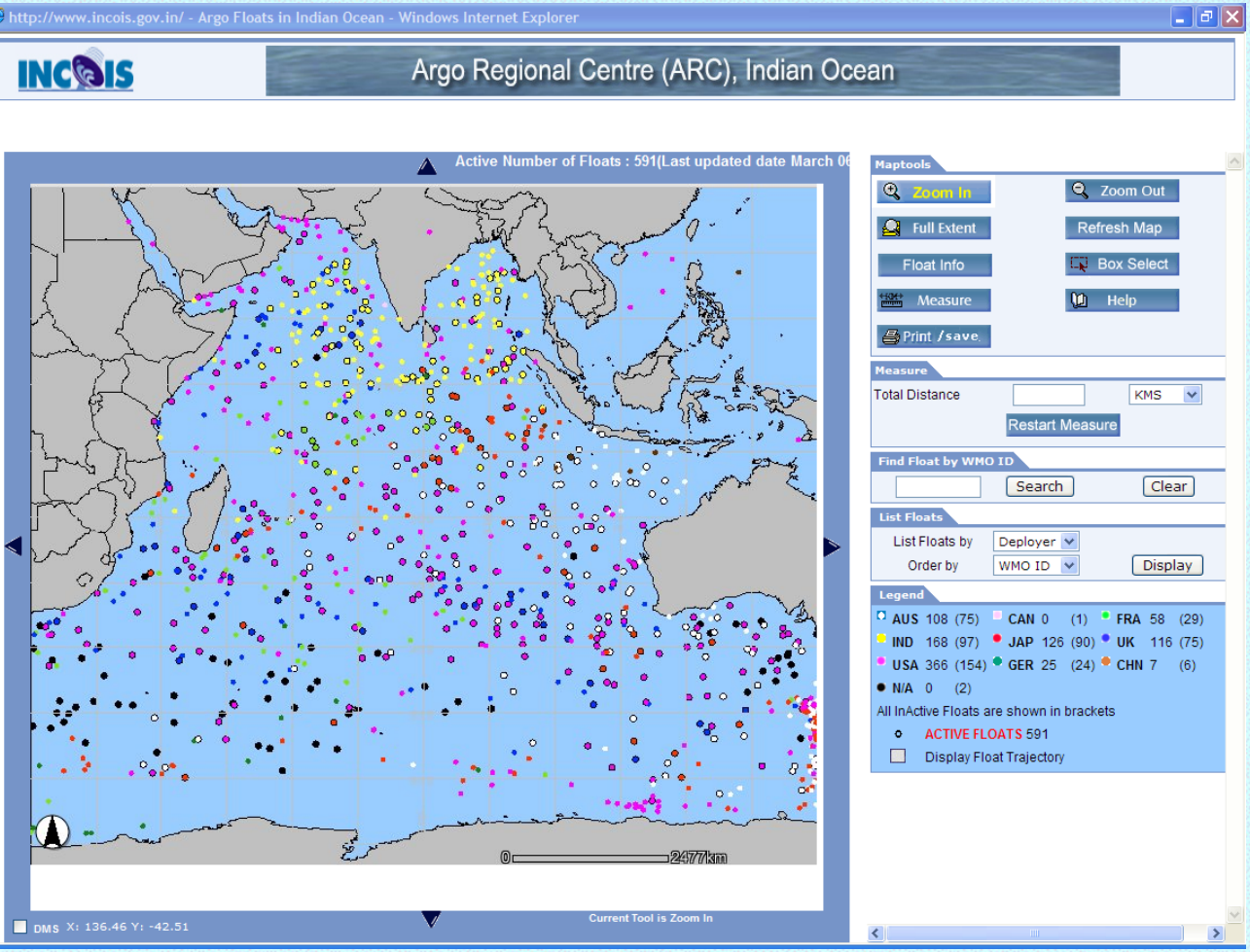
Type of Communication	No
ARGOS	250
IRIDIUM	34

Present location of Indian Active floats



Not many floats in the Arabian Sea due to Piracy issue

Argo Float Data – Indian Ocean

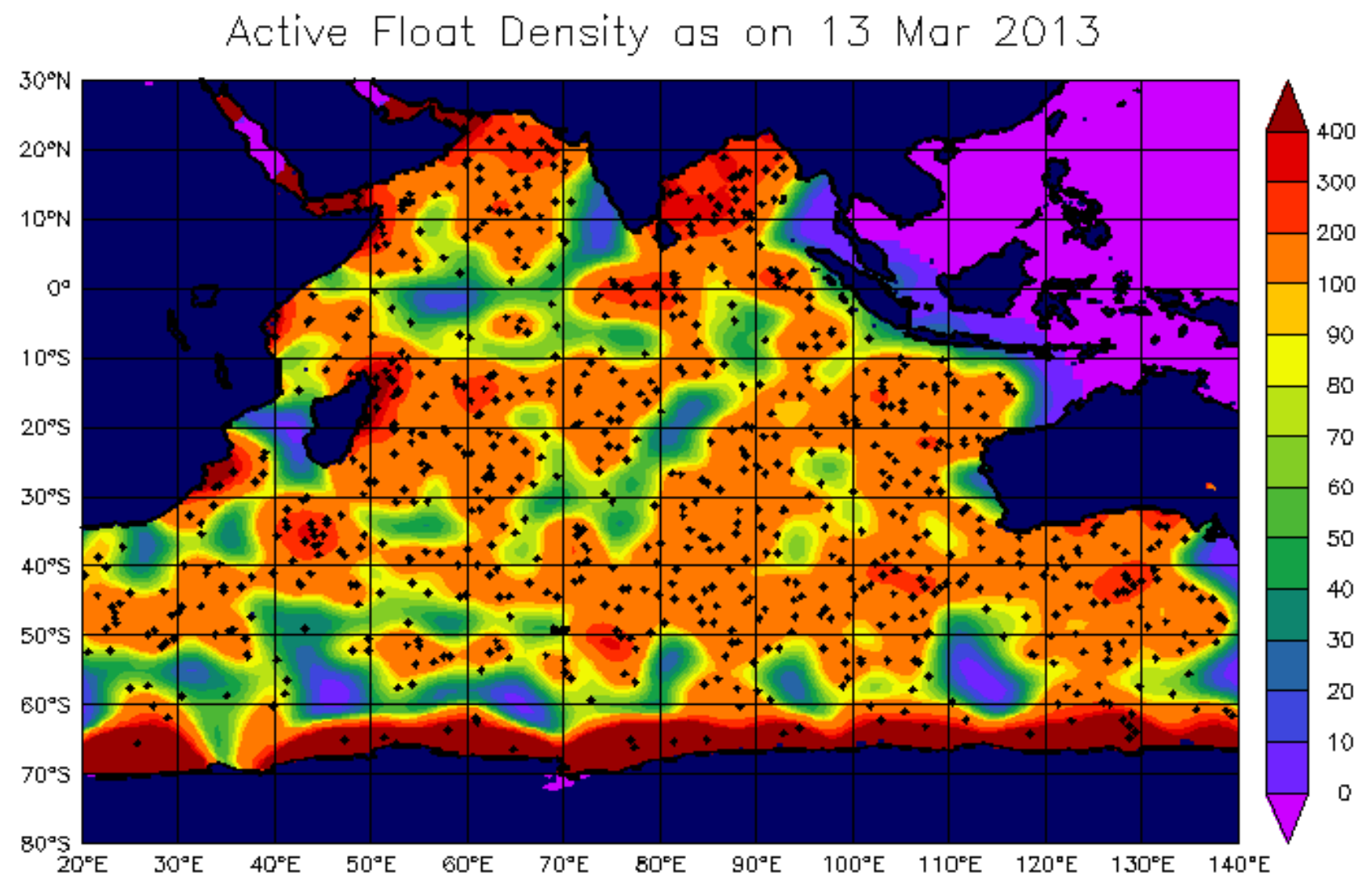


- Data availability:

