OPERATIONAL OCEANOGRAPHY VALUE CHAIN: OBSERVATIONS TO OCEAN INFORMATION AND ADVISORY SERVICES

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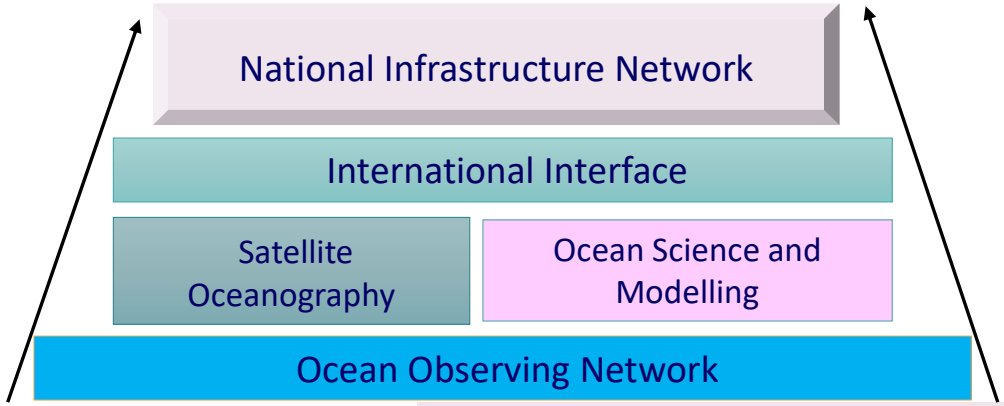
Ocean Observation, Information & Advisory Services

- Ecosystem Services (PFZ, CBA, HAB, CWQ)
- Ocean State Forecast Services
- Disaster Related Warning Services (Tsunami, Storm Surge, High Waves)
- Coastal Geospatial Applications (CVI, MHVM, 3D GIS)
- Data & Web-based Services
- Capacity Building (ITCOocean)



Remote Sensing Satellites

- Oceansat-1 (Ocean Colour Monitor)
- Oceansat-2 (Ocean Colour Monitor, Scatterometer)
- SARAL-ALTIKA
- Foreign Satellites

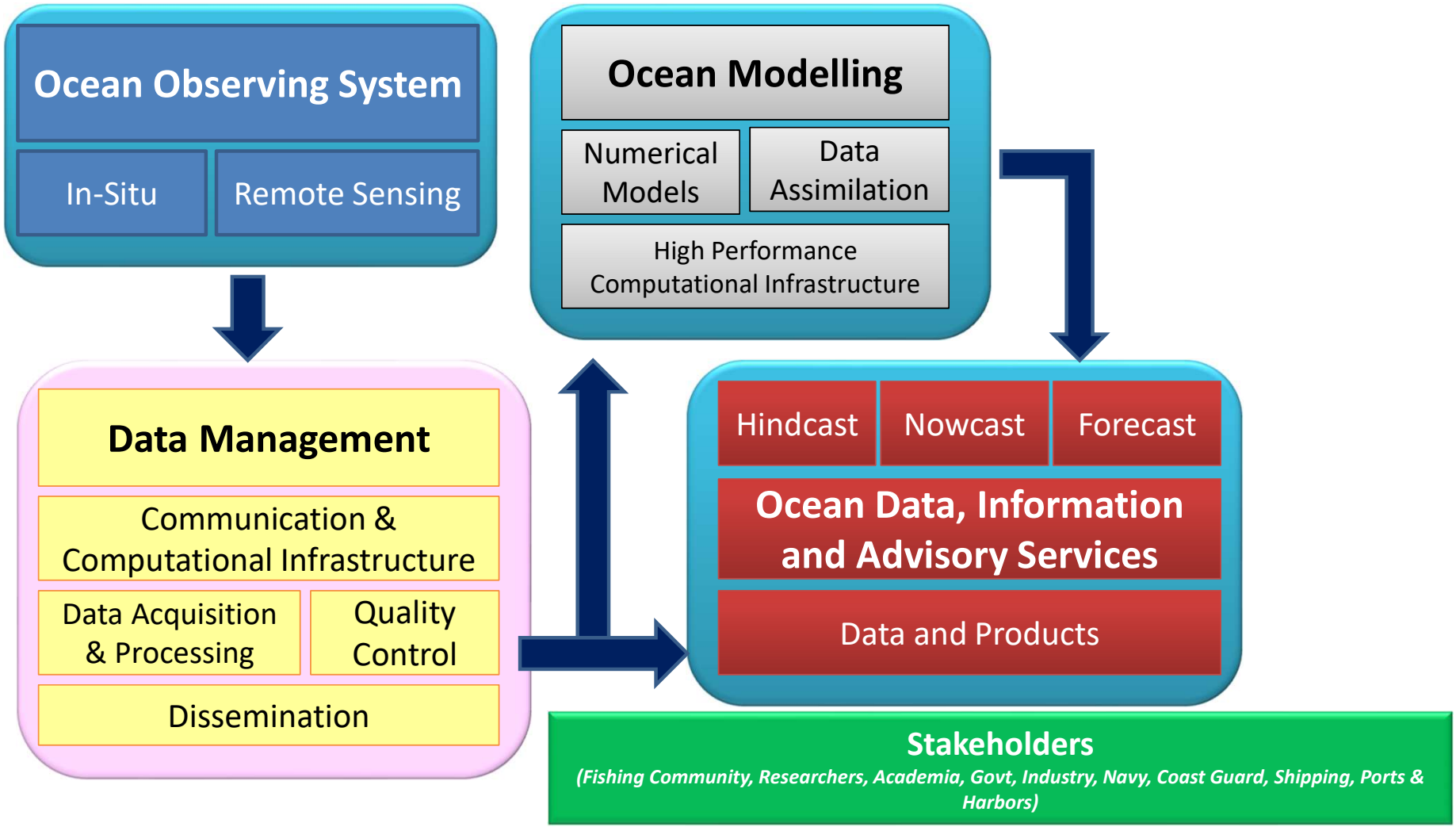
In-situ Observations

- Argo Profiling Floats
- Data Buoys (Moored , Drifting)
- AWS, WRB, Wave Drifters
- Current Meter Arrays, XBT / XCTD
- Gliders, uCTD, VMP,
- Tide gauges, BPRs
- Research Vessels

