Dr. R.Venkatesan

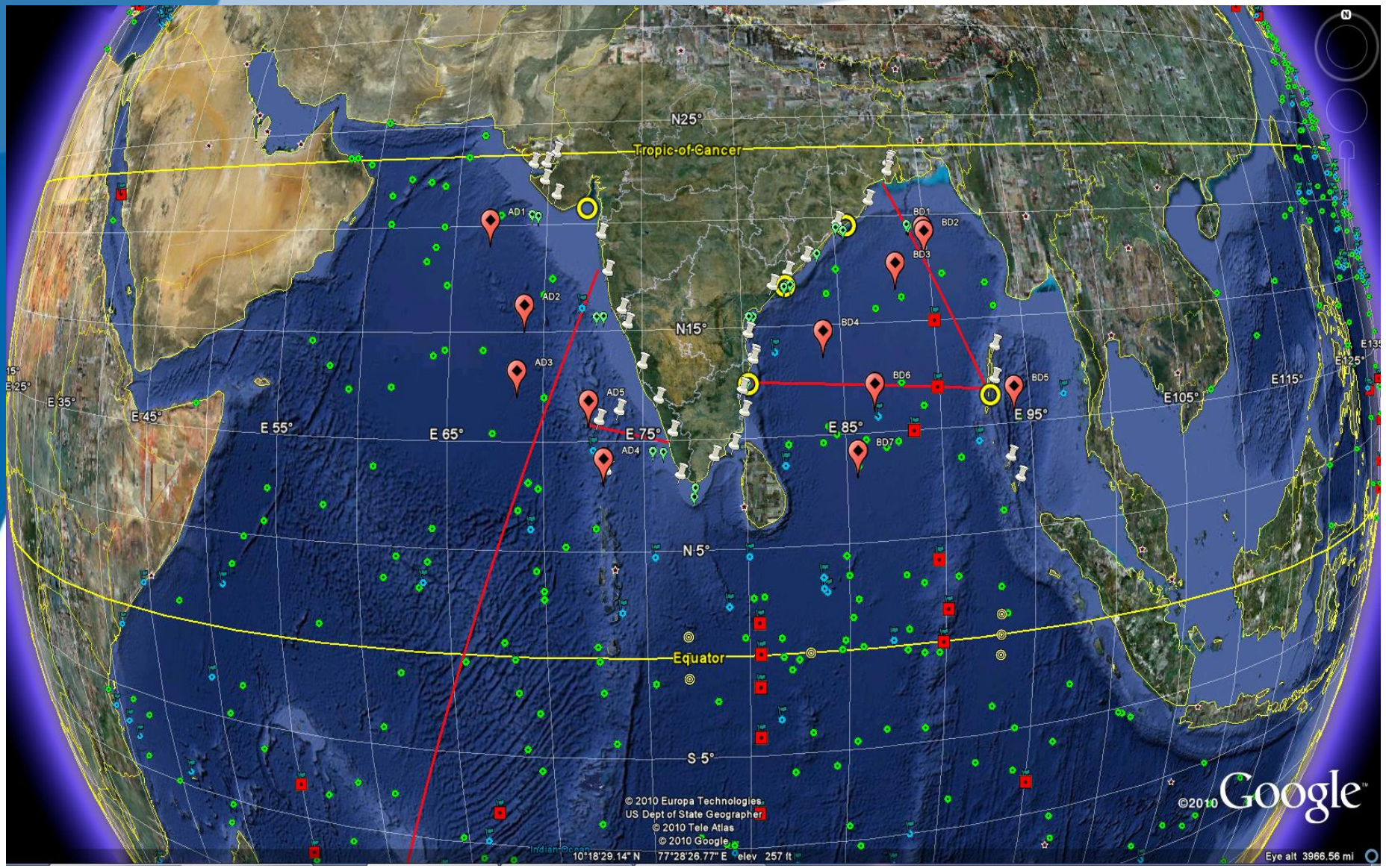
National Institute of Ocean Technology
समुद्र राष्ट्रीय प्रौद्योगिकी संस्थान
Earth System Science Organization
पृथ्वी प्रणाली विज्ञान संगठन

An Autonomous Institute under Ministry of Earth Sciences, Govt. of India

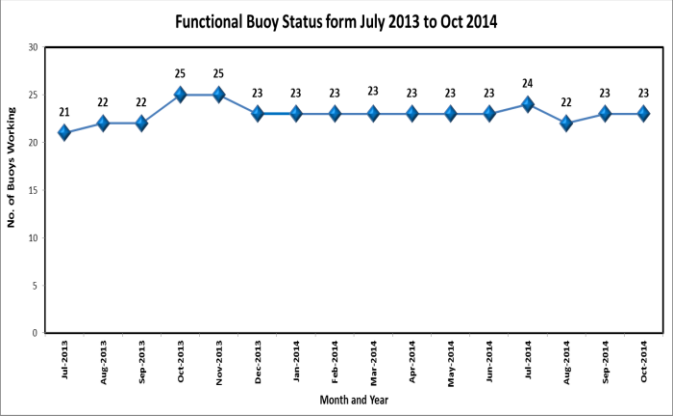
पृथ्वी विज्ञान मंत्रालय, भारत सरकार के तहत *एक स्वायत संस्थान*

31 October 2014

ESSO Ministry of Earth Sciences
Indian Ocean Observation Netw



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

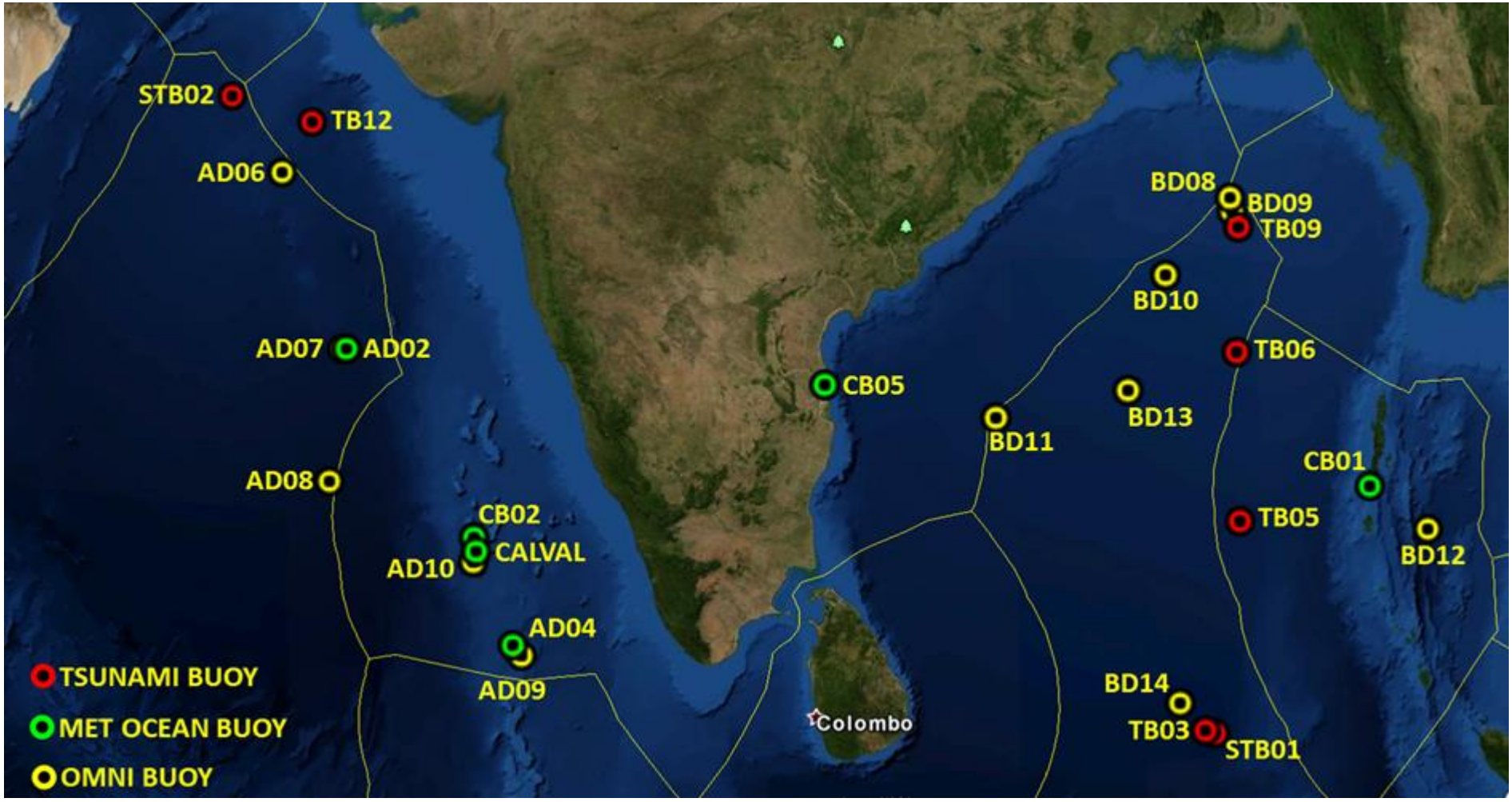


Present Buoy Network

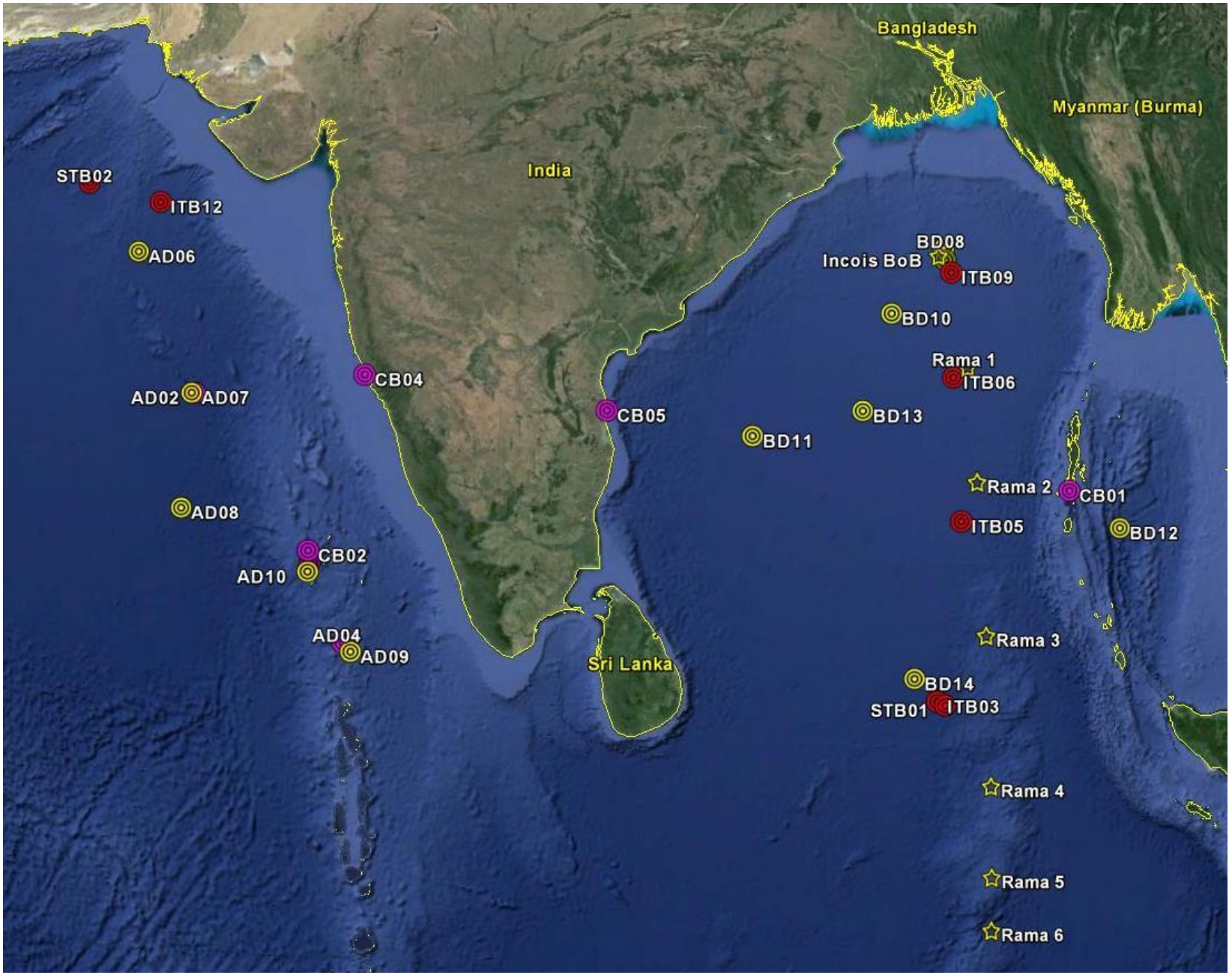
12 OMNI, 7 Met Ocean & 5 Tsunami

Buoy Location

OMNI Buoy				Met Ocean Buoy				Tsunami Buoy			
Buoy ID	Latitude (N)	Longitude (E)	Station Depth (m)	Buoy ID	Latitude (N)	Longitude (E)	Station Depth (m)	Buoy ID	Latitude (N)	Longitude (E)	Station Depth (m)
AD06	18.8	67.0	3300	AD02	15.0	69.0	3850	TB03	6.4	88.5	3850
AD07	15.0	68.9	3980	AD04	8.5	73.1	2250	TB05	11.0	89.5	3225
AD08	12.0	68.7	4300	CALVAL	10.5	72.3	2070	TB06	14.6	89.5	2770
AD09	8.2	73.3	2000	CB01	11.6	92.6	8	TB09	17.5	89.8	2280
AD10	10.3	72.2	1925	CB02	10.8	72.2	20	TB12	20.2	67.6	3050
BD08	18.1	89.6	2200	CB04	15.4	73.7	15	STB01	6.2	88.9	2500
BD09	17.8	89.6	2250	CB05	14.2	80.2	12	STB02	20.8	65.3	3000
BD10	16.5	88.0	2650								
BD11	13.5	84.0	3260								
BD12	10.5	94.0	3200								
BD13	14.0	87.0	3065								
BD14	7.0	88.0	3770								



Observational Moorings handled by India

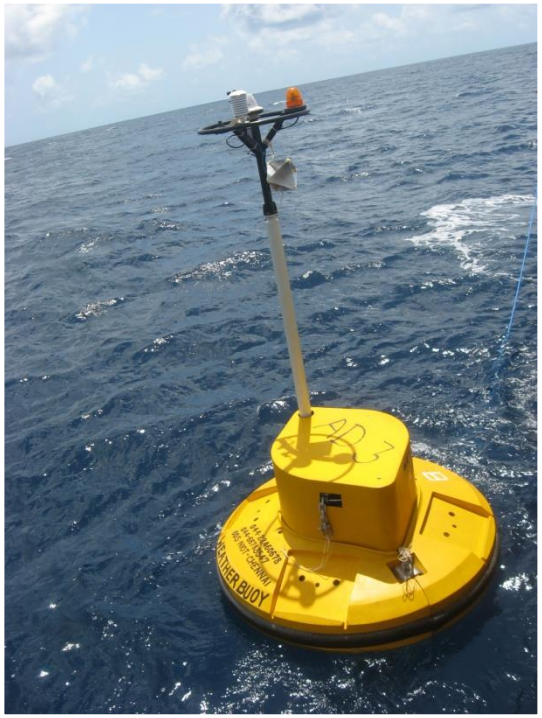


OOS Activities

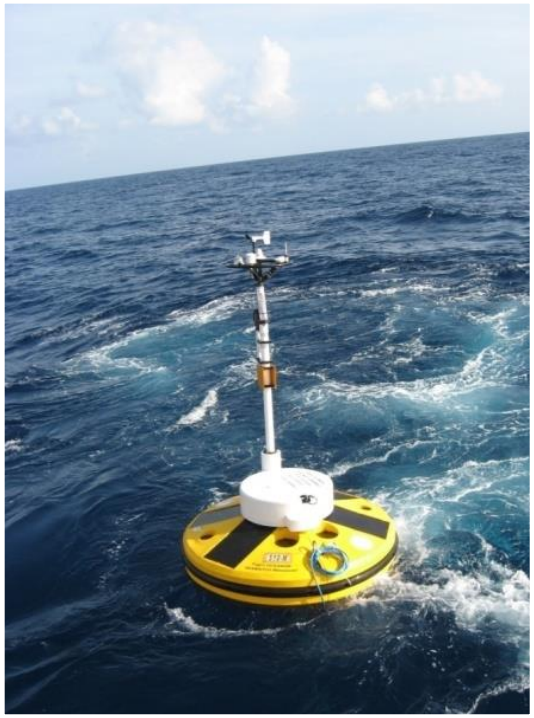
- ✓ **Moored buoy Network**
  - **OMNI Buoy systems**
  - **Tsunami Buoy systems**
  - **Coastal Buoy systems**
- ✓ **CALVAL Phase –II Jointly with SAC**
- ✓ **Technology demonstration of new observation tools, Calibration Facility**
  - Indian OMNI Buoy System (Prakruti)
  - Indigenized Tsunami Buoy System- SAGAR BHOOMI
  - Integrated Marine Surveillance System (R-Darsh)
  - Automatic Identification System (AIS) for Buoy
  - Met –Ocean Buoy interfaced with INSAT and GPRS communication
  - Twin mode communication
  - Design and Development of Autonomous Ocean Observation - Robotic Fish (AquaBot)
  - Calibration facility
  - Optimization of power consumption in OMNI buoy systems using Hybrid power management technique
  - BPR Tracker
  - Buoy Position Tracker
- **International Projects**
  - *ASIRI-Air Sea Interaction Research Initiative*
  - *Interaction with International organizations:*
    - *NOAA-PMEL,USA*
    - *NOAA-NWS-NDBC,USA*
    - *JAMSTEC,JAPAN*
    - *SCRIPPS & WHOI, USA*