  Jan 2001 - till date
- Active No. of Floats: 745
- Total No. of Floats: 1982
- Indian Floats: 284
- T and S Profiles: ~ 2,20,000
- Data formats:

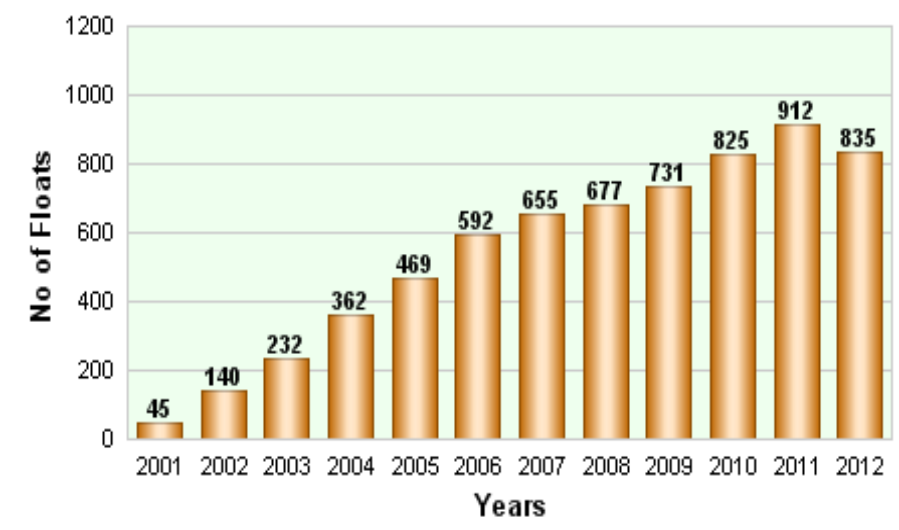
  ASCII, NetCDF, Plots

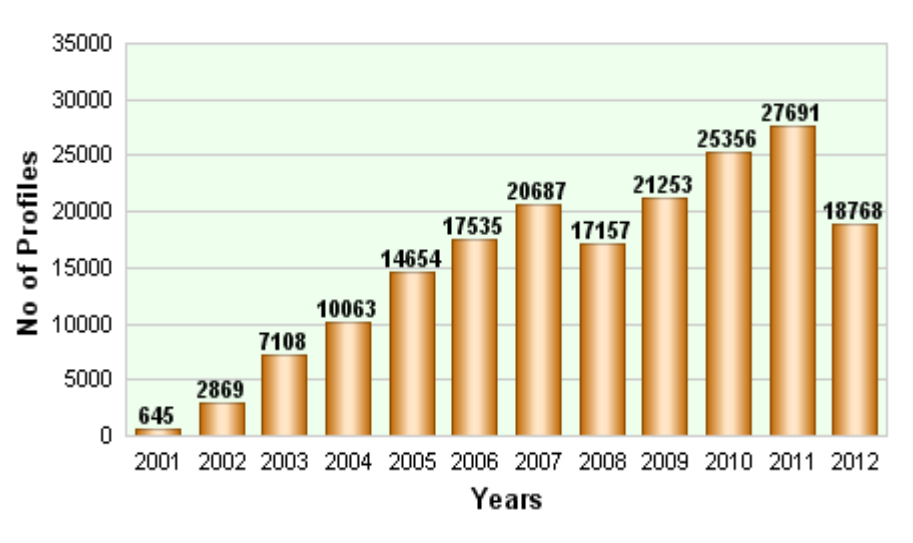
Argo float density



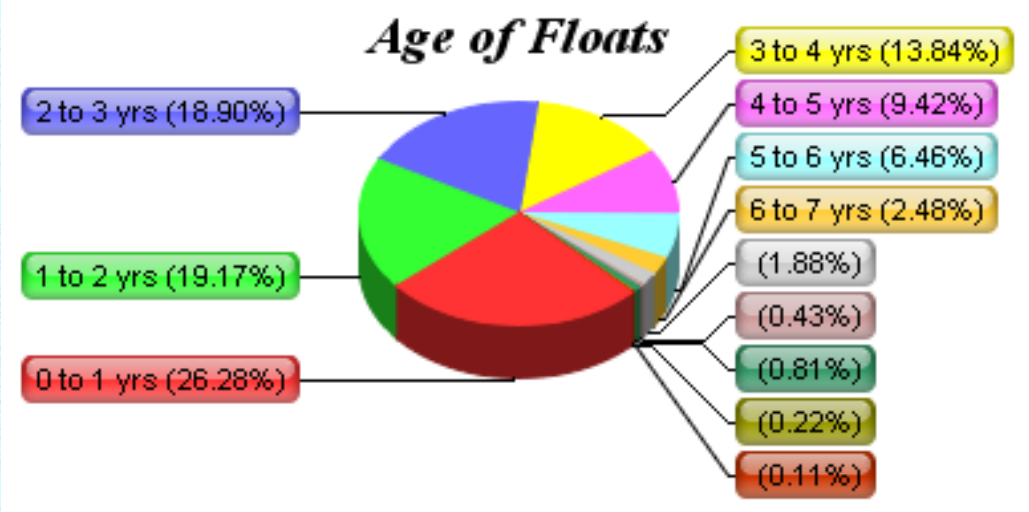
Locations varies with season

Float statistics – Indian Ocean





Page (last one year)	Views	Visitor
Argo Web-GIS	511	258
Data downloads	761	1017
Live Access Server	79,191	21,173
Argo products	1089	739



Argo – Data utilization in India

- New In-sights (~ 75 papers)
- Operational – Value added products and Ocean Analysis
- Other in-situ ocean observation in the Indian Ocean - IndOOS

New in-sights
Indian Ocean process studies

- Buoyancy flux changes in the Bay of Bengal
- Upper ocean response of T & S to local atmospheric forcing
- ISO thermocline and BL variability in the Bay
- Cyclone genesis and Intensity
- Water mass properties in the Arabian Sea
- Mixed layer variability in the North Indian Ocean
- Delineating upwelling zones
- Role of salinity in thermal inversion in the Arabian sea
- Contribution of halo-steric height in dynamic height
- …..