Stakeholders

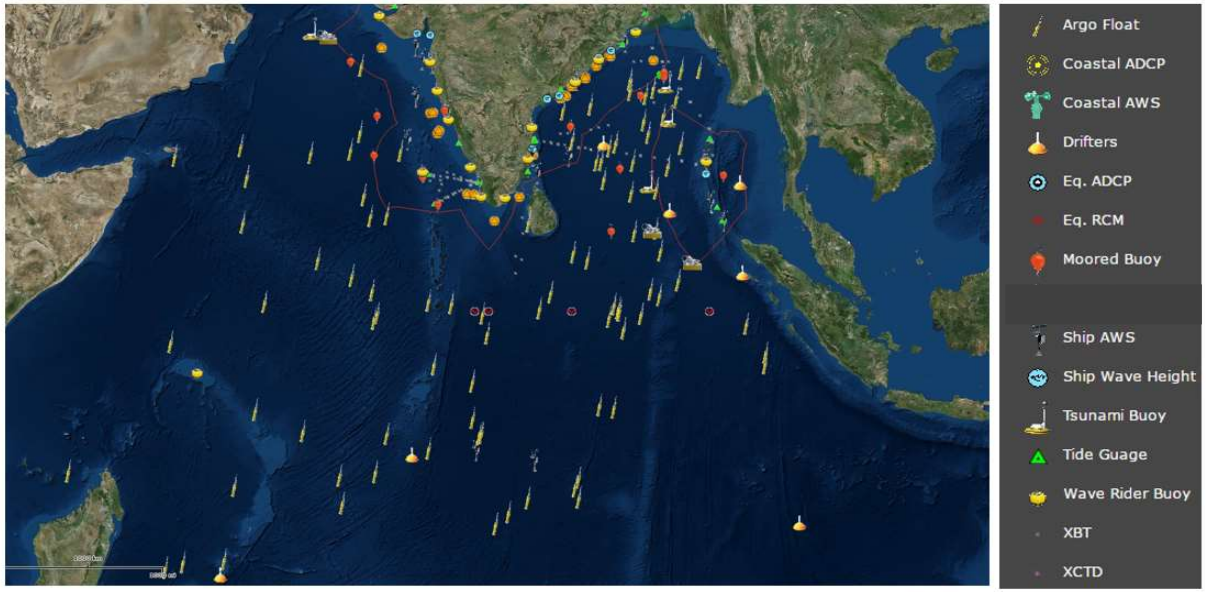
- Fishing Community
- Coastal States
- IMD, Navy, NHO, Coast Guard
- Ports and Harbours
- Off-shore and Shipping
- Research Institutions
- Academia

Essential Components of Operational Oceanography



OCEAN OBSERVATIONS BY INDIA

To obtain long term high quality in-situ sub-surface oceanographic and near surface met-ocean parameters to support operational services



INCOIS NIOT IOGOOS IIOE-2 2nd International Indian Ocean Expedition 2015-2020 Argo Ship Observations Team jcomm SOOP DBCP WMO-IOC OceanSITES

Current Status and Future Plans (2022-2026)

Indian National Centre for Ocean Information Services (INCOIS)

- Argo Floats [493 (73 BGC) – 50 per year]
- ***Drifting Buoys*** [430 – 30 per year]
- Automatic Weather Stations onboard Research Vessels [36 – Sustain]
- ***Wave Rider Buoys*** [16 - Sustain]
- ***Wave Drifters***[*4* - 150]
- Tide Gauges[36 – Setup 15 new TG and GPS]
- ***Tsunami Buoys*** [4 - Sustain]
- XBT/XCTD Surveys [3 transects - Sustain]
- Coastal ADCP [17 - Sustain]
- Equatorial Current Meter Mooring [3 - Sustain]

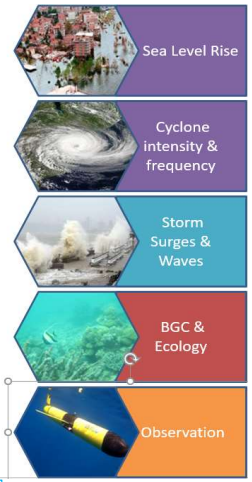
National Institute of Ocean Technology (NIOT

- OMNI Buoy Network [12 - Sustain]
- Tsunami Buoys [3 - Sustain]
- HF RADARS [5 Pairs – Sustain]

OCEAN OBSERVATIONS - NEW PROGRAMMES

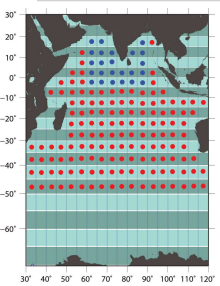
Deep Ocean Mission

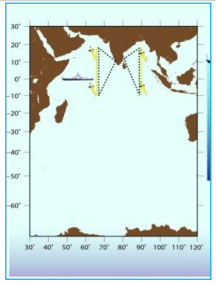
OCEAN CLIMATE CHANGE ADVISORY SERVICES



Objectives:

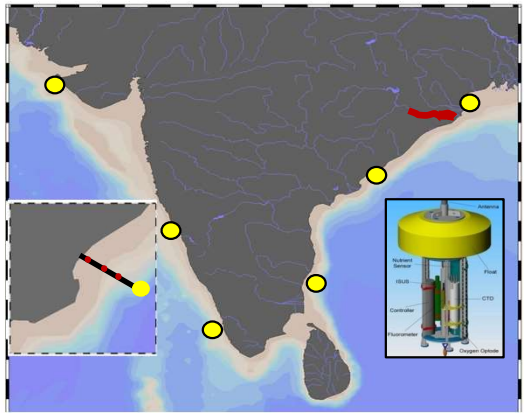
- To facilitate climate change advisories for the societal and economical benefit of the Indian coastal regions.
- Under this mission a suite of models will be developed to understand and provide future projections of important climate variables on seasonal to decadal time scales.





- Deep Argo Flats [10]
- Gliders [8]
- Wave Drifters [150]

Coastal Water Monitoring



- To monitor and understand biogeochemical processes in the Indian coastal waters
- To provide water quality services along the Indian Coast
- To provide long-term data for validation / tuning of high-resolution (1/48°) coastal biogeochemical model used for PFZ forecasts.

Arabian Sea Field Campaign

To improve the quality of monsoon forecasts issued by IMD and operational ocean forecast services issued by INCOIS by understanding the specific physical processes in based on focused observations in the Arabian Sea and incorporating them in the numerical models.

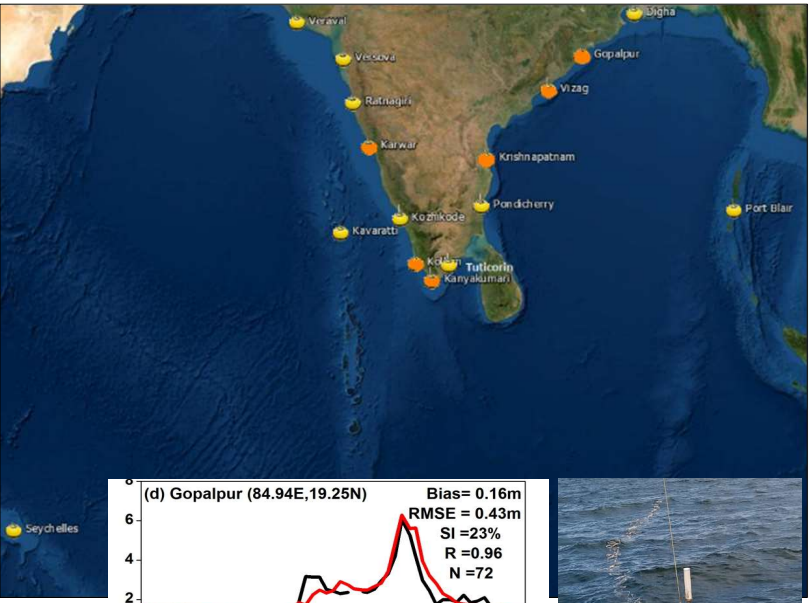
INCOIS, IITM, NIOT, NCCR, CMLRE, NCPOR, NCMRWF, IMD.