Types of buoy Systems Handled

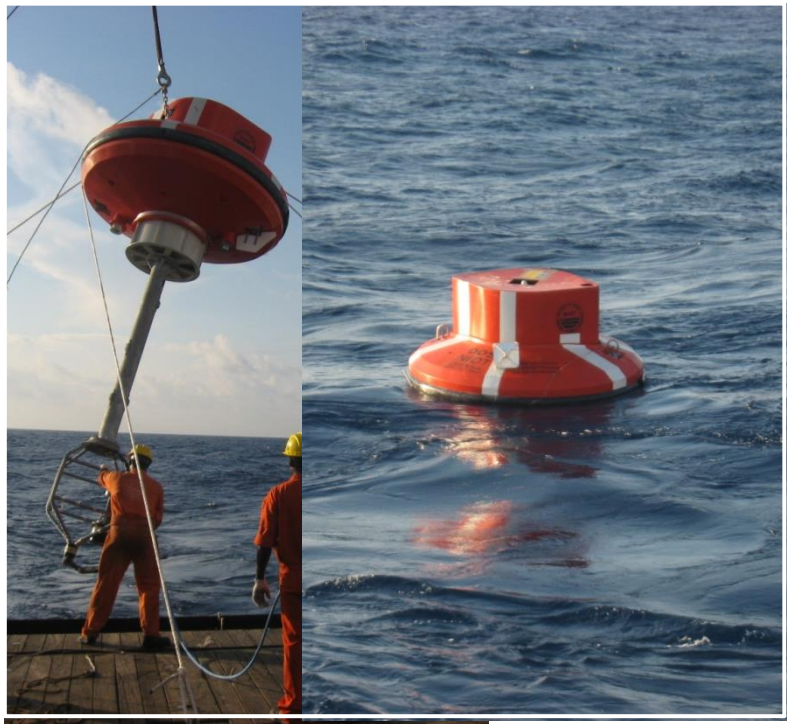
MET OCEAN BUOY



OMNI BUOY

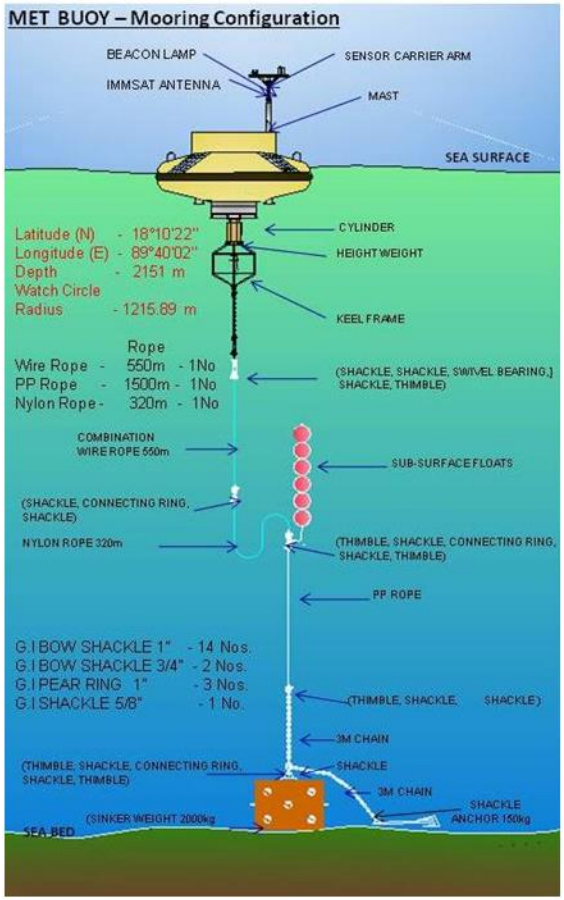


TSUNAMI BUOY

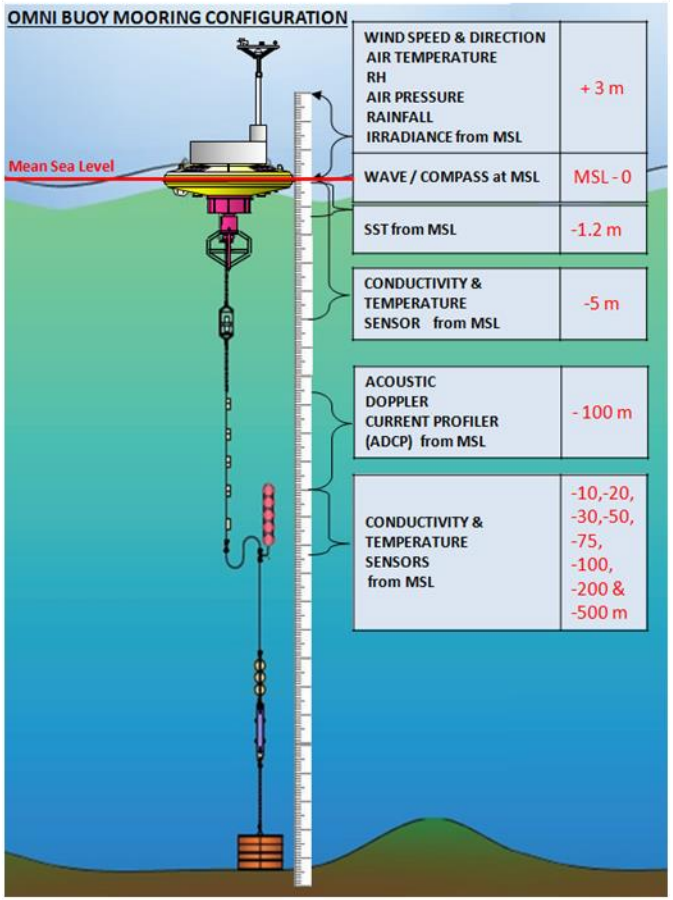


Year	No of Cruises	No of buoys	sailed days
2010	14	12	106
2011	14	21	206
2012	13	24	150
2013	16	25	152
2014	13	24	138

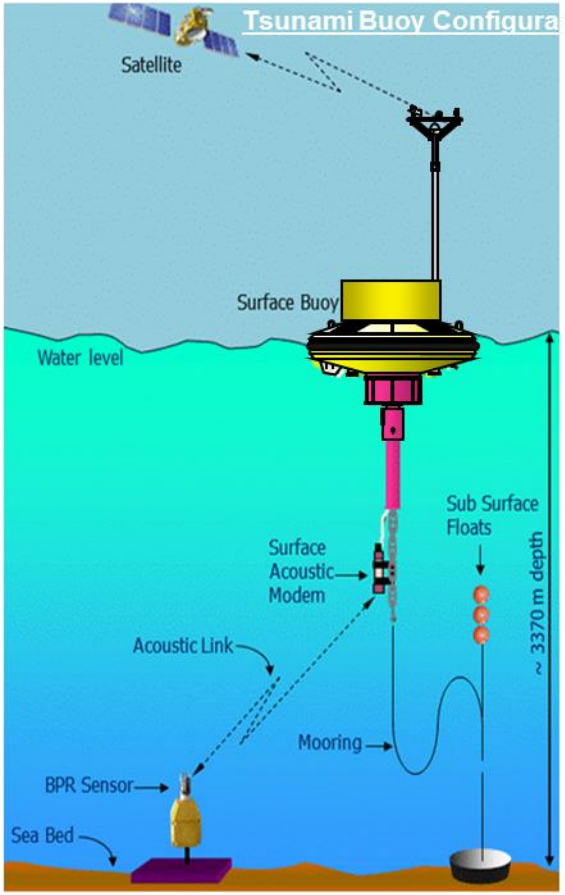
Types of Moorings handled



Met Ocean Mooring



OMNI Mooring



Tsunami Mooring

In –house expertise - Design of mooring using software tools such as OrcaFlex & Cable
Insitu mooring load from site compared with design analysis

Vessels used to achieve buoy network

75185 nm sailed since the year 2010
(equals to 10 times the Earth's diameter)

Sagar Kanya

S.No	Year	Period		No. of days	Name of the vessel
		From	To		
1	2006	05-12-2006	12-12-2006	8	Sagar Kanya
2	2006	13-12-2006	21-12-2006	9	Sagar Kanya
3	2007	10-04-2007	25-04-2007	16	Sagar Kanya
4	2007	28-04-2007	12-05-2007	15	Sagar Kanya
5	2007	12-07-2007	24-07-2007	13	Sagar Kanya
6	2007	30-08-2007	13-09-2007	15	Sagar Kanya
7	2007	21-09-2007	28-09-2007	8	Sagar Kanya
8	2010	26-03-2010	04-04-2010	10	Sagar Kanya
9	2010	06-04-2010	20-04-2010	15	Sagar Kanya
10	2010	20-04-2010	29-04-2010	10	Sagar Kanya
11	2010	22-10-2010	18-11-2010	28	Sagar Kanya
12	2010	20-11-2010	08-12-2010	19	Sagar Kanya
13	2010	11-12-2010	21-12-2010	11	Sagar Kanya
14	2010	27-12-2010	04-01-2011	9	Sagar Kanya
15	2011	09-05-2011	17-05-2011	9	Sagar Kanya
16	2011	18-05-2011	09-06-2011	23	Sagar Kanya
17	2011	21-07-2011	19-08-2011	30	Sagar Kanya
18	2011	24-08-2011	14-09-2011	22	Sagar Kanya
19	2012	22-04-2012	23-05-2012	32	Sagar Kanya
20	2012	27-06-2012	06-07-2012	10	Sagar Kanya
21	2012	10-09-2012	29-09-2012	20	Sagar Kanya
22	2014	04-02-2014	09-03-2014	34	Sagar Kanya
23	2014	24-06-2014	16-07-2014	23	Sagar Kanya

Sagar Nidhi

S.No	Year	Period		No. of days	Name of the vessel
		From	To		
1	2008	08-02-2008	22-02-2008	15	Sagar Nidhi
2	2008	27-03-2008	30-03-2008	4	Sagar Nidhi
3	2008	21-04-2008	07-05-2008	17	Sagar Nidhi
4	2008	10-05-2008	21-05-2008	12	Sagar Nidhi
5	2008	10-07-2008	24-07-2008	15	Sagar Nidhi
6	2008	20-09-2008	09-10-2008	20	Sagar Nidhi
7	2009	03-02-2009	16-02-2009	14	Sagar Nidhi
8	2009	20-05-2009	10-06-2009	22	Sagar Nidhi
9	2010	05-07-2010	21-07-2010	17	Sagar Nidhi
10	2010	01-09-2010	30-09-2010	30	Sagar Nidhi
11	2010	19-10-2010	01-11-2010	14	Sagar Nidhi
12	2011	01-01-2011	21-01-2011	21	Sagar Nidhi
13	2011	13-03-2011	08-04-2011	27	Sagar Nidhi
14	2011	02-08-2011	25-08-2011	24	Sagar Nidhi
15	2011	14-11-2011	05-12-2011	22	Sagar Nidhi
16	2011	05-12-2011	22-12-2011	18	Sagar Nidhi
17	2012	12-10-2012	04-11-2012	24	Sagar Nidhi
18	2012	25-12-2012	07-01-2013	14	Sagar Nidhi
19	2013	28-02-2013	04-04-2013	36	Sagar Nidhi
20	2013	10-06-2013	20-06-2013	11	Sagar Nidhi
21	2013	06-08-2013	22-08-2013	17	Sagar Nidhi
22	2013	18-09-2013	15-10-2013	28	Sagar Nidhi
23	2014	17-03-2014	26-04-2014	41	Sagar Nidhi
24	2014	01-05-2014	14-05-2014	14	Sagar Nidhi
25	2014	16-07-2014	15-08-2014	31	Sagar Nidhi

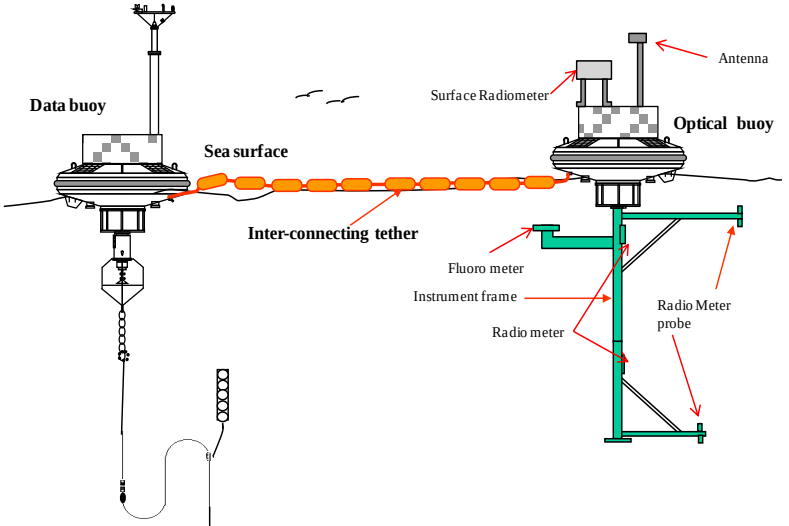
Sagar Manjusha

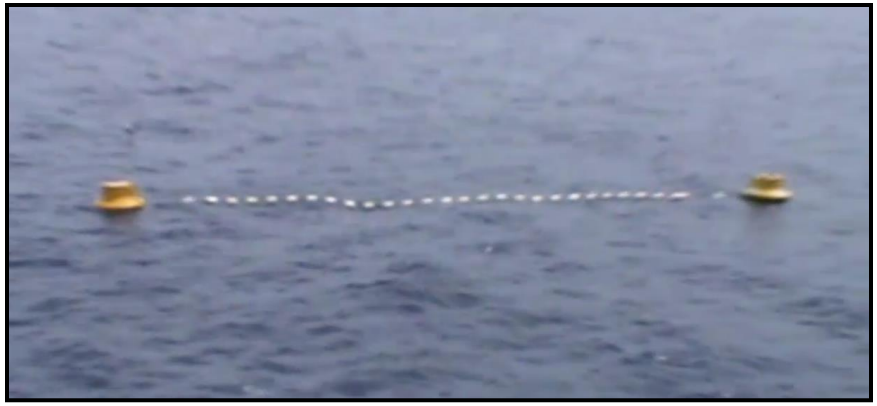
S.No	Year	Period		No. of days	Name of the vessel
		From	To		
1	2006	7/22/2006	7/31/2006	10	Sagar Manjsuha
2	2007	7/25/2007	7/25/2007	1	Sagar Manjsuha
3	2010	8/29/2010	9/6/2010	9	Sagar Manjsuha
4	2011	3/15/2011	3/28/2011	14	Sagar Manjsuha
5	2011	12/6/2011	12/14/2011	9	Sagar Manjsuha
6	2012	2/15/2012	3/10/2012	25	Sagar Manjsuha
7	2012	3/27/2012	4/1/2012	6	Sagar Manjsuha
8	2012	4/6/2012	4/25/2012	20	Sagar Manjsuha
9	2012	6/21/2012	6/29/2012	9	Sagar Manjsuha
10	2012	9/14/2012	9/25/2012	12	Sagar Manjsuha
11	2013	2/6/2013	2/13/2013	8	Sagar Manjsuha
12	2013	4/29/2013	5/5/2013	7	Sagar Manjsuha
13	2013	7/1/2013	7/4/2013	4	Sagar Manjsuha
14	2013	10/7/2013	10/11/2013	5	Sagar Manjsuha
15	2014	4/17/2014	4/21/2014	5	Sagar Manjsuha
16	2014	5/16/2014	5/28/2014	12	Sagar Manjsuha

Apart from the above vessels, Boris Petrov, Siderenko & Sagar Poorvi were also used.