New in-sights

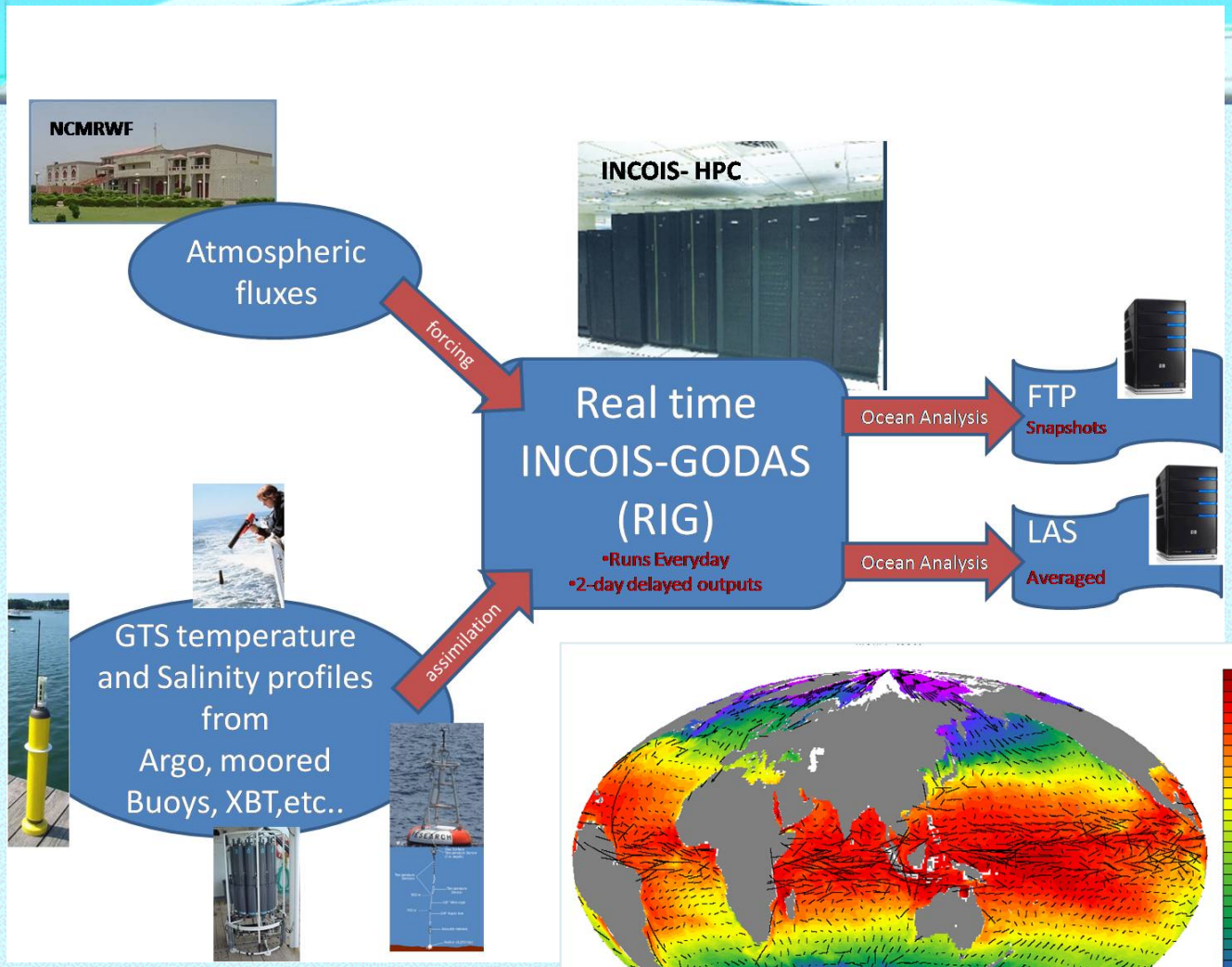
Indian Ocean dynamics and validation of models

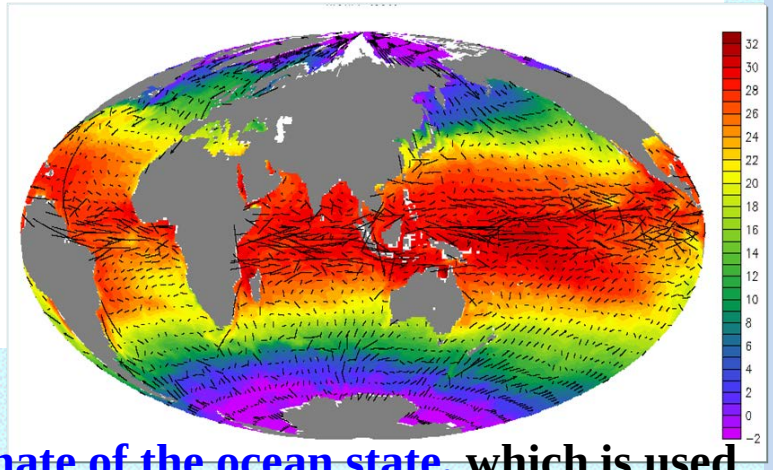
- Impact of summer monsoon ISO in tropical Indian ocean using Argo and OGCM
- Surface currents from Argo, altimeter and scatterometer
- Validation of OGCM using Argo observations
- Analysed Ocean state using Argo and OGCM
- New climatology and Atlases

New In-sights
Indian Ocean dipole and monsoon

- Generation and termination of IOD mechanism
- Summer cooling in the Arabian Sea
- Impact of IOD on SSS revealed from Argo
- Role of subsurface Temp anomalies in the SW Indian Ocean during 2006 dipole event
- Monsoon interactions and drought over India in relation to Indian ocean sub-surface features

Global Ocean analysis





To provide an accurate estimate of the ocean state, which is used to initialize coupled model for the seasonal monsoon forecast and to understand the variability of ocean in different time scales

Model used : MOM 4 (GFDL)

Domain: Global

Resolution: 50 km zonal and 25 km meridional, 40 vertical levels.

Atmospheric forcing: Fluxes from Global Assimilation Forecast System (GFS)- T254L64 run at NCMRWF.

Data assimilation scheme: 3D VAR -GODAS (NCEP)

Parameters assimilated: Temperature and salinity profiles from Argo, XBT and moorings

Relaxation: OISST-V2 [Reynolds, 2007]

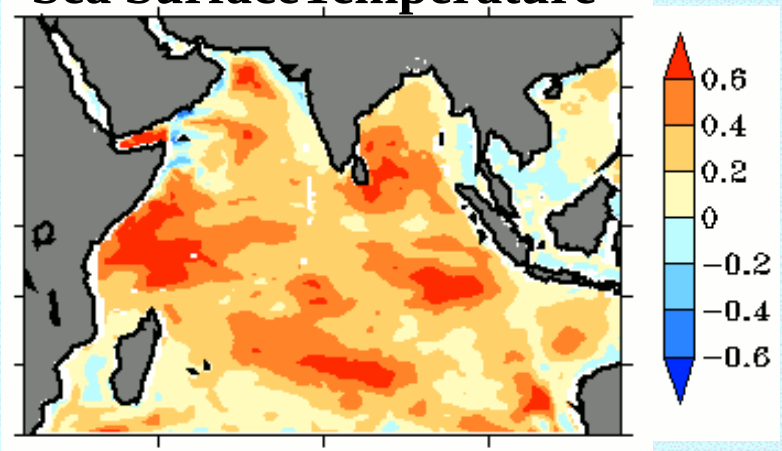
Outputs: Temperature, Salinity, SSH, and Currents