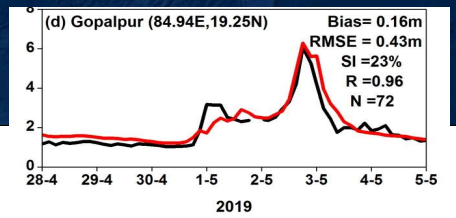
IISc, NIO, SAC, IIT-D, IIT-M, IIT-Bhu, Univ. Allahabad

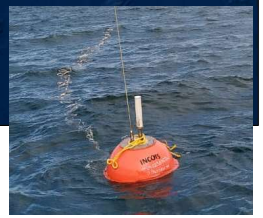
U. Mass., WHOI, UW, SIO, OSU. NOAA-PMEL

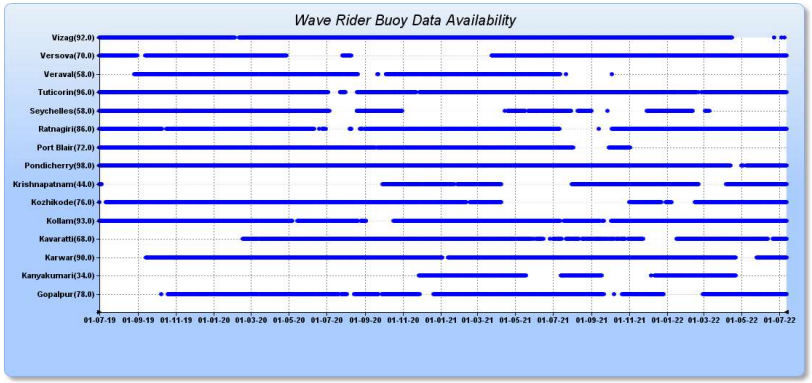
- INCOIS Flux Mooring with Direct Covariance Flux System
- Field Campaigns in the Arabian Sea

Wave Rider Buoy Network



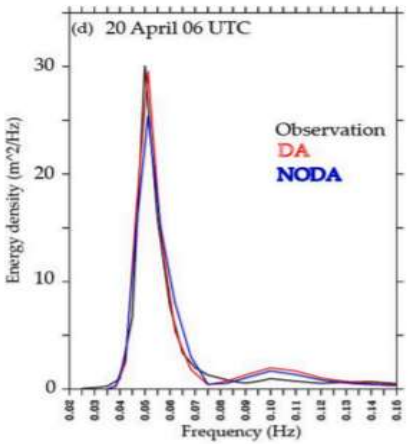




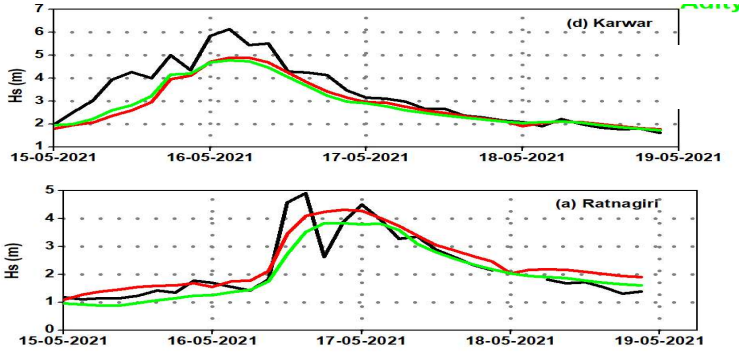


- ✓ **Network of 16 wave rider buoys (WRB) maintained in collaboration with various research and academic institutes in India**

Data Assimilation



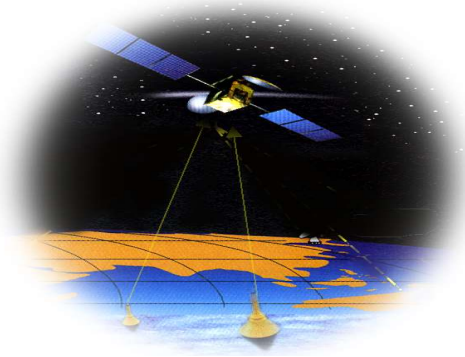
Comparison during Tauktae Cyclone

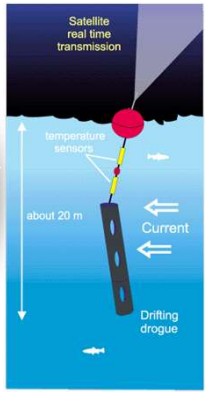


Observation, DA-SAT-Aditya, DA-SAT+ Buoy-Mihir

Satellite Tracked Surface Drifters (SVP)

NIO/INCOIS



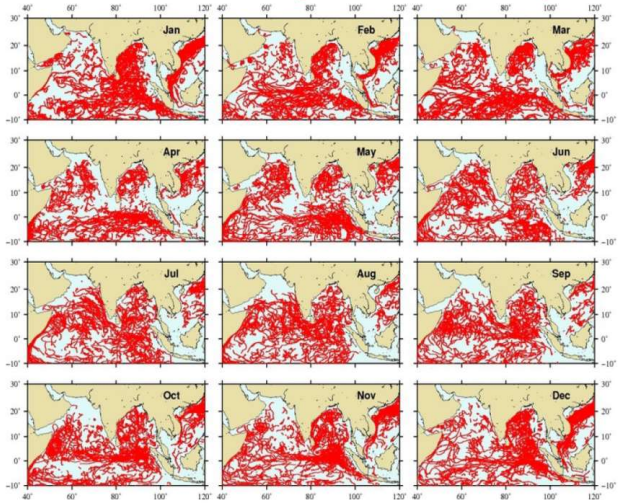


Objectives

- To collect surface meteorological (atmospheric pressure and winds) and oceanographic (SST, surface velocities, and sub-surface temperature) data using the satellite tracked drifting buoys.
- To provide near-real time data (SST, sea level pressure and surface winds on GTS) for operational weather analysis and prediction
- To develop monthly mean mixed-layer velocities in the Indian Ocean on 1° x 1° resolution.
- Provide data sets as 'seatruths' for validation of remotely sensed ocean surface parameters
- To build an Indian Ocean drifter data archival.

