Ocean Observations

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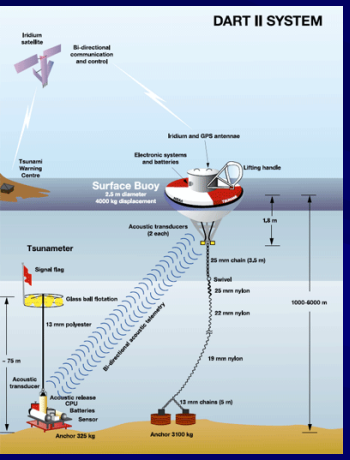
Outline

- Ocean Observations by India
- Present status of IndOOS
- Status of Global Ocean Analysis

Ocean Observing Systems by India

(7)
Tsunami buoys



(17)
AWS onboard Ship

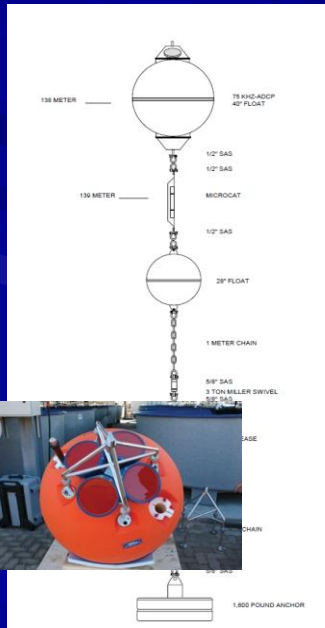
(10)
Wave buoy

(4 pairs)
HF Radar

(20)
RAMA buoys

(4+2)
Research Vessels

(20)
ADCP



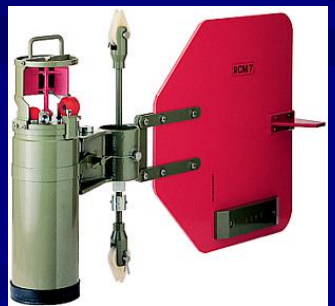
(108)
Argo floats

(15)
Moored Buoys

(3)
XBT Lines

(30)
Drifters

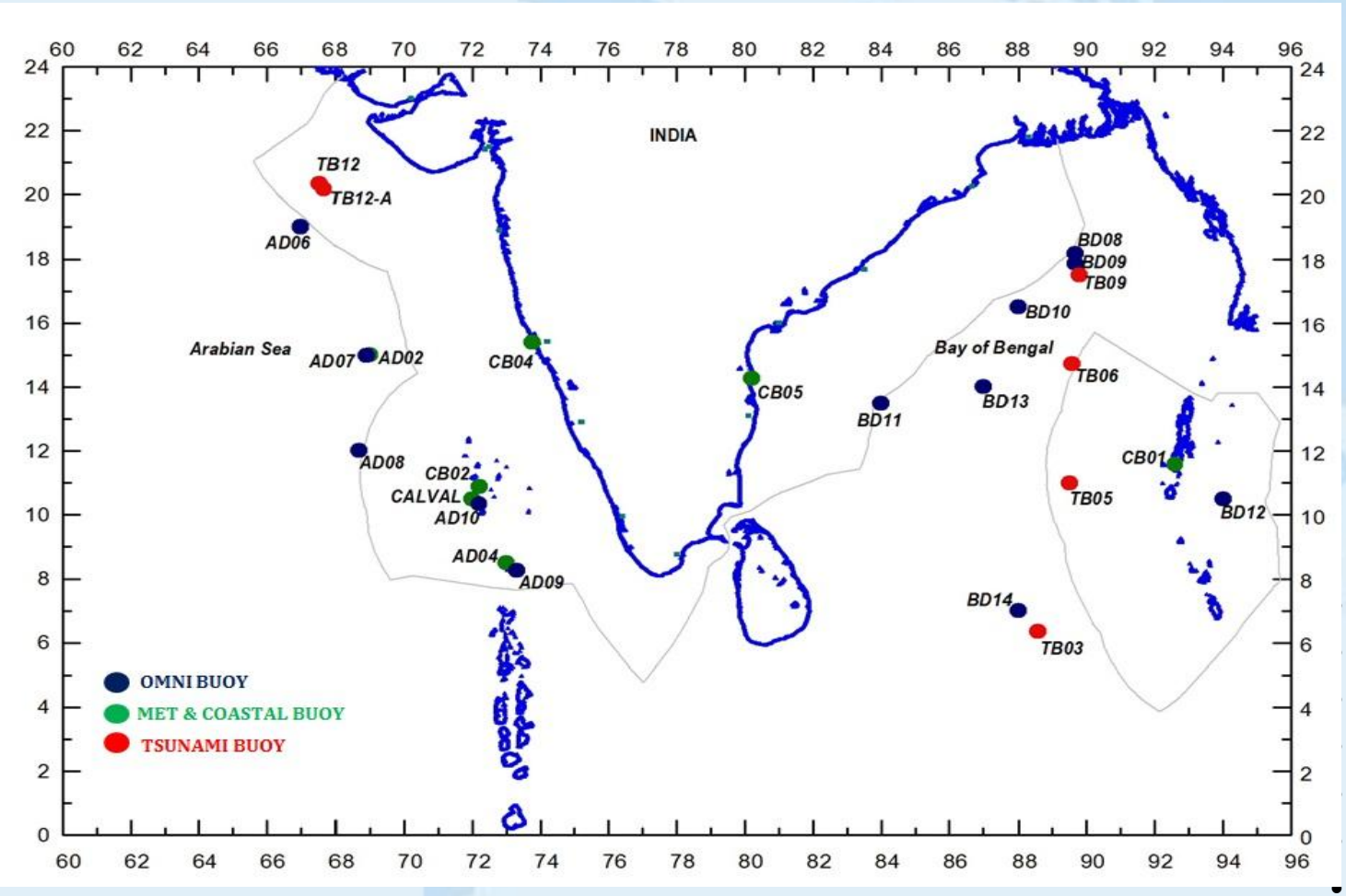
(7)
Arrays



(36)
Gauges

Moored Buoy Network

(NIOT)



OBJECTIVES

To collect real-time measurement of met-ocean parameters in Indian Seas

PARAMETERS

Air Temperature
Air Pressure
Humidity
Radiation
Rainfall
Wind vector

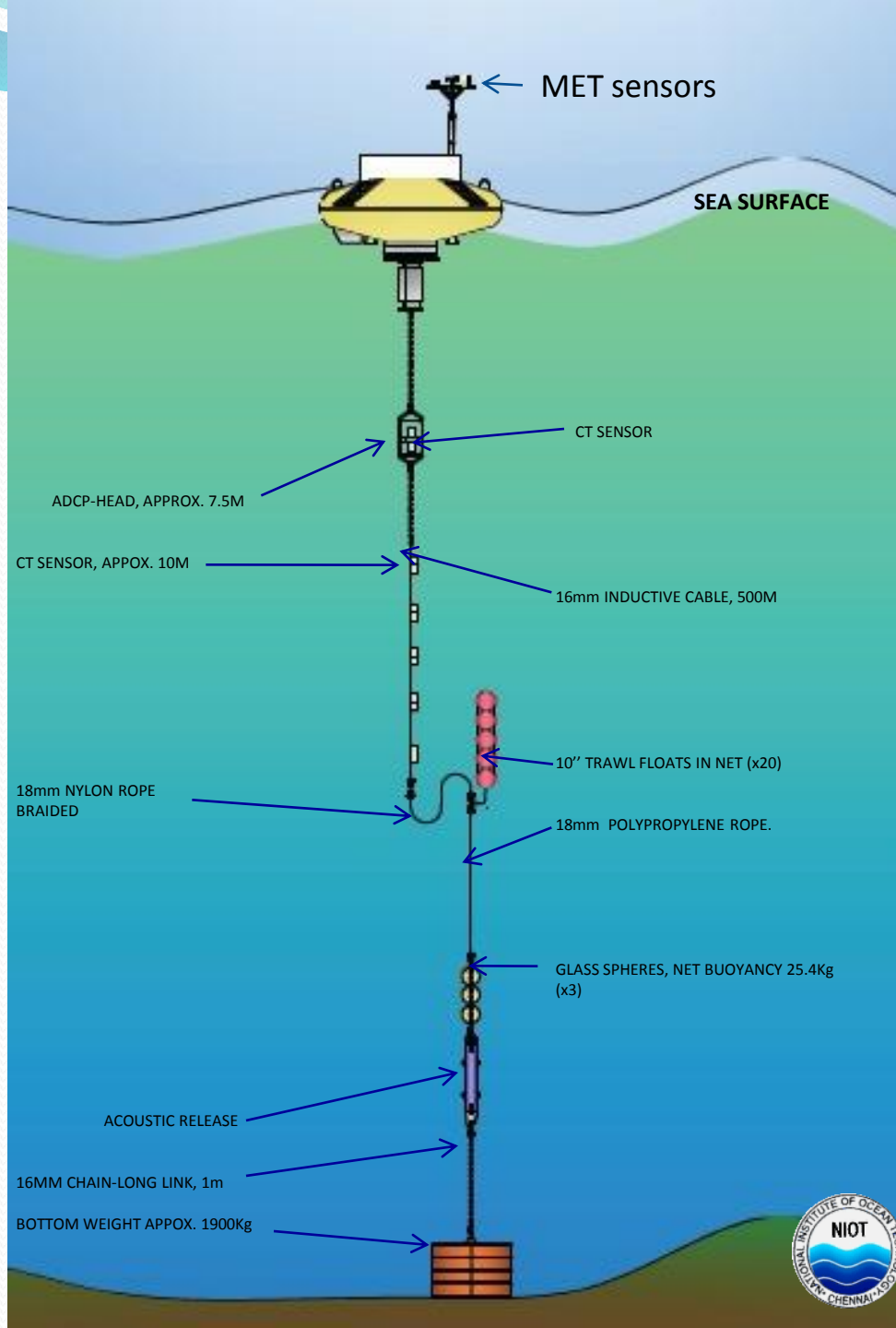
- Current vector
- Water temperature
- Salinity

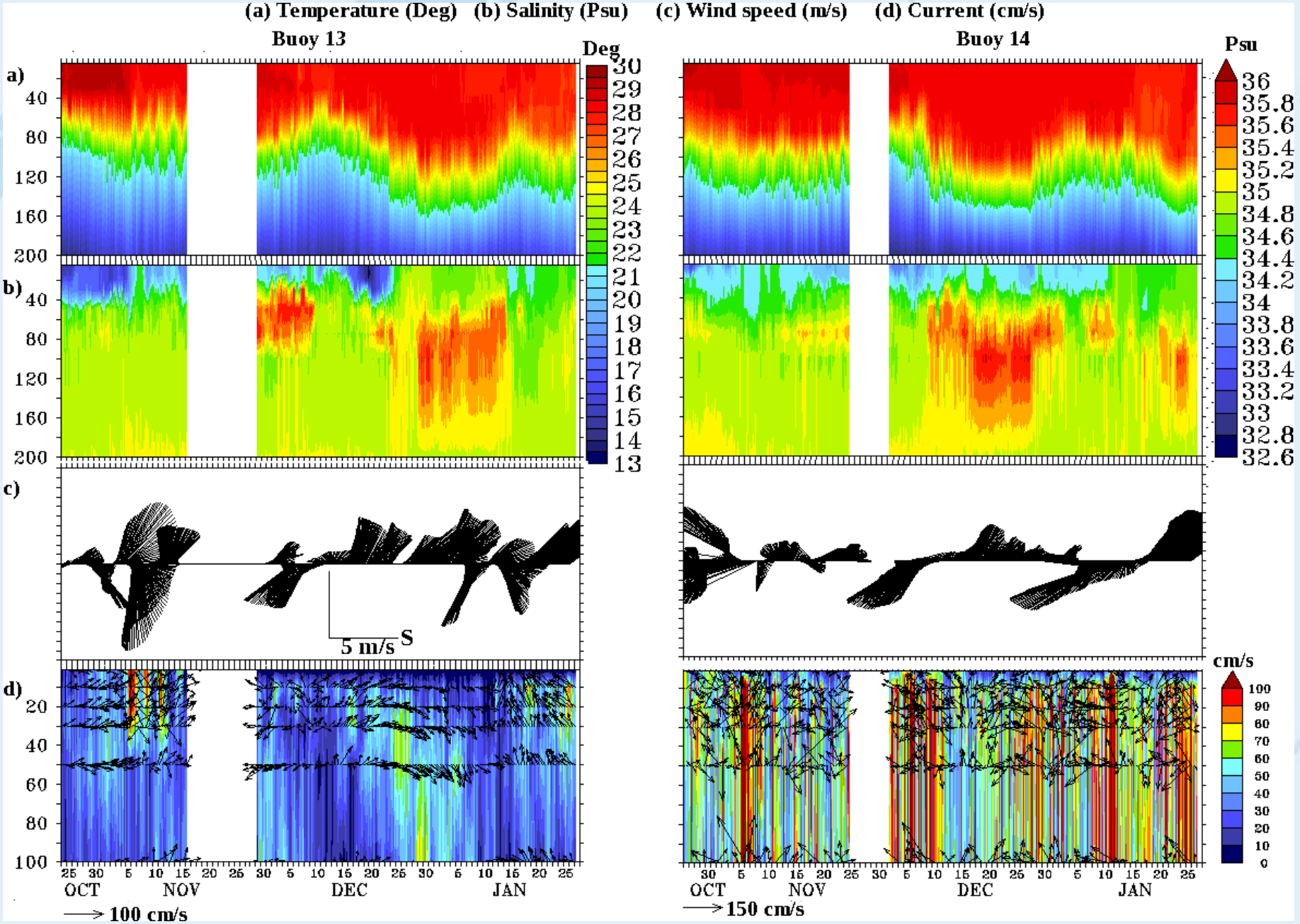
OMNI BUOY MOORING

- **Surface meteorological**
  - Wind speed and direction
  - Air temperature
  - Air pressure
  - Humidity
  - Short wave radiation
  - Incoming long wave radiation
  - Precipitation