Impact of Argo in Ocean analysis

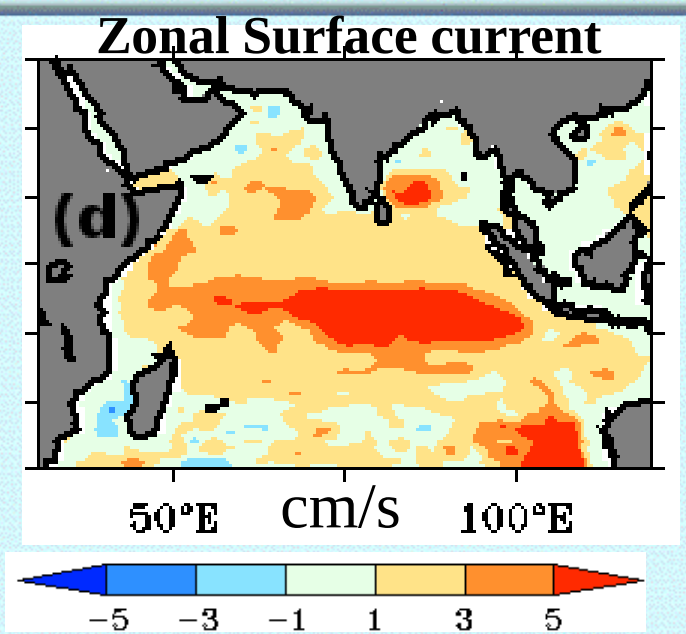
- REF- Assimilates T&S observations from all Ocean Observing Systems (OOS)
- With held assimilation of T&S observations from
  - Moored buoys (e.g. RAMA, TAO/PIRATA, TRITON): XBU
  - Profiling floats (ARGO): XPR
  - Ship-based measurements (e.g. XBT, CTD): XSH
- PRF- Assimilates T&S observations from Argo Profiling floats alone

Difference in RMSEs (XPR - REF)