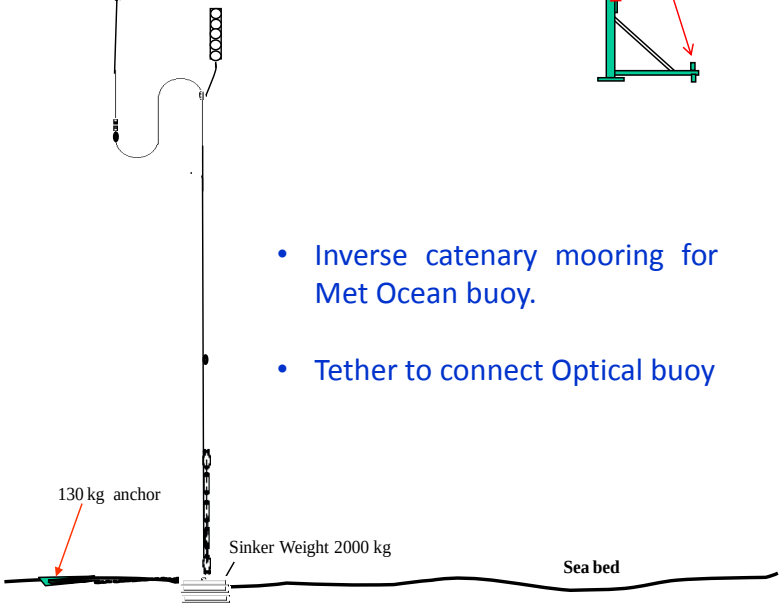
CALVAL

(in collaboration with SAC-Ahmedabad)





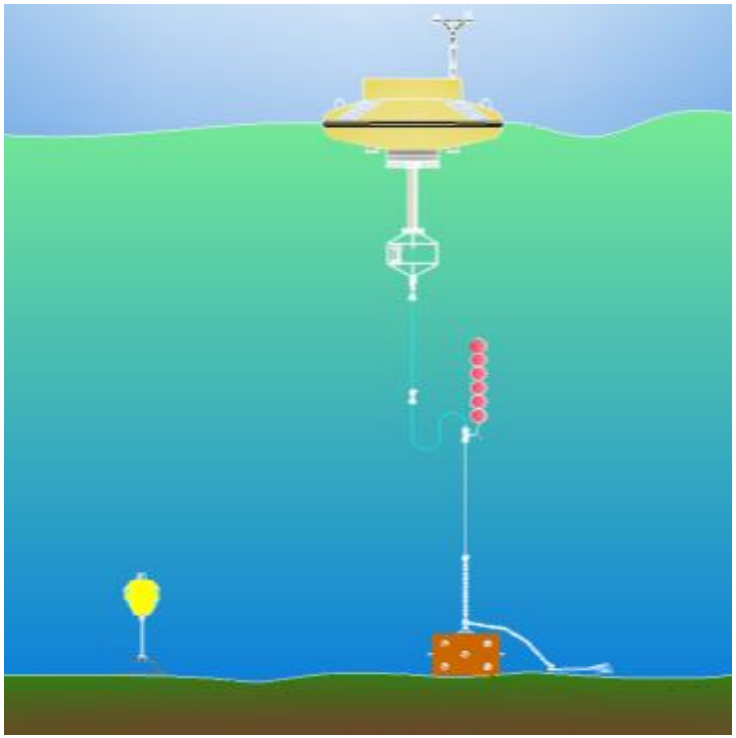
- Inverse catenary mooring for Met Ocean buoy.
- Tether to connect Optical buoy



General mooring of optical buoy With meteorological buoy

Indian Tsunami Buoy System

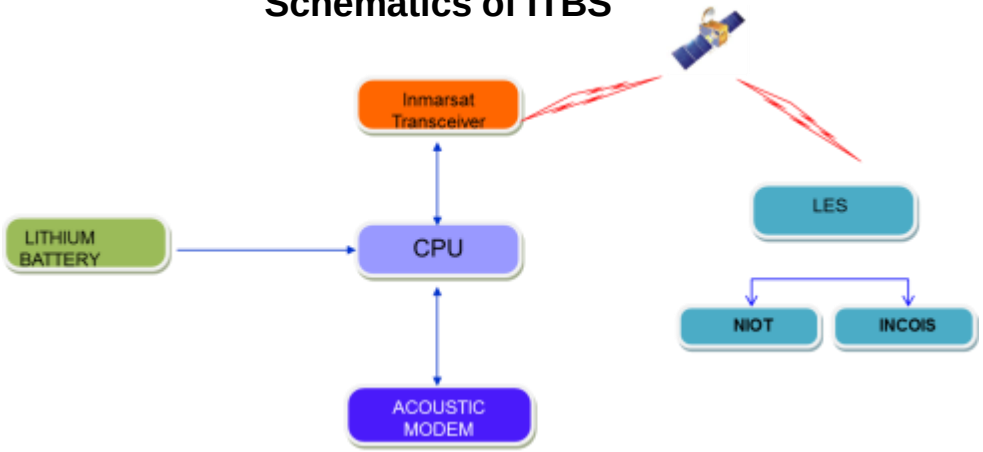
Tsunami buoy mooring with BPR



Surface Buoy

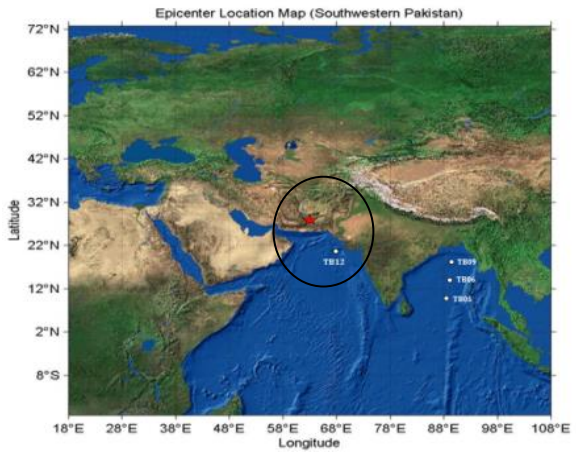
Sea Bed unit(BPR)

Schematics of ITBS



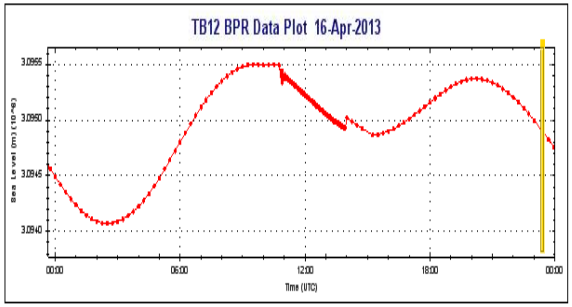
- *Paroscientific digiquartz Technology*
- *Range: 6,000m deep*
- *Built-in Temperature sensor*
- *Resolution: 1 mm in 6000 m*
- *Accuracy 0.01%*
- *High stability and reliability*

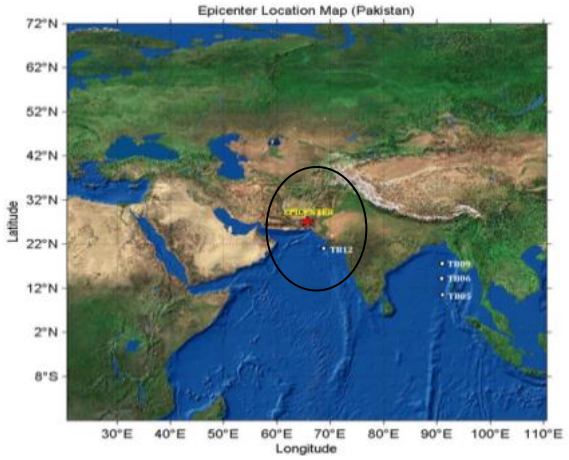
Tsunami Events Captured by Indian Tsunami Buoys



MAGNITUDE : 7.9 Mw (mB)
LOCATION : SW of Pakistan
DATE : 16 APR 2013

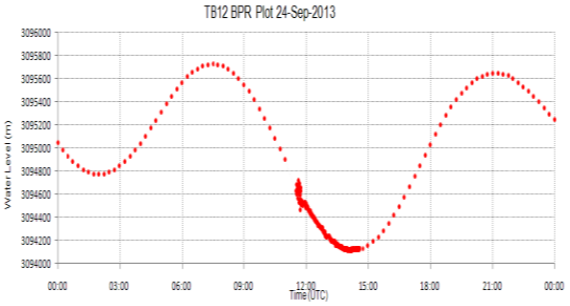
Earthquake observed at land : 10:44 GMT
Signal Picked up by TB12 at sea : 10:51 GMT
Data Received at Shore station : 10:52 GMT

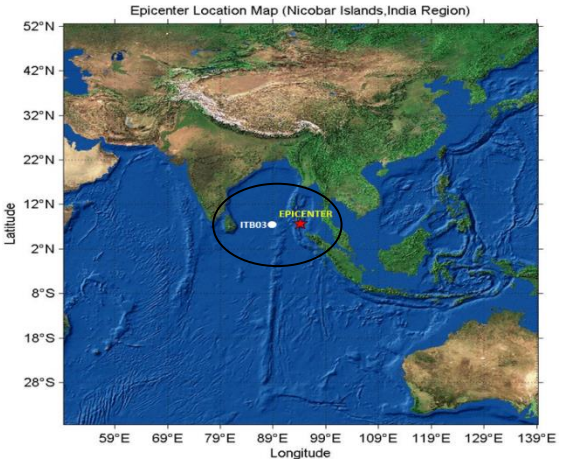




MAGNITUDE : 7.7 Mw (mB)
LOCATION : SW of Pakistan
DATE : 24 SEP 2013

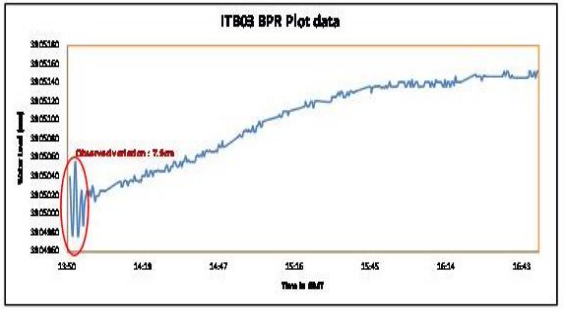
Earthquake observed at land : 11:29 GMT
Signal Picked up by TB12 at sea : 11:35 GMT
Data Received at Shore station : 11:36 GMT





MAGNITUDE : 6.5 Mw (mB)
LOCATION : Nicobar Islands, India
DATE : 21 MAR 2014

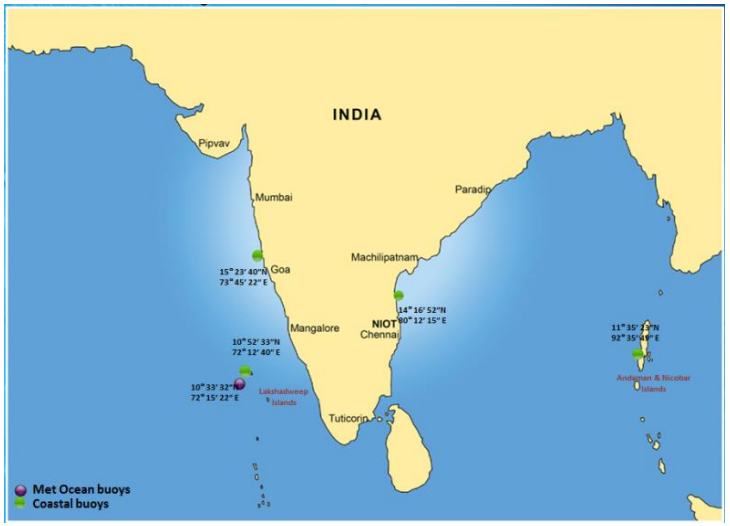
Earthquake observed at : 13:11 GMT
Signal Picked up by TB03 at sea : 13:50 GMT
Data Received at Shore station : 13:52 GMT



Coastal buoys with INSAT Communication

Coastal Buoys
Integrated with INSAT, GPRS communication systems and are deployed at

Agatti – Lakshadweep Island, Goa, Andaman
&
Krishnapattinam Port - AP



Buoy with dual mode communication with INSAT, GPRS:

The coastal buoy was integrated with dual transceiver system (GPRS and INSAT) and tested successfully at NIOT and installed off Agatti, Lakshadweep Island, Goa, Andaman & Krishnapattinam Port-AP.

In this buoy system the General Packet Radio Service (GPRS) technology is utilized to handle huge volume of data through low power, higher transmission rate and cost effective means.

The main data transmission components consist of a data logger, a GPRS modem, INSAT transceiver and a receiving server. Every three hours (UTC) the raw data are collected by the sensors and processed by CPU and stored in the data logger.

The stored data are sent through GPRS modem using GSM network as well as through INSAT communication to shore station, NIOT.

State-of-the-Art
Data reception facility

24 x 7 Constant vigil on Data Reception

SOP (Standard Operating Procedure) evolved

Vetted by NDBC, PMEL – USA

DOC. NO. : OOS/ SOP/ SS / 001 VER. NO. : 1.0
SHEET : 1 of 2 VALID FROM : 1st May 2011

	STANDARD OPERATING PROCEDURE (SOP)
TITLE	OOS - Escalation & Notification
Stake Holder(s)	SSPIT & SSAPIC
Document Type	Procedure / Process / Policy

DOCUMENT CONTROL / AMENDMENT RECORD SHEET

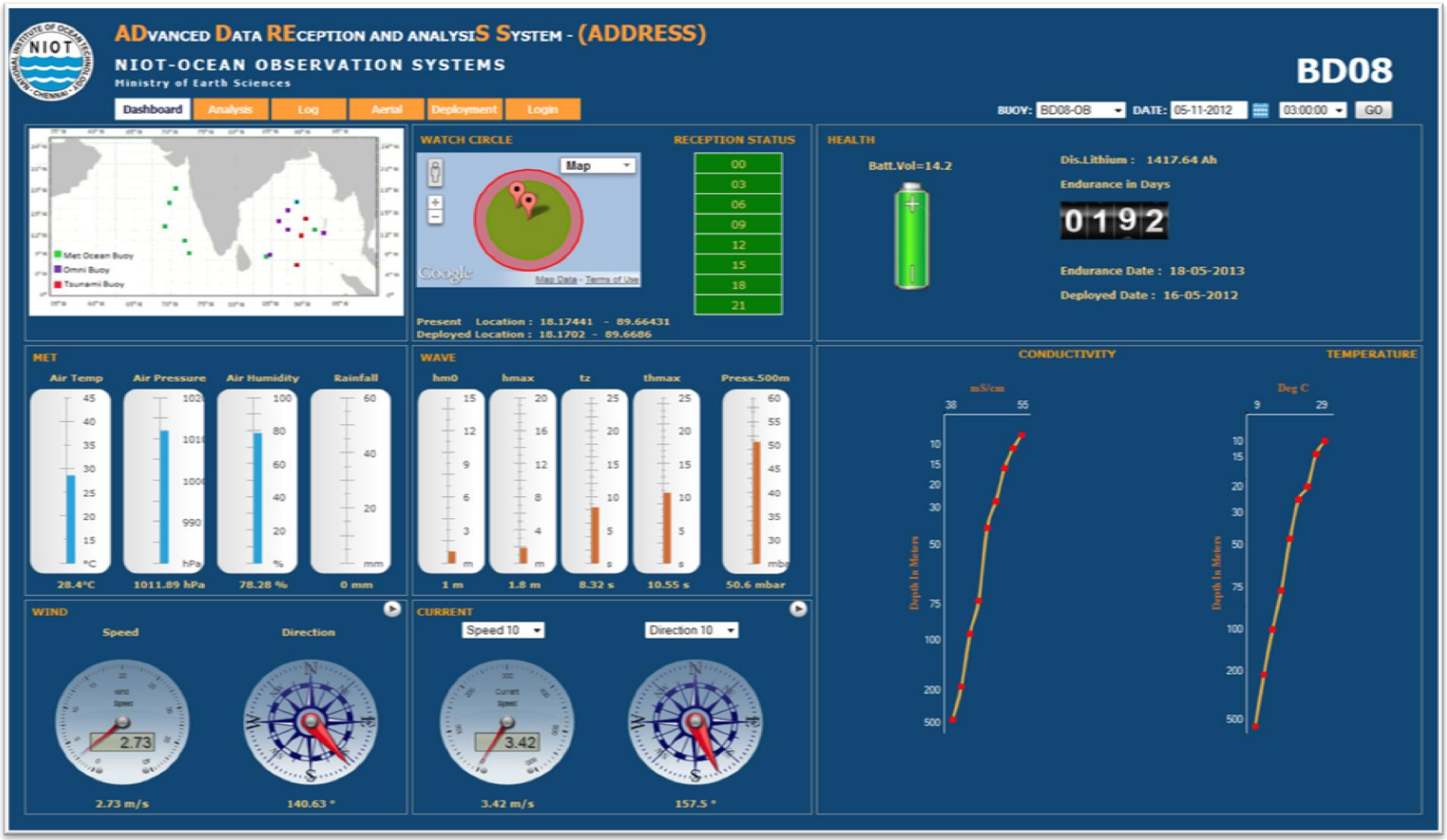
Sl. No.	Release No.	Revision No.	Valid From	Brief Description of Change	Approved By
1	1	0	1st May 2011	New Process for Escalation and Notification	Dr. R. Venkatesan
2	1	1			

PREPARED BY	APPROVED BY	AGREED BY
Name: S. Ramasundaram	Name: Dr. R. Venkatesan	Name:
Designation: Project Scientist	Designation: Group Head	Designation:
Organization: NIOT	Organization: NIOT	Organization: Electronic Lab
Signature:	Signature:	Signature:
Date: 29th Apr 2011		