- ✓ Deployed 15 drifters in North Indian Ocean 2021-22.
- ✓ Evaluated data from indigenous satellite-tracked (INSAT) drifter.
- ✓ **Planning to deploy 50 drifters per year**

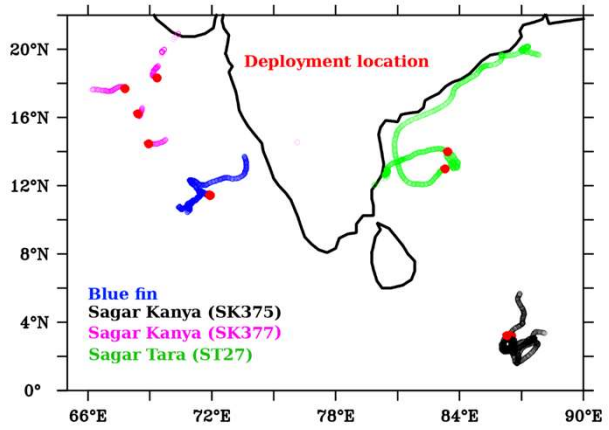
Month wise availability of drifter data (2000-15)



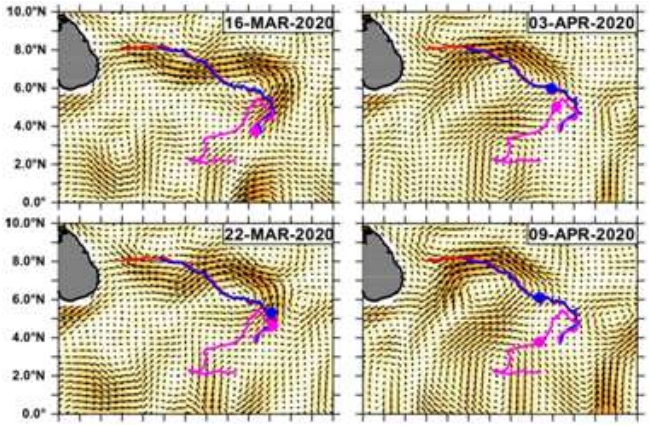
http://odis.incois.gov.in/index.php/in-situ-data/drifting-buoy/data-access
ftp://ftp.aoml.noaa.gov/pub/phod/buoydata/

- Deployed 430 Drifting Buoys since 1991

Recent Deployments

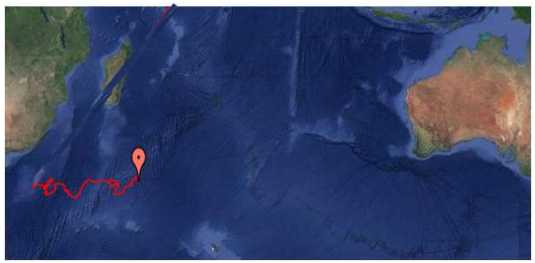


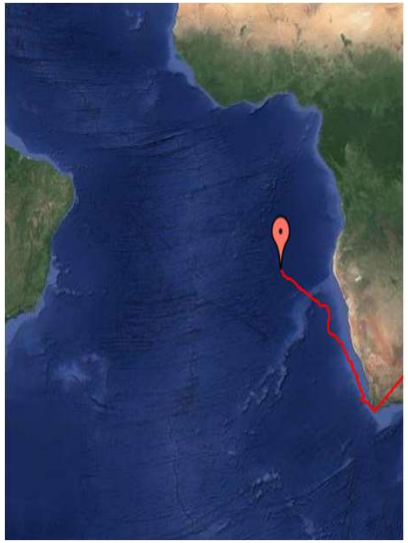
Indigenized Drifters



Satellite Tracked Wave Drifters

Lack of in situ wave observations in the Southern Ocean for validation of Wave Forecast





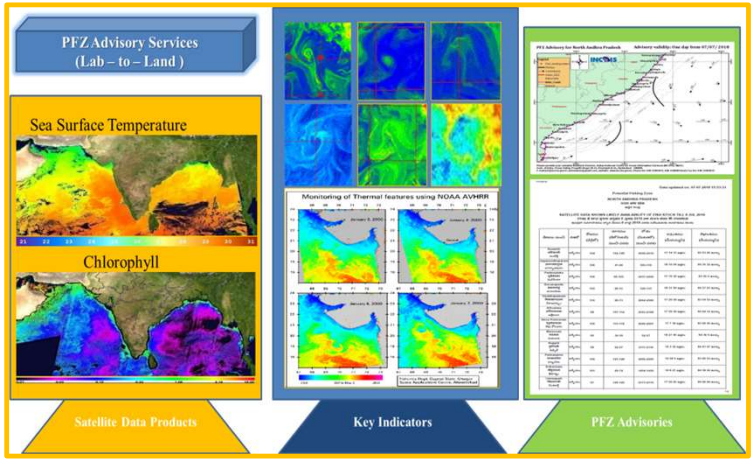
Deployment locations

- **Four wave drifters were deployed in the Indian Ocean sector of Southern Ocean in 2021 and three of them were in the major swell generation areas of IO**
- **Planning to deploy 150 Wave Drifters during the period 2021-2026**

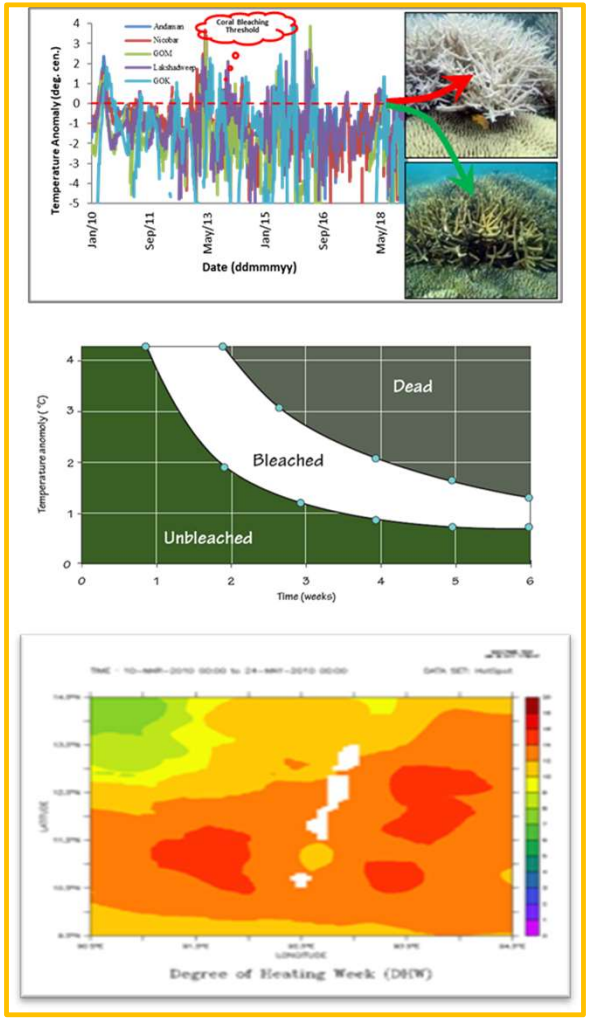
Wave parameters from the drifters were extensively used to validate the simulated data of operational Wave Watch III set up for the Indian Ocean