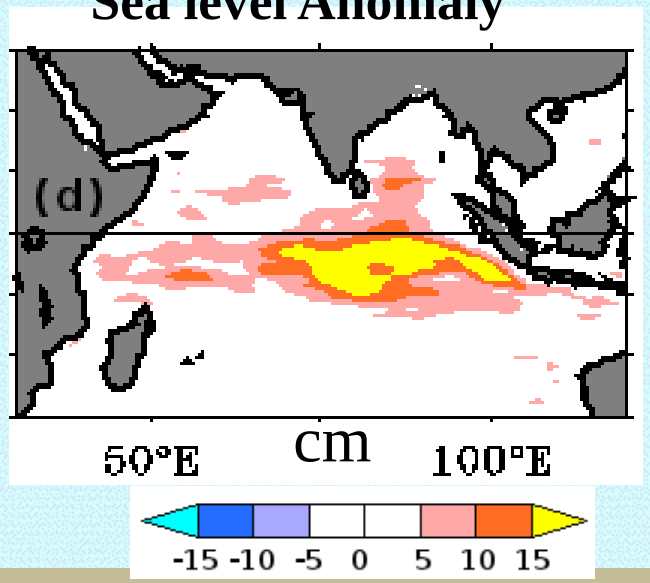
Sea SurfaceTemperature

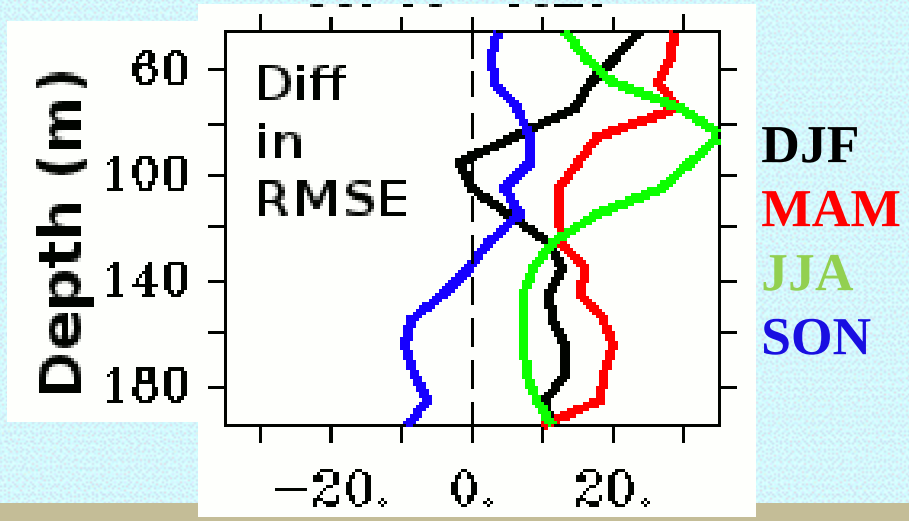


Zonal Surface current



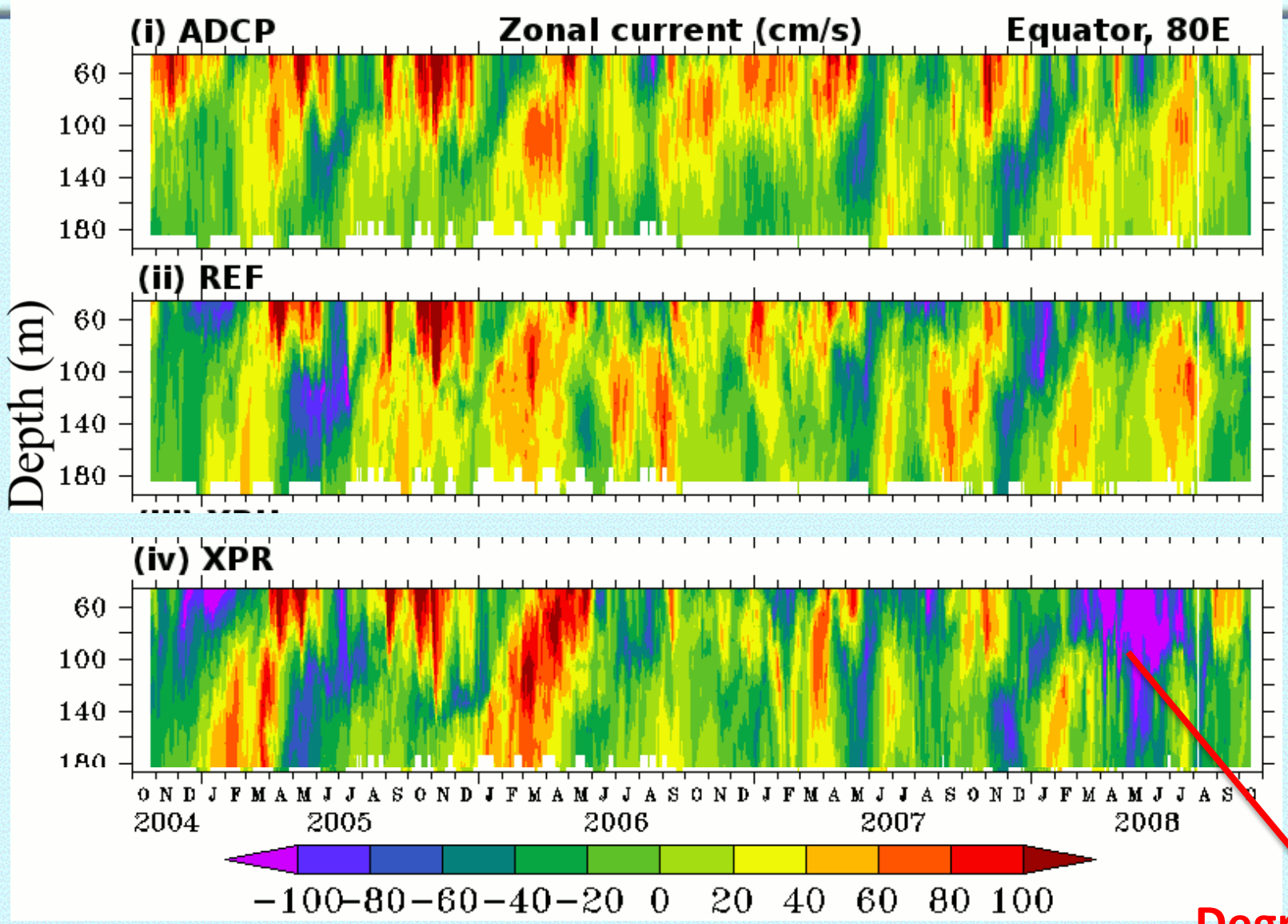
Sea level Anomaly





Positive values indicate that errors grow large in the absence of ARGO T&S profiles.

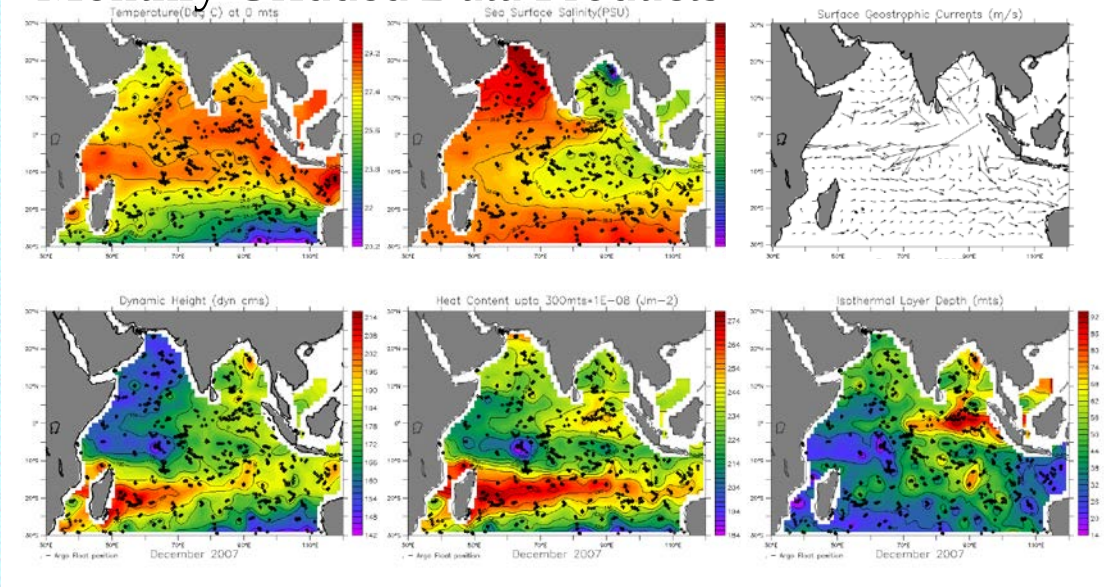
Sub-surface currents in the Equator



Degradations

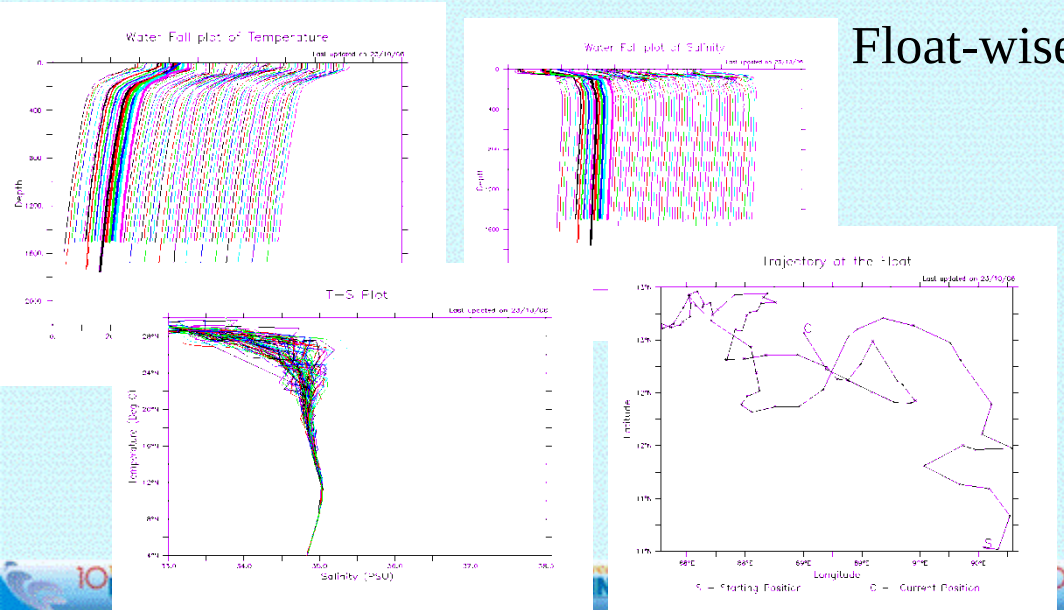
Argo Data Products

Monthly Gridded Data Products



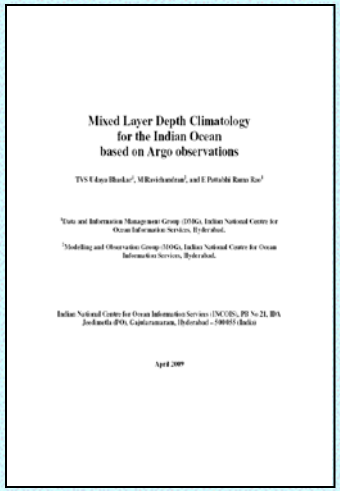
- Temperature, Salinity and Geostrophic Currents (0, 75, 100, 200, 500, 100 M depths)
- Heat Content up to 300 M
- Mixed Layer Depth, Isothermal Layer Depth
- Depth of 20° and 26° Isotherms
- Dynamic Height
- Sea Surface Height Anomaly

Float-wise Plots

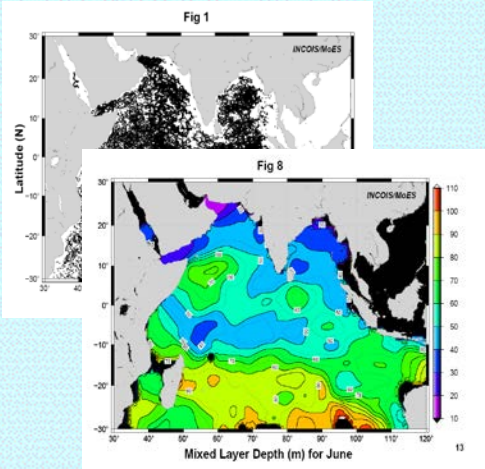


- Water Plot of Temperature
- Water Plot of Salinity
- Temp Vs Sal Plot
- Time Series Surface Temperature
- Time Series Bottom Pressure
- Time Series Surface Salinity
- Time Series Surface Pressure
- Float Trajectory