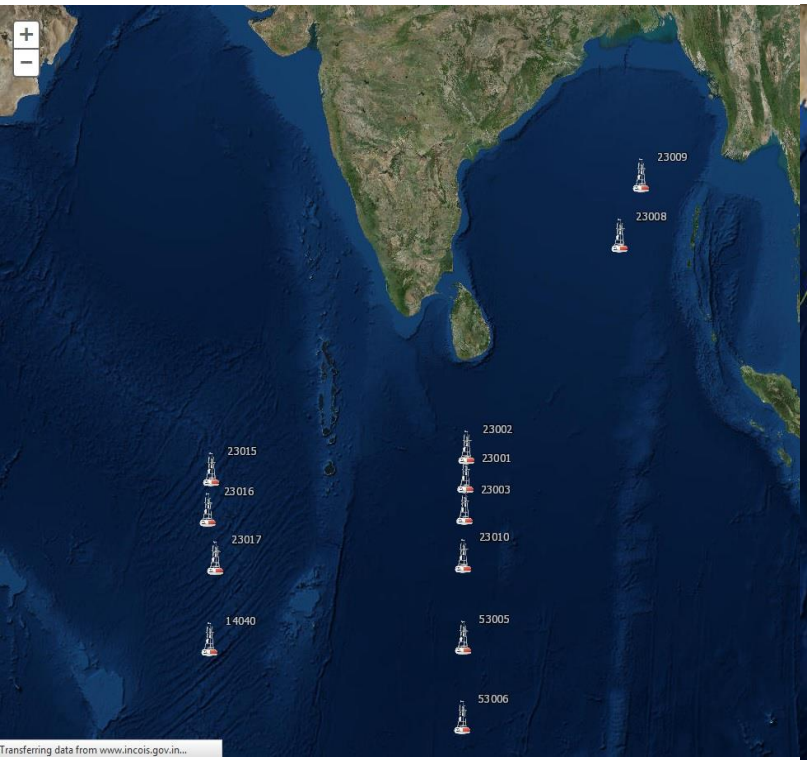
1

ADDRESS

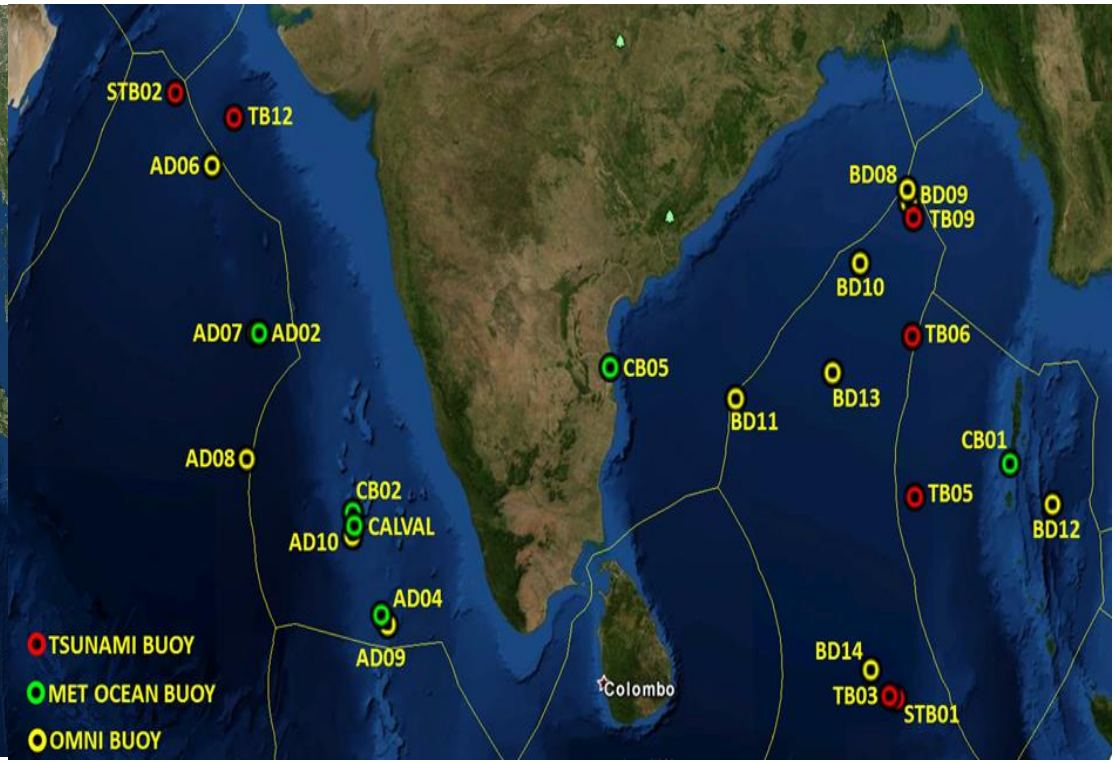
ADvanced Data REception & analysiS System



Working NIOT vs RAMA Buoy Network

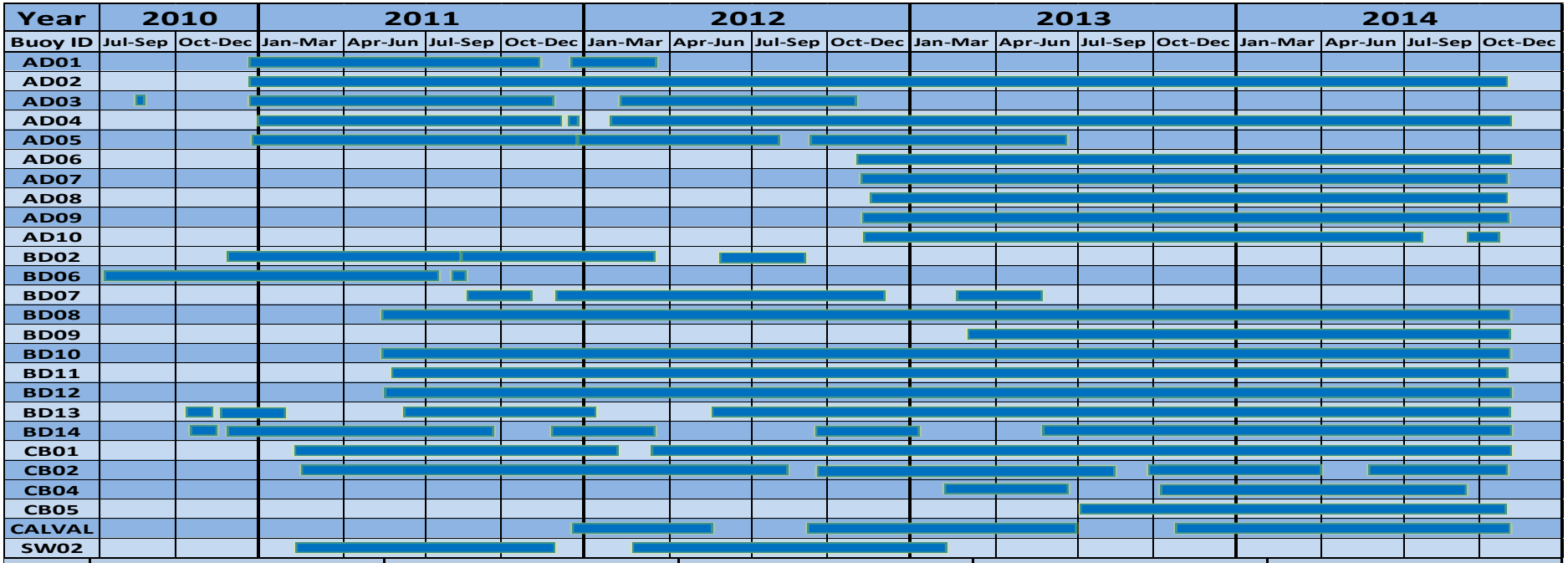


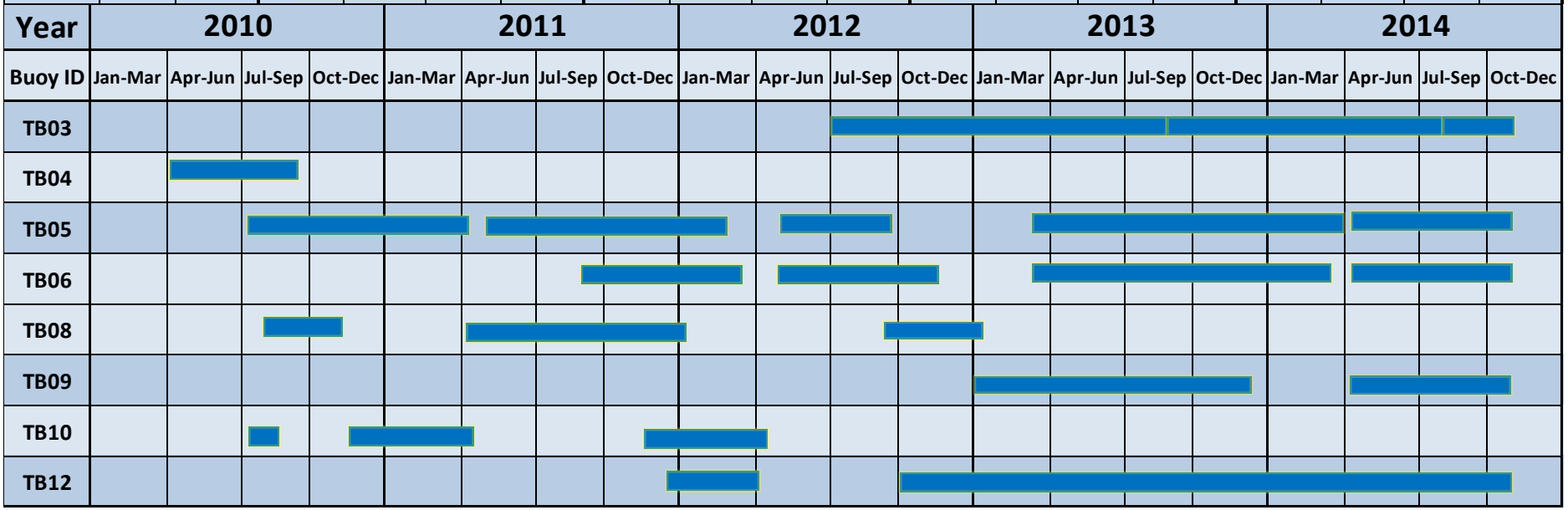
RAMA Network



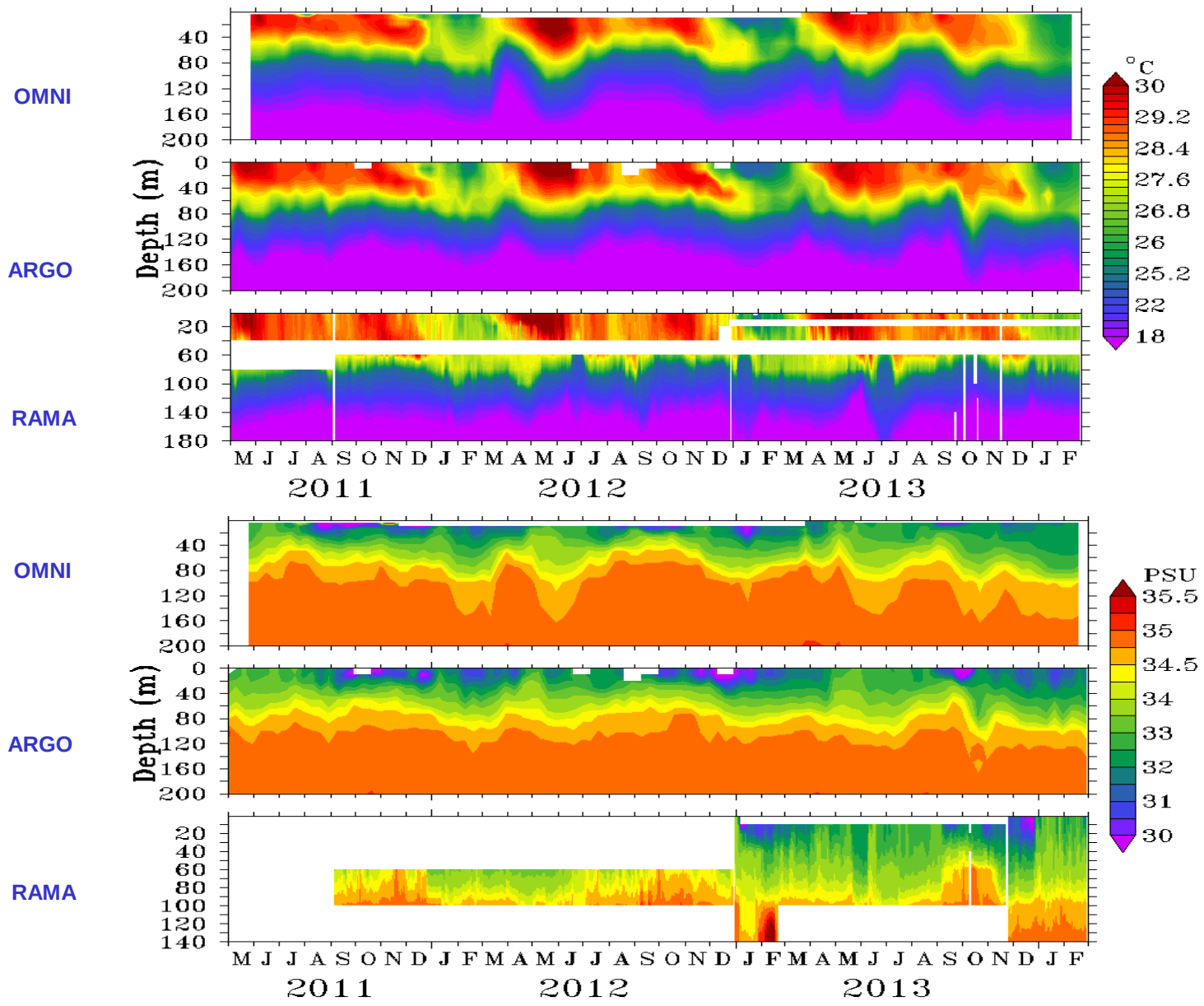
NIOT Network

NIOT Moored buoy Data Availability





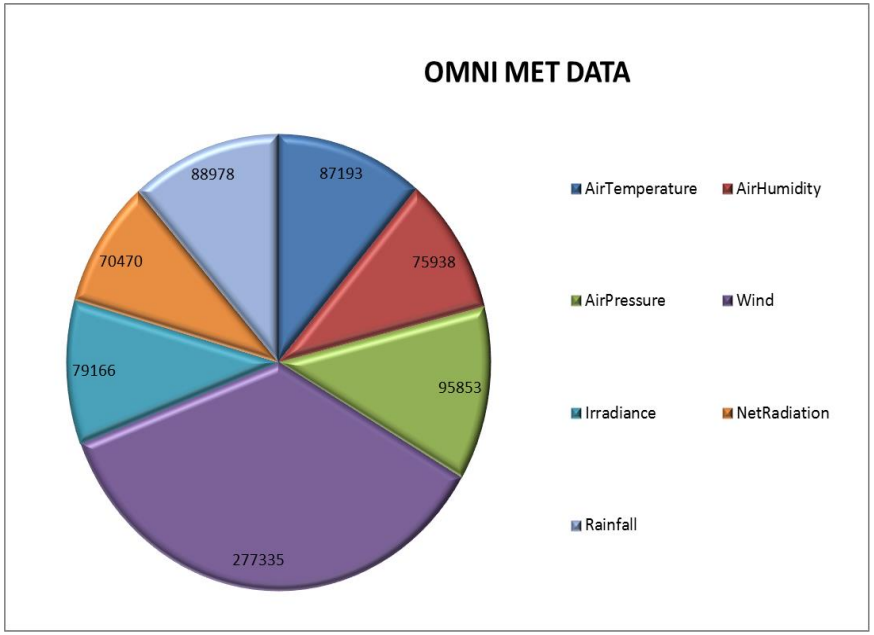
Comparison of temperature (°C) and salinity (PSU) data: OMNI vs ARGO (18.18°N,89.68°E-BD08) alongwith RAMA (15°N, 90°E)

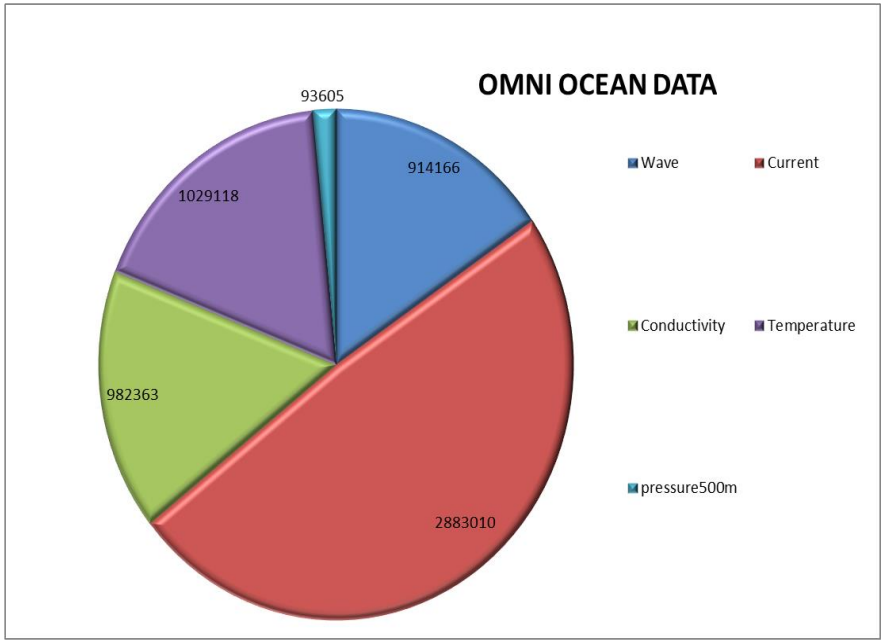


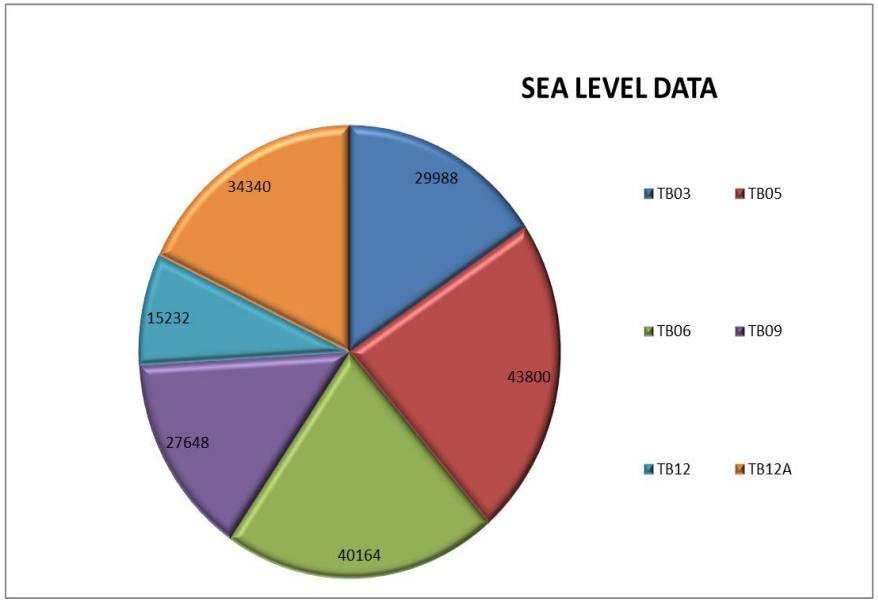
OMNI Buoy: Data returns (%)