Significant Wave Height Comparison

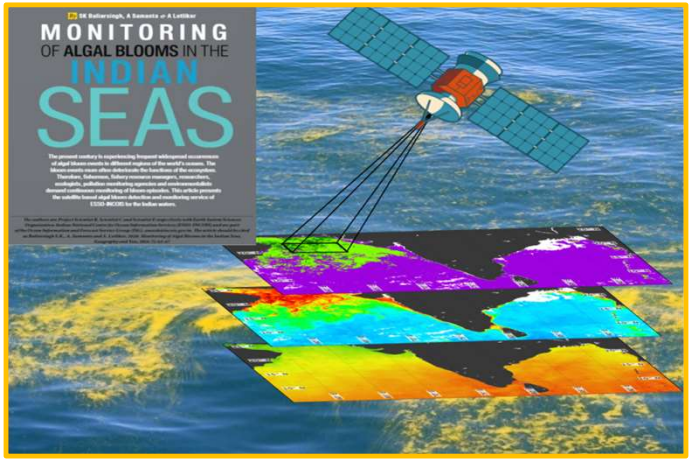
Ecosystem Services



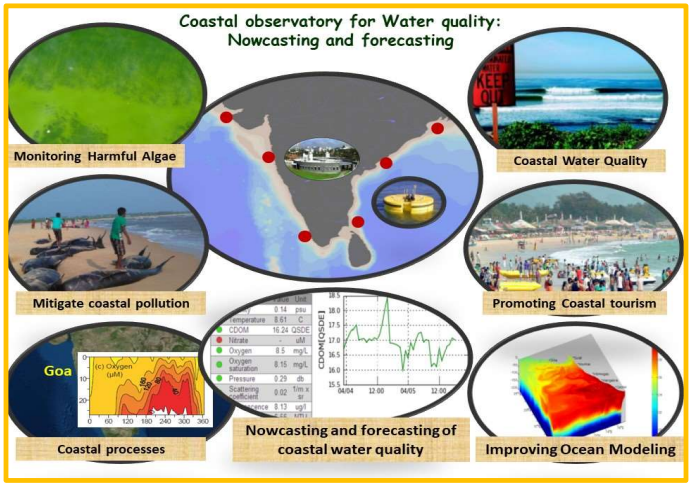
Marine Fishery Advisory Services



Coral Bleaching Alerts



Algal Blooms Information Services

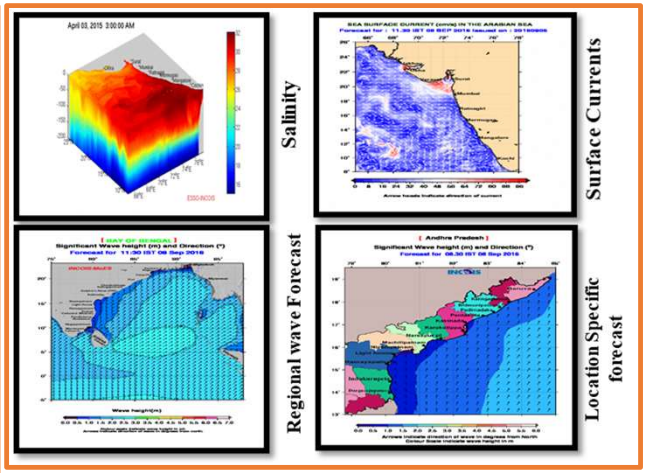


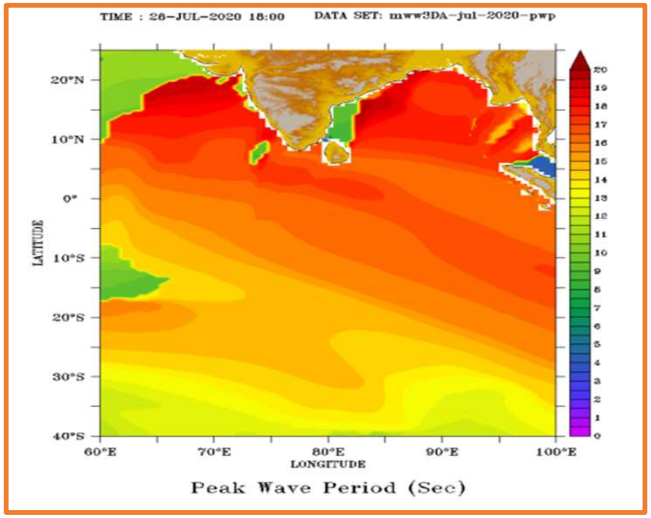
Water Quality Services

Marine Safety Services

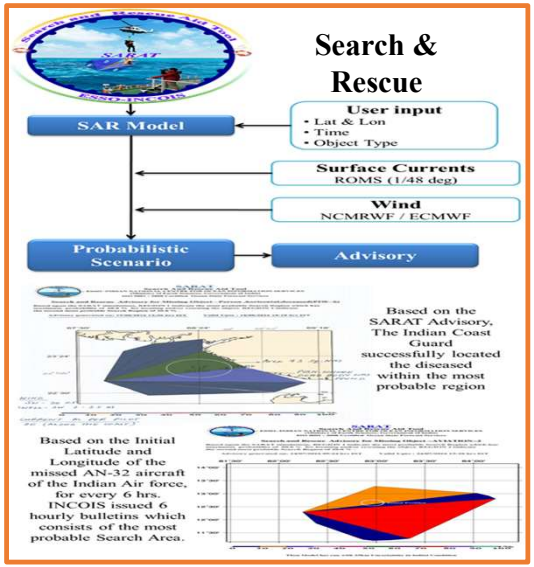
Ocean State Forecasts

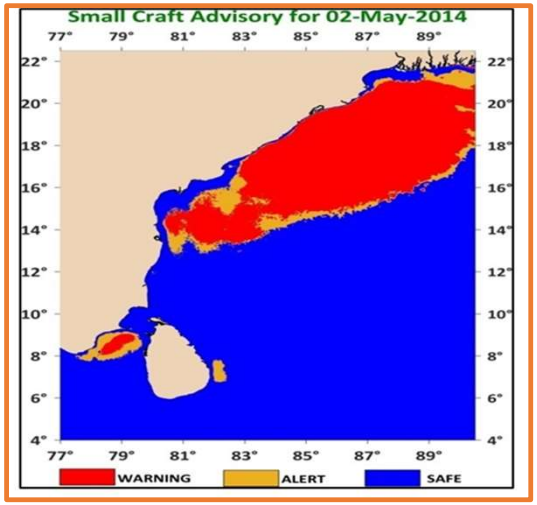
45 User specified daily forecast products for India and 06 Neighbouring Countries

