

Keynote Talk

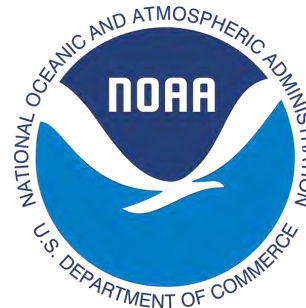
Societal Application Of Ocean Colour To Fisheries Information Service

Dr. Srinivasa Kumar Tummala
Director

Indian National Centre for Ocean Information Services (INCOIS, MoES)

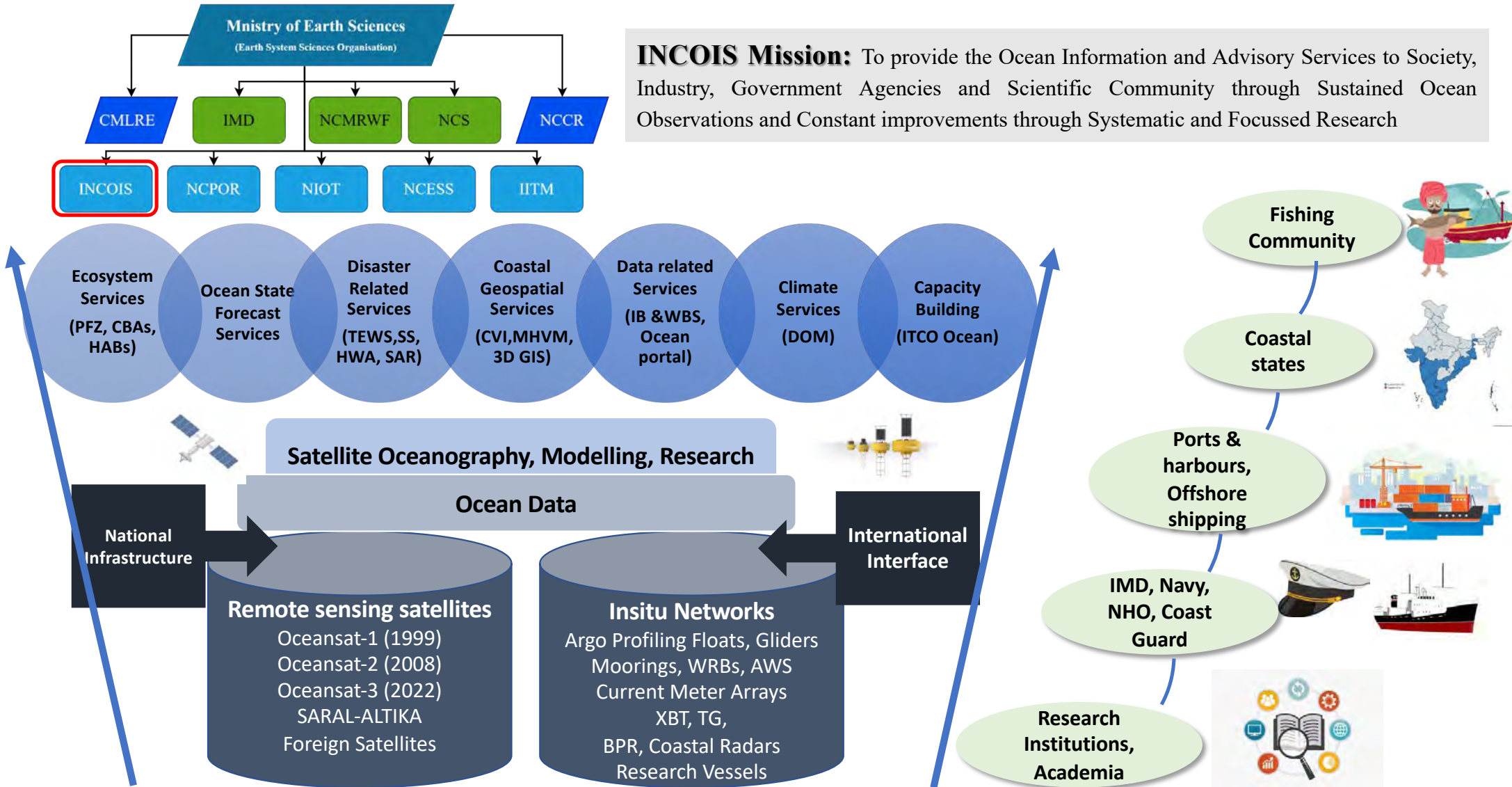
Fifth International Ocean Colour Science meeting (IOCS-2023)
International Ocean Colour Coordinating Group (IOCCG)

14-17 November 2023
St. Petersburg, Florida, USA.

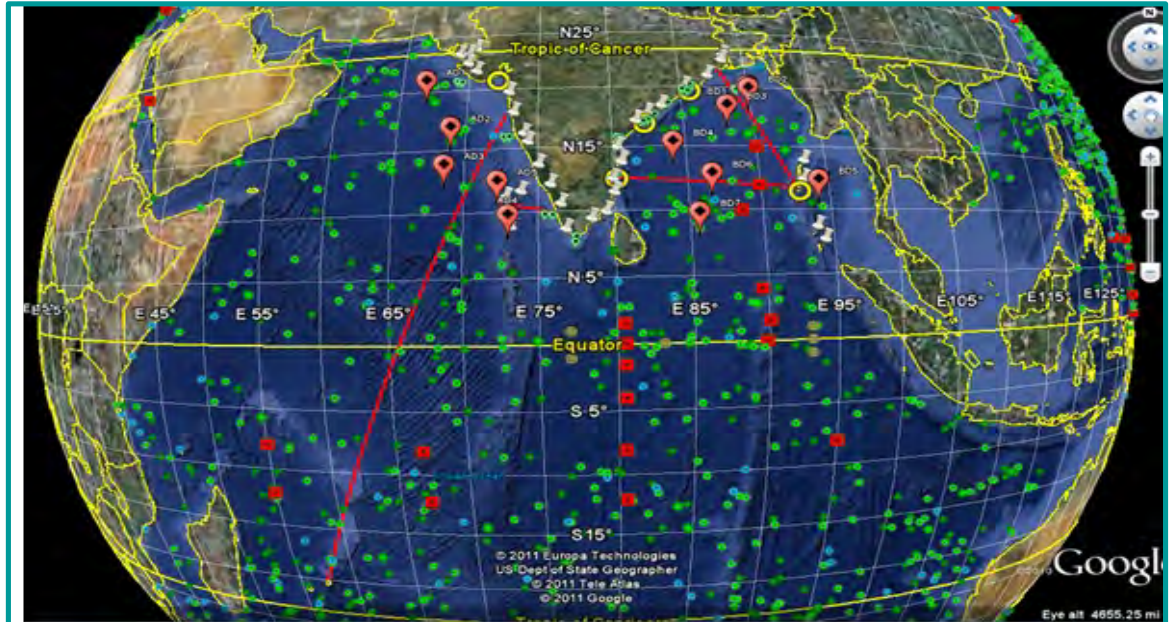
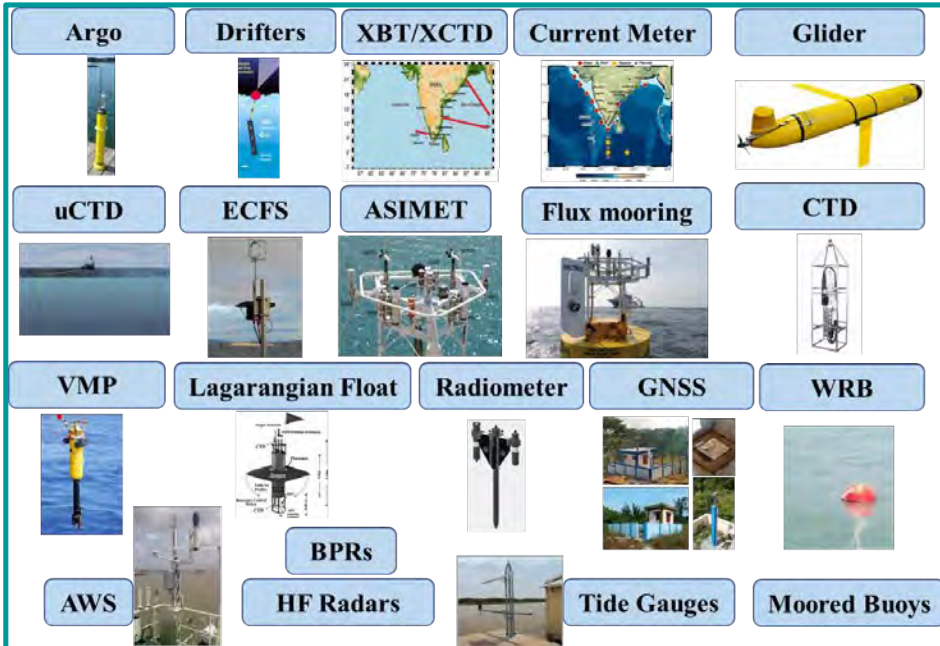


Ocean Value Chain - Observations to Services

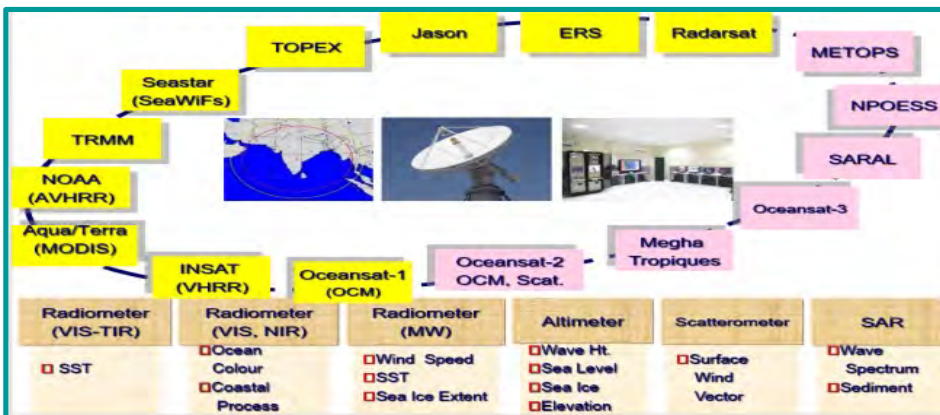
INCOIS Mission: To provide the Ocean Information and Advisory Services to Society, Industry, Government Agencies and Scientific Community through Sustained Ocean Observations and Constant improvements through Systematic and Focussed Research



Ocean Observation Network



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



Global Design (GOOS) -> Regional Implementation (IndOOS) -> National Contributions (INCOIS & NIOT OOS, IMD Weather Watch)
Themes: Climate, Operational Ocean Services, and Ocean Health
Essential Ocean Variables: Physics, BGC, Biology & Ecosystems, Atmosphere