Buoy ID	BD 08	BD 09	BD 10	BD 11	BD 12	BD 13	BD 14	AD 06	AD 07	AD 08	AD 09	AD 10
Sensor												
Winds	100	100	100	92	100	91	45	95	94	93	91	92
Air Temp	100	100	100	92	100	91	35	95	94	93	91	92
Air Press.	100	100	100	92	100	91	52	95	94	93	91	92
Humidity	79	100	48	75	16	67	35	95	64	93	89	91
SST 1m	80	40	66	39	7	39	19	95	94	93	92	92
SST 5m	69	100	67	84	49	62	42	83	91	93	92	92
SS Temp (10m)	98	100	98	98	100	97	70	95	94	93	91	92

Data Availability from July 2013 to September 2014







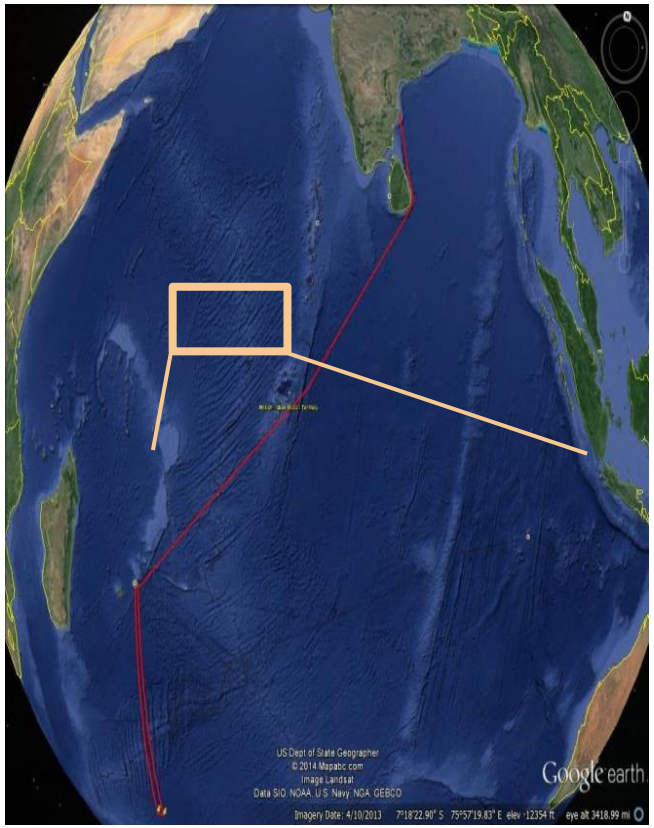
Inter Institutional R&D Projects

- **The first underwater moored observatory deployed by India in Polar Waters.**
- **The moored observatory consist of a suite of ten oceanographic sensors from international repute measuring temperature, salinity, current profiles and other vital parameters.**
- **The information measured and recorded by the sensors would yield much needed data to understand the cause and impact of climate variability in a regional to global perspective.**
- **The design, development and installation of this underwater moored observatory were successfully executed by OOS-NIOT in collaboration with NCAOR Goa. This in-house effort designed to withstand harsh polar region is a milestone achievement for MoES and India.**

Southern Ocean

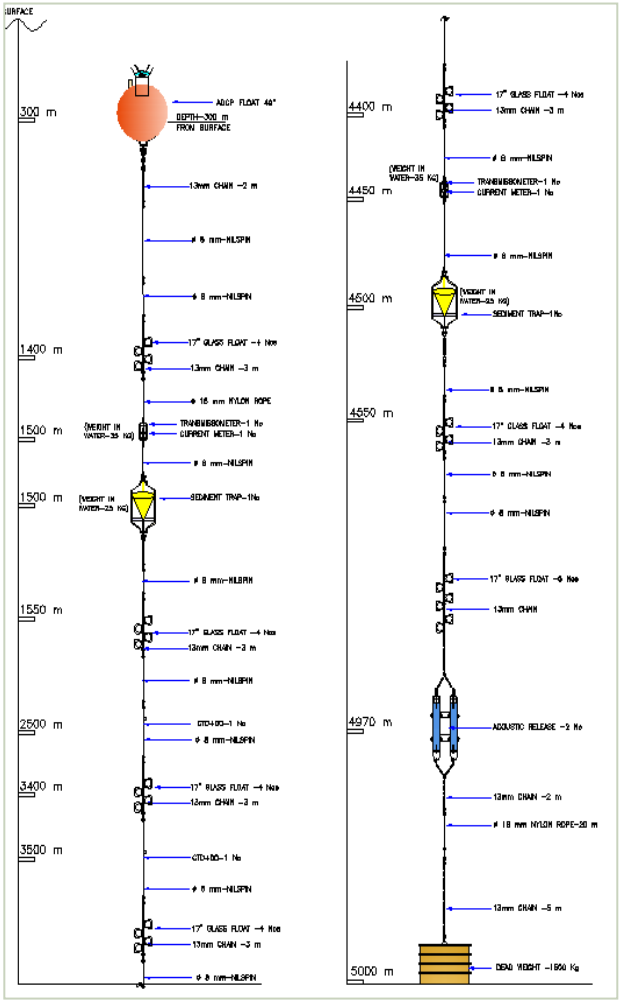
Southern Ocean Carbon Processes (SOCarP) Study in 2015

Deployment location



Type of mooring	Lat (S)	Long (E)	Depth (m)
Subsurface	40	57.5	~5000

Mooring Details



Sensor Position In Mooring

SENSOR POSITION IN MOORING		
Sl. NO	ITEM DESCRIPTION	DEPTH FROM SEA SURFACE (m)
1	ADCP	300
2	Current meter	1450
3	Transmissometer	1450
4	Sediment trap	1500
5	CTD + DO	2500
6	CTD + DO	3500
7	Current meter	4450
8	Transmissometer	4450
9	Sediment trap	4500
10	Acoustic release	4970

ANTARTIC MOORING IN 2016

INDO – US collaborative Project

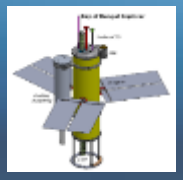
Air-Sea Interactions in the Northern Indian Ocean – Regional Initiative
Ocean Mixing and Monsoons



Indian

INDIAN INSTITUTE OF SCIENCE, BANGALORE
INDIAN NATIONAL CENTRE FOR OCEAN INFORMATION SERVICES,
NATIONAL INSTITUTE OF OCEAN TECHNOLOGY, CHENNAI
NATIONAL INSTITUTE OF OCEANOGRAPHY(NIO) - GOA
NATIONAL INSTITUTE OF OCEANOGRAPHY(NIO) - RC VIZAG
INDIAN INSTITUTE OF TROPICAL METEOROLOGY, PUNE
SPACE APPLICATIONS CENTRE, AHMEDABAD
TATA INSTITUTE OF FUNDAMENTAL RESEARCH,
INDIAN INSTITUTE OF TECHNOLOGY MADRAS
INDIAN INSTITUTE OF TECHNOLOGY BHUBHANESWAR

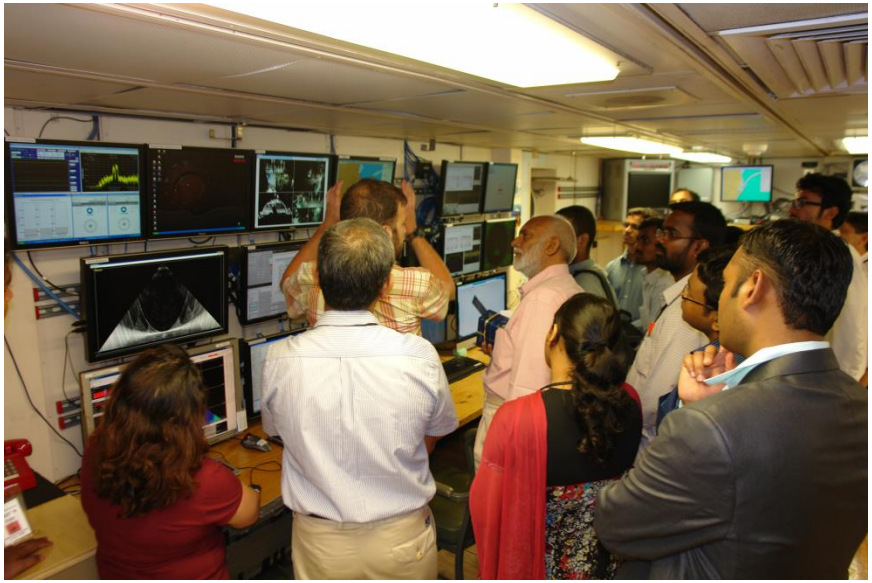


USA

SCRIPPS INSTITUTION OF OCEANOGRAPHY
WOODS HOLE OCEANOGRAPHIC INSTITUTION
UNIVERSITY OF MASSACHUSETTS
OREGON STATE UNIVERSITY
UNIVERSITY OF WASHINGTON
UNIVERSITY OF NOTREDAME
COLORADO STATE UNIVERSITY
COLUMBIA UNIVERSITY
UNIVERSITY OF MIAMI
UNIVERSITY OF ALASKA

Pictures from NIOT & Roger Revelle-USA – Onboard Meet



In-house Innovations

INSAT/GPRS/INMARSAT

ADDRESS

PRAKRUTI

OOS INNOVATIONS

Wind Powered Green Buoy System
Indigenous Data Acquisition System (IDAS)
Aquabot
Variable Buoyancy of Aquatic Glider
Dual Communication (INSAT & INMARSAT) for Tsunami Buoys
R-Darsh
Indigenised OMNI Buoy - PRAKRUTI
New Generation Buoy - SAGAR BHOOMI
&
ADDRESS - (ADvanced Data REception & analysiS System)

Dual Communication

IN (Indian Satellite)

RSA time Satellite)

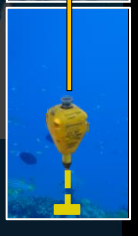
INSAT[MSS]

INMARSAT [Mail/Modem]

Norm al Mode

Tsunam i Mode

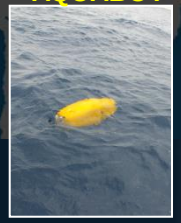
Surfac e Buoy



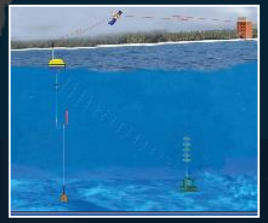
BP R

R-DARSH

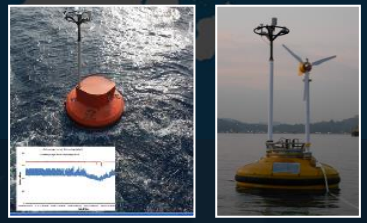
AQUABOT



SAGAR BHOOMI



DUAL POWER GREEN BUOY



IndARC

CALVAL

Technological Developments…

Indigenous OMNI Buoy system-*Prakruti*

A prototype Indigenous OMNI buoy system was designed, developed, integrated, tested and deployed during first trial in October 2013. The Second phase trial is in progress.

Salient Features of *Prakruti*

- More number of parameters (106) collected and transmitted in real time.
- Capability to transmit data via INSAT,GPRS and INMARSAT.
- Low power processor(Sleep mode, Active mode)
- Interface to various Analog and Serial Sensors with Individual Power control.
- Three level Watch Dog Timer interface for recovering the system in case of any malfunction.
- Individual communication line, sensor power status and buoy health data in real time to shore using bi-directional communication.
- NVSRAM Memory interface for two years processed data and raw data storage.
- Hybrid charge controller to work with multiple power sources like primary and secondary battery, wind turbine, solar panel.
- Qualified in standardized qualification test to work in marine environment:
- The performance of the system was satisfactory throughout the period of working and data generated was in line with the proven systems.

Integrated Marine Surveillance System -R-Darsh

- Out of four coastal buoys, a unique feature (IMSS) is introduced in CB04 (Goa) buoy to have real time visual observations of the buoy surrounding remotely.
- Three Cameras are installed on the mast of the buoy system at 120° displacement covering 360°.
- Apart from standard met-ocean measurements the buoy can also transmit real-time day and night video and still photographs of the surrounding environment, captured using the high resolution video cameras encapsulated to work in hostile marine environment.
- The video and photographs are transmitted through 3G telemetry. This is accomplished above water and could be implemented underwater also.
- The above facility would help to view the present sea conditions remotely, which would be more useful for the fishermen community. In addition, this feature helps to track the buoy system for its continuous functioning and also alert the respective authorities, in case of any disturbances to the buoy system.

Technology Developments
Coastal Buoys Integrated with INSAT, GPRS

✓ **Buoy with dual mode communication with INSAT, GPRS:**

✓ **The coastal buoy was integrated with dual transceiver system (GPRS and INSAT) and tested successfully at NIOT and installed off Agatti, Lakshadweep Island, Goa, Andaman & Krishnapattinam Port-AP.**

✓ **In this buoy system the General Packet Radio Service (GPRS) technology is utilized to handle huge volume of data through low power, higher transmission rate and cost effective means.**

✓ **The main data transmission components consist of a data logger, a GPRS modem, INSAT transceiver and a receiving server. Every three hours (UTC) the raw data are collected by the sensors and processed by CPU and stored in the data logger.**

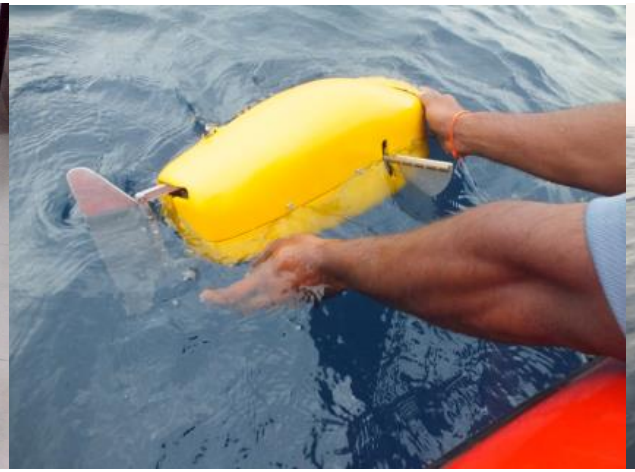
✓ **The stored data are sent through GPRS modem using GSM network as well as through INSAT communication to shore station, NIOT.**

Technological Advancements

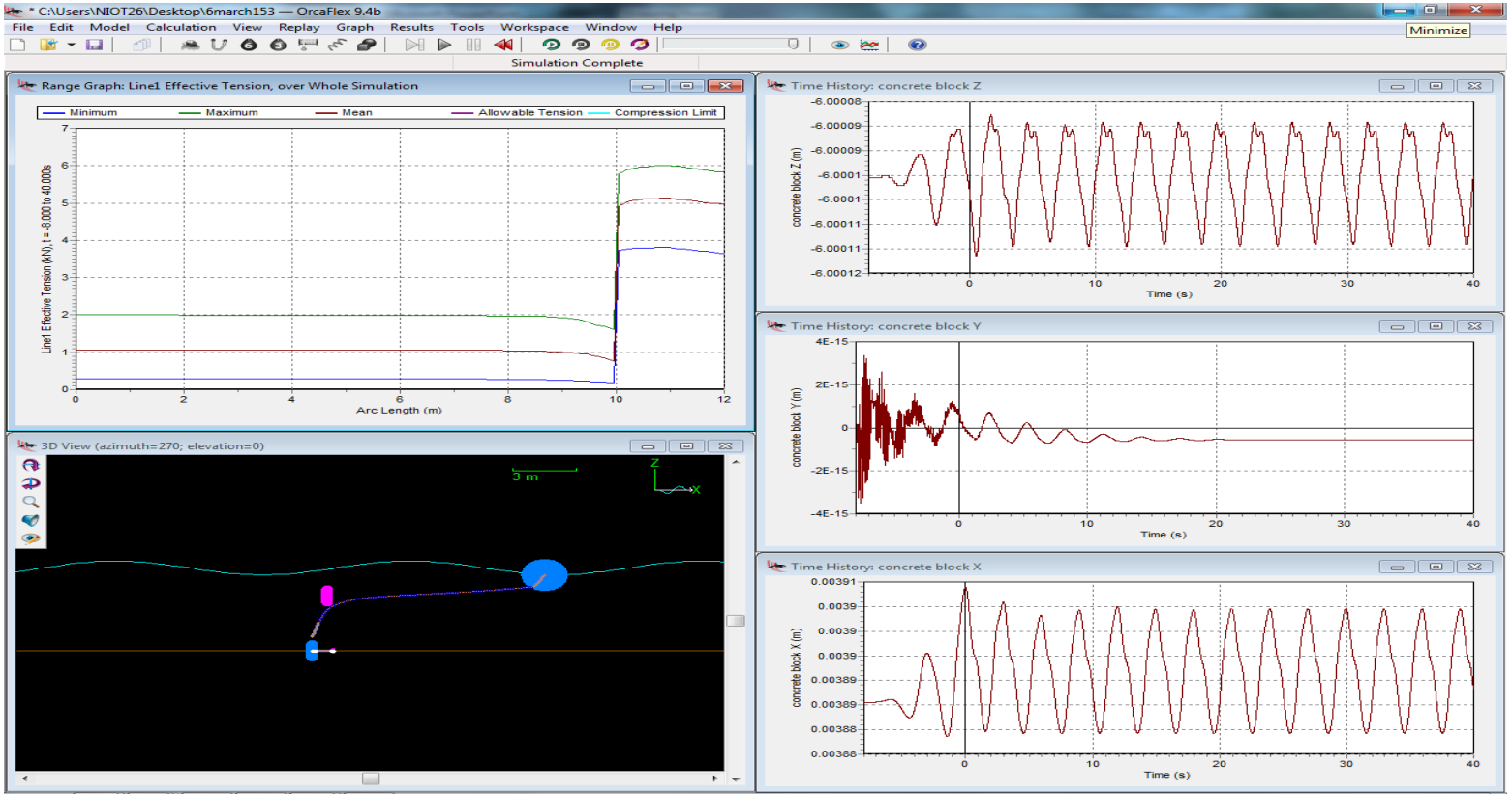
Aquabot

As a part of the developmental projects undertaken by OOS, second phase development of the laboratory scale AquaBot prototype with individually controlled pectoral fins for the pitch control and caudal fin for propulsion is developed. In this development, presently, an FRP outer hull is produced to give a hydrodynamic shape and fish like appearance. The present prototype has been tested in sea environment to study the behavioral analysis of the prototype in salt water. Full pledged control system is underway.