- **surface Ocean parameters**
  - Sea surface temperature
  - Conductivity
  - Wave (6 buoys only – ie BD2, BD4, BD7, AD1, AD2, AD4)
  - Current speed and direction

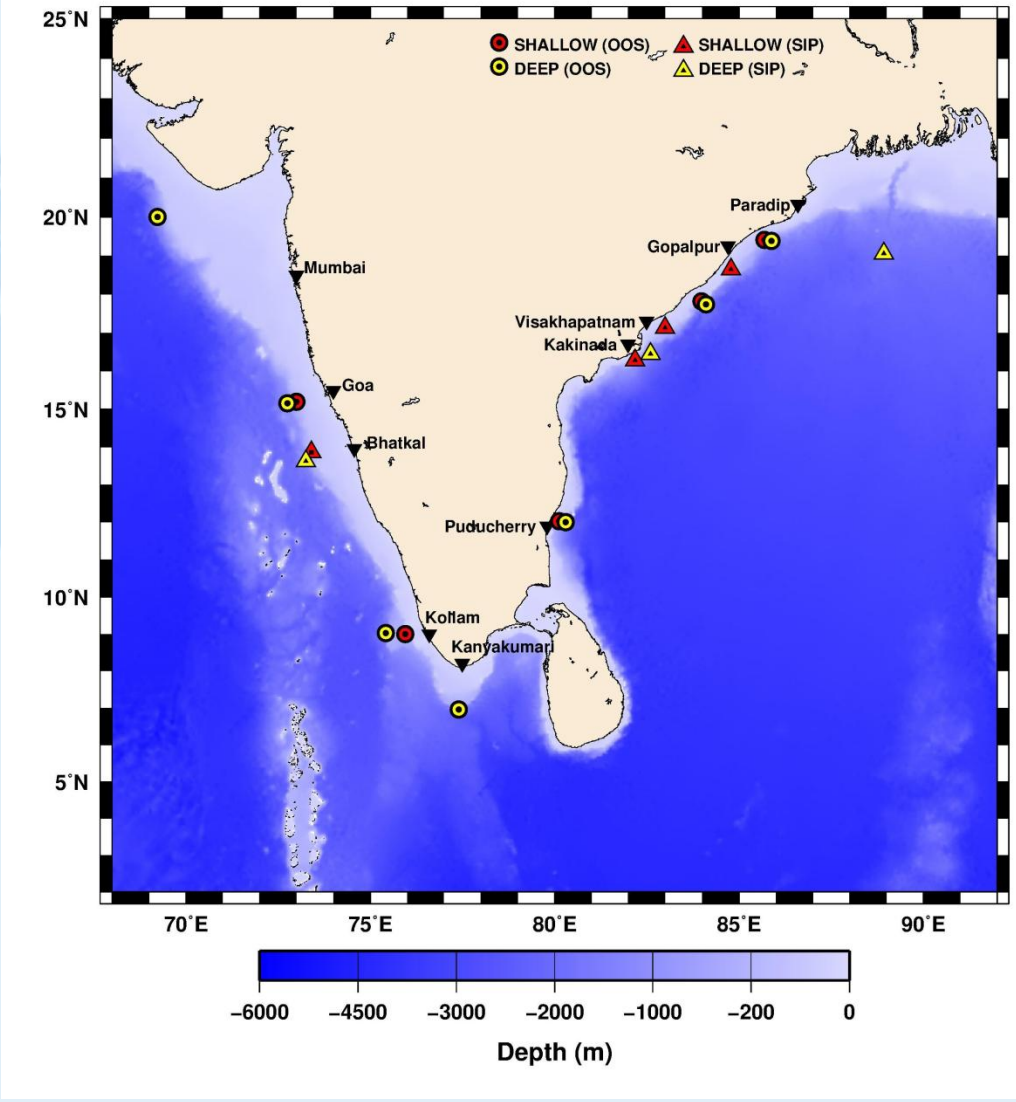
- **Sub surface parameters**
  - Temperature and salinity at depths starting from 5m, 10m, 15m, 20m, 30m, 50m, 75m, 100m, 200m and 500m
  - Currents at depth levels 10m, 20m, 30m, 50m and 100m (7 buoys only ie BD2, BD4, BD6,BD7, AD1, AD4, AD5)



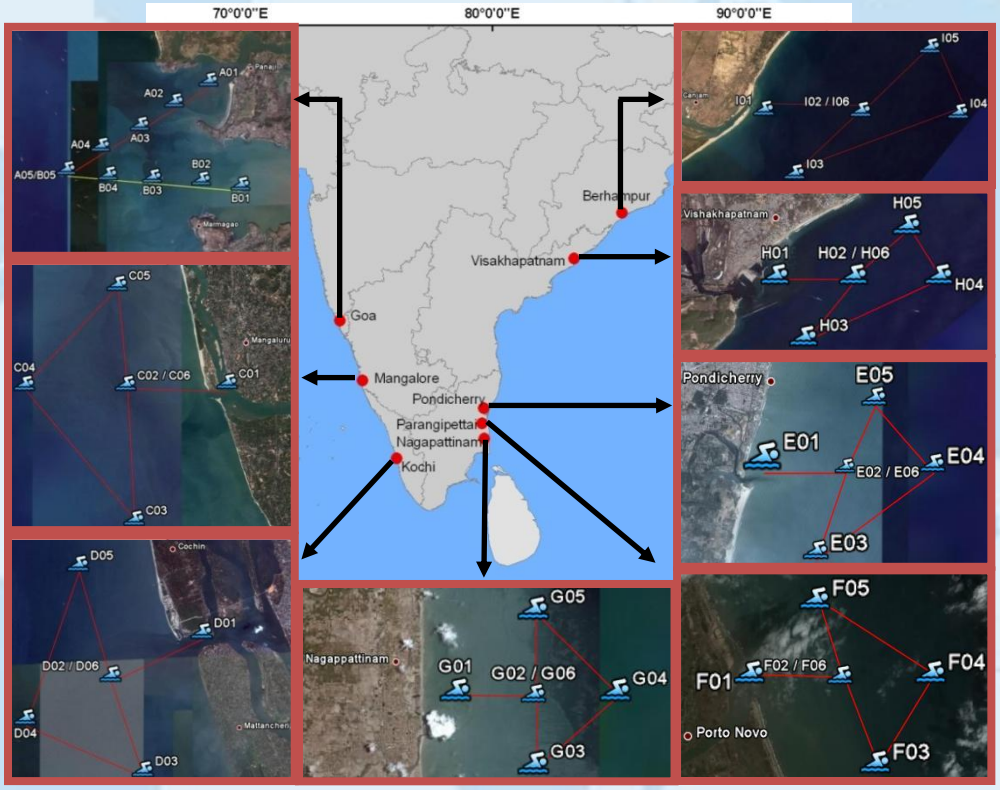

(a) Temperature (Deg)
(b) Salinity (Psu)
(c) Wind speed (m/s)
(d) Current (cm/s)
Buoy 13
Buoy 14
Deg
Psu
a)
b)
c)
d)
5 m/s
S
cm/s
OCT
NOV
DEC
JAN
100 cm/s
150 cm/s

ADCP moorings along the coast of India

10 pairs (on the shelf and off the shelf)

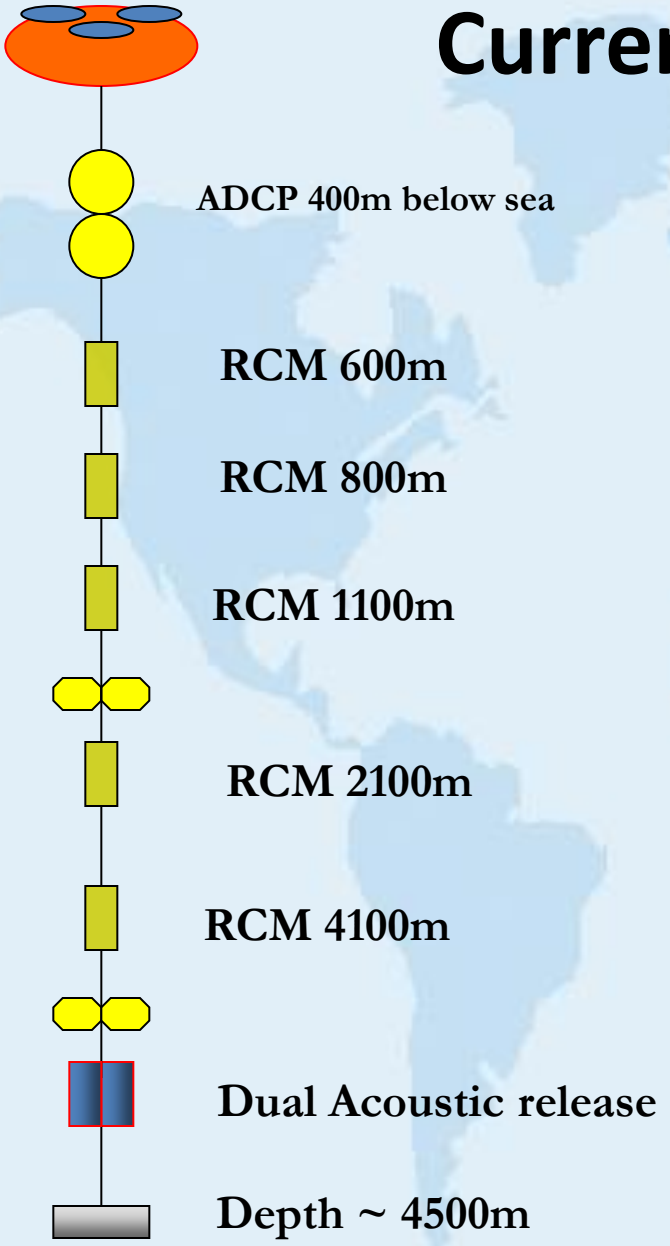


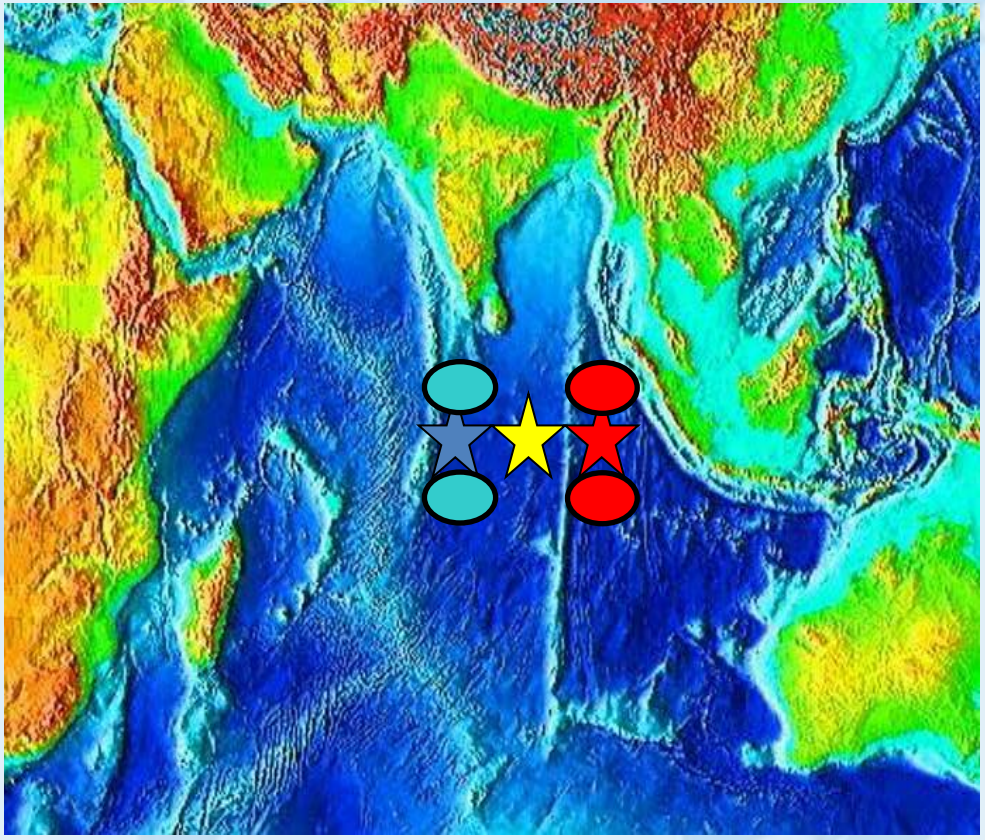
Coastal Time series station – In situ (Bio-optical)