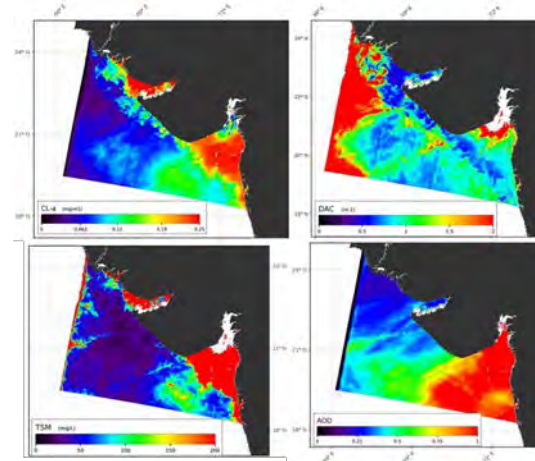


Ocean Observation Network – Oceansat - 3 OCM



OCM-3 Bands and Applications

Band. No's	Central wave length (λ nm)	Bandwidth (nm)	Primary application
B1	412	10	Differentiate Yellow substance from Chlorophyll
B2	443	10	Low chlorophyll
B3	490	10	Moderate Chlorophyll
B4	510	10	High Chlorophyll; Total suspended Mater
B5	555	10	Reference baseline for Chlorophyll
B6	566	10	phyco cyanin absorption; Tricodesmium bloom detection
B7	620	10	Turbidity in coastal case-2 waters; phycoerythrin absorption
B8	670	10	Baseline for fluorescence line height (FLH); Chlorophyll secondary absorption
B9	681	7.5	Chlorophyll fluorescence
B10	710	10	Baseline for FLH, Vegetation, Chlorophyll fluorescence; Atmospheric correction
B11	780	10	Atmospheric correction; Avoid O2 absorption
B12	870	20	Atmospheric correction; Good assessment of scattering
B13	1010	20	Atmospheric correction at turbid coastal case-2 waters



- Chlorophyll-a (mg/m³)
- Total Suspended sediment (mg/L)
- Diffuse attenuation coefficient (m⁻¹)
- Aerosol optical Depth (AOD)

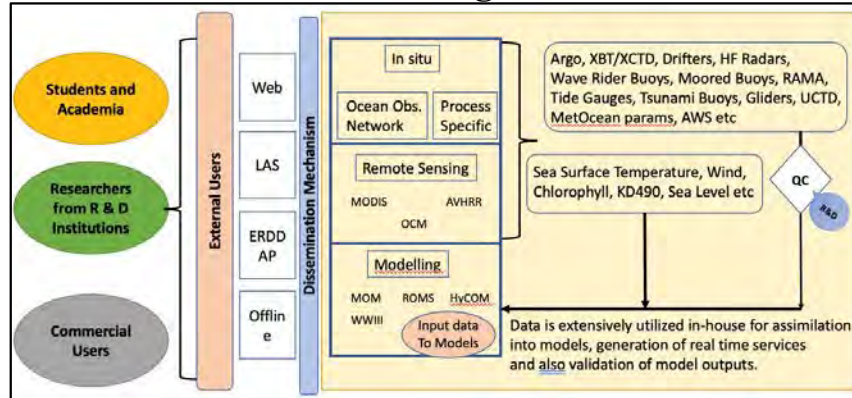
OCM-3 is configured to meet the following goals

- Spatial resolution \approx 360 m
- Swath \approx 1500 Km
- Better radiometric performance; Target SNR:
 - > 1000 for Band # 1 – 10 @ 360 m
 - > 800 for Band # 11 – 13 @ 1.1 Km
- *Marching orbit to obtain glint-free data*

Accreditation



Data Management



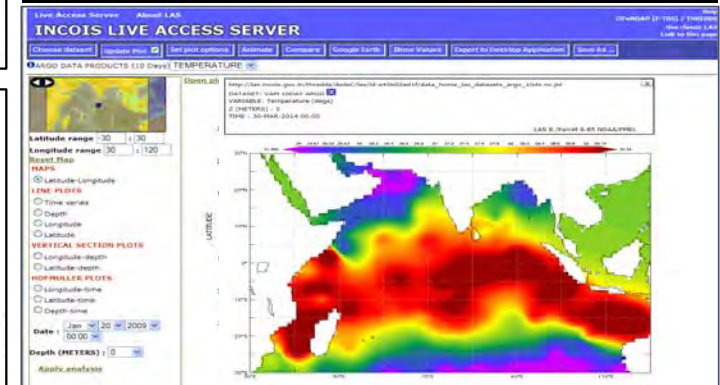
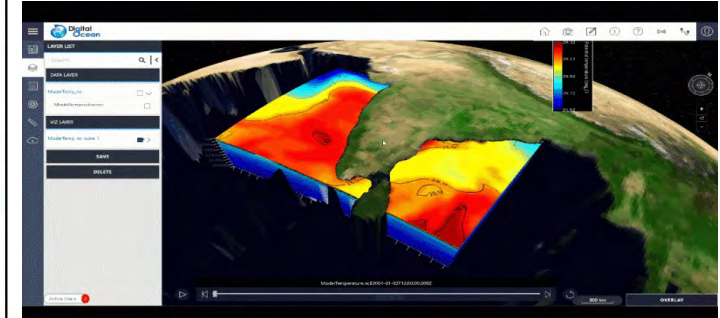
Acquiring AVHRR (Metop-1, Metop-2, NOAA-18 & NOAA-19), VIIRS (Suomi-NPP), MODIS (AQUA & TERRA) & OCM (Oceansat-2).



Data Sharing through

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

Data Dissemination



Ocean Modelling & Prediction Systems



INCOIS Ocean Modeling and Data Assimilation Activities

Ocean Modeling Mission

Deep Ocean Mission

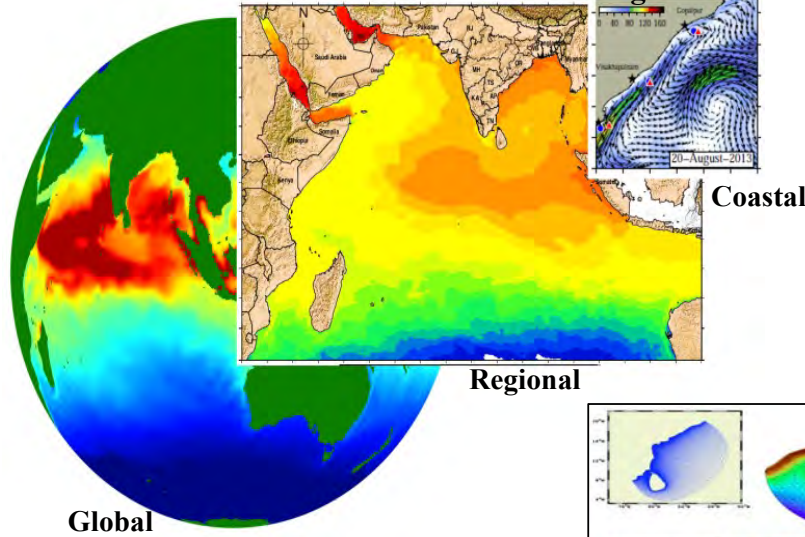
Monsoon Mission

Coastal Water Quality Monitoring and Forecast Program

Ocean Predict (GODAE Ocean View)



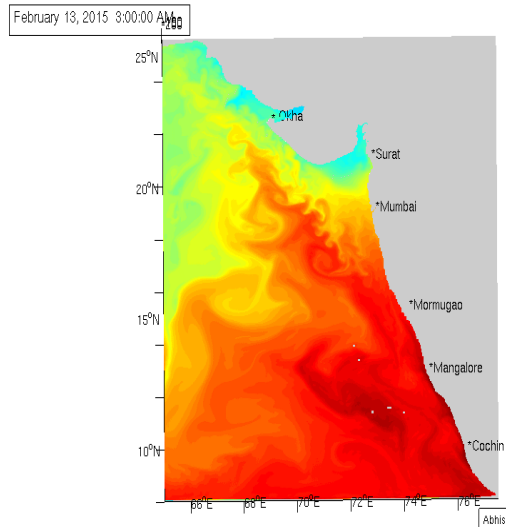
Ocean Circulation Modelling



Global

Regional

Coastal



Wave, Tsunami and Storm Surge Modeling

Model simulated variability of Temperature

Ocean Analysis (GODAS)

Monsoon Forecast (CFS model)

Tropical Cyclone Heat Potential

Cyclone Prediction

Climate Indices

Data Assimilation (LETKF, 3DVAR, OI)

Circulation Models (ROMS, MOM, HYCOM)

Regional Analysis

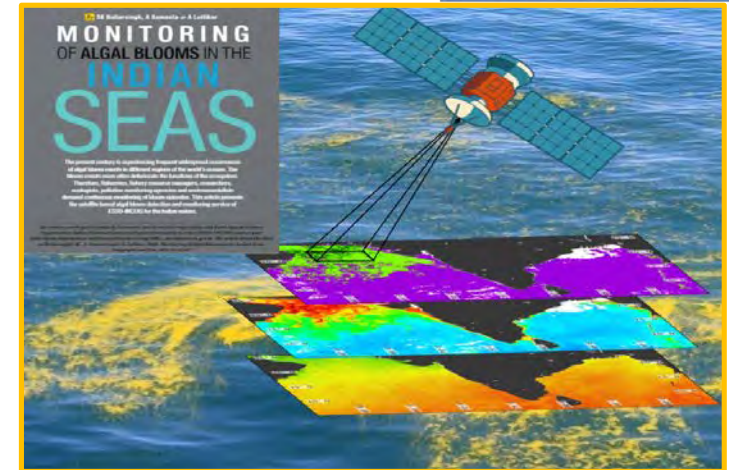
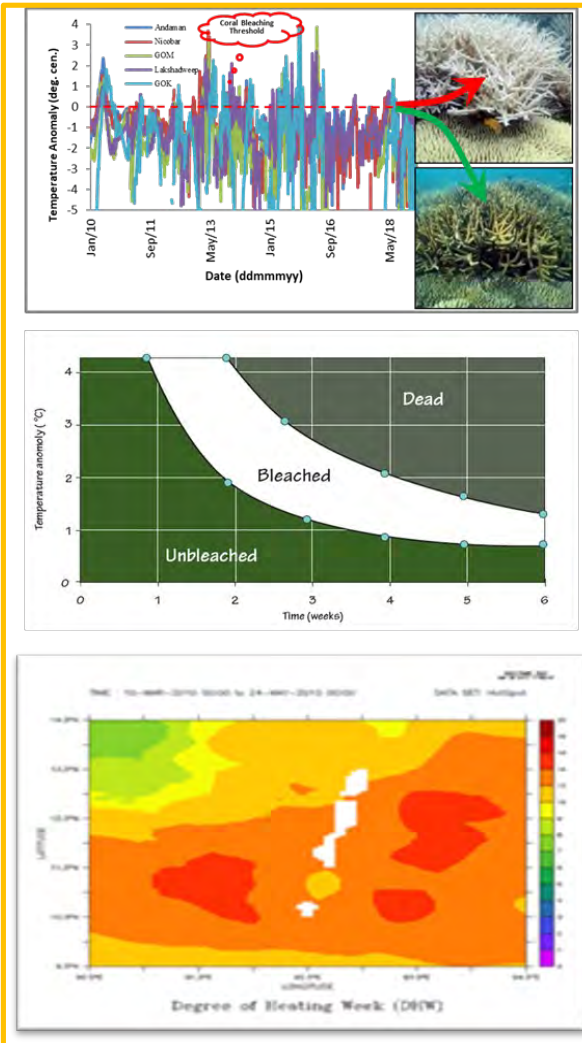
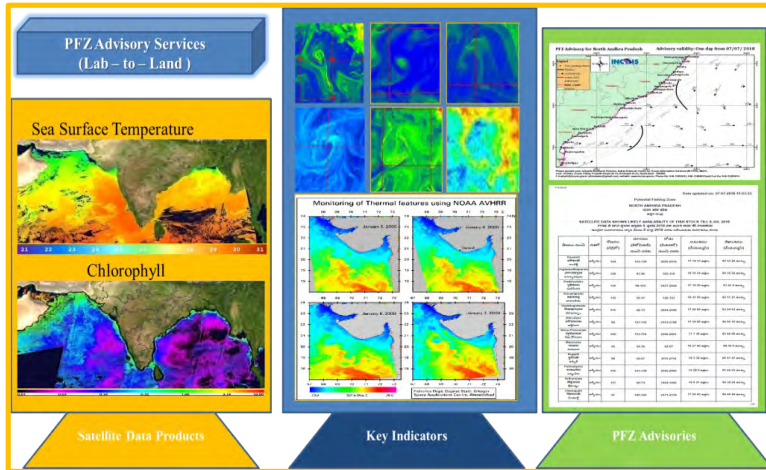
Regional and Coastal Forecasts