AquaBot after assembly at NIOT



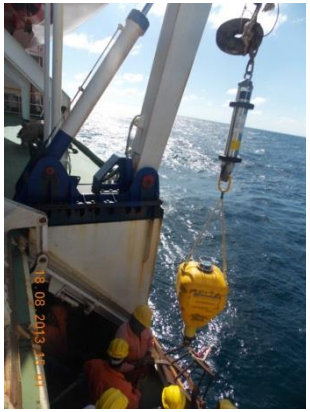
COMPARISON OF MOORING ANALYSIS



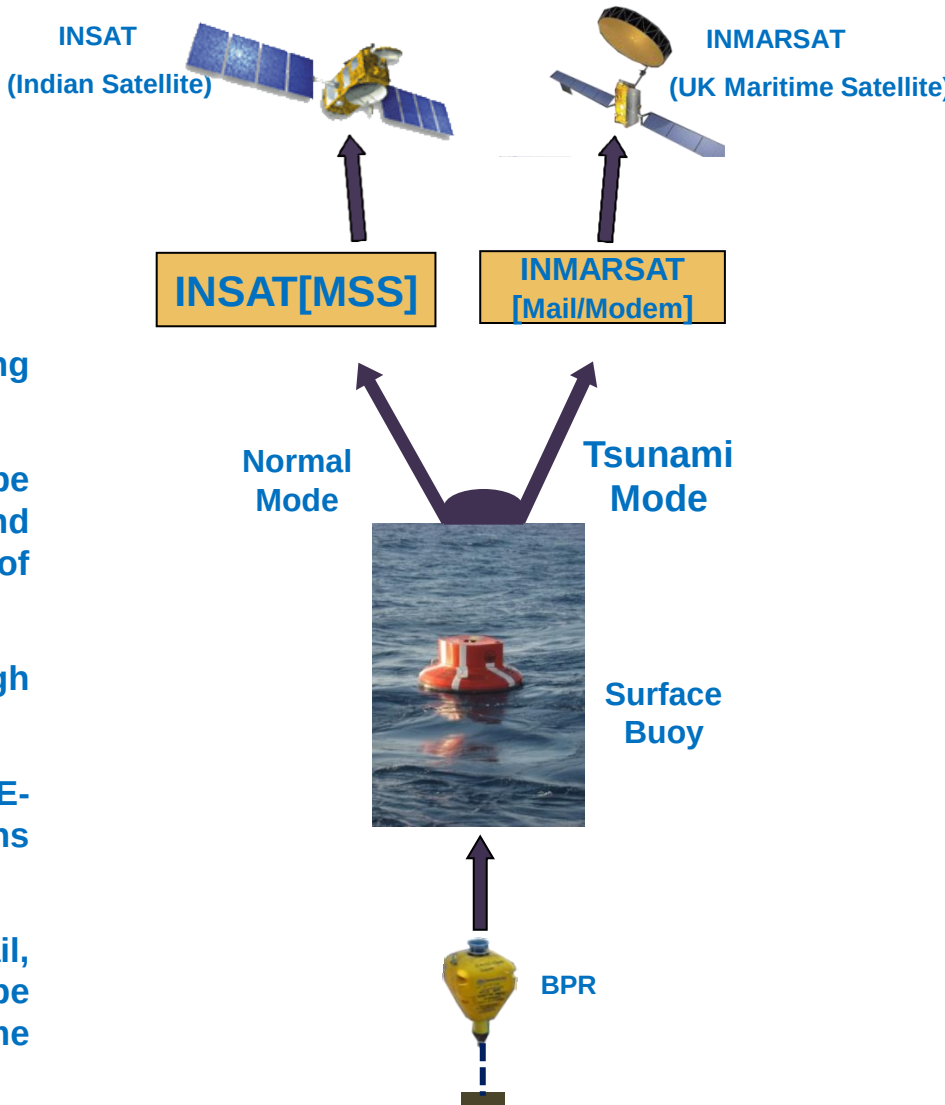
RESULTS COMPARISON

S.No	Parameter	CABLE Results	ORCAFLEX Results
1.	Tension on Mooring	5.5 KN	6 KN
2.	Anchor Draft	1.07 m	Not specified, but given that, draft is negligible.

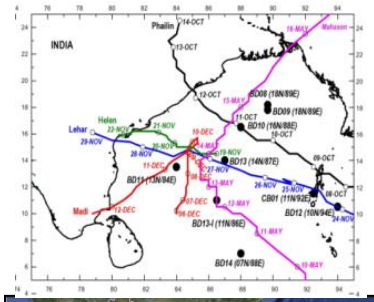
Twin mode Communication System was established in ITB03 Tsunami Buoy on 18th August 2013 for Proof of Concept (POC)

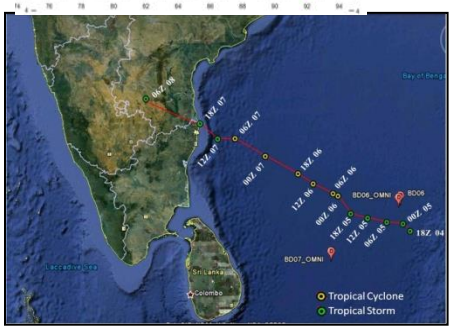


- Standard mode data will be sent through INSAT during the configured time slot at hourly interval
- Every day 5th hour GMT standard mode data will be transmitted through INMARSAT (if both INSAT and INMARSAT available) to daily check the status of INMARSAT modem.
- Event data, Post event data will be transmitted through INMARSAT.
- INMARSAT Modem can be configured for destined E-Mail ID (Maximum 2 email ID) and Modem destinations (Maximum 2 modem no) during Tsunami Event
- Data from INSAT and INMARSAT [INSAT E-mail, INMARSAT E-mail and INMARSAT Modem] can be received in same GUI application and updated in same log file.

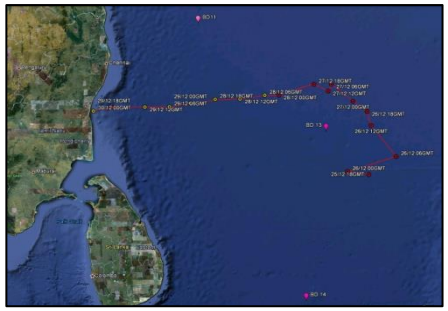


Significance & Utilization of Buoy data

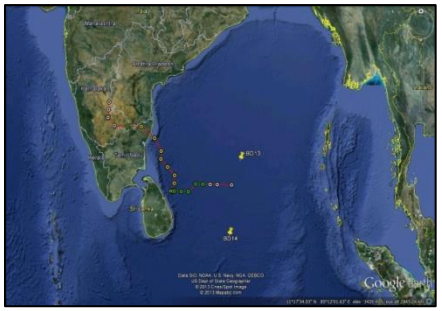




JAL – November 2010



THANE – December 2011

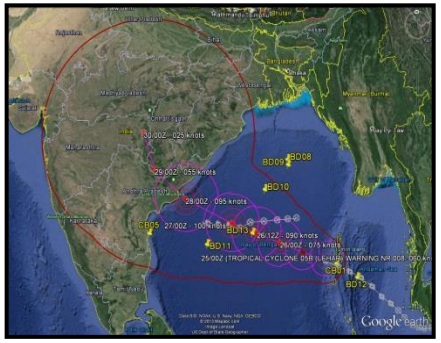


NILAM – October 2012

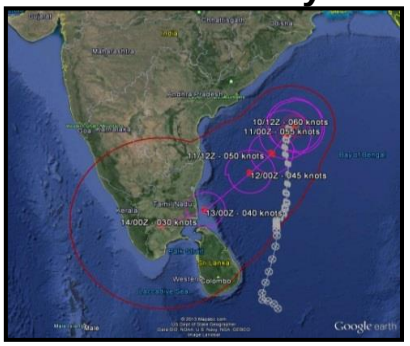
MAHASEN – May 2013

PHAILIN - October 2013

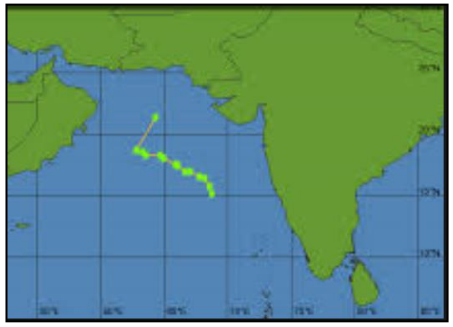
HELEN - November 2013



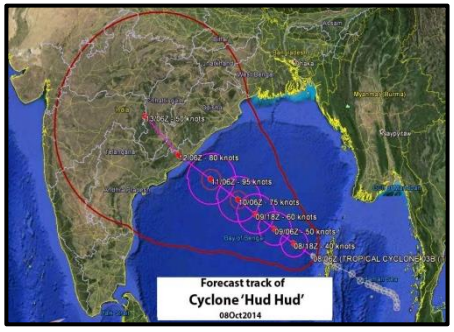
LEHAR - November 2013



MADI – December 2013



NANAUK – June 2014



HUD HUD – Oct 2014

More cyclones occur in the Bay of Bengal than the Arabian Sea.

Since inception, moored buoys have made measurements during extreme events and provided real time data to IMD, for data assimilation in operational forecasting models for cyclones. State-of-the-art observation technology helped to track many cyclones

PHAILIN CYCLONE COMES UNDER CATEGORY 5 AND ONE OF MOST FURIOUS CYCLONE FORMED IN THE BAY OF BENGAL IN THE LAST 14 YEARS.

Buoys 400km away helped track Phailin

TIMES NEWS NETWORK

New Delhi: Strategically located buoys, some as far as 400km from India's coastline, telegraphed via satellite vital data on sea pressure, surface temperature and wind speeds that helped Indian scientists read Cyclone Phailin with unerring accuracy.

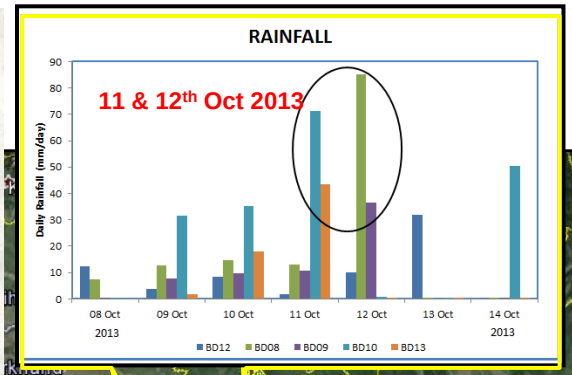
The sea-borne platforms add significant muscle to India's capacity to decipher destructive weather systems like Phailin days before they strike the Indian coast, saving thousands of lives by giving authorities crucial lead time to take pre-emptive action.

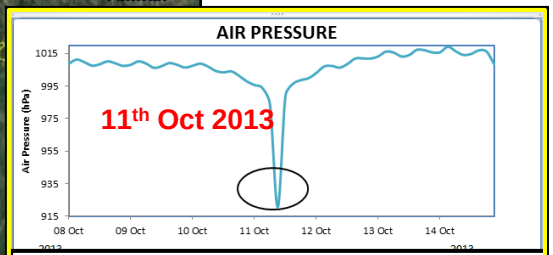
A man looks at his damaged house in Podampeta village

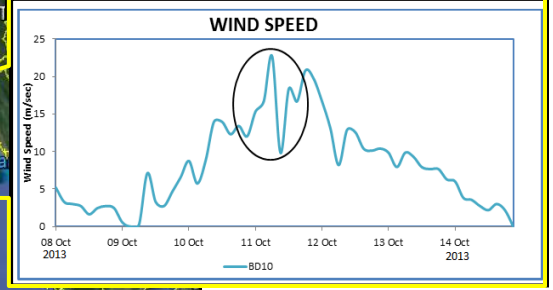
At present, there are 14 buoys in the Arabian Sea and Bay of Bengal busily supplying meteorologists, analysts, programmers and researchers a wealth of information.

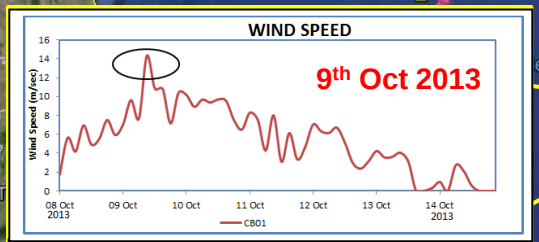
India is now looking to step up its scientific capacities by acquiring an aircraft equipped with advanced gadgetry that allows a specialist crew to take readings of clouds and atmospheric exchanges as much as 12-14 km above the earth's surface.

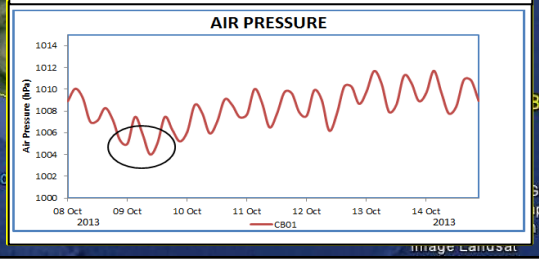
The fruits of a modernization programme has seen the IMD and the department of earth sciences' various facilities deliver more precise information on the monsoon and weather systems.



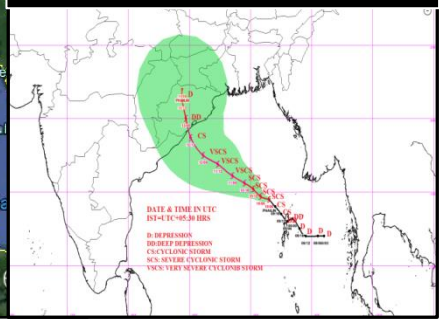








IMD track of the Phailin cyclone



Hudhud Cyclone-Oct 2014

Significant Observations by CB01, BD12, BD10,BD11 & BD 13 buoys

NATIONAL NETWORK 7

Toll at 21, Hudhud brings Visakhapatnam to its knees

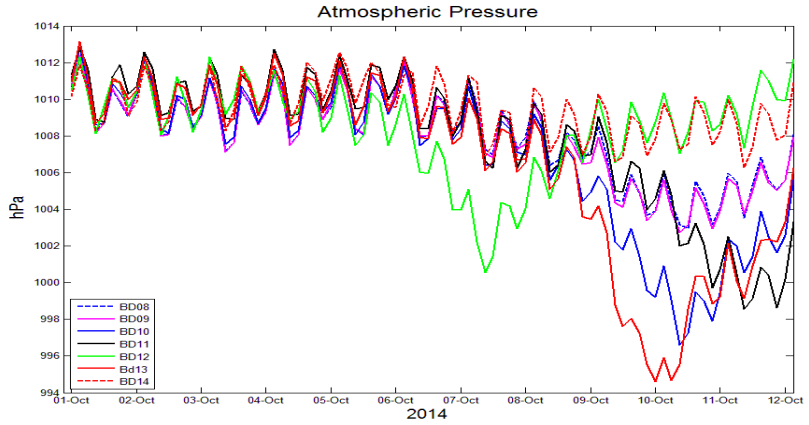
NO POWER, NO WATER, NO FUEL 'A cyclone of this intensity has shown the city is vulnerable'

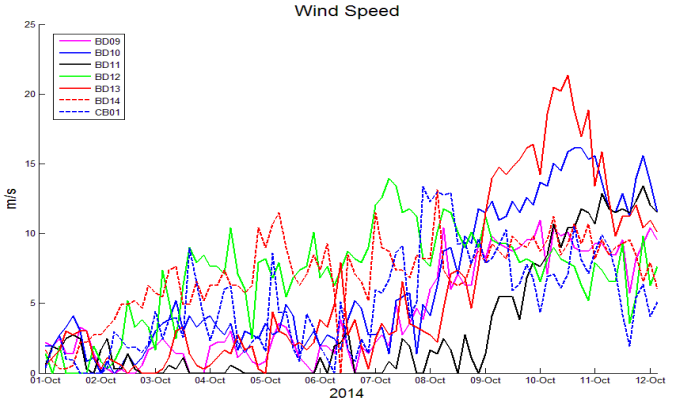
ANDHRA'S AGONY: 60 CYCLONES

How India learnt to tackle cyclones

Task on Andhra's hand: restore power

Mohapatra said significant upgradation in infrastructure enabled improved forecast. Remote sensing data from satellites have provided vital parameters to IMD's cyclone models. The computing ability has been scaled up by several notches. At least 30 observation stations have been set up in the Bay of Bengal and the Arabian Sea by the National Institute of Ocean Technology, Chennai. An agreement was signed in 2010, which enabled interactions of Indian weather scientists with their US counterparts. "The result is that today we are able to make accurate predictions about cyclones," Mohapatra said.