- **Monthly sampling at 8 pre-defined transects covering case 1 & case 2 waters**
- **Radiometric Measurements**
- **Water Sample Collection for Chl-a, TSM & CDOM**

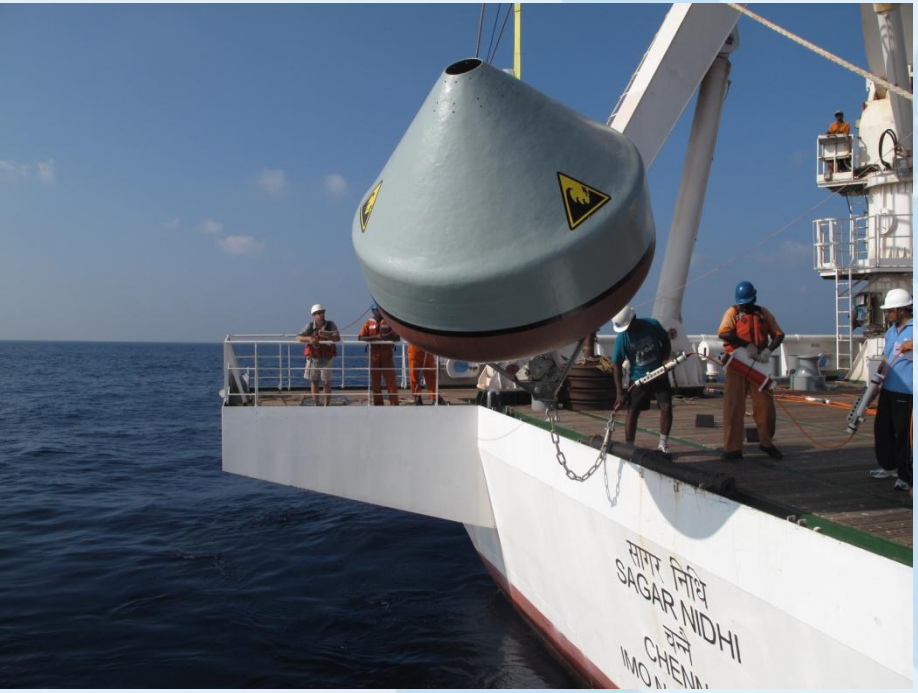
Current meter moorings





7 Current meter moorings

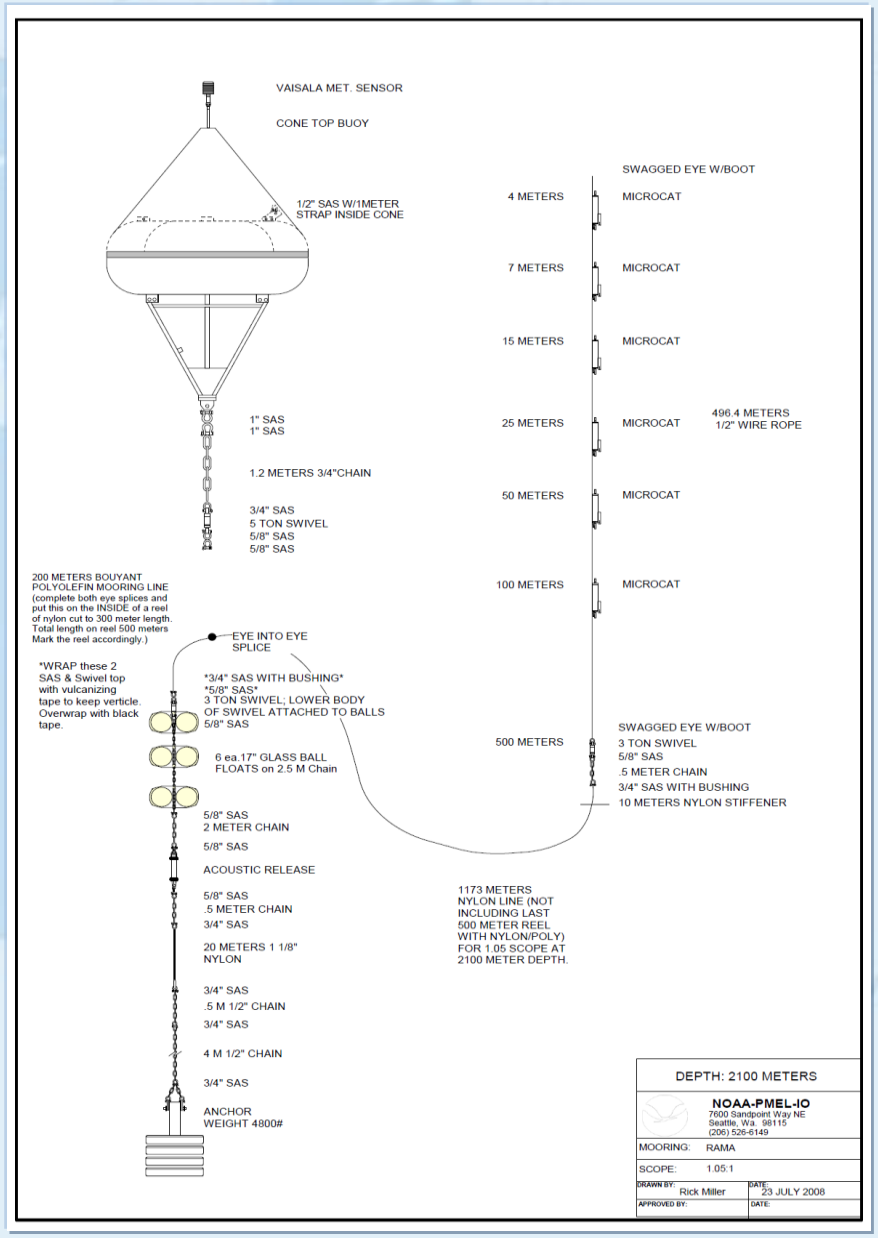
Bay of Bengal Observatory



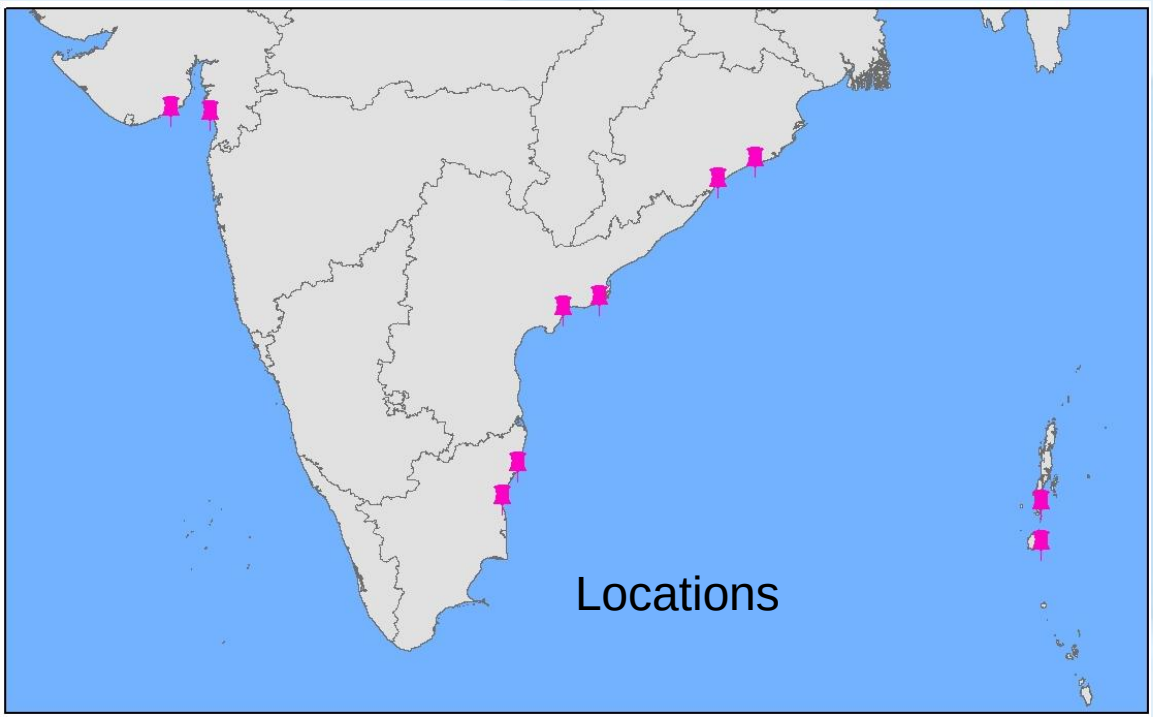
- Sensors:
  - 1 upward looking current meter (5 m),
  - 1 SST sensor (1 m),
  - 6 temperature and salinity sensors

    MicroCATs (4, 7, 15, 25, 50, 100 m)

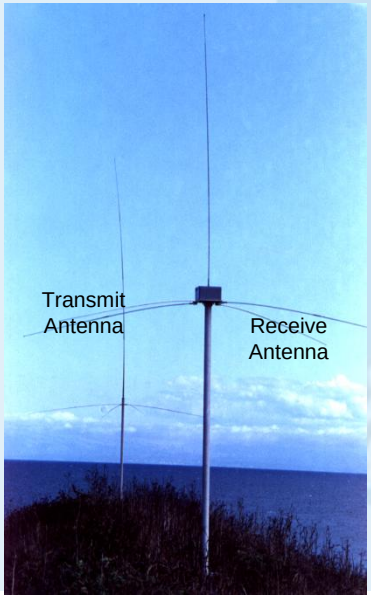
- Sampling time:
  - 10 minute for each sensor

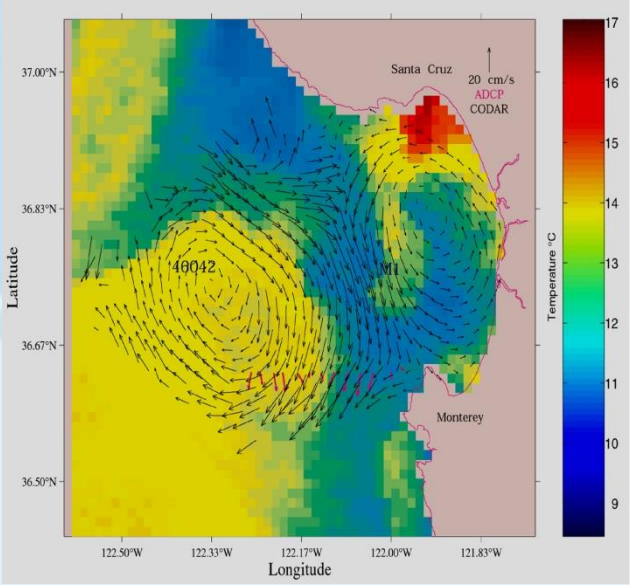


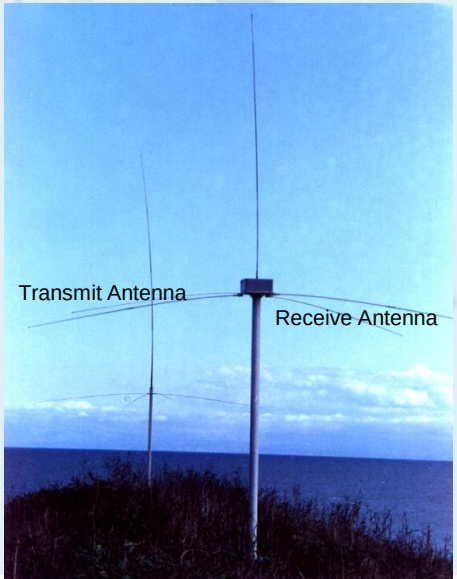
HF Radar Network



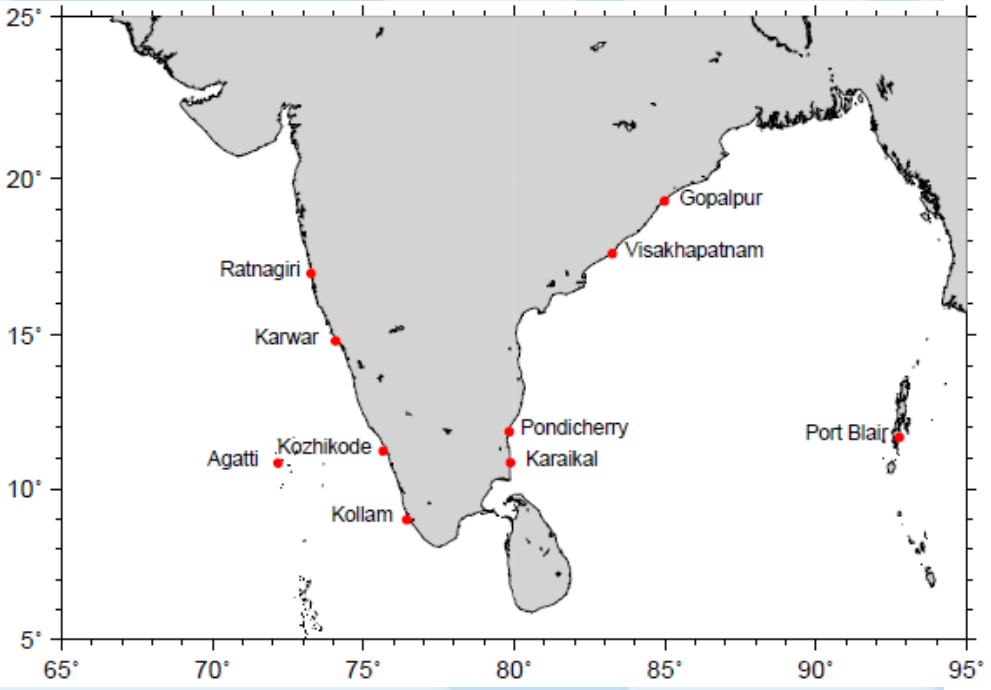
- **5 sets of CODAR are installed at Gujarat, Tamilnadu, Andhra Pradesh, Orissa and Andaman & Nicobar Islands coasts and real time data being received at INCOIS & NIOT**
- **Enables measurement of Waves & Currents to about 100 Kms from the Coast**