Other Valued Added products from Argo

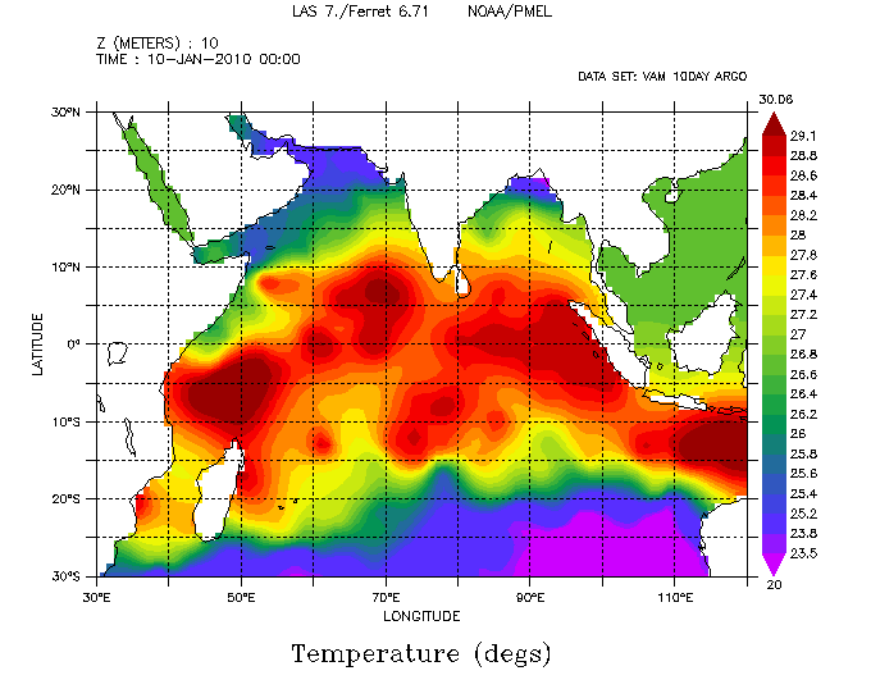

Mixed Layer Depth Climatology
for the Indian Ocean
based on Argo observations

April 2009



- **MLD Climatology for the Indian Ocean based using Argo Observations**

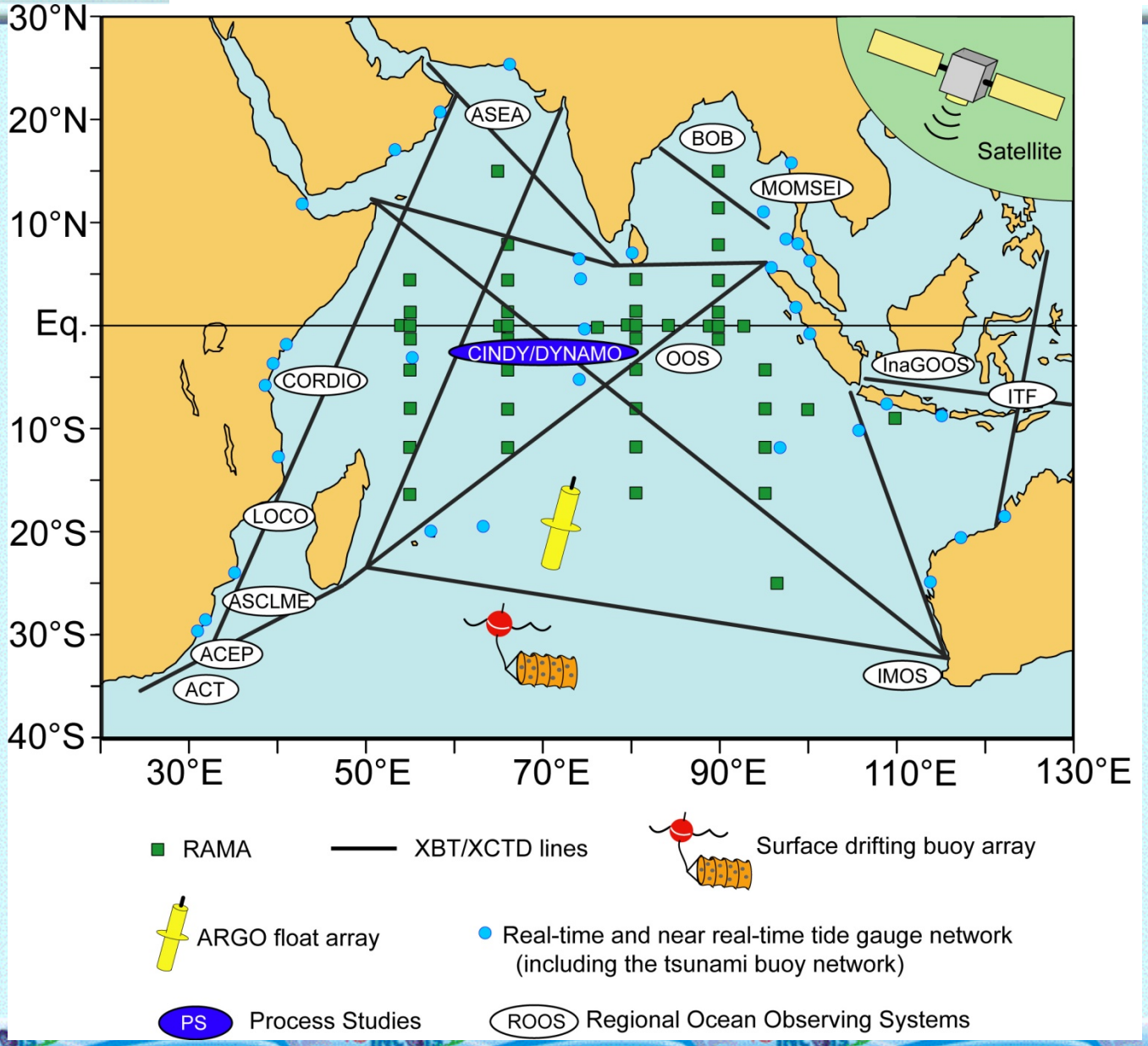
- Objective Analysis
- Variational Analysis