Constraints and Challenges….

- Ship time allotment at favourable weather conditions
- Bio-Fouling and Corrosion
- Vandalism & Piracy
- Funds
- Manpower

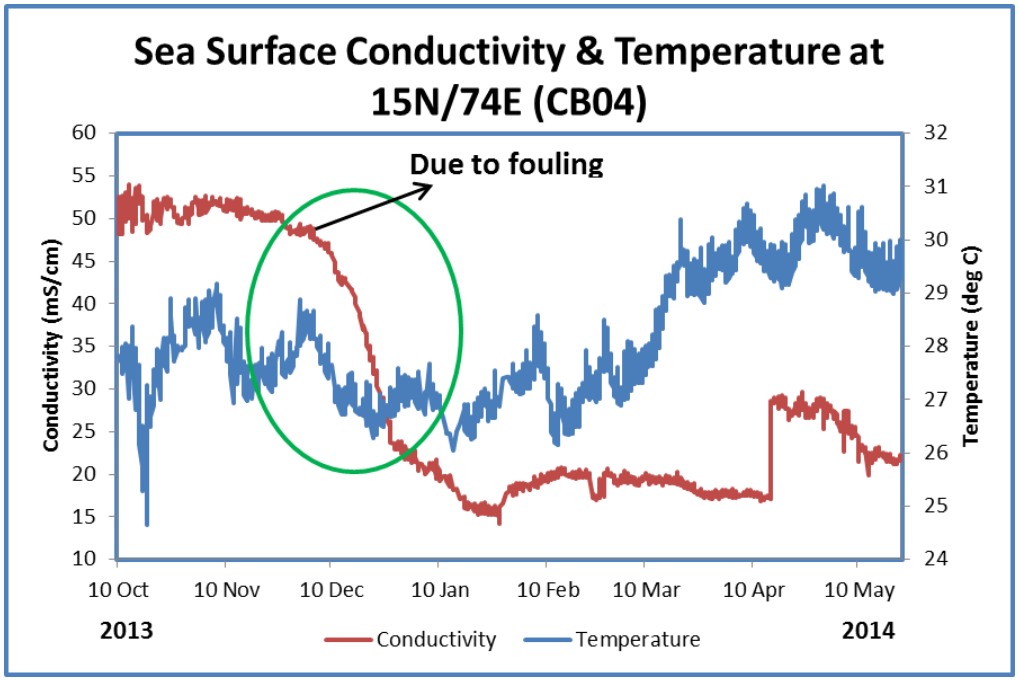
Retrieval of CALVAL Data buoy – OBM Boat Damage Incident

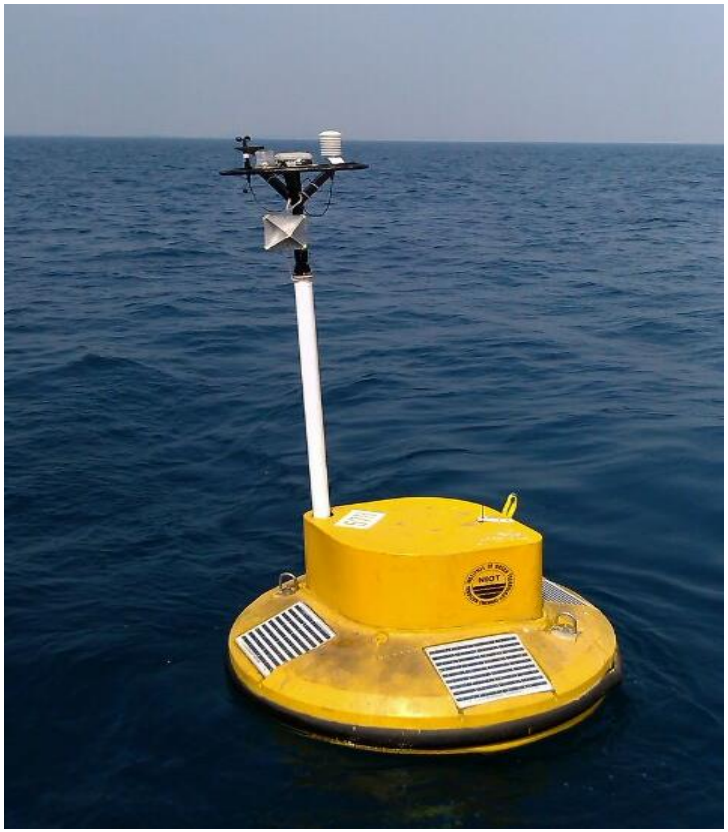
- **Incident Date : 31-07-2014**

Very Rough Weather during retrieval

Boat deck boards damaged

- **During the course of CALVAL buoy retrieval operation, Men on boat approached the buoy.**
-
- **Sudden high swells and high wind speeds were picked up after approached the buoy**
- **Men on boat communicated to deck that they wanted to come back to deck due to very bad weather**
- **FT, Crew team picked up men on boat safely on to deck, but while lifting OBM boat deck boards got damaged**

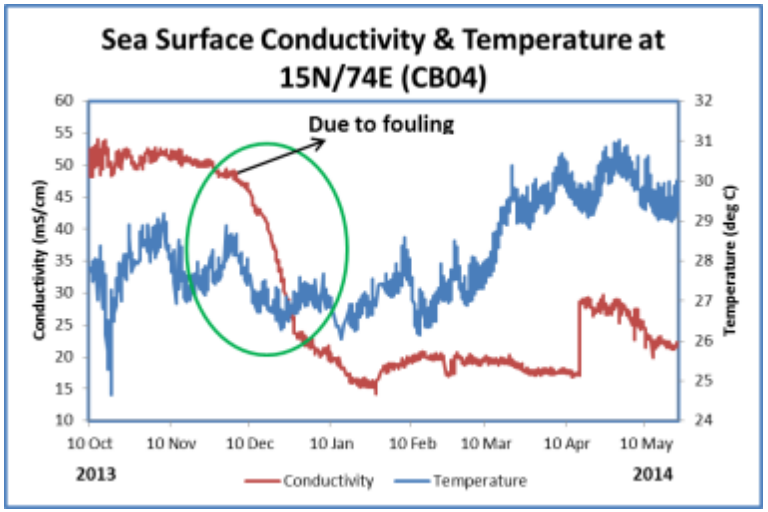

Sea Surface Conductivity & Temperature at 15N/74E (CB04)
Due to fouling
Conductivity (mS/cm)
Temperature (deg C)
60
55
50
45
40
35
30
25
20
15
10
32
31
30
29
28
27
26
25
24
10 Oct
10 Nov
10 Dec
10 Jan
10 Feb
10 Mar
10 Apr
10 May
2013
2014
Conductivity
Temperature



Natural Challenge – Biofouling

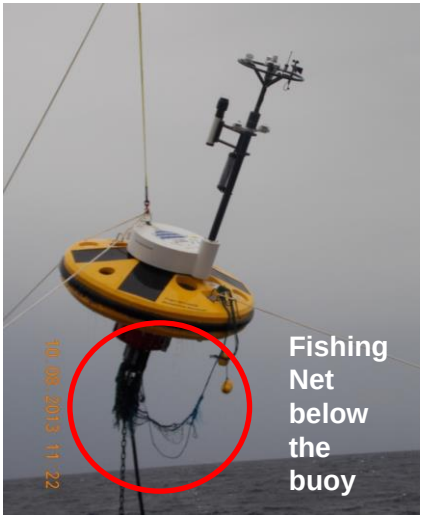
Measures taken for antifouling

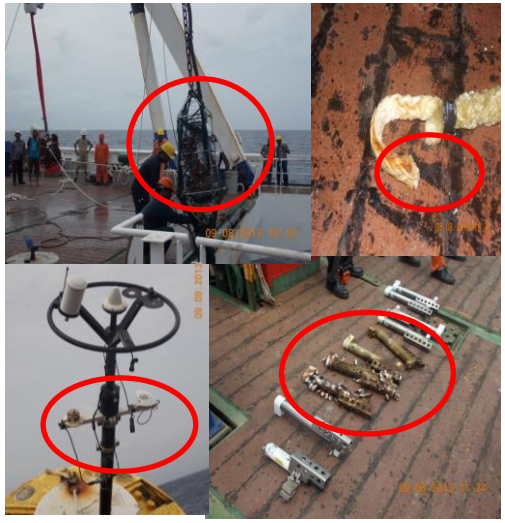
- Rolling copper foils over the sensors
- TBT mounting on sensors
- Rolling polythene sheets
- Antifouling paint



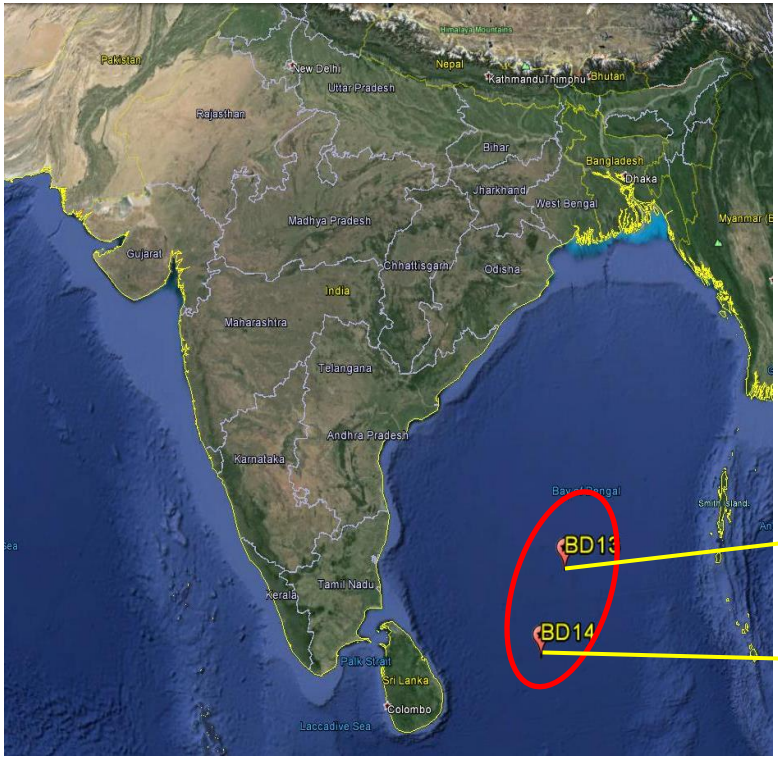
Preventive measures

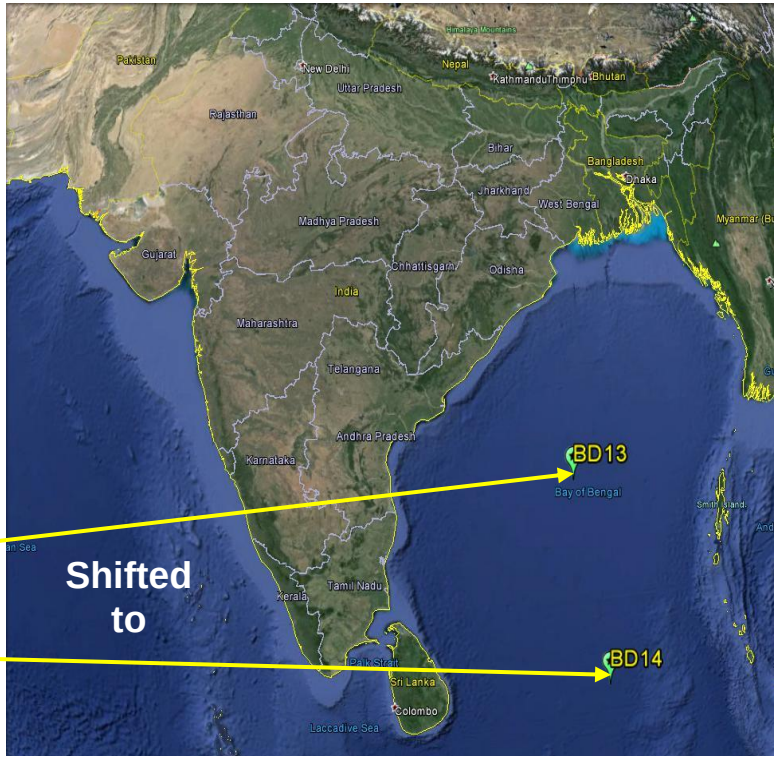
Vandalism on Buoys





No Vandalism after change of Location





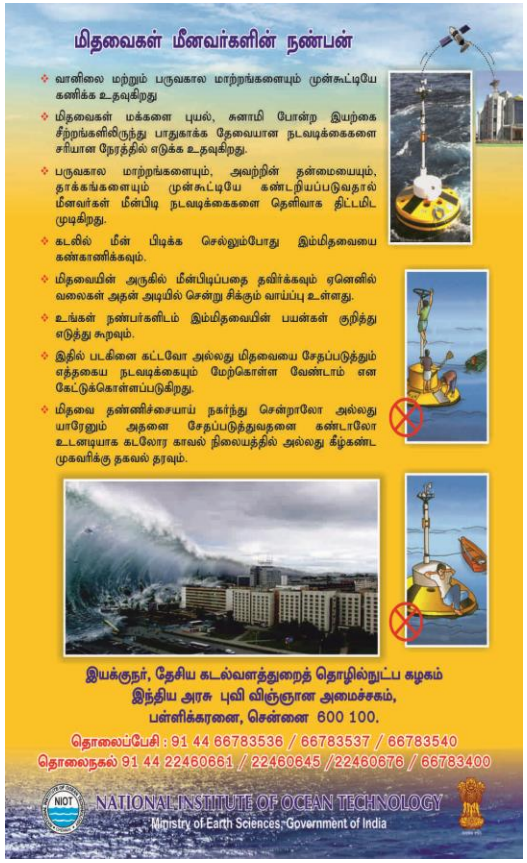
NIL

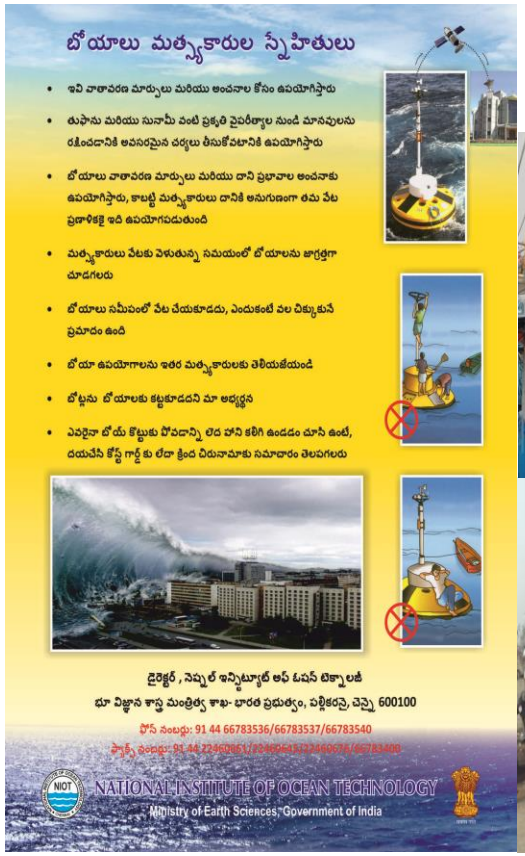
Inconsistent Performance of Argo Transmitters

Buoy ID	Count of Deployment	Argos Transmitter ID	Deployed Date	Position Last received	Working Days
AD06	I	76631	20-10-2012	03-10-2013	348
AD06	II	76694	03-10-2013	24-09-2014	356
AD06	III	76716	24-09-2014	27-09-2014	3
AD07	I	76716	22-10-2012	01-10-2013	344
AD07	II	76716	07-10-2013	26-02-2014	142
AD07	III	76716	24-04-2014	22-09-2014	151
AD07	IV	76694	26-09-2014	24-10-2014	Working
AD08	I	76531	23-10-2012	06-06-2013	226
AD08	II	76699	29-09-2013	16-03-2014	168
AD08	III	76699	21-04-2014	01-10-2014	163
AD09	I	76694	26-10-2012	25-09-2013	334
AD09	II	76631	12-10-2013	27-07-2014	288
AD09	III	76631	29-07-2014	24-10-2014	Working
AD10	I	76699	25-10-2012	26-09-2013	336
AD10	II	76531	10-10-2013	10-12-2013	61
AD10	III	76531	20-09-2014	04-10-2014	14
BD08	IV	76694	28-03-2013	15-06-2013	79
BD08	V	76721	15-06-2013	13-02-2014	243
BD08	VI	76721	20-02-2014	01-05-2014	70
BD09	I	76758	27-03-2013	16-06-2013	81
BD09	II	76742	16-06-2013	29-11-2013	166
BD09	III	76742	23-02-2014	24-10-2014	Working
BD10	IV	76649	30-03-2013	08-06-2013	70
BD10	V	76655	17-02-2014	29-06-2014	132
BD10	VI	76655	01-07-2014	24-10-2014	Working
BD11	III	76691	02-04-2013	07-10-2013	188
BD11	IV	76683	11-02-2014	26-02-2014	15
BD11	V	76758	13-07-2014	24-10-2014	Working
BD12	III	76703	21-03-2013	30-12-2013	284
BD12	IV	76703	27-02-2014	14-04-2014	46
BD13	VII	76655	25-06-2013	10-08-2013	46
BD13	VIII	76655	13-08-2013	13-02-2014	184
BD13	IX	76747	14-02-2014	19-03-2014	33
BD14	V	76745	23-06-2013	10-08-2013	48
BD14	VI	73745	16-08-2013	01-03-2014	197
BD14	VII	76745	02-03-2014	25-05-2014	84
BD14	VIII	76745	09-07-2014	02-09-2014	55