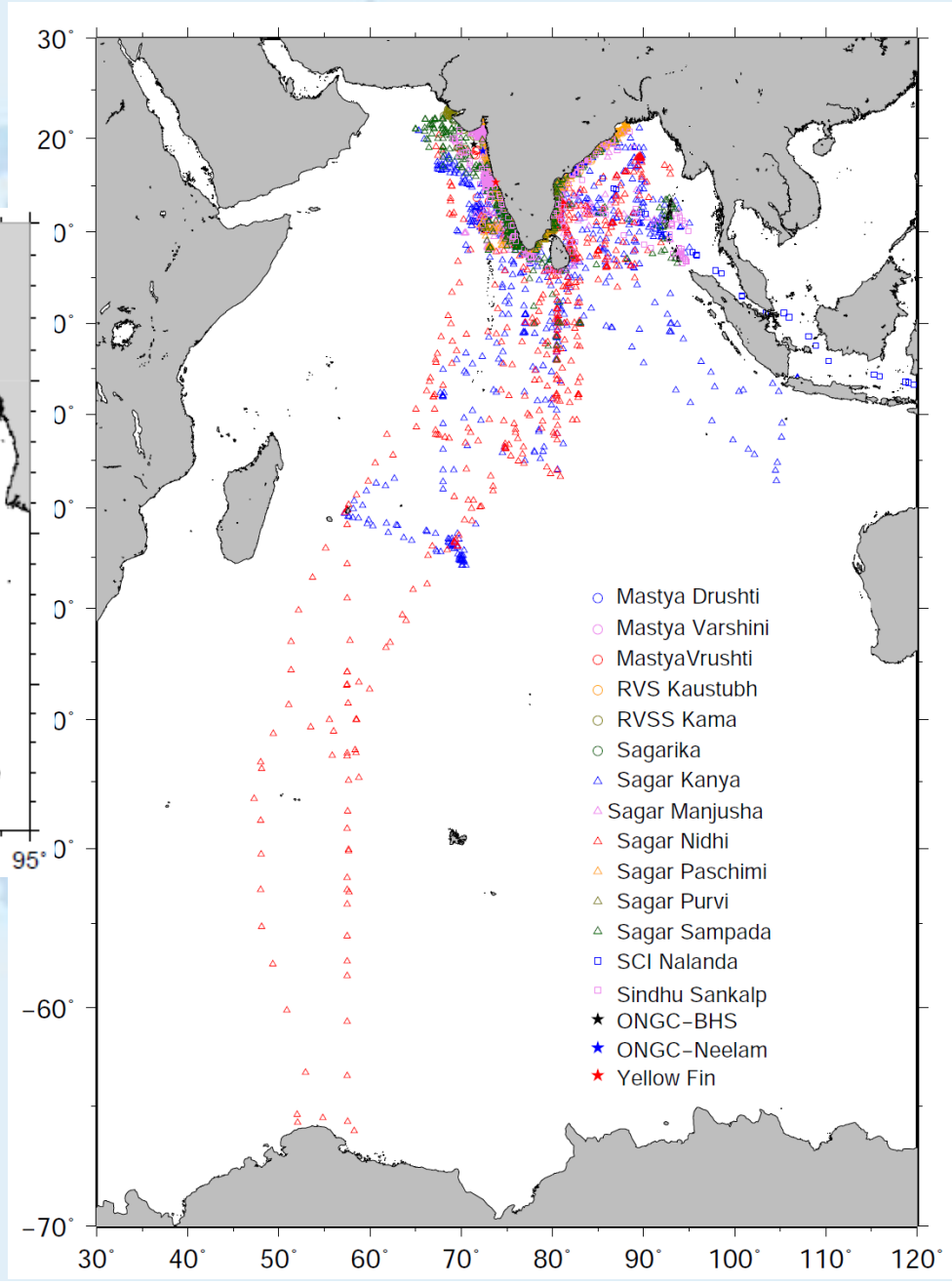




INCOIS Wave Rider Buoy network



INCOIS Real-time AWS (I-RAWS) network

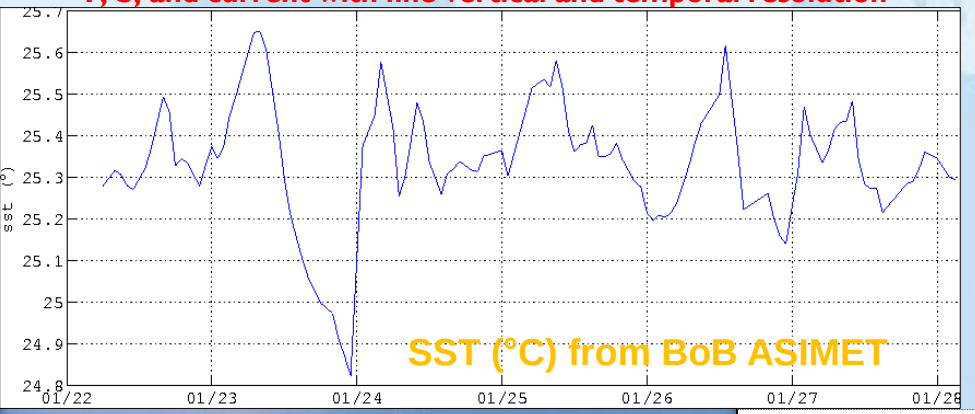


Ocean Mixing and Monsoon (OMM)-Air-Sea Interaction Research Initiative (ASIRI)

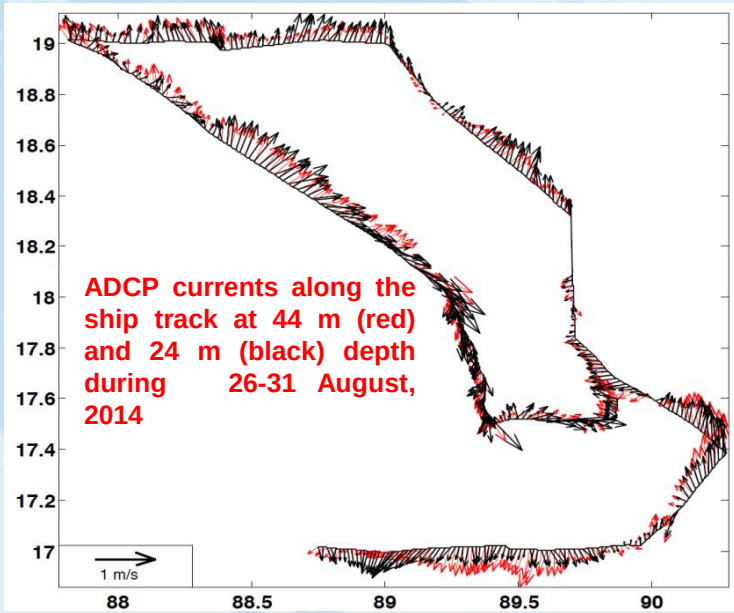
Collaborative between National Monsoon Mission Program, (MoES), India- Office of Naval Research, US

Objective: To obtain multi-scale observation in the near surface layer in the Bay of Bengal to improve our knowledge on the air-sea exchange and sub-mesoscale process

- **Major activity during last six month**
  - **Field survey in the Bay of Bengal**
    - *22 August-09 September, 2014 using the ORV Sagar Nidhi (Phase-IV)*
    - *.24 November-13 December, 2014 ORV Sagar Nidhi (phase-V)*
  - **Deployment of Air-Sea Interaction METeorology (ASIMET) System**
    - **Deployed on 11 November, 2014 at 18°N and 89.5°E in Northern BoB**
    - **Surface meteorology and radiation with IMET packages**
    - **T, S, and current with fine vertical and temporal resolution**

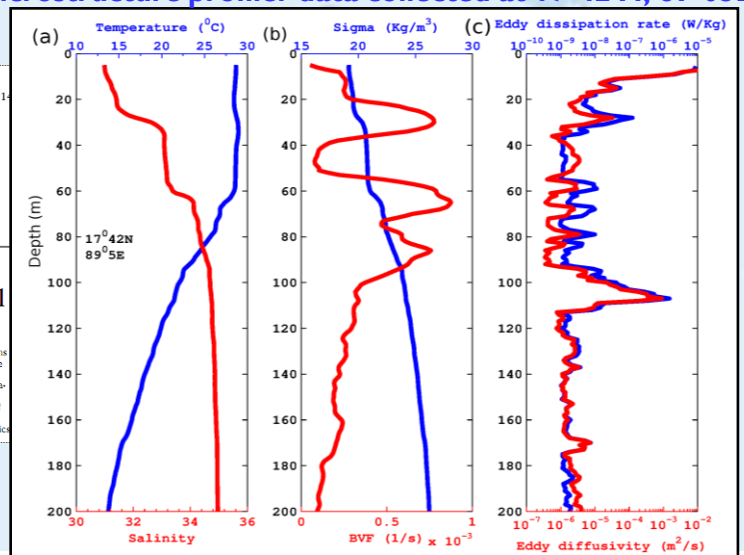


SST (°C) from BoB ASIMET

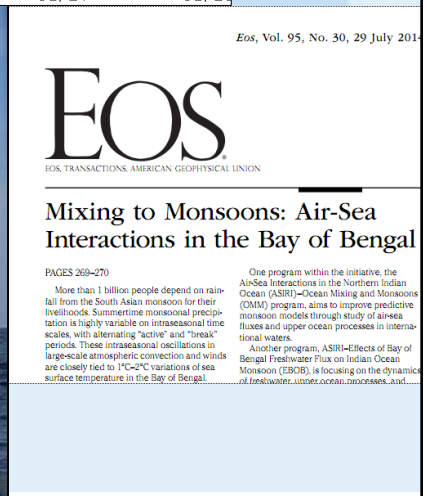


ADCP currents along the ship track at 44 m (red) and 24 m (black) depth during 26-31 August, 2014