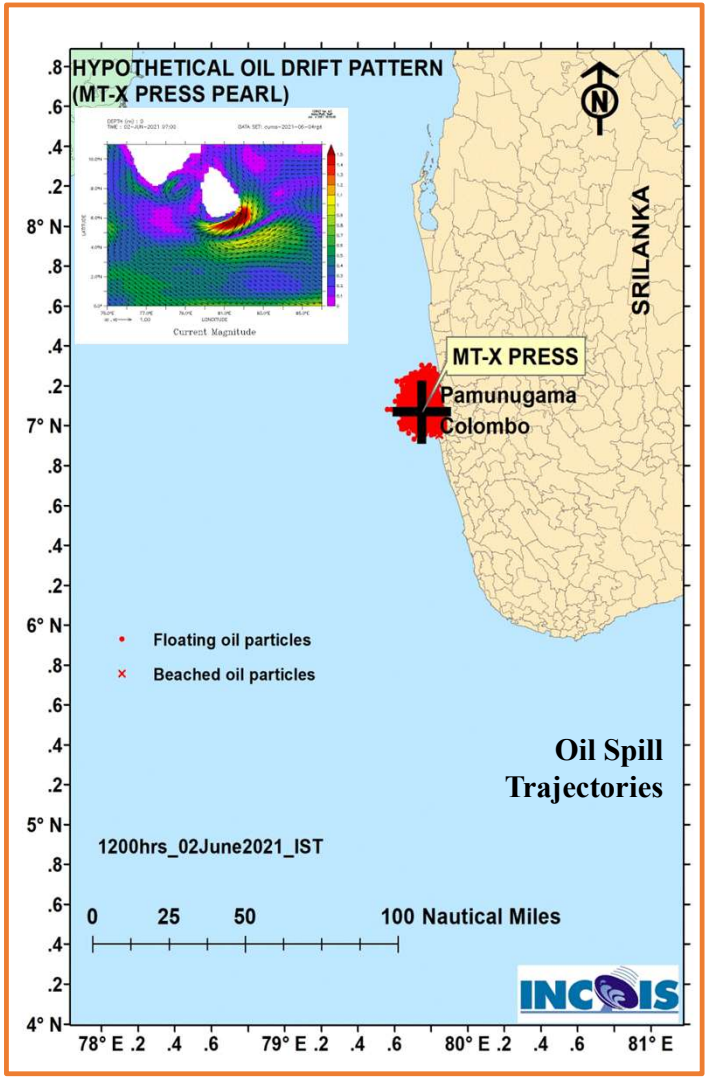




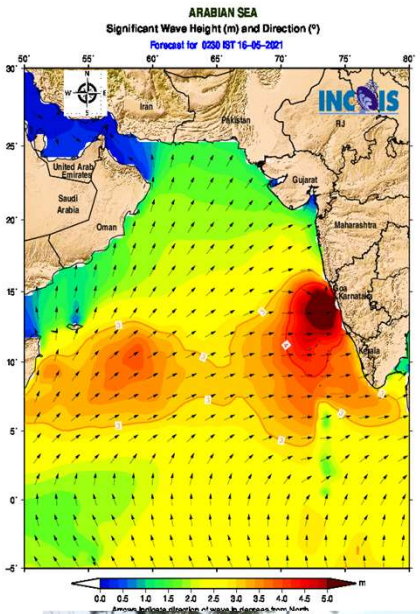
Swell Surge Forecast

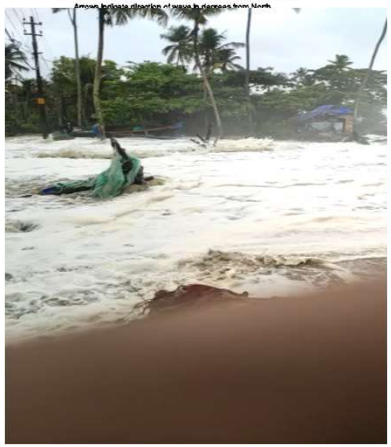




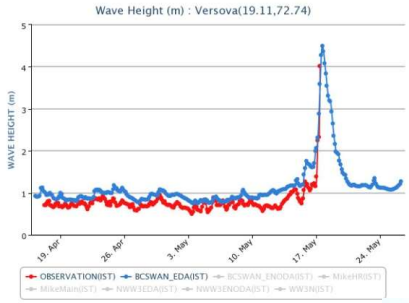


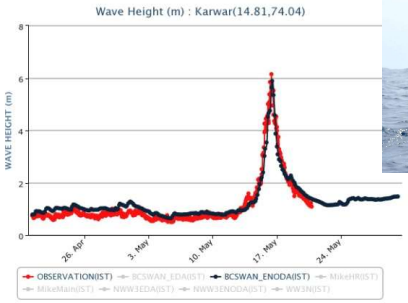
Marine Safety Services – Extreme Weather Events

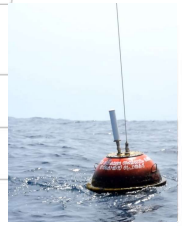




Coastal Inundation (Storm)







INCOIS-IMD JOINT BULLETIN

Time of issue: 11:30 hours IST Dated: 17.05.2021, Bulletin No.: INCOIS/17/05/2021/4

Sub: INCOIS-IMD Joint Bulletin - Ocean State Forecast associated with the Extremely Severe Cyclonic Storm "Tauktae" (pronounced as Tau'Te) over Eastcentral Arabian Sea: ***Cyclone Warning for Gujarat & Diu coasts & & post landfall outlook for Gujarat & Rajasthan (Red message)***

The **Extremely Severe Cyclonic Storm "Tauktae" (pronounced as Tau'Te)** over eastcentral Arabian Sea moved north-northwestwards with a speed of about 15 kmph during past 06 hours, and lay centred at 0830 hours IST of today, the 17th May, 2021 over eastcentral Arabian Sea near latitude 18.8°N and longitude 71.5°E, about 150 km west of Mumbai, 220 km south-southeast of Diu, 260 km southeast of Veraval (Gujarat), and 490 km east-southeast of Karachi (Pakistan).

It is very likely to move north-northwestwards and reach Gujarat coast in the evening hours of 17th & cross Gujarat coast between Porbandar & Mahuva (Bhavnagar district) during the night (2000 – 2300 hrs IST) of 17th May with a maximum sustained wind speed 155-165 kmph gusting to 185 kmph.

High Wave/Ocean State warning/alert for Maharashtra, Goa, Gujarat, Karnataka, Kerala and Lakshadweep

Maharashtra:

Table: Forecasted Significant wave height and corresponding swell height, for coastal region, into the sea upto 10 km off Maharashtra. There is a possibility that the low lying areas (Malvan, Munage, Phanase, Velas, Colaba, Gateway of India) may be surged (gushing of sea water into these areas) intermittently, because of the waves and tidal conditions.