Societal Awareness Programmes:

Stickers and stickers pasted on boat for awareness





January 2014	Fishermen awareness programme conducted at Andaman during CB01 buoy maintenance
08 May 2014	Fishermen awareness programme conducted with Boat owners at Kasimedu, Chennai on 08th May 2014
19 May 2014	Fishermen Awareness Programme conducted during Workshop on Chennai Marine Expo 2014 organized by Fishermen Trust at Kasimedu, Chennai on 19th May 2014
20 May 2014	Fishermen awareness programme conducted with Fishermen Community at Krishnapatnam Port, Andhra Pradesh on 20th May 2014

Indo- Japan Collaboration

Ocean observation

Suggested Areas of Collaboration

Capacity Building

- OOS training on calibration of sensors for meteorological and oceanographic observations
- Testing and calibration of pressure sensor for water level measurements for Tsunami
- Training on interpretation and understanding of Tsunami triggered data
- Training on new methodology on early detection of Tsunami
- Support in development of deep sea floor observatory
- Support and design of mooring system for southern ocean
- Development of newer materials for deep sea applications

Joint Development of newer observation tools and Systems

Control of bio fouling on Sensors

Development of Lithium battery

Indo- Norwegian Collaboration

Suggested Areas of Collaboration

Exchange of scientific personnel

Technical knowledge Support

Improvement or development in Earth science and services

Arctic observations & collaboration

Ocean observation & Research Programmes

Indo US Collaboration

RAMA

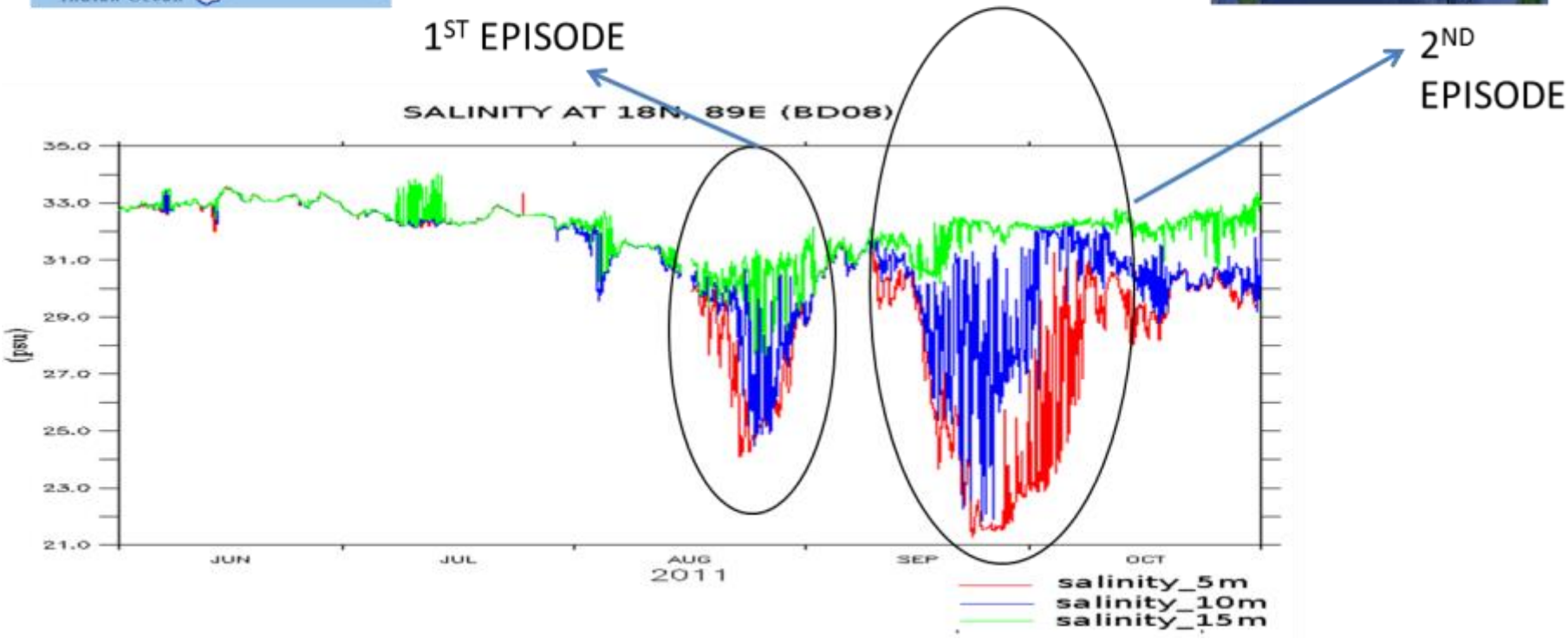
ASIRI OMM Project

Research Initiatives

- Inter-annual variability of the freshening in the northern Bay of Bengal
- The observed temperature inversion in the Bay of Bengal and their role in the intensification of cyclone formed in the Bay of Bengal during North-east monsoon season.
- Validation of satellite current data with buoy observed current
- The intra-seasonal oscillation observed in the ocean parameters during southwest monsoon period and its relation to monsoon breaks
- Upper ocean response to tropical cyclone ‘Nanauk’ in the Arabian Sea
- Analysis of wave characteristics
- Comparison of theoretical and observed wave spectra
- Simulation of WAM model significant wave height during extreme events.
- Cyclonic responses in the Bay of Bengal

FRESHENING EPISODES IN THE HEAD BAY -2011 (18N, 89E)

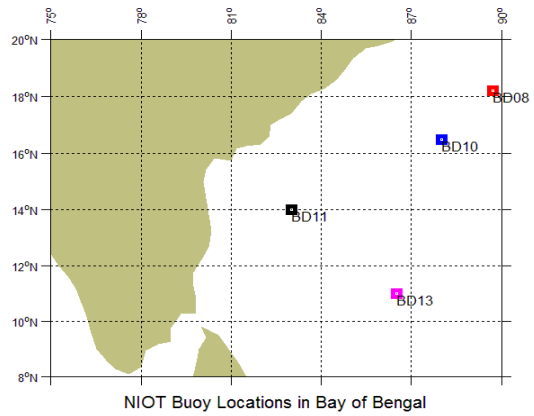
- The Bay of Bengal is characterized by a strong ocean salinity stratification resulting from an excess of freshwater supply over evaporation.
- Fresher surface water increases the vertical stability of the water column thereby heat gets trapped in the upper layer.



VALIDATION OF SATELLITE DATA

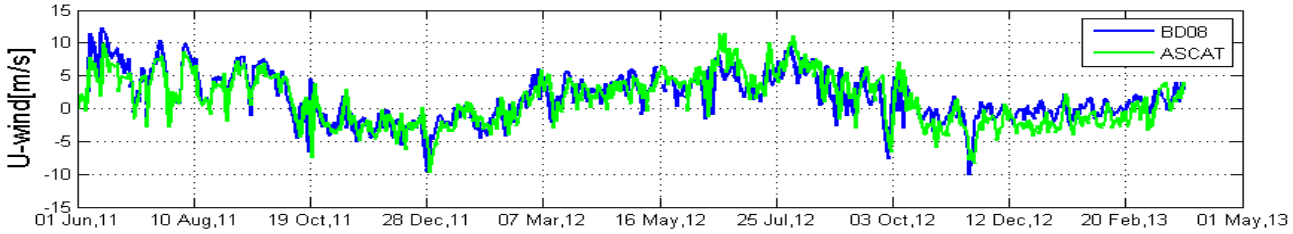
- The inter-comparison of the surface currents and winds obtained from the moored buoy with the satellite data.
- Validation of TRMM-3B42 precipitation product with the rain gauge data from the OMNI Buoys.
- Validation of radiation data with CERES daily data

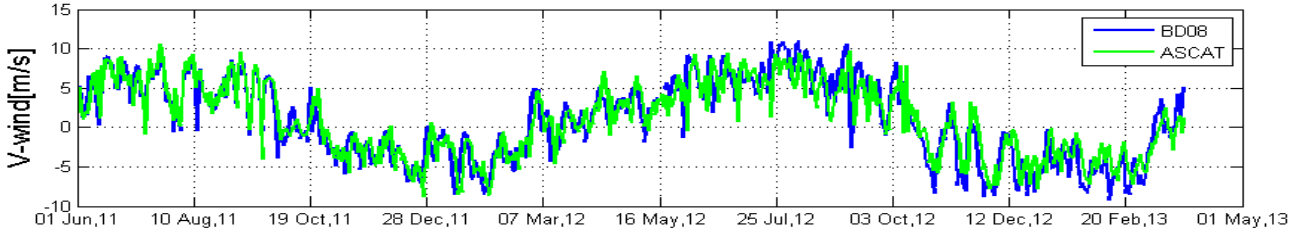
Validation of surface current data from the OMNI buoys were validated using OSCAR and GEKCO products



NIOT Buoy Locations in Bay of Bengal

- OOS, NIOT Buoy Data (Wind, Current)
- ASCAT Wind (INCOIS)
- GEKCO Current (CTOH, France)
- OSCAR current (NOAA)
- Data availability duration 22months from



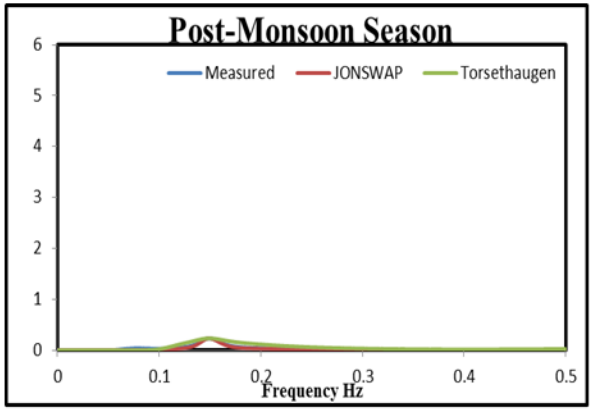


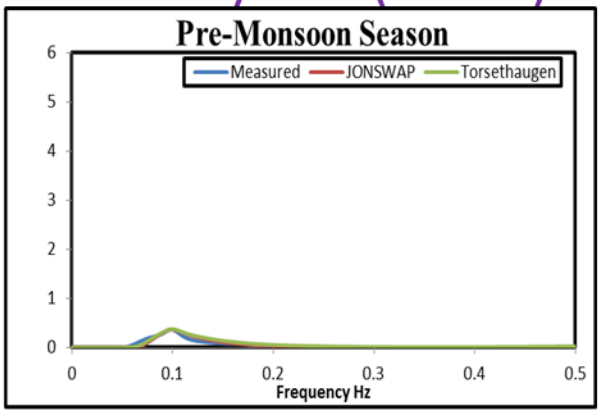
Correlation between ASCAT & Buoy wind sensor	Zonal	Meridional
BD08	0. 7890	0. 8748
BD10	0. 8960	0. 8517
BD11	0. 9546	0. 9244
BD13	0. 8624	0. 8349

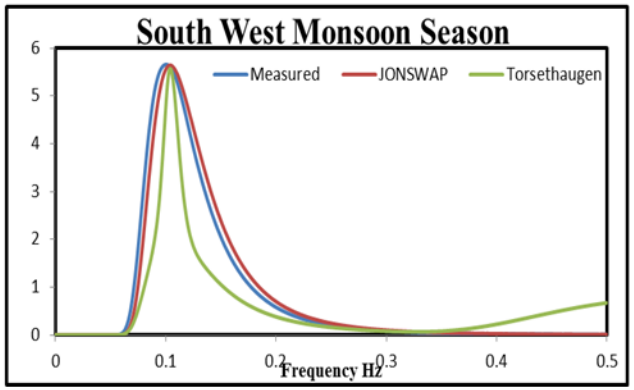
WAVE SPECTRUM ANALYSIS

- To analyze wave spectrum over the northern Indian Ocean using observations from moored buoy.
- Comparison of observed spectrum with the theoretical spectrum
- Validation of WAM model spectrum with help of the observed spectrum.
- Simulation of significant wave height for cyclones in the Northern Indian Ocean during 2010-2014 using wave model WAM

Comparison of observed spectrum with the theoretical spectrum at 15N/69E (AD07)







Equations for the JONSWAP (Hasselmann *et al*, 1973) is

$$S(f) = \alpha(g^2/f^5)e^{-\beta(f_p/f)^4}\gamma^{e^{1/2((f-fp)/\sigma fp)^2}}$$

Equations for the Torsethaugen spectrum (Torsethaugen, 2004)

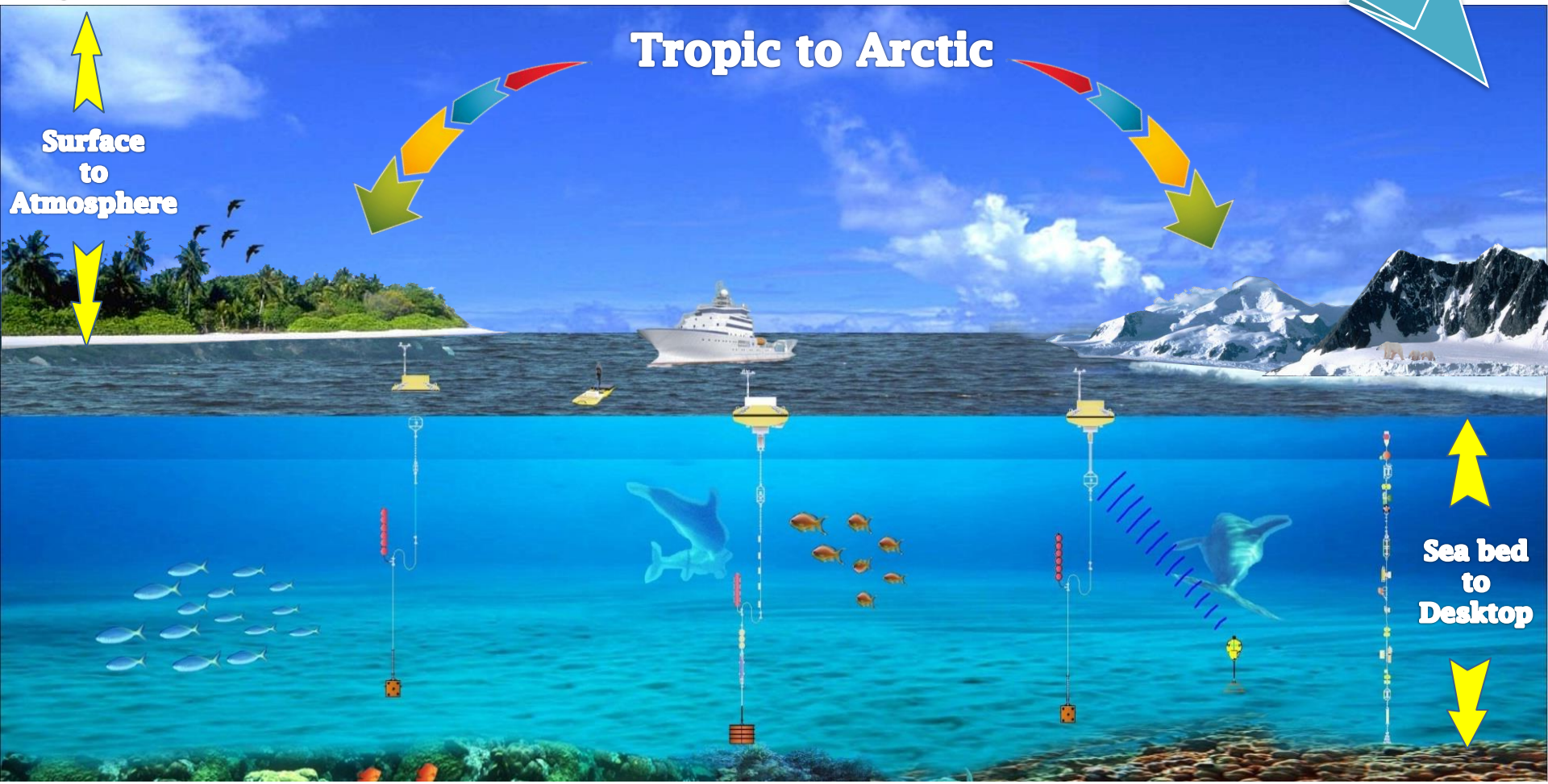
$$S(f_n) = \sum_{j=1}^{2} E_j S_{jn}(f_{jn})$$

- Theoretical spectrum matches with the primary peak of the observed wave spectrum
- During the southwest monsoon season the theoretical and wave spectrum from the buoy system exhibits good agreement

Published in International Journal of Remote sensing Vol. 35, Issue 14, July 2014, "Validation of in-situ wave spectrum with JONSWAP in the Indian Ocean" - Vimala J, Latha G and Venkatesan R

Thank You!

75185 nm sailed since the year 2010
(equals to 10 times the Earth's diameter)



Dr. R. Venkatesan
dr.r.venkatesan@gmail.com