Microstructure profiler data collected at 17°42'N, 89°05E



ASIMET system



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EOS

EOS, TRANSACTIONS, AMERICAN GEOPHYSICAL UNION

Mixing to Monsoons: Air-Sea Interactions in the Bay of Bengal

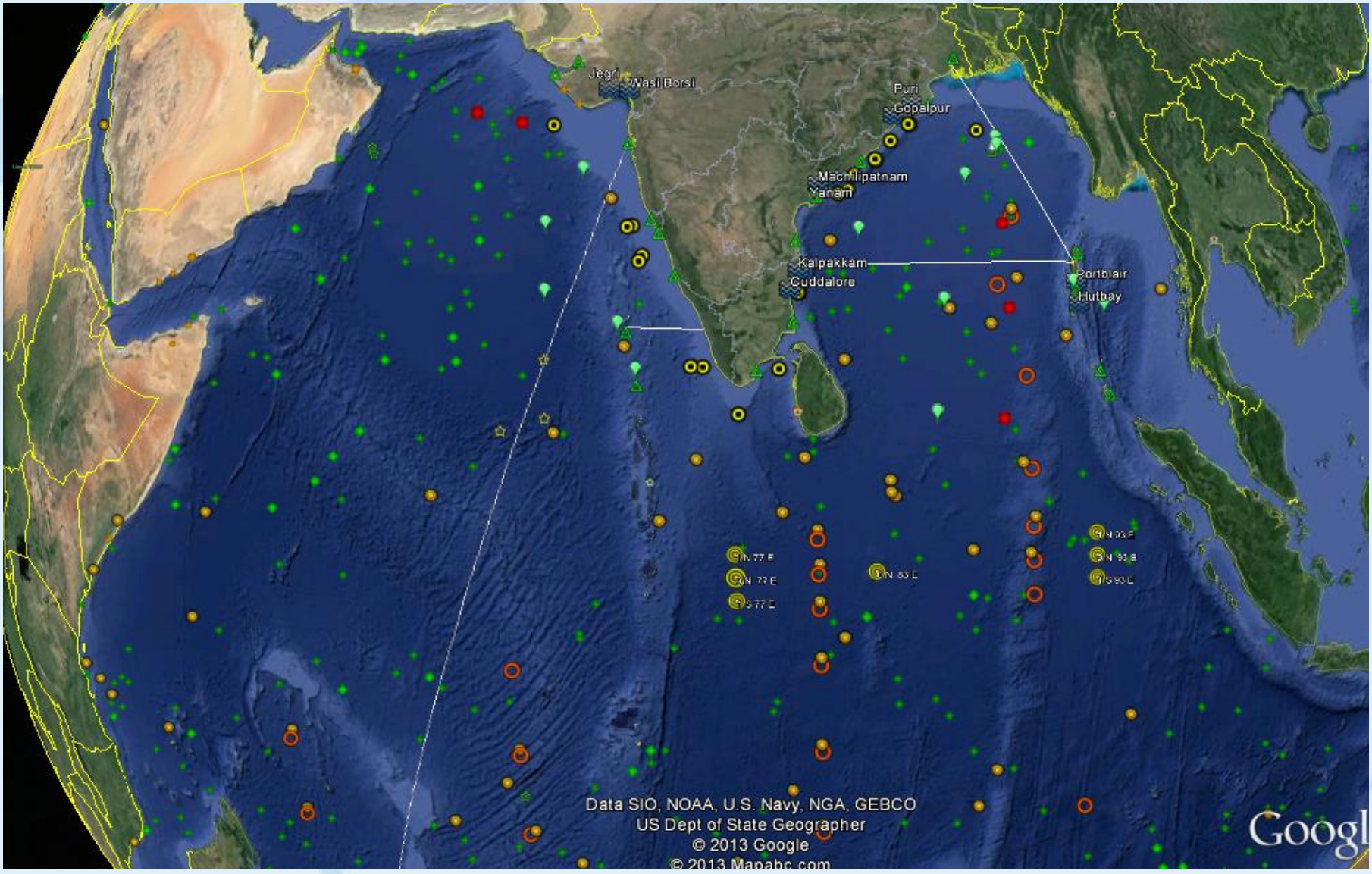
PAGES 269–270

More than 1 billion people depend on rainfall from the South Asian monsoon for their livelihoods. Summertime monsoonal precipitation is highly variable on intraseasonal time scales, with alternating "active" and "break" periods. These intraseasonal oscillations in large-scale atmospheric convection and winds are closely tied to 1°C–2°C variations of sea surface temperature in the Bay of Bengal.

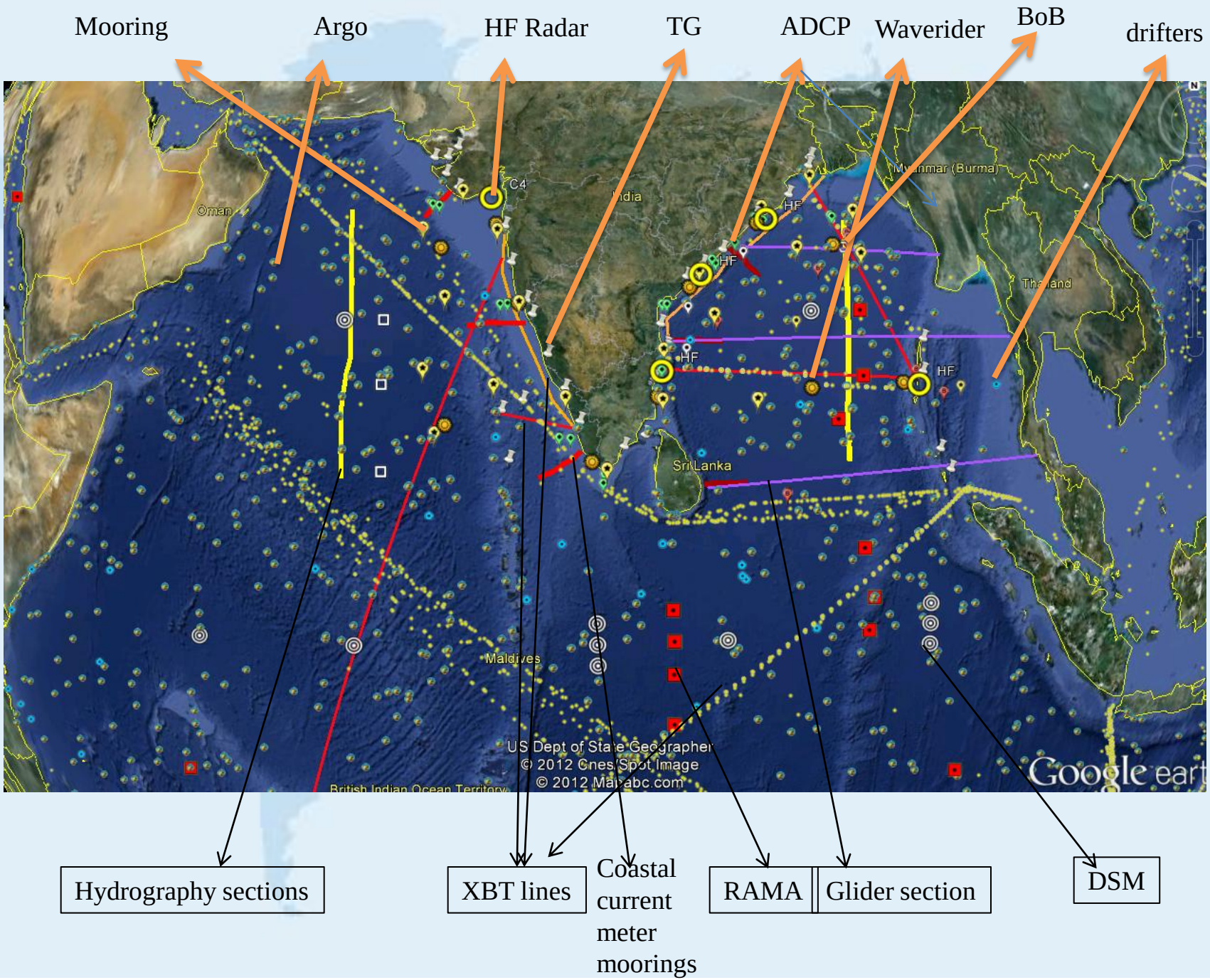
One program within the initiative, the Air-Sea Interactions in the Northern Indian Ocean (ASIRI)–Ocean Mixing and Monsoons (OMM) program, aims to improve predictive monsoon models through study of air-sea fluxes and upper ocean processes in international waters.

Another program, ASIRI–Effects of Bay of Bengal Freshwater Flux on Indian Ocean Monsoon (EBOB), is focusing on the dynamics of freshwater, upper ocean processes, and...

Present status of Ocean Observation Network



Argo, Moorings, ADCP, drifters, RAMA buoys, current meter moorings, XBT, CODAR, Tsunami buoys, wave rider buoys


Mooring
Argo
HF Radar
TG
ADCP
Waverider
BoB
drifters
C4
HF
HF
HF
HF
Oman
Sri Lanka
Maldives
Thailand
US Dept of State Geographer
© 2012 Cnes/Spot Image
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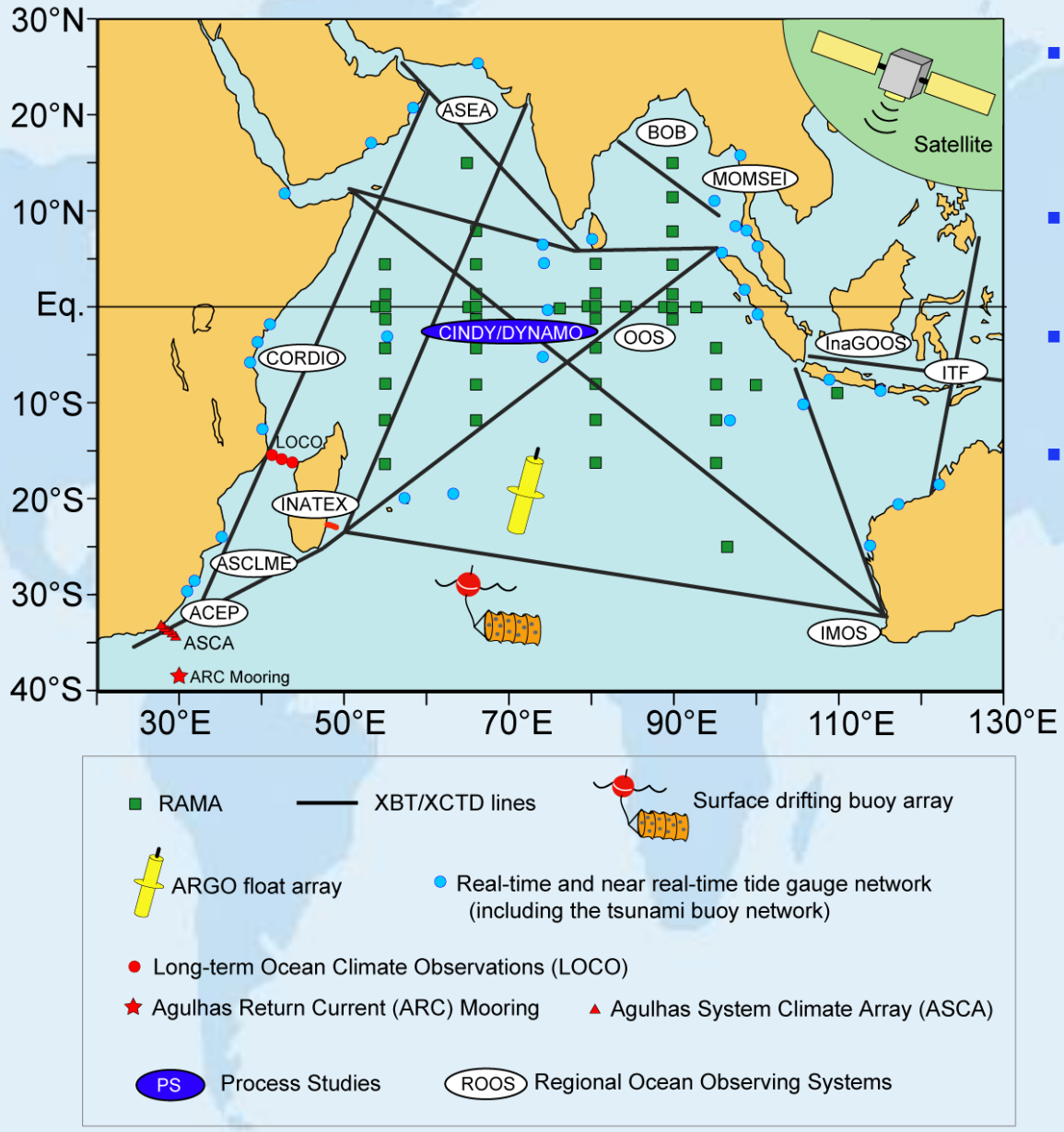
Hydrography sections
XBT lines
Coastal current meter moorings
RAMA
Glider section
DSM

Near Future

- Thrust on Coastal Observations
  - Gliders, uCTD, ADCP, …
- High resolution observations [temporal (days to hours), vertical (m to cm) and spatial (less than a km)]