Value Added Services (OOSA, SARAT)

Wave, Tsunami, Cyclone, Storm Surge (Wavewatch III, ADCIRC, SWAN, HWRF+HYCOM)

Forecast and Advisory services

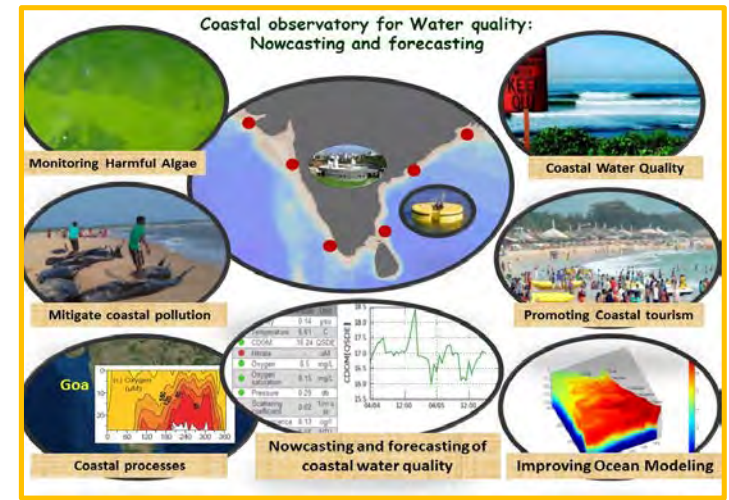
Ecosystem Services – PFZ, HAB, MHW, CBAS, WQ



Algal Blooms Information Services



Marine Fishery Advisory Services



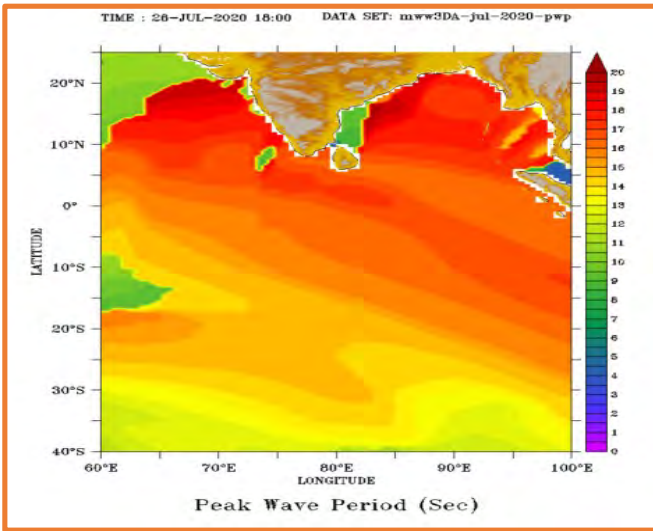
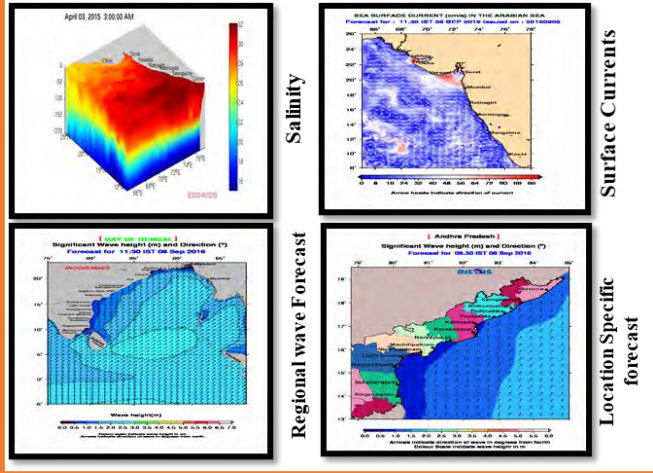
Water Quality Services

Coral Bleaching Alerts

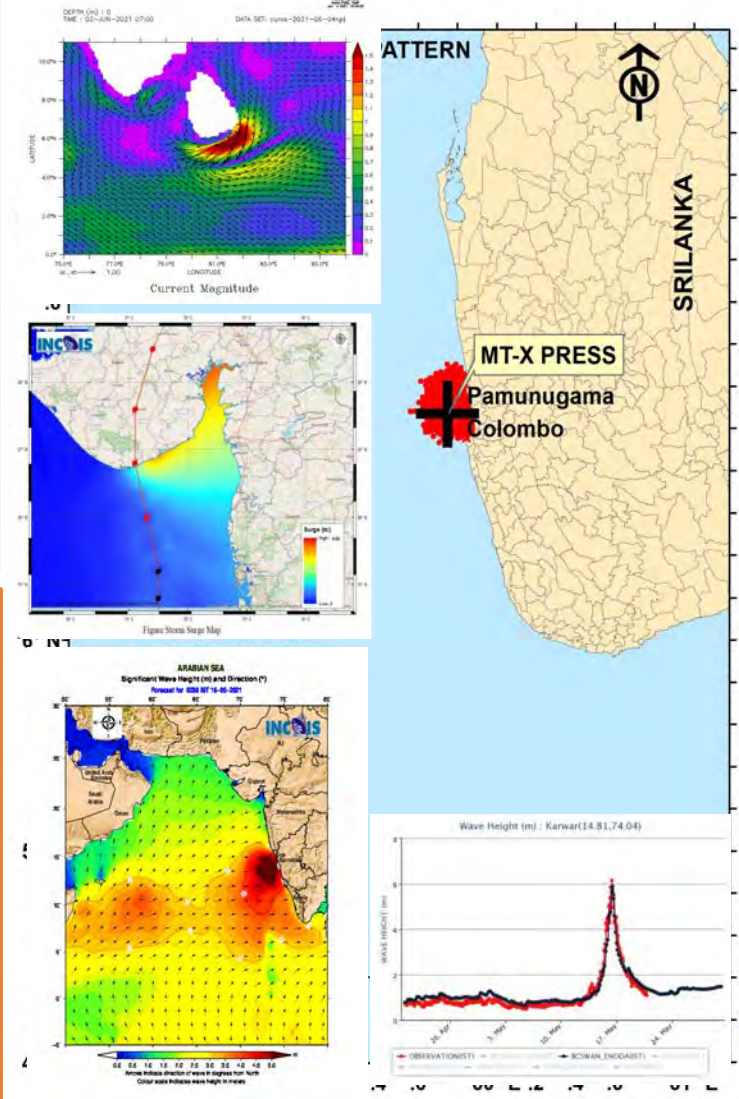
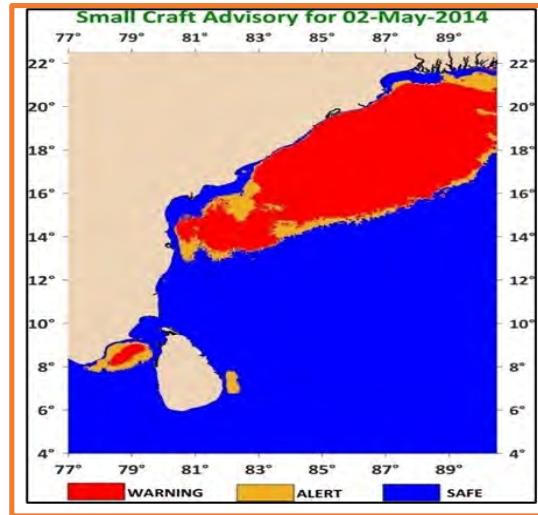
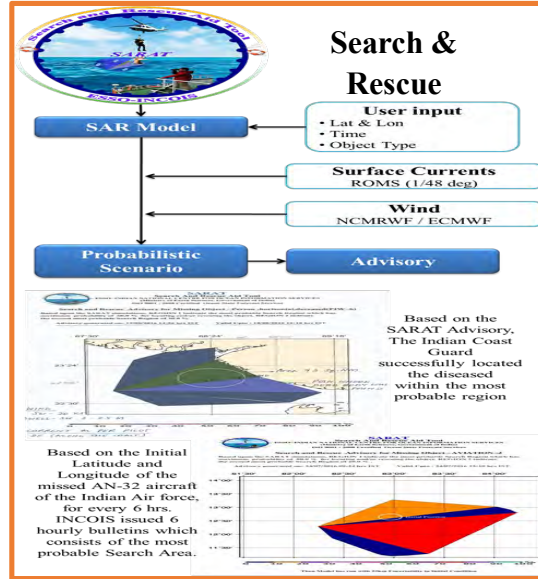
Marine Safety Services – OSF, SS, HWA, SAR, SVAS, Oil Spill



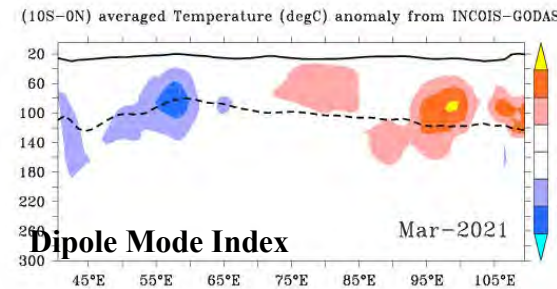
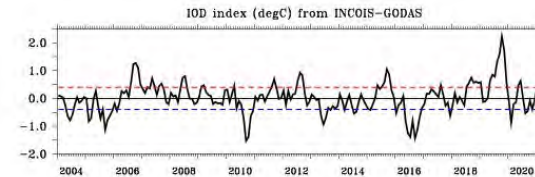
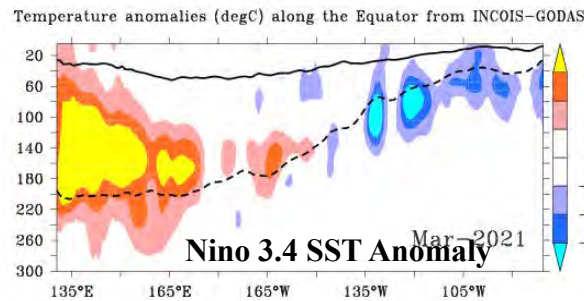
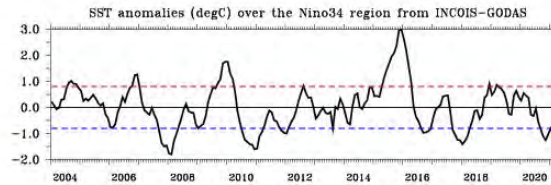
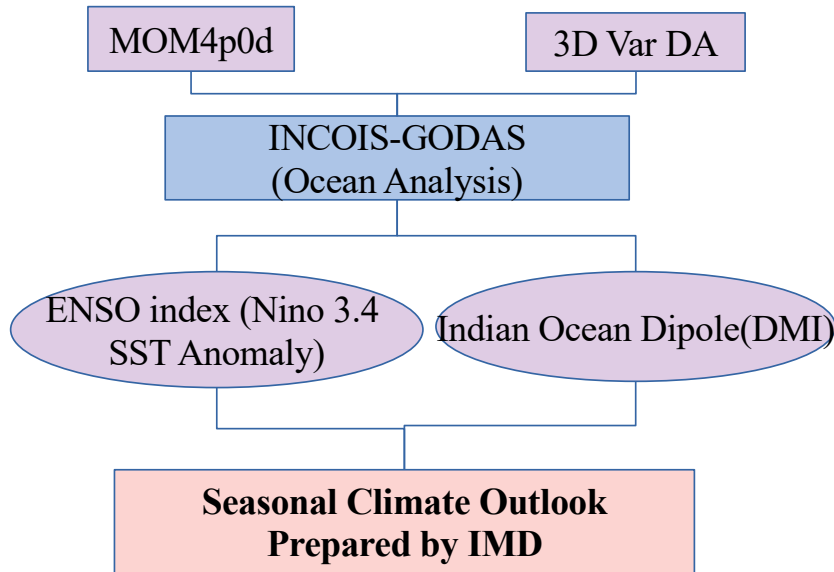
Ocean State Forecasts
45 User specified daily forecast products for India
and 06 Neighbouring Countries



Swell Surge Forecast



Ocean Climate Services



Indian Ocean Dipole Index based on INCOIS-GODAS SST analysis and Monthly climatology of OISST (Reynolds sst; constructed using 1981-2010 data).

DD-MMM-YYYY / SNO:	WESTERN BOX		EASTERN BOX		DMI
	10S-10N 50E-70E	SSTA	10S-Eq 90E-110E	SSTA	
14-SEP-2020 / 1:	0.0604	27.70	0.5108	28.59	-0.4504
15-OCT-2020 / 2:	0.4862	28.58	0.5632	28.76	-0.0769
14-NOV-2020 / 3:	0.1866	28.55	0.5837	29.08	-0.3971
15-DEC-2020 / 4:	0.0968	28.37	0.1434	28.83	-0.0465
14-JAN-2021 / 5:	-0.3390	27.69	-0.6831	28.11	0.3441
13-FEB-2021 / 6:	-0.1117	28.23	-0.3688	28.50	0.2571
16-MAR-2021 / 7:	0.0746	29.08	-0.1602	29.03	0.2349
15-APR-2021 / 8:	0.2222	29.96	-0.1112	29.37	0.3333
16-MAY-2021 / 9:	-0.1431	29.34	0.2384	29.74	-0.3815
15-JUN-2021 / 10:	-0.0367	28.26	0.3424	29.58	-0.3791

Ocean Climate Change Advisory Services of Deep Ocean Mission

- Regional Climate Change Assessment for Northern Indian Ocean
- Future Projections of important climate variables and their Impact on coastal regions of India
 - Sea level
 - Cyclones, Storm Surges, Waves
 - Marine Ecosystem



Sea Level Rise



Cyclone Intensity & Frequency



Observation

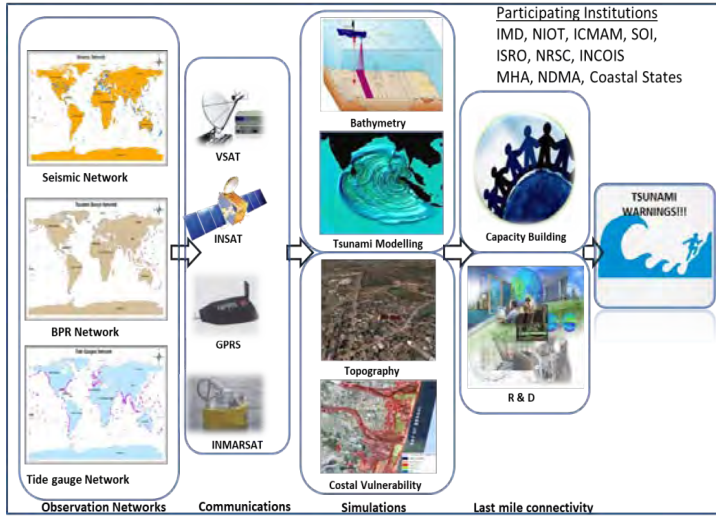


Storm Surges & Waves

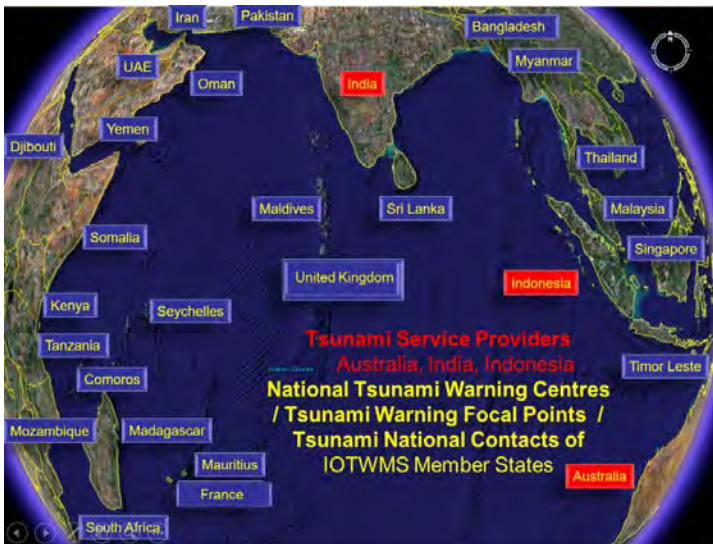
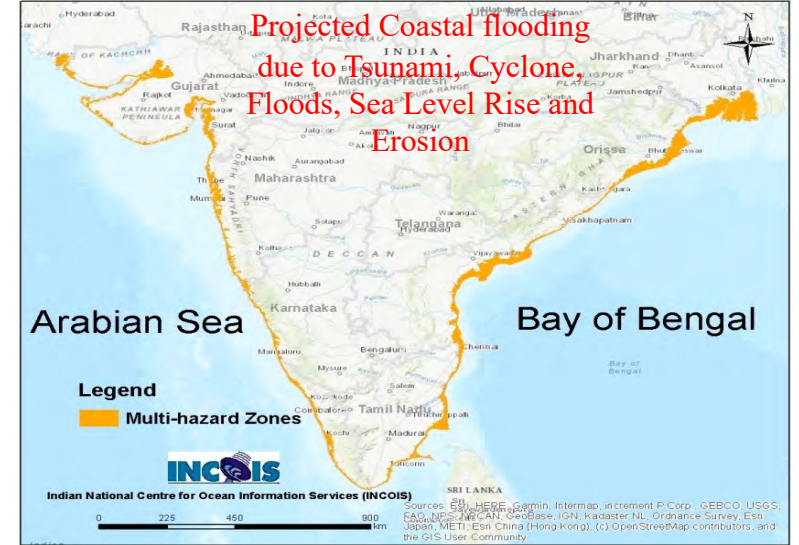


BGC & Ecology

Coastal Multi-Hazard Early Warning Services



Indian Tsunami Early Warning Centre



Tsunami Early Warning Services



Coastal Inundation – 3D Mapping

Ocean Colour Remote Sensing - Applications

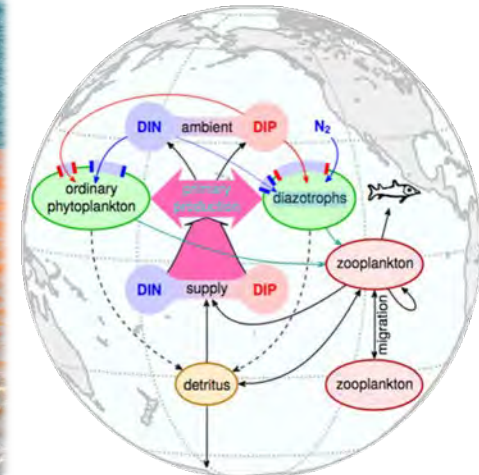
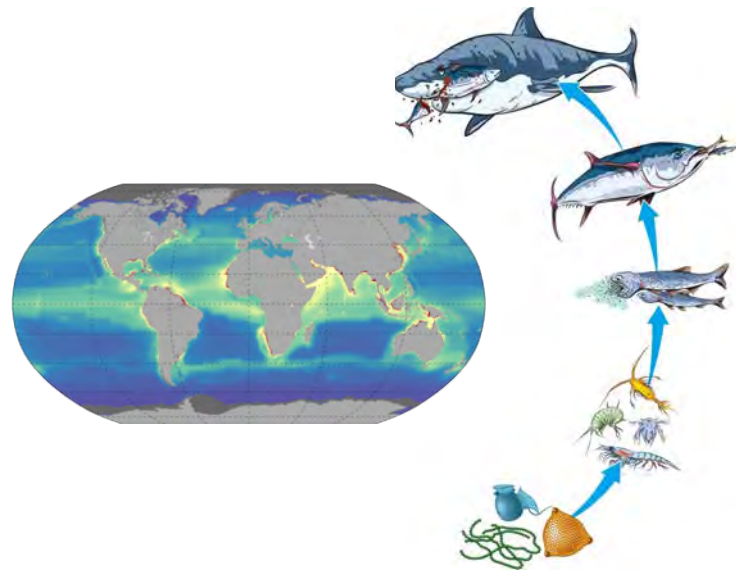
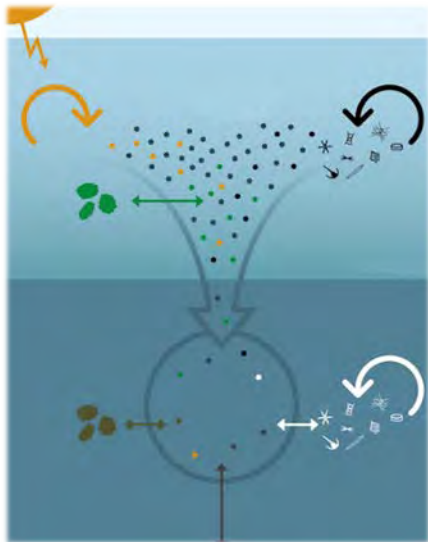
Organic Carbon Fluxes & Carbon Cycle

Primary Production & Food Web

Marine Fisheries Advisory Service

Algal Bloom, Eutrophication & Pollution Monitoring

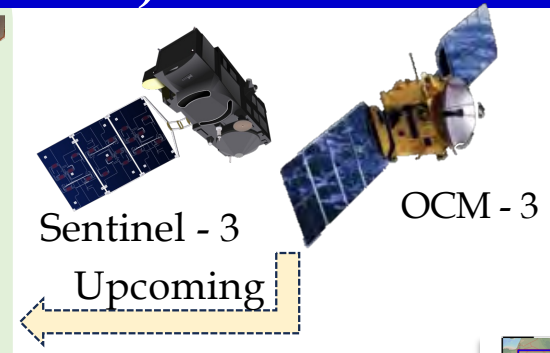
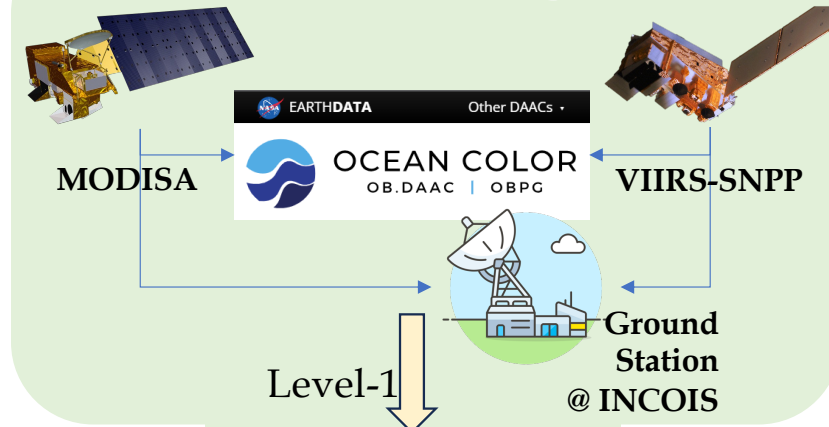
Ecosystem Modeling & Water Quality Studies



Ocean Colour Automatic Data Processing Chain (ADPC)



- ✓ INCOIS Services
- ✓ User Curated Data
- ✓ R&D Use



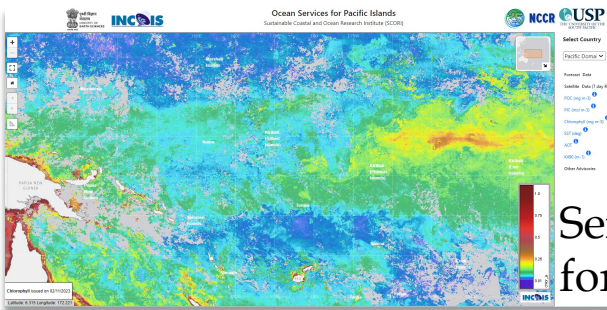
Level-1



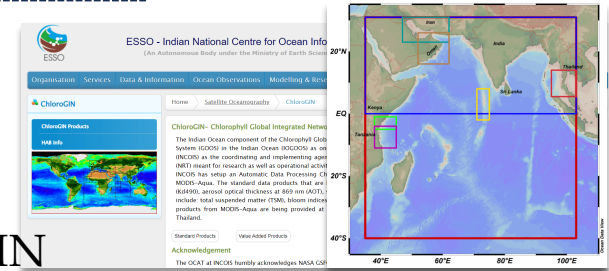
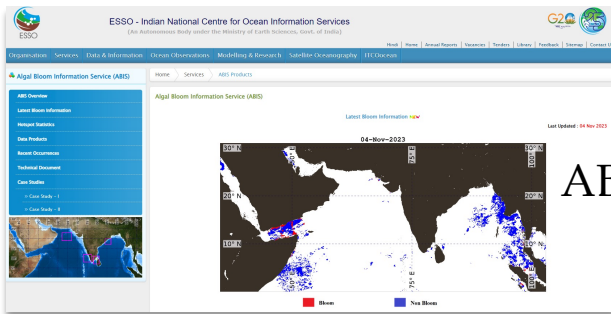
Output

Level-3/4

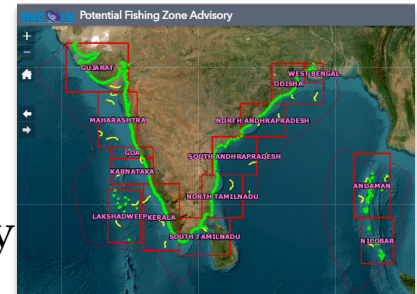
- ✓ Standard
- ✓ Value Added
- ✓ Anomaly
- ✓ Roll



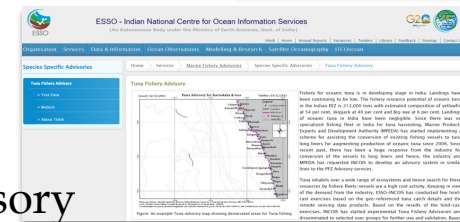
Services for PIs



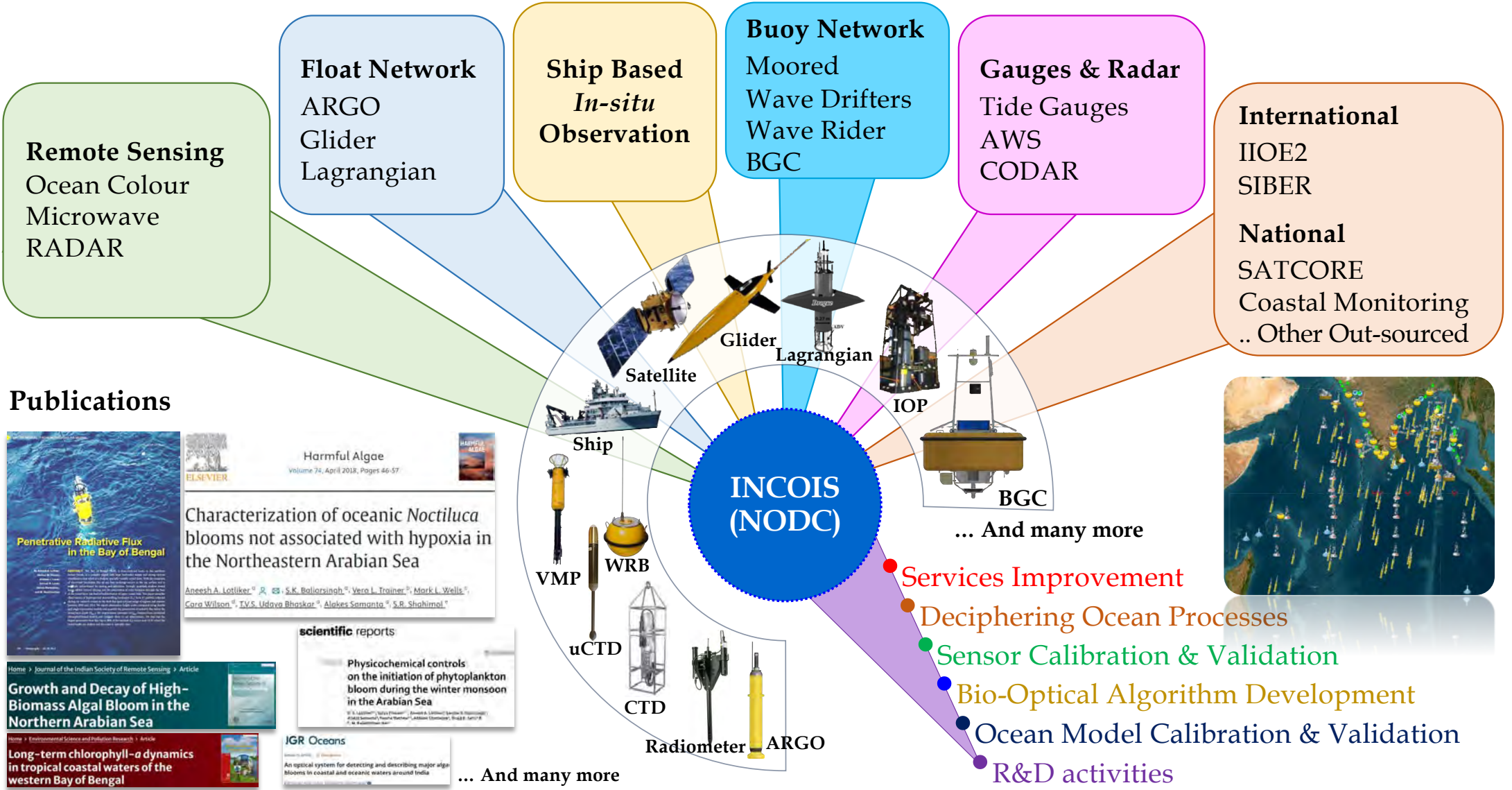
ChloroGIN



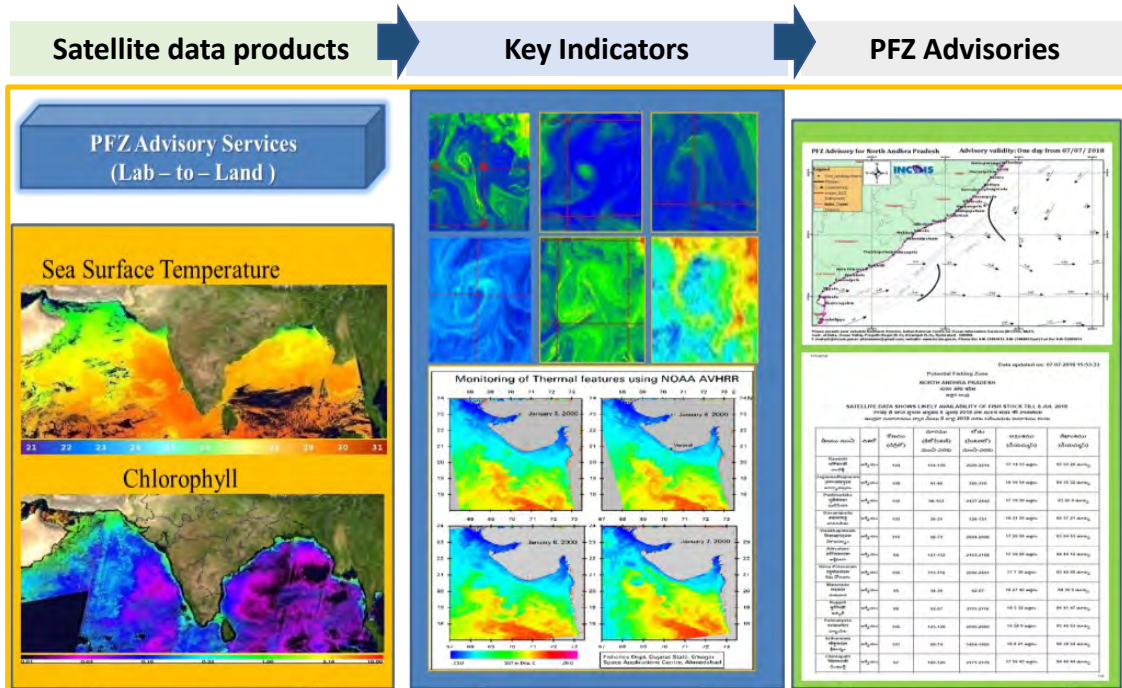
PFZ Advisory



Tuna Advisory



Potential Fishing Zone(PFZ) Advisories

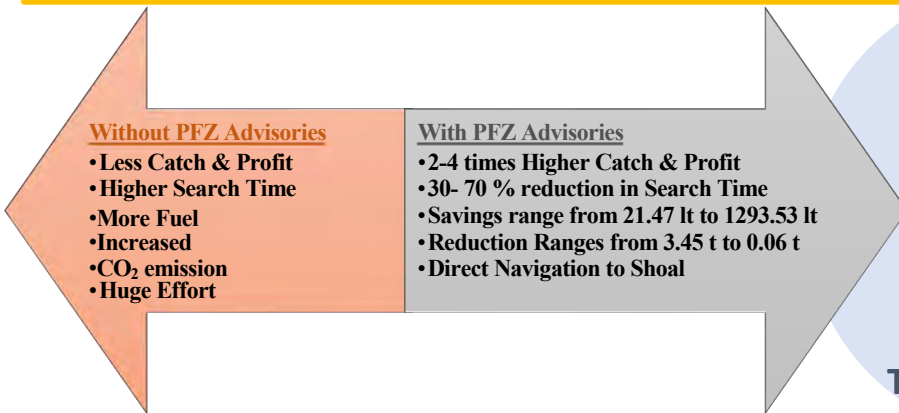


Dissemination



SAMUDRA Mobile App

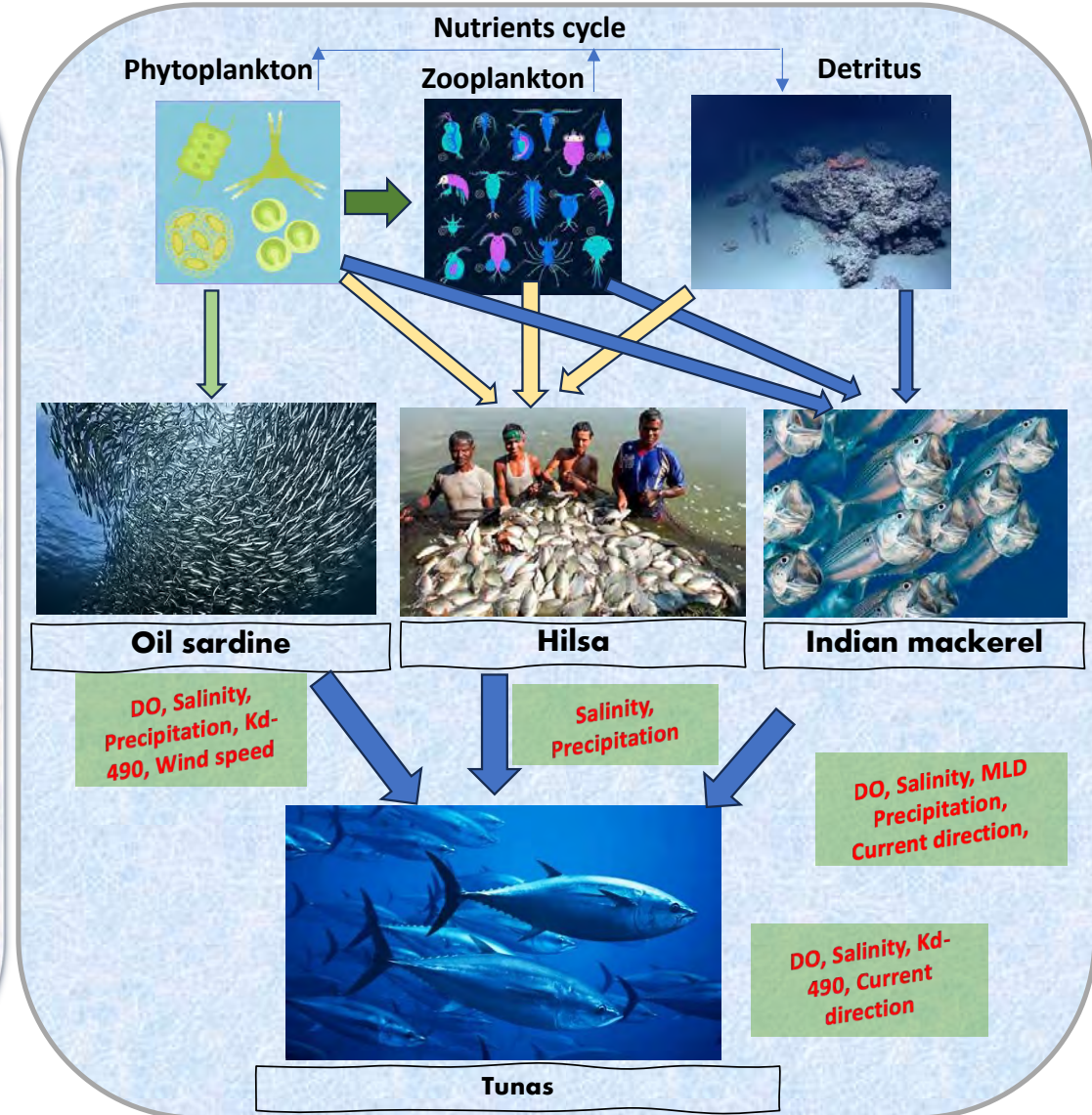
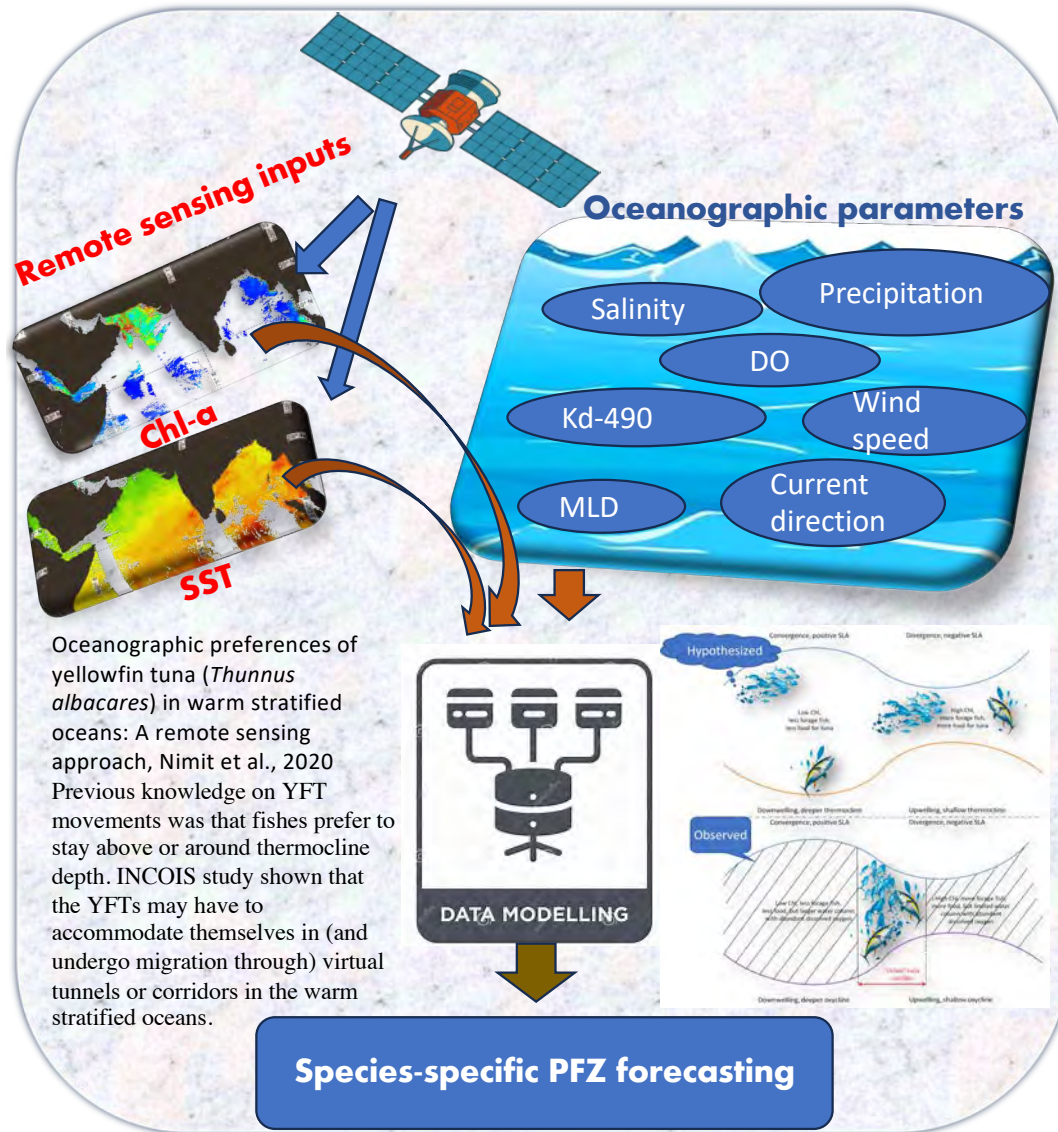
GAGAN based GEMINI: Satellite based Solution



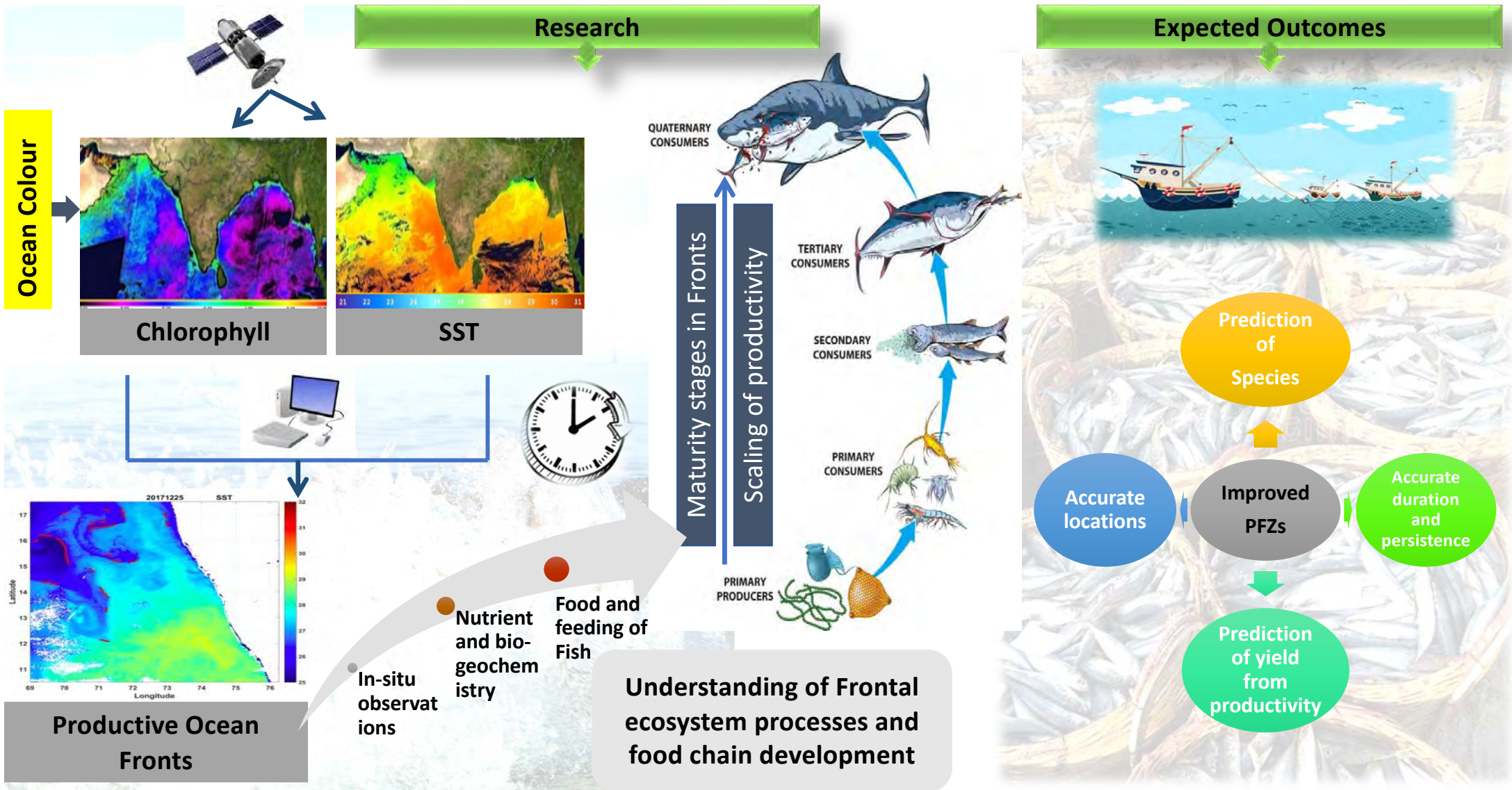
The Blue Economy



Research Towards Species-specific Fishery Advisory Services



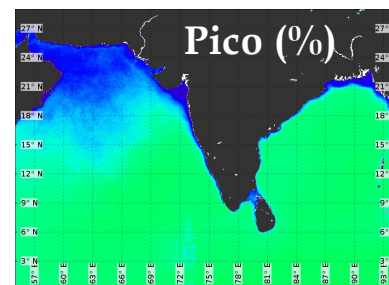
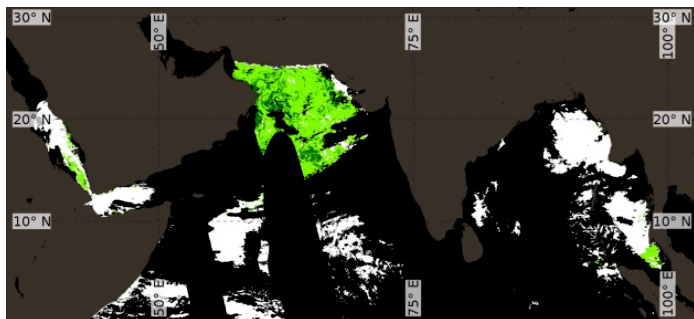
Front to Fish: Linking Frontal Succession to Fisheries Potential



Phytoplankton Species/Groups & Phytoplankton Size Class



Green Noctiluca Red Noctiluca Diatoms

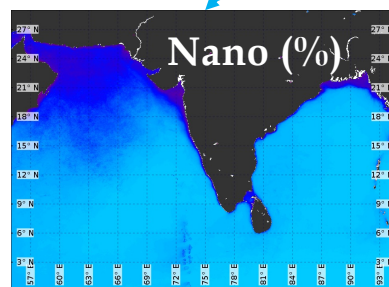
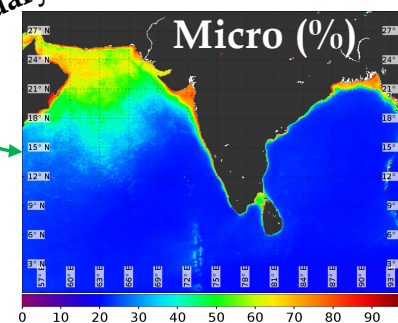


Plankton Type	Size Chart
Micro	>20 μm
Nano	2-20 μm
Pico	0.2-2 μm

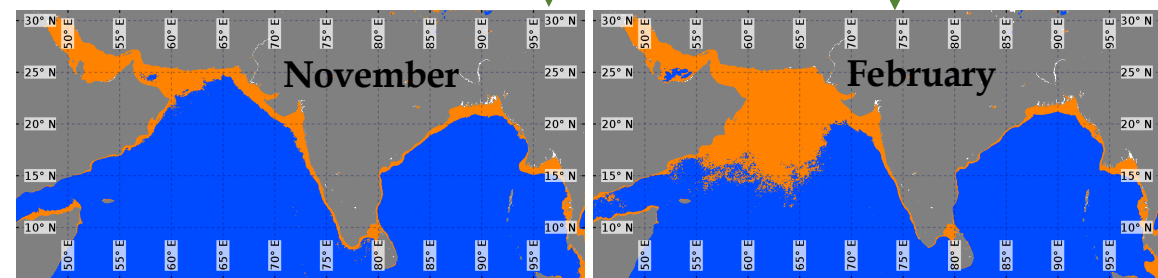
Sahay et al, 2017

Phyto Size Class

February



Seasonal Variability



Microplankton Dominant Water

Natl. Acad. Sci. Lett.
<https://doi.org/10.1007/s40009-023-01205-2>
 SHORT COMMUNICATION
Satellite-Based Detection of Noctiluca Bloom in the Coastal Waters of the South-eastern Arabian Sea: A Case Study Implicating Monitoring Needs
 Alakes Samanta¹ · Sanjiba K. Baliarsingh¹ · Aneesh A. Lotliker¹ · Sudheer Joseph¹ · T. M. Balakrishnan¹

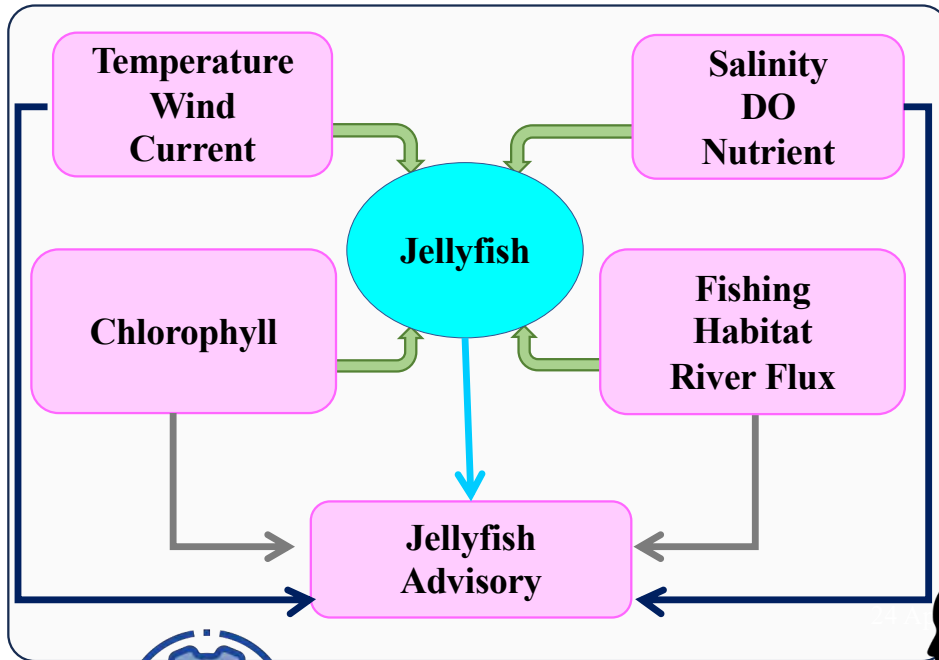
Home > Environmental Monitoring and Assessment > Article
An optical remote sensing approach for ecological monitoring of red and green *Noctiluca scintillans*

Oceanologia
 Volume 63, Issue 1, January–March 2021, Pages 40–50
 Original Research Article
Satellite estimates of the long-term trend in phytoplankton size classes in the coastal waters of north-western Bay of Bengal
 Joereen Miranda^a · Aneesh Anand Rao Lotliker^b · Sanjiba Kumar Baliarsingh^b · Amit Kumar Jena^a · Alakes Samanta^b · Kali Charan Sahu^a · Tummala Srinivasa Kumar^b

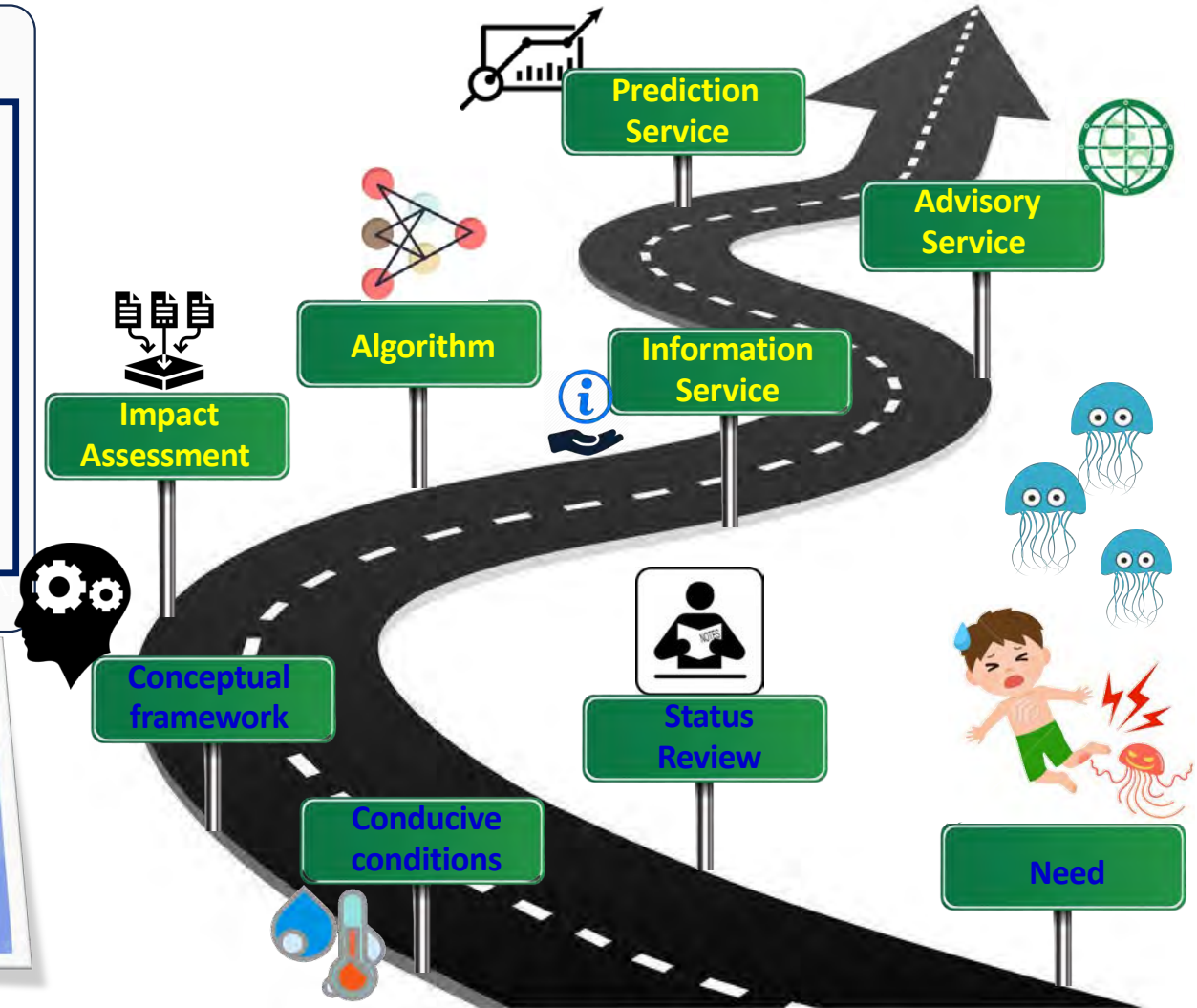
Journal of the Indian Society of Remote Sensing (November 2022) 50(11):2221–2228
<https://doi.org/10.1007/s12524-022-01597-6>
 RESEARCH ARTICLE
Satellite-Based Characterization of Phytoplankton Blooms in Coastal Waters of the Northwestern Bay of Bengal
 Suchismita Srichandan^a · Sanjiba K. Baliarsingh^b · Alakes Samanta^a · Amit K. Jena^{a,b} · Aneesh Anand Rao Lotliker^a · T. M. Balakrishnan Nair^a · Kamal K. Barik^a · Tamoghna Acharyya^a

Journal of the Indian Society of Remote Sensing (October 2020) 48(10):1413–1419
<https://doi.org/10.1007/s12524-020-01165-w>
 RESEARCH ARTICLE
Satellite Retrieved Spatio-temporal Variability of Phytoplankton Size Classes in the Arabian Sea
 Kamal Kumar Barik¹ · Sanjiba Kumar Baliarsingh² · Amit Kumar Jena¹ · Suchismita Srichandan² · Alakes Samanta² · Aneesh Anand Rao Lotliker²

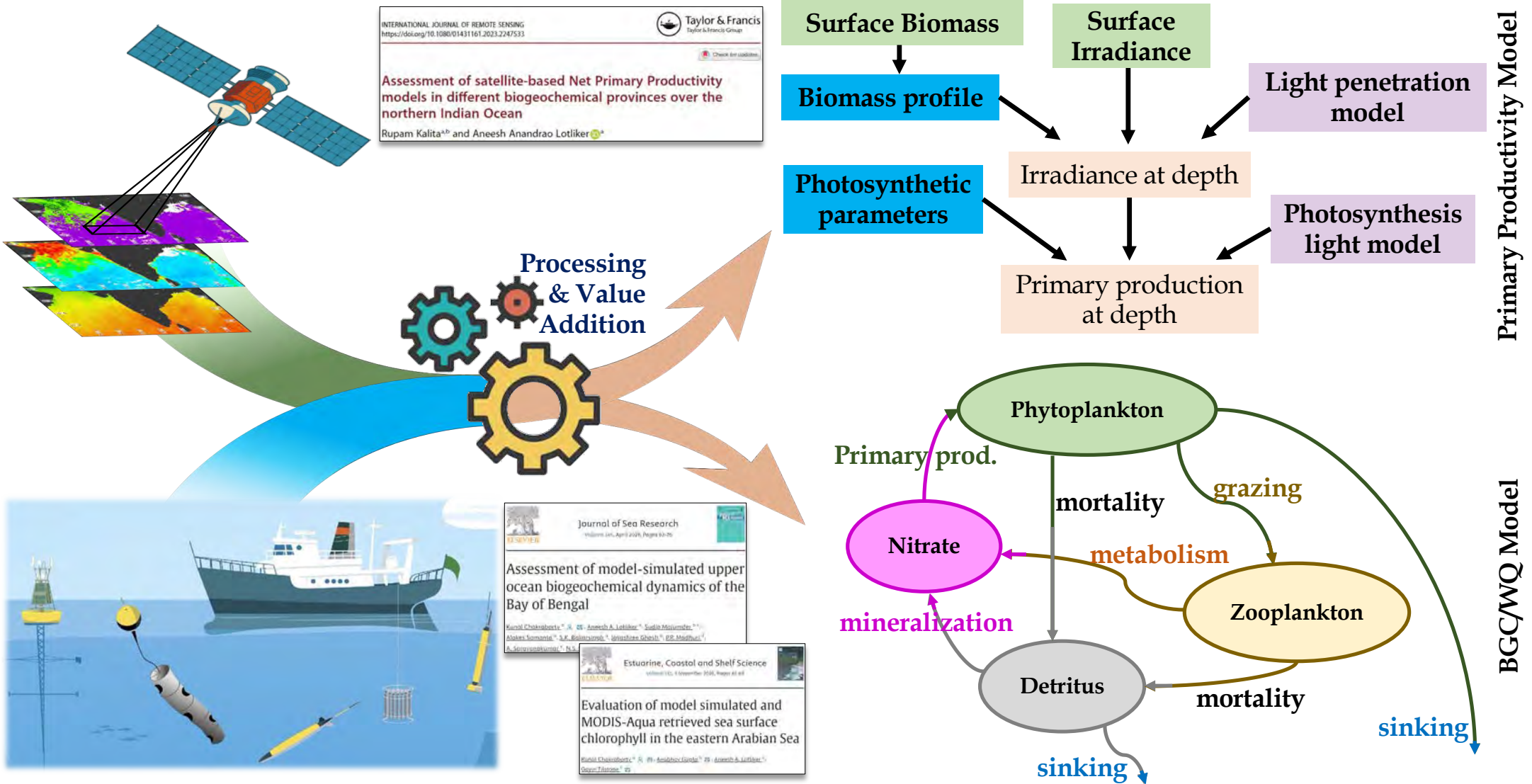
Research Towards Jellyfish Aggregation Advisory Service



Ocean Colour Model, *In situ* WQNS



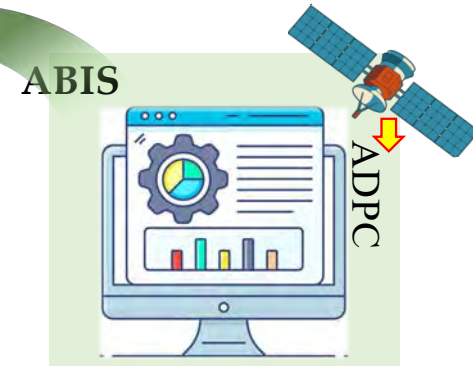
Primary Productivity & Ecosystem Modelling



Water Quality Nowcasting System (WQNS)



Data Acquisition, Processing & Quality Control



Home Services Water Quality Nowcast System Feedback

Water Quality Nowcast System

The human impacts on the coastal ocean in terms of pollution and waste disposals have greatly modified the water quality and the fluxes of material to the coastal waters. Natural processes of monsoonal winds, river water fluxes, and ocean circulation often make anthropogenic perturbations more complex to study. "Coastal Monitoring" program of INCOIS envisages monitoring time-series of various biogeochemical parameters to assess the biogeochemical variability in the Indian coastal waters and understand the ecosystem trophic status. Under this program, INCOIS has established two time-series stations in the Indian coastal waters [read more...](#)

Water Quality Status
Normal Oxidic condition for Kochi (Updated on 2023-11-05 19:30:00.0)

Real-Time Feed

Derived Parameters

Satellite Retrieved Parameters

Sensors:

- ✓ Physical
- ✓ Biogeochemical
- ✓ Optical

Visakhapatnam Kochi

Water Quality Nowcast for Visakhapatnam

Live Image from Buoy

Water Temperature

Salinity

Current

pH

Nitrate

Nitrite

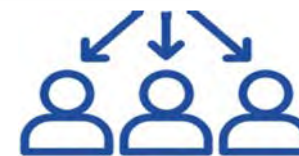
Ammonium

Silicate

Phosphate

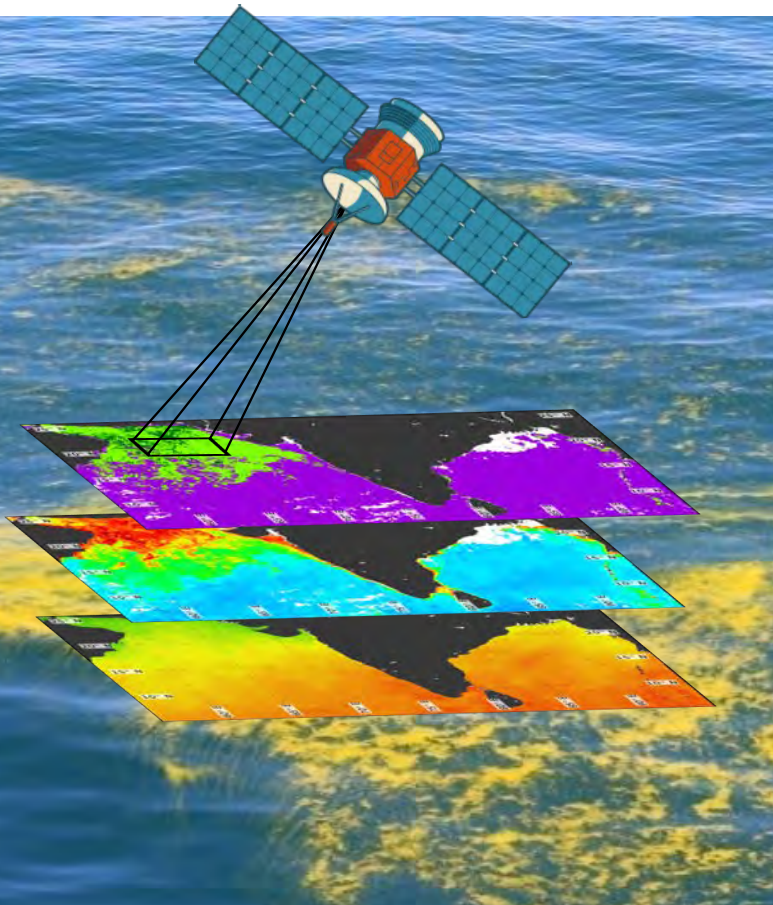
pCO₂

pCO₃



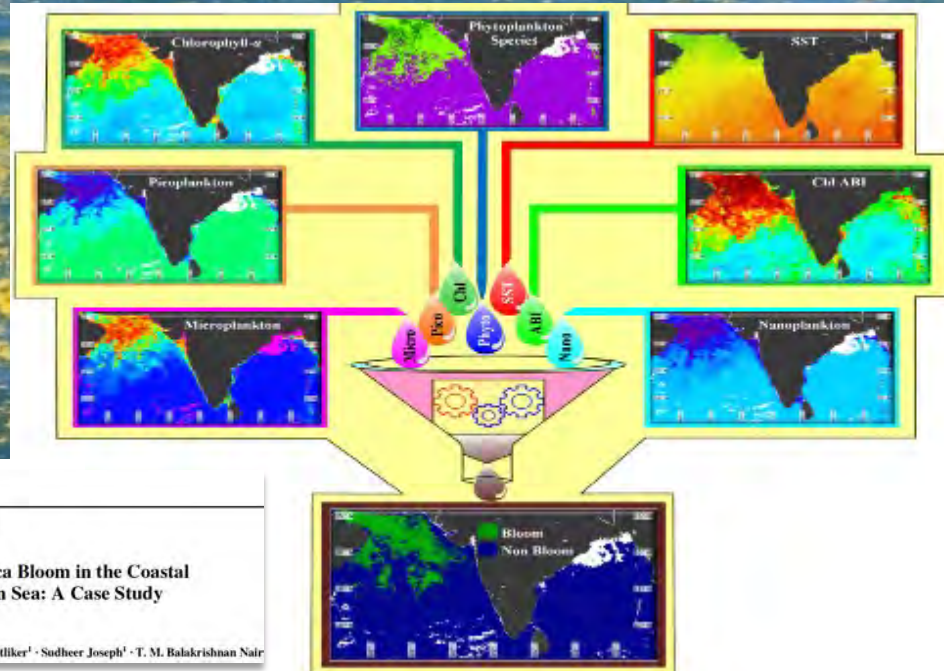
Fishery Resource Managers, Tourists, Tourism Industries, Ecologists, Fishermen, Researchers, & Environmentalists

Algal Bloom Information Service (ABIS)



- INCOIS Algal Bloom Information Service in the four hot-spots in Indian Ocean
 - Northern Arabian Sea
 - Kochi
 - Gulf of Mannar
 - Gopalpur

Satellite parameters as indicators



Status	Condition	Colour Code
Normal	Bloom pixels < 50%	Green
Watch	Bloom pixels ≥ 50% and < 75%	Yellow
Warning	Bloom pixels ≥ 75%	Red

Natl. Acad. Sci. Lett.
<https://doi.org/10.1007/s40009-023-01205-2>

SHORT COMMUNICATION