Location/District	Date/ Time (IST)		Significant Wave Height (m)	Swell height (m)
	From	To		
Greater Mumbai	11:30 hrs, 17-05-2021	23:30 hrs, 18-05-2021	**3.0-5.5**	**1.5-3.0**
Raigarh	11:30 hrs, 17-05-2021	23:30 hrs, 18-05-2021	**3.0-5.6**	**1.5-3.2**

Mode	Number
SMS Alerts	1253449
NO. of INCOIS-IMD Joint Bulletins Issued	38
Bulletins sent to emails	13964
No. of High Wave Alerts/Warnings bulletins issued	44
No. of NAVIC messages	30
IMD hourly bulletins in INCOIS website	33

ESCS Tauktae
May 13 – 18, 2021

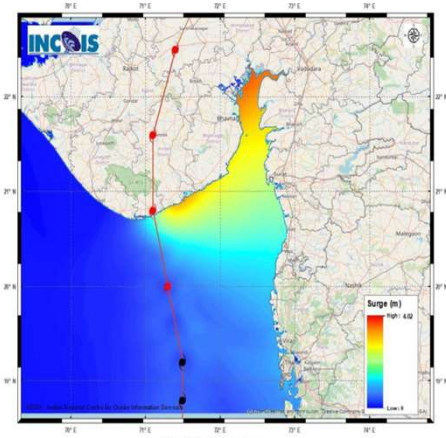
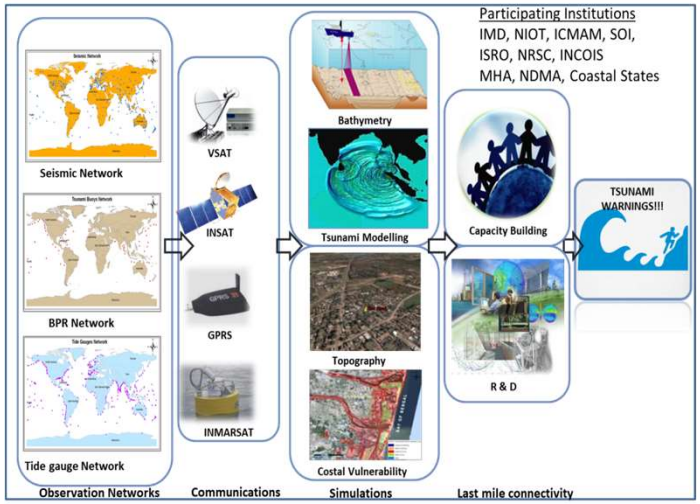
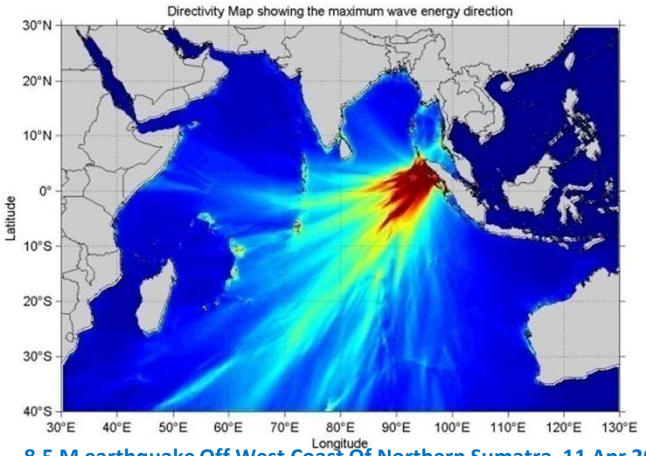


Figure:Storm Surge Map

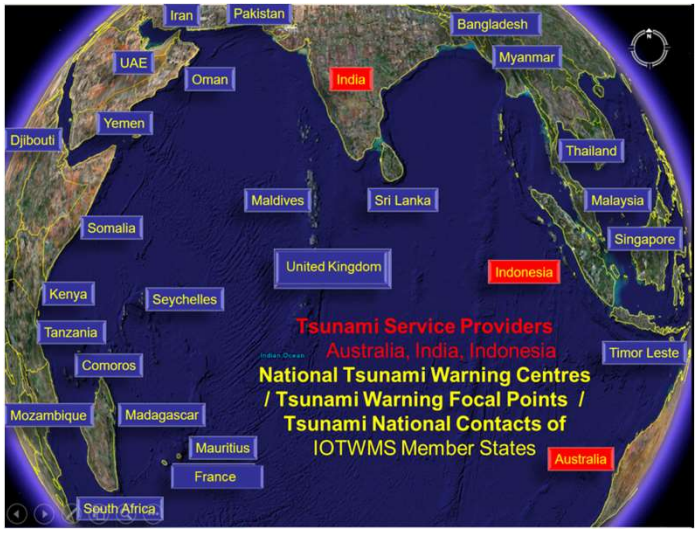
Tsunami & Coastal Multi-hazard Warning Services