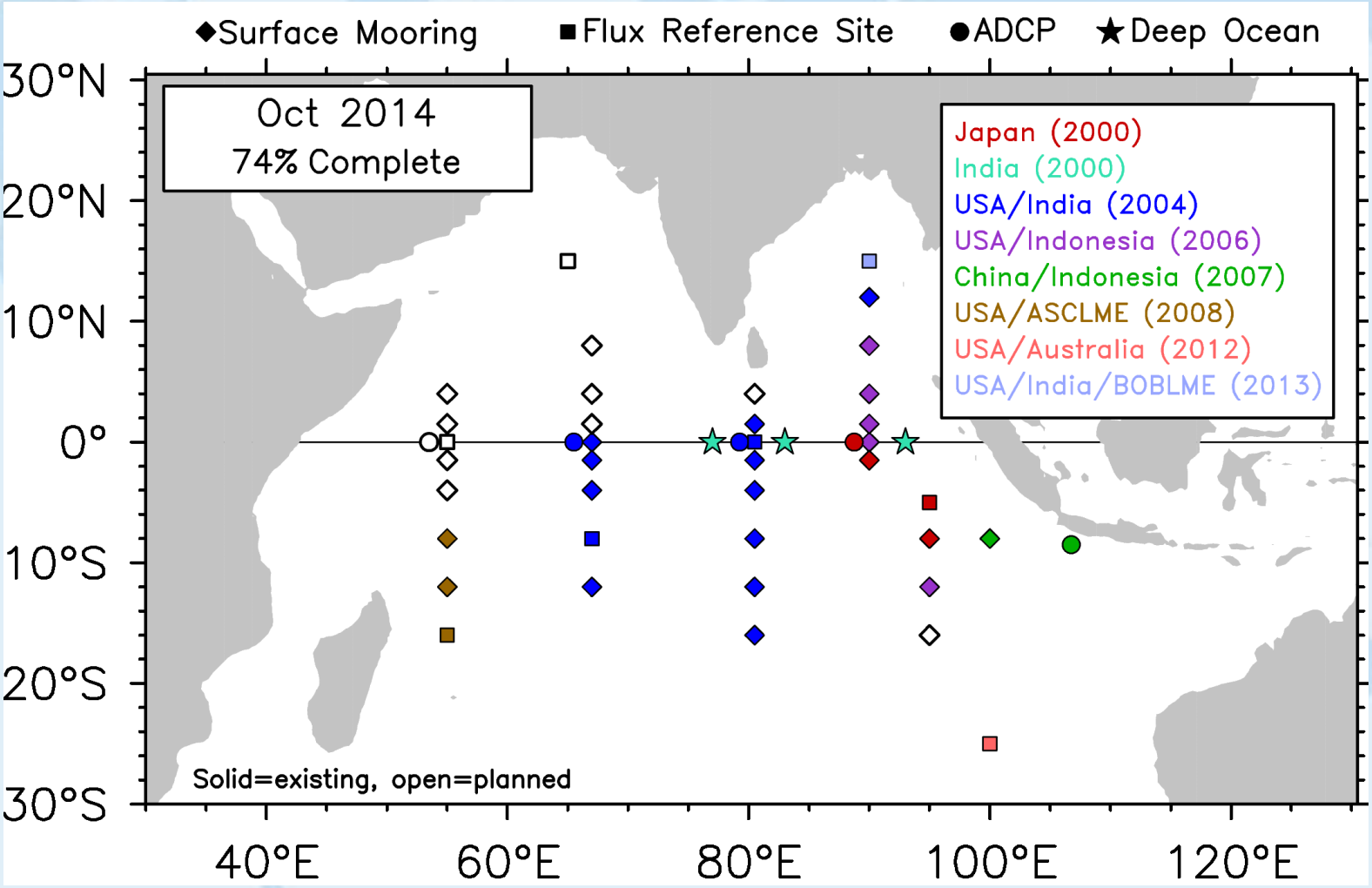
Indian Ocean Observing System (IndOOS)



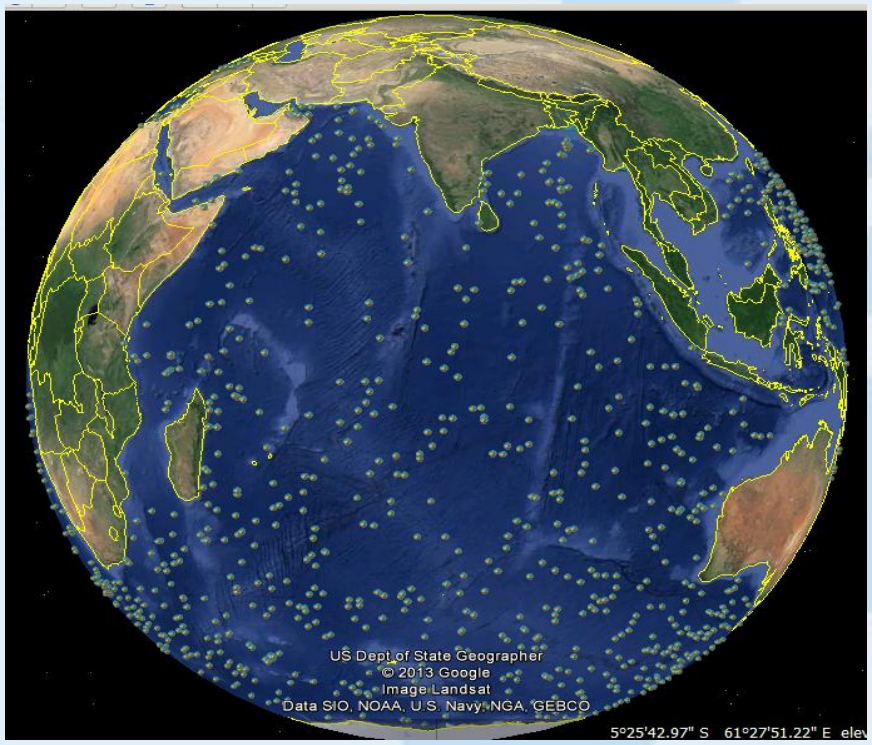
- Planned by CLIVAR/GOOS IOP in 2004
- Basin scale with regional elements
- Supports short term process studies
- Design supported by numerical model observing system simulation studies

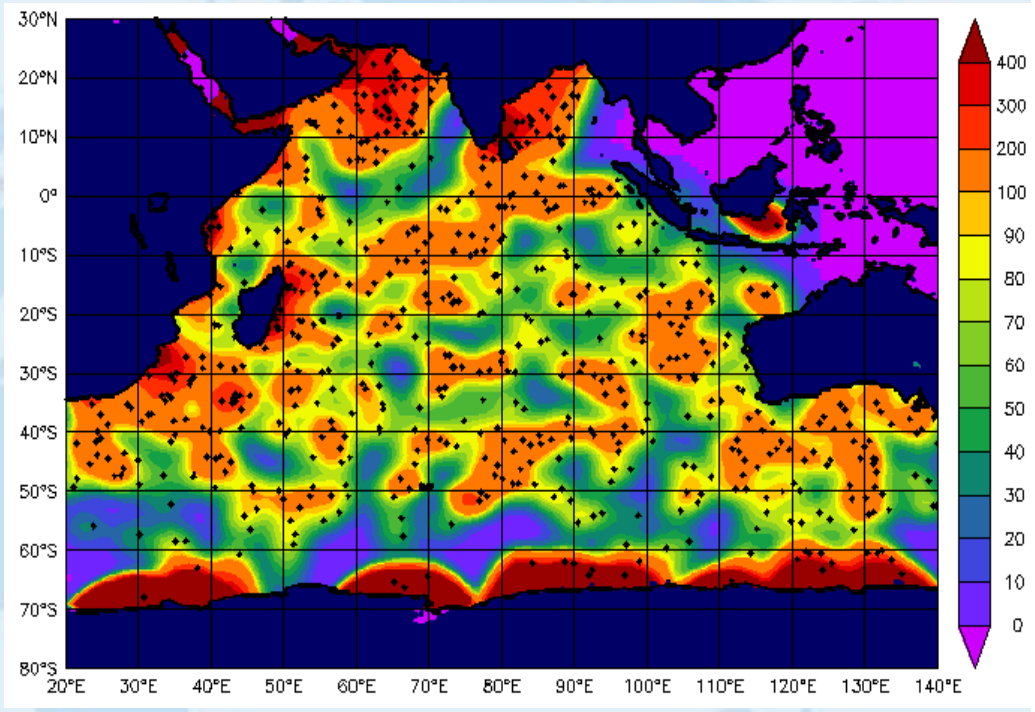
Multi National
Multi Institutional
Multi Platform

Status of RAMA



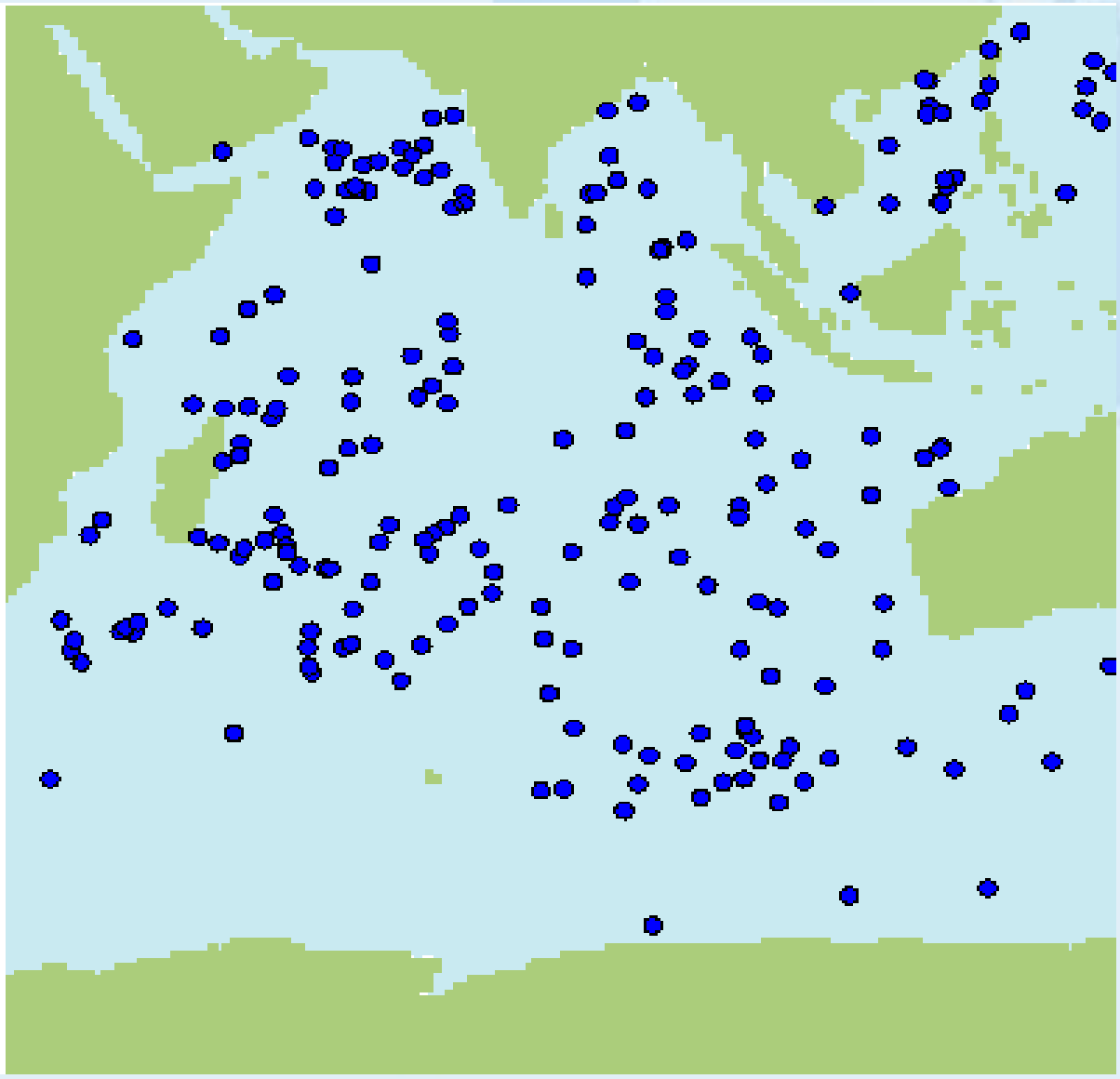
Present status of Indian Ocean Argo floats