Other in-situ observations in the Indian Ocean

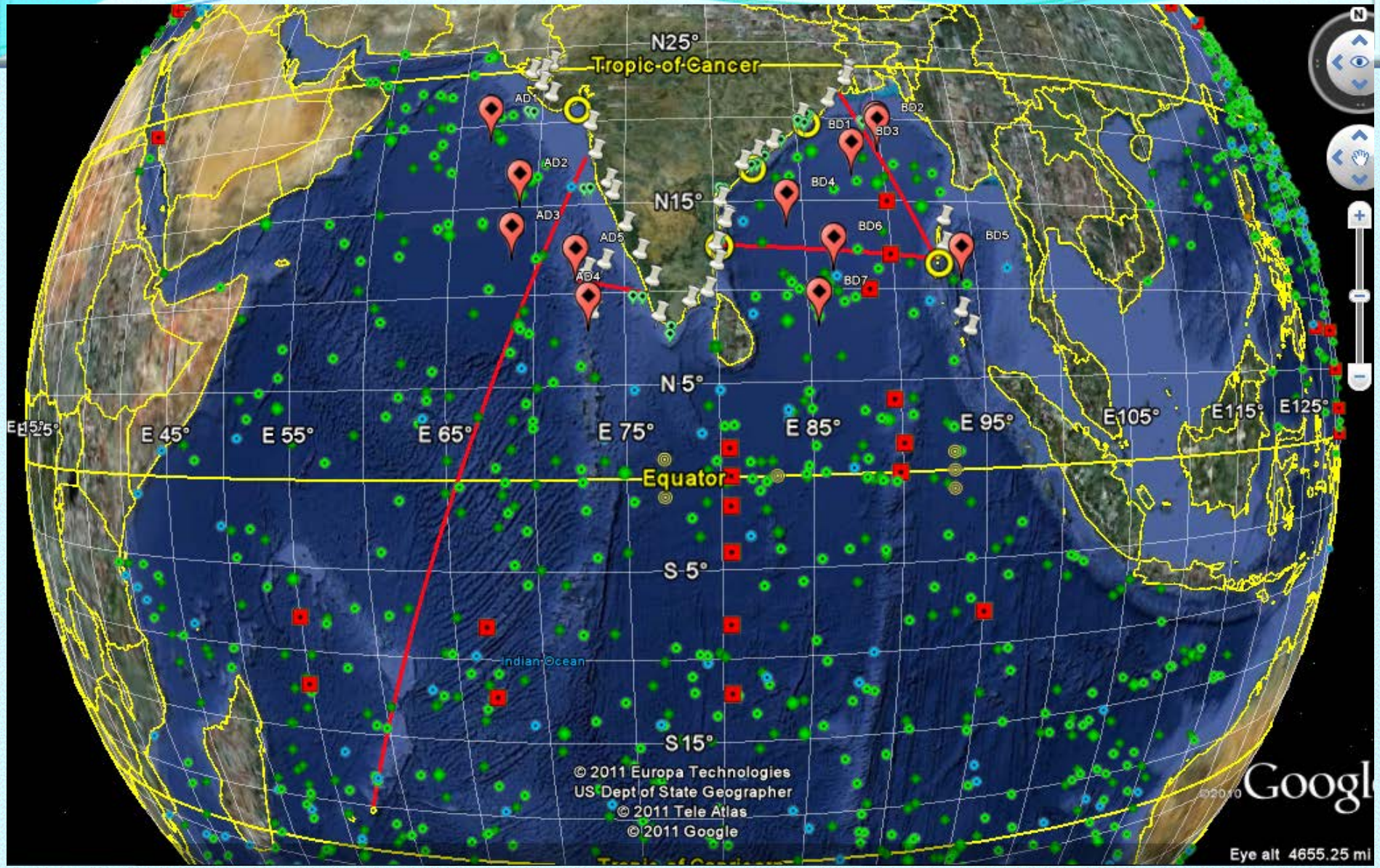
- Before Argo, Indian Ocean is a data void region compared to Atlantic and Pacific
- In the year 2002, Argo floats were deployed in the Indian Ocean by many countries
- Provoked, Why not other in-situ?
- IndOOS (Indian Ocean Observing system) implementation plan started

Indian Ocean Observing System (IndOOS)



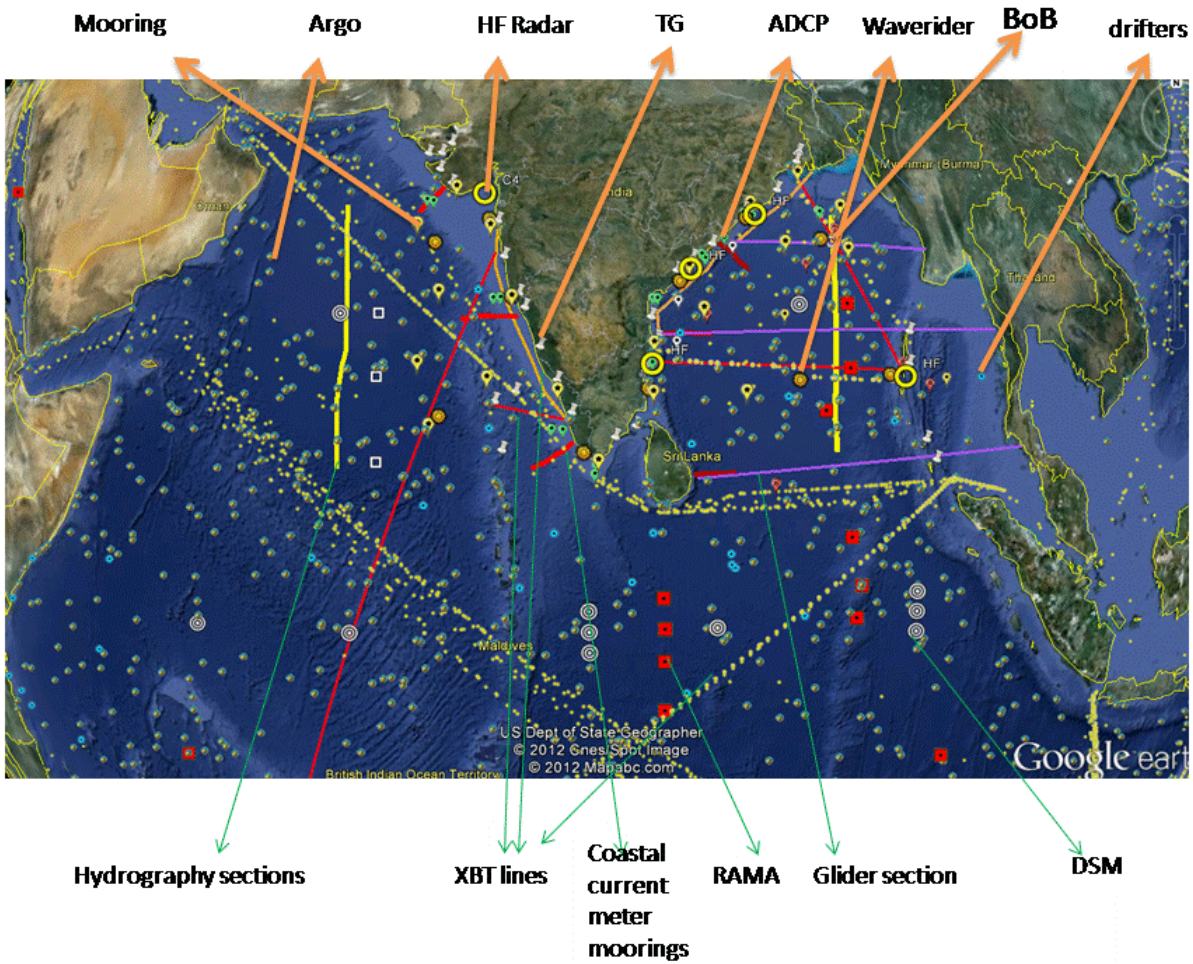
Multi-platform
Multi-national
Multi-institutional
Long-term Ocean Observation Network

Ocean Observing System – Indian Ocean



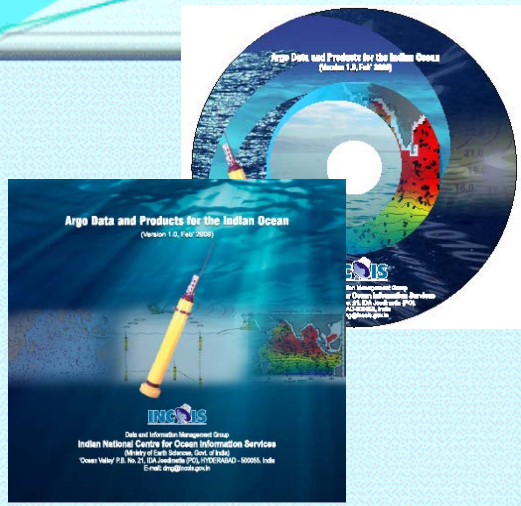
Green – Argo, Red line – XBT, Blue – Drifters, red square – RAMA, Yellow- CODAR, green oval- ADCP, Red oval – Moorings, white mark - TG

Next 5 Years



- 12 moored buoy in the open ocean
- 4 moored buoy in the coastal ocean
- 40 Argo floats / year
- 30 drifters/year
- 4 XBT lines
- 10 pairs of adcp mooring
- 5 pairs of HF Radar
- 10 wave rider buoys
- 20 AWS onboard research vessels
- Bay of Bengal Observatory
- 10 bottom mounted tide gauges in the shelf
- 35 tide gauge along the coast of India
- 8 tsunami buoys
- 3+3 Glider sections
- R & D Ocean Observations
- RAMA moorings – Ship time

Education and Outreach



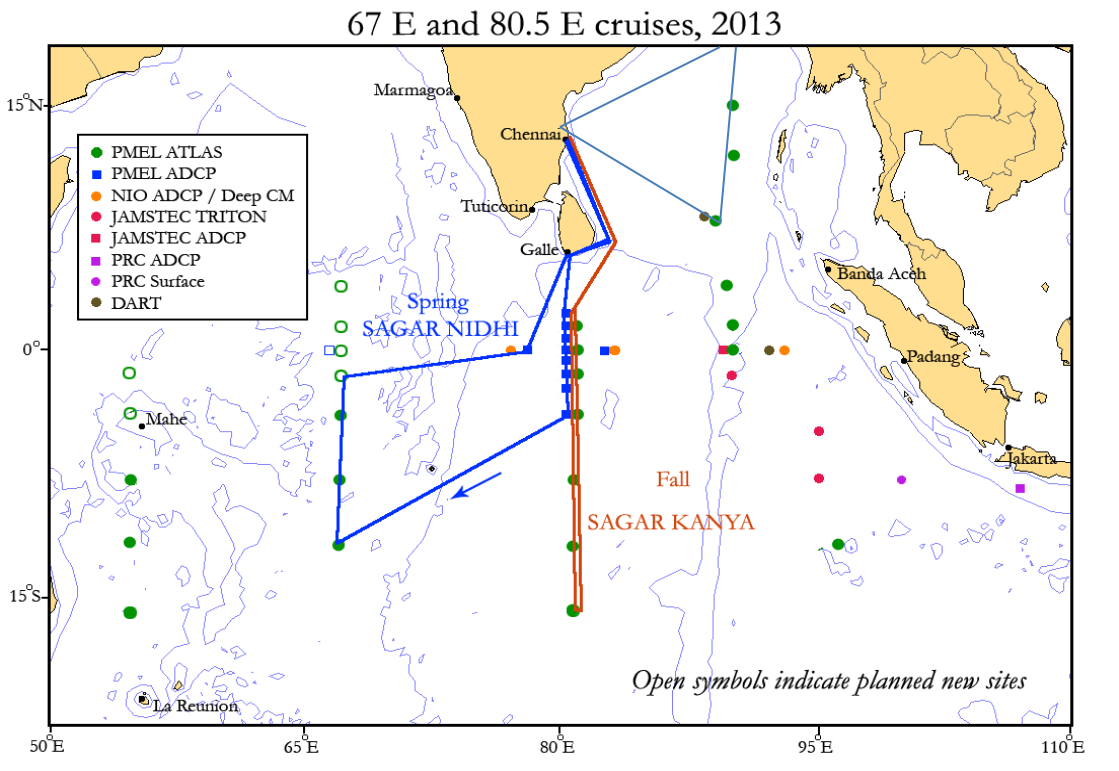
DVD Version 1.0, Feb'2009

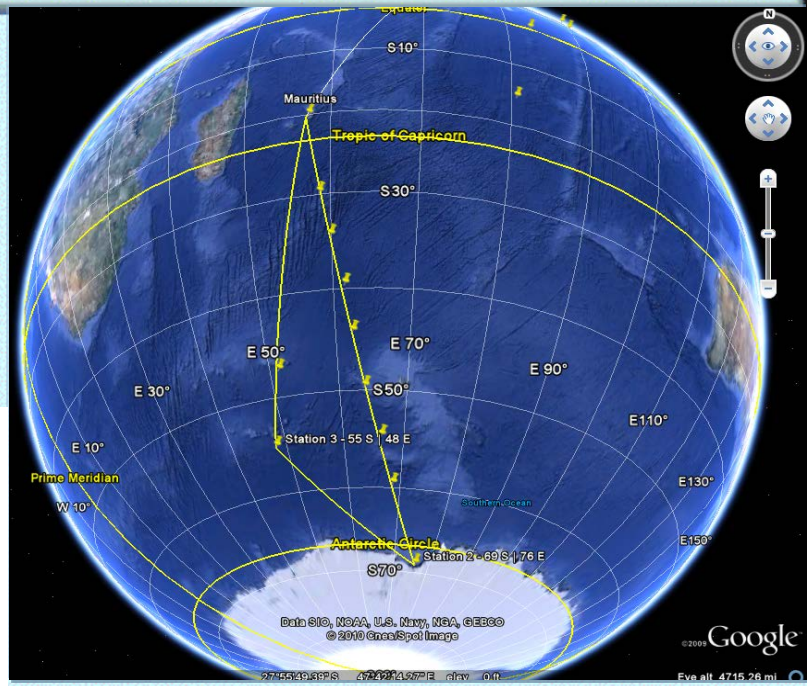
- **Argo Data and Data Products for the Indian Ocean (*Version 1.0, Feb'2009, Version 2.1 – Apr 2013*)**
  - **T-S Profiles (~210,000)**
  - **Period: Jan 2002- Dec 2012**
  - **Gridded Data Products (plots)**
  - **ASCII & netCDF Formats**
  - **GUI for easy navigation, browsing, data extraction with user defined spatial and temporal domains**
  - **Software for viewing the NetCDF files**

- **User interaction meet every year on February 03.**
- **"Data aware program" to bring about awareness about the Argo data to student community.**
- **"Argo DVD" - data and products pertaining to India Ocean, mainly targeting the students at University with low band width.**

Deployment opportunities

Cruise track for ORV SK and ORV SN





November – BoB

Mar-Apr /Oct– Equator

Dec-Jan – Southern Ocean

Thank you for your kind attention