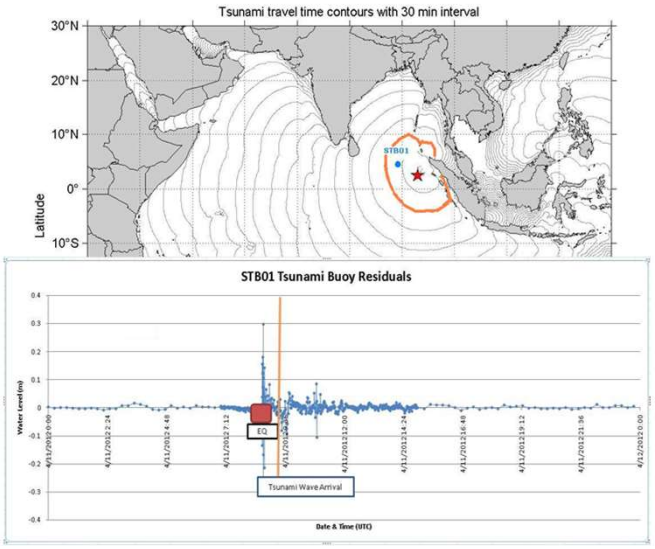
Indian Tsunami Early Warning Centre

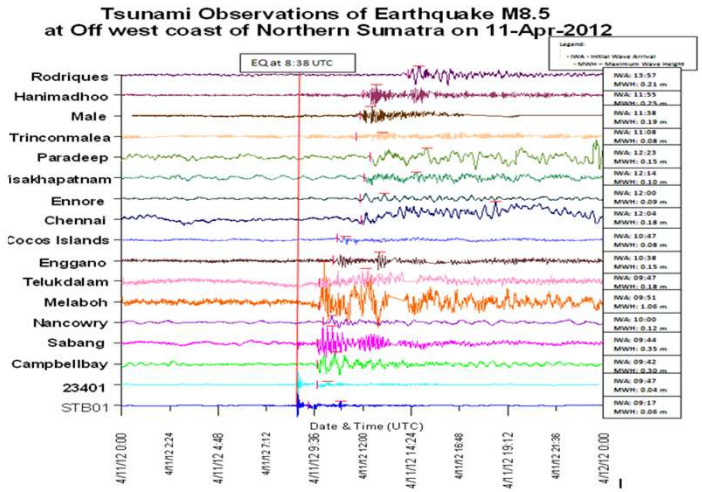


8.5 M earthquake Off West Coast Of Northern Sumatra, 11 Apr 2012

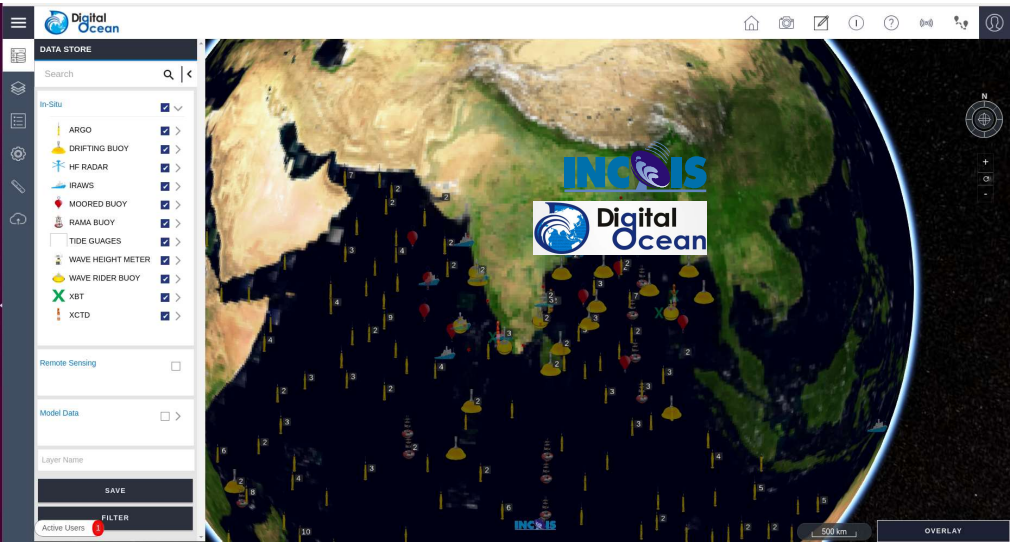


Tsunami Early Warning Services



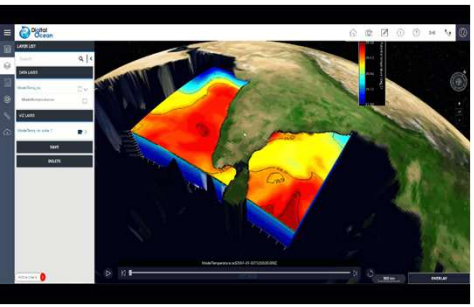


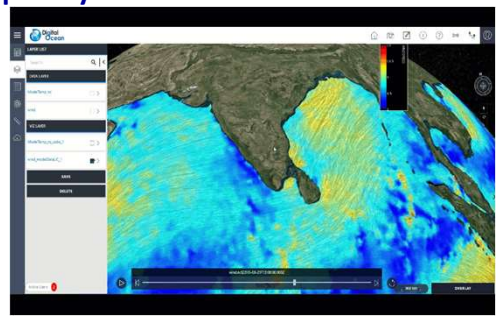
Ocean Data Services



An innovative web-application to Manage and Visualise multi-disciplinary Ocean Data

MoES-NOAA OMNI-RAMA Joint Data Portal
(https://incois.gov.in/portal/datainfo/buoys.jsp)

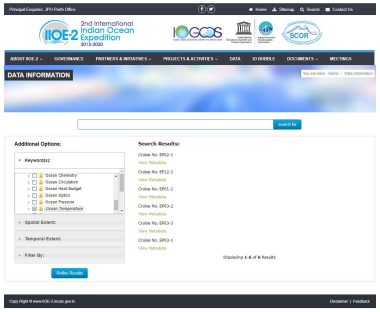


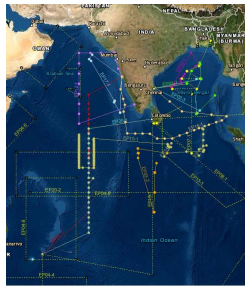


Data Sharing through

- **WMO GTS**
- **IOC Sea Level Monitoring Facility**
- **MoES – NOAA OMNI RAMA Joint Data Portal**
- **INCOIS Web Services & Digital Ocean**

IIOE-2 Metadata Portal





Argo

IODE International Oceanographic Data and Information Exchange

UNESCO United Nations Educational, Scientific and Cultural Organization

Intergovernmental Oceanographic Commission

IOGOOS GLOBAL OCEAN OBSERVING SYSTEM FOR INDIAN OCEAN

Indian Ocean Observing System (IndOOS-2)

A roadmap to sustained observations of the Indian Ocean for 2020-2030

CLIVAR GOOS IndOOS-2

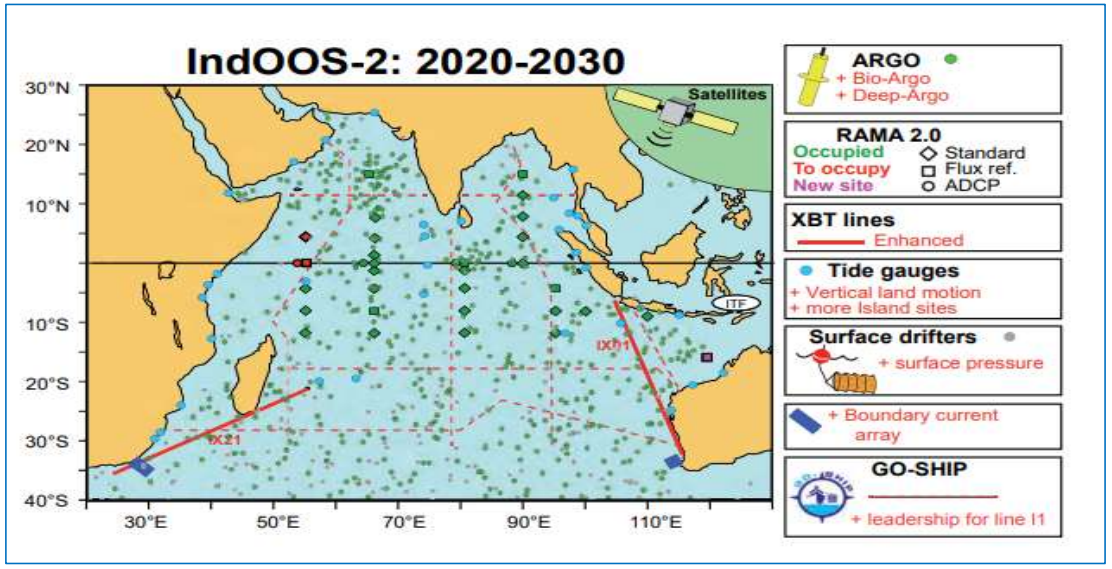
Need to better observe, understand and model the Indian Ocean

Societal Needs

- Rapid growth in blue economies and opportunities to exploit ocean resources and services
- Agriculture Farming dependent on Monsoon
- Marine Fisheries dependent on ocean conditions
- Coastal populations vulnerable to extreme weather events and climate change

Operational Drivers

- Operational Subseasonal-to-Seasonal (S2S) Forecasting
- Improvement of Surface Fluxes
- Ocean Data Assimilation Systems



THANK YOU

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