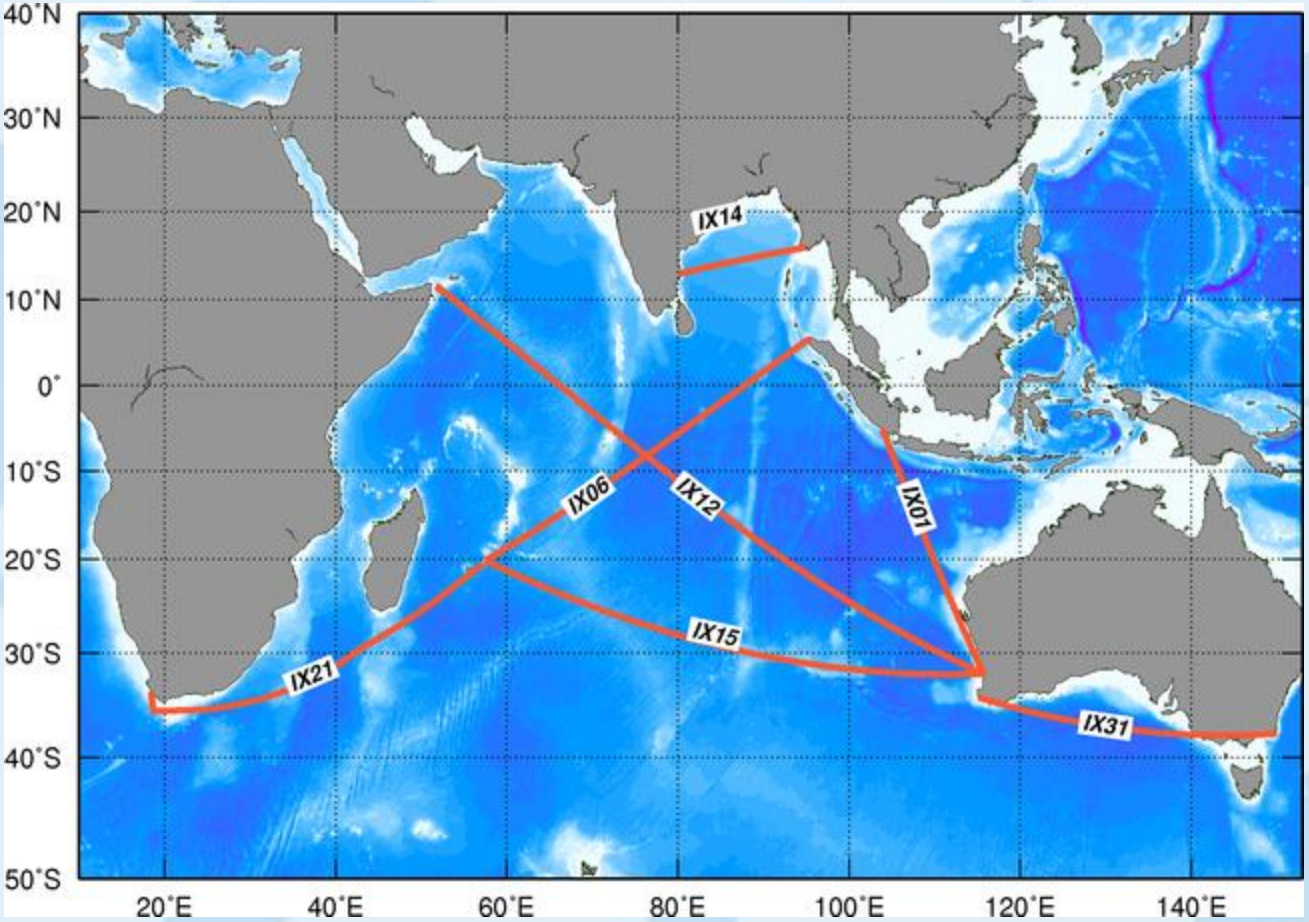
- 672 floats are active in the Indian Ocean (430 floats are active north of 30S)
- Most new floats: iridium communication (higher vertical resolution ~ 2m)
- Few floats with biogeochemical sensors (~ 10 cm vert. res. in the top 30 m)
- 68 % of the float have been QC'ed in delayed mode

Surface Drifters in the Indian Ocean



- improvement compared to last year, but need more

XBT Sections in the Indian Ocean

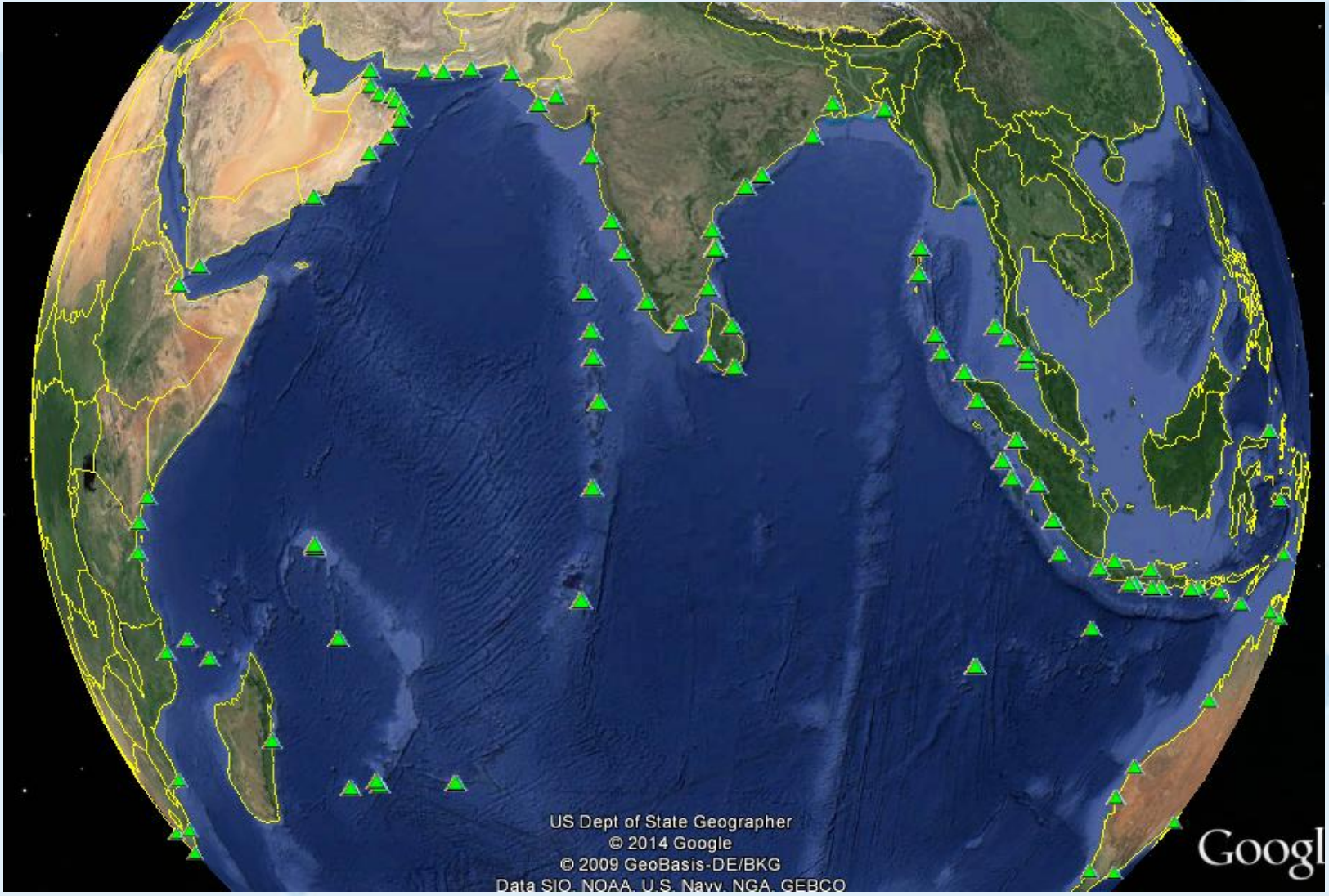


Active transects: IX1 ~ weekly

IX12 ~ monthly

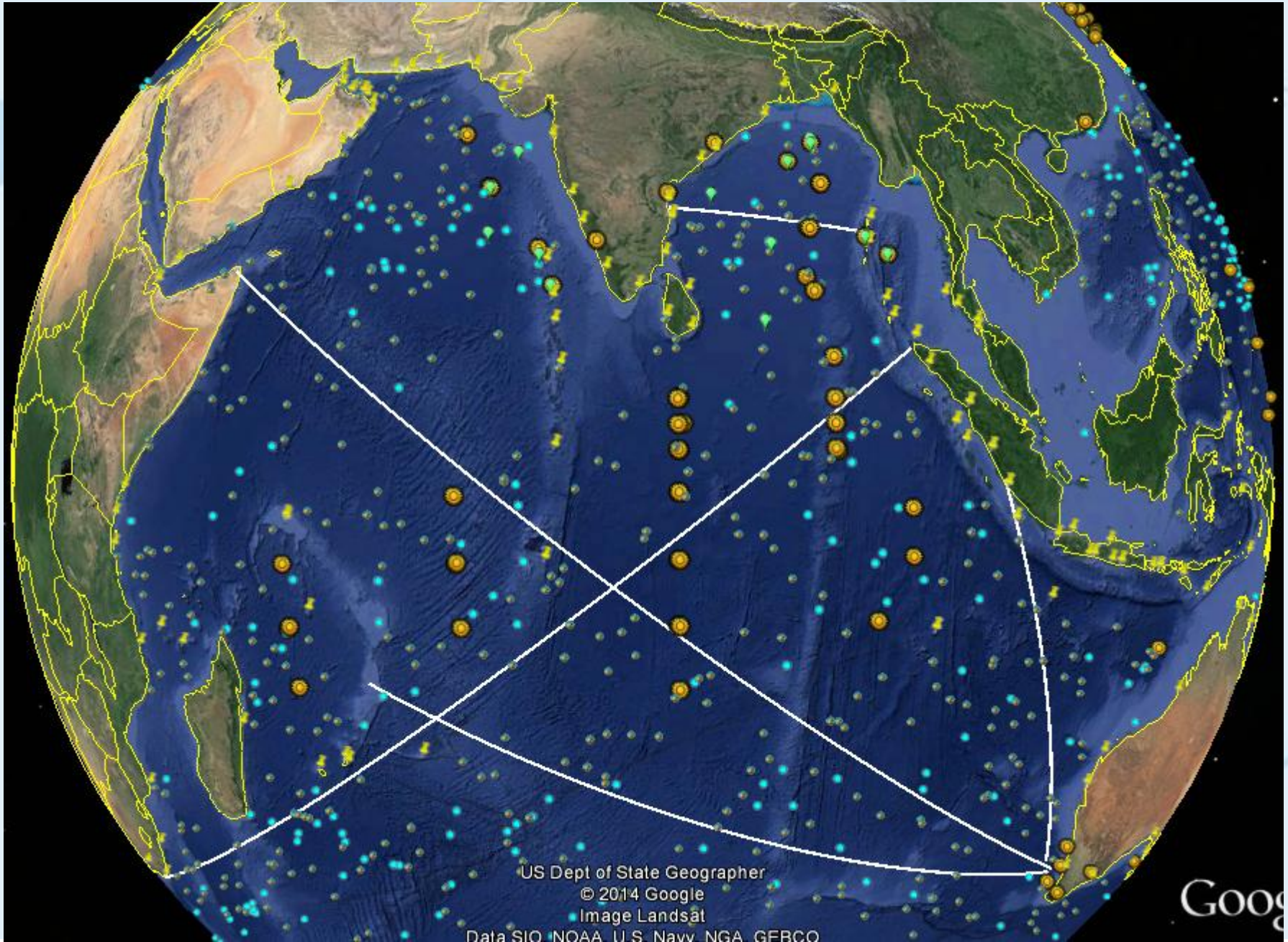
IX15/21 ~ quarterly

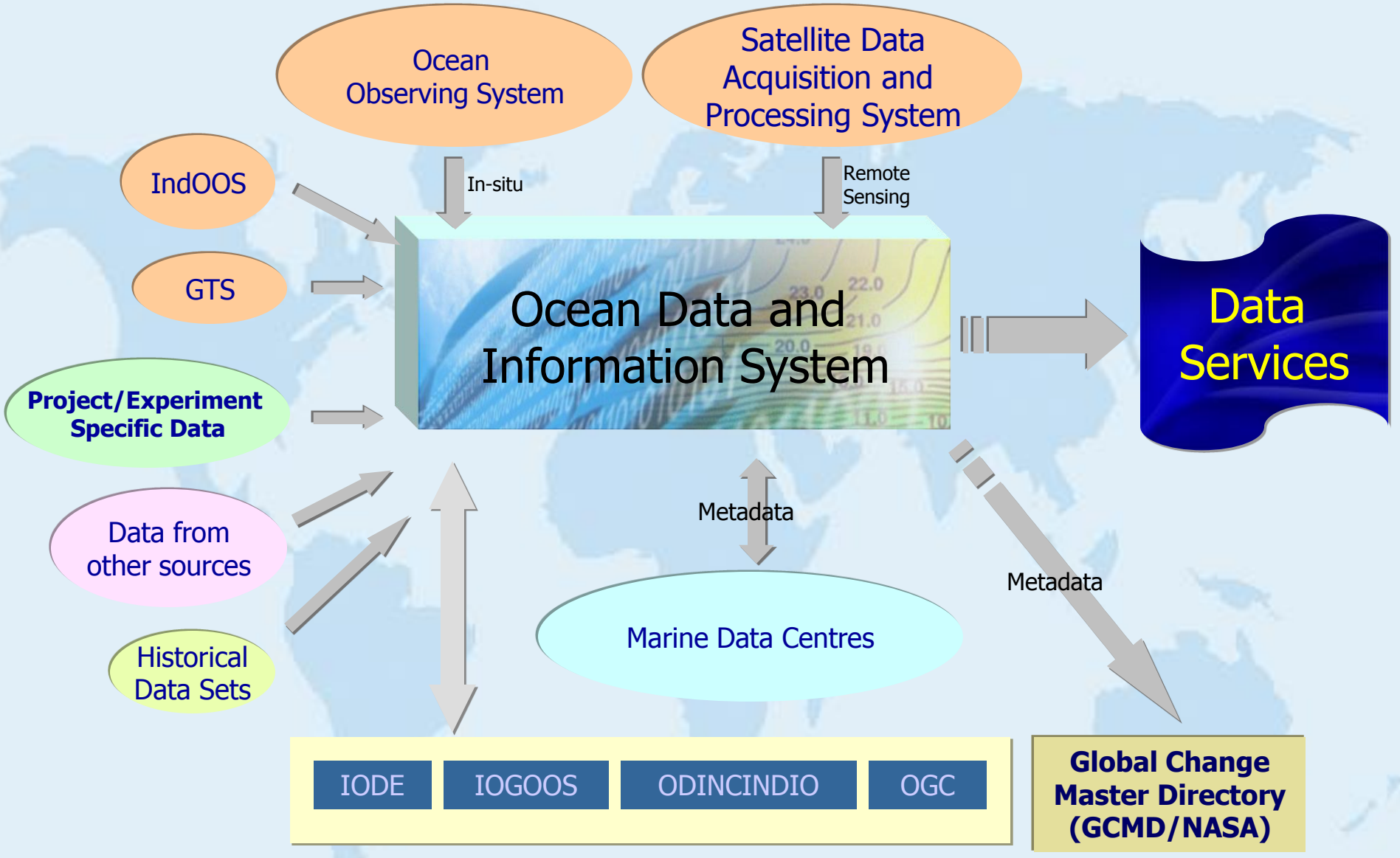
Tide gauge locations



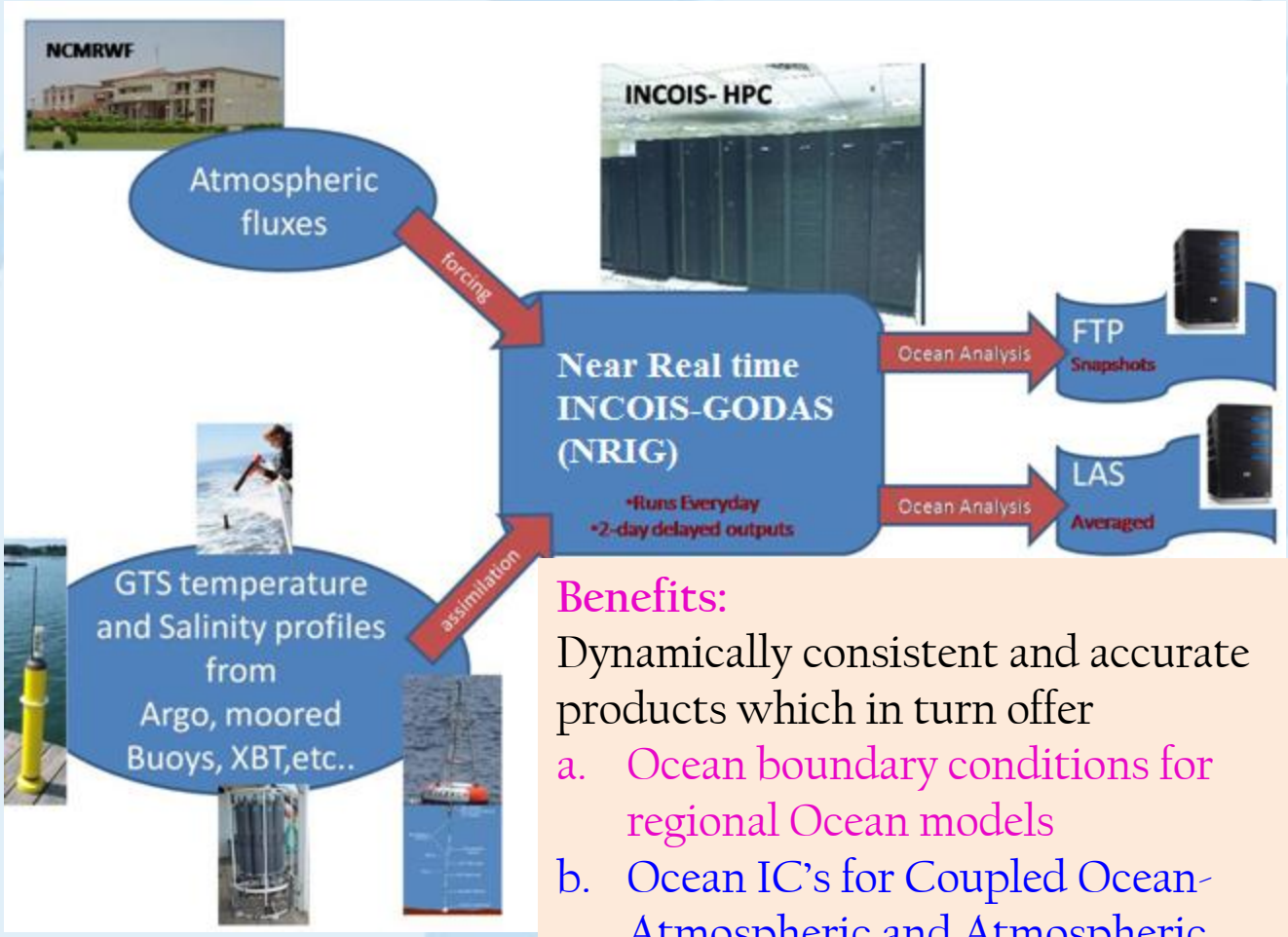
125 active Tide gauges in the Indian Ocean (67 last year)

Present status of IndOOS




Ocean Observing System
Satellite Data Acquisition and Processing System
IndOOS
GTS
Project/Experiment Specific Data
Data from other sources
Historical Data Sets
In-situ
Remote Sensing
Ocean Data and Information System
Data Services
Metadata
Metadata
Marine Data Centres
IODE
IOGOOS
ODINCINDIO
OGC
Global Change Master Directory (GCMD/NASA)

Global Ocean Analysis on near real time



Benefits:

Dynamically consistent and accurate products which in turn offer

a. Ocean boundary conditions for regional Ocean models
b. Ocean IC's for Coupled Ocean-Atmospheric and Atmospheric models to provide long and short range forecasts (IITM and IMD)
c. Understanding the Ocean dynamics

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)- T574L64 run at NCMRWF.

Data assimilation scheme: 3D VAR

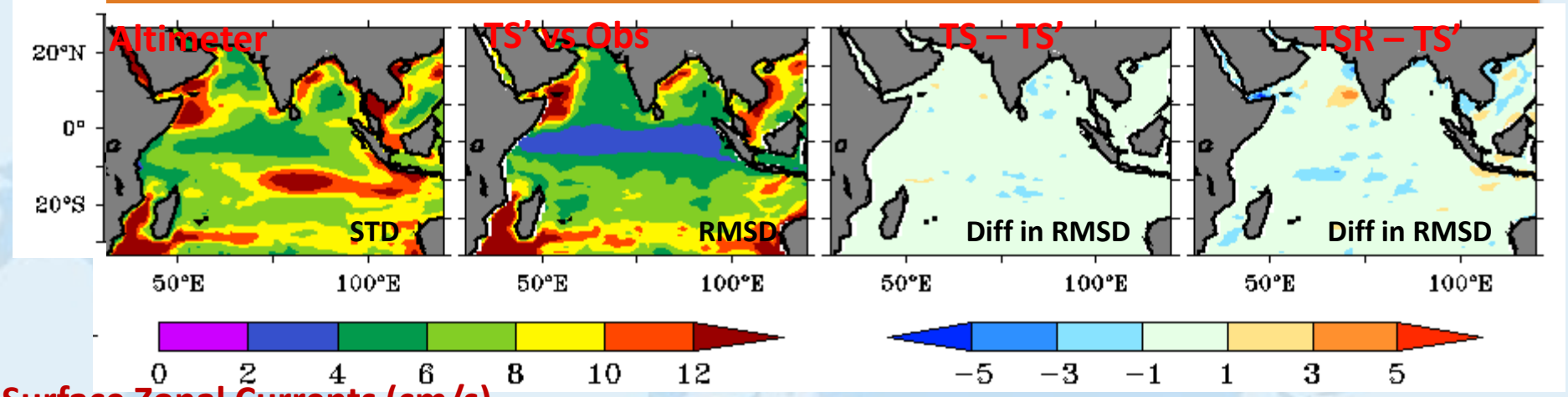
Parameters assimilated: Temperature and salinity profiles from Argo, XBT and moorings

Relaxation: OISST-V2 [Reynolds, 2007]

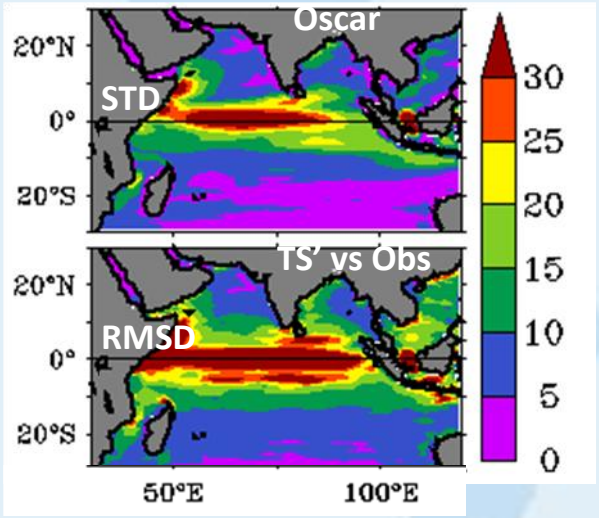
Outputs: Temperature, Salinity, SSH, and Currents

Ravichandran et al., 2013, *Ocean Modelling*

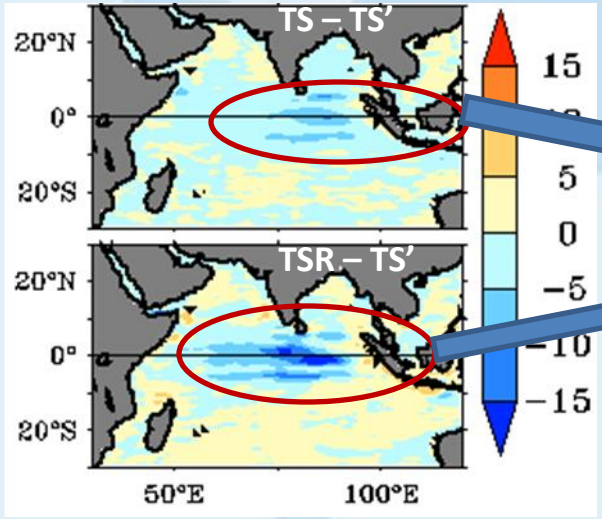
Evaluation of GODAS in the Indian Ocean



Surface Zonal Currents (cm/s)

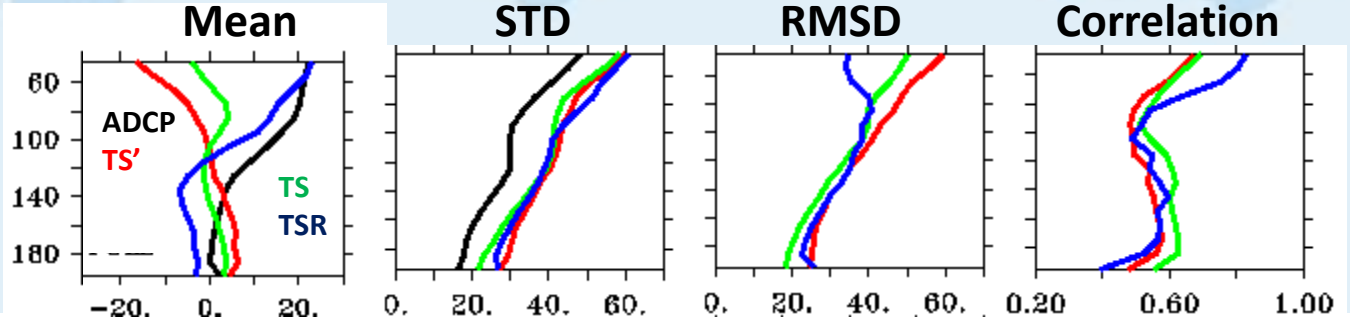


Diff in RMSD



Improvements in TSR over TS' are due to both insitu salinity assimilation and satellite based wind.

Sub- Surface Zonal Currents (cm) at Eq, 80.5E



Global Ocean Analysis

- Upgraded the present mom4p0d with mom4p1 in INCOIS-GODAS.
- Implemented Altimeter assimilation in GODAS (MOM4p1).
- Implemented of LETKF assimilation in a nested regional IOM.

With support from NOAA-CIRA visiting scientist

Near future Plan

- Operationalise INCOIS-GODAS for generating Global Ocean analysis with assimilation of altimeter based sea level and *in-situ* data
- Nesting regional and coastal model with GODAS for operational forecast for Ocean state (Ensemble??? Or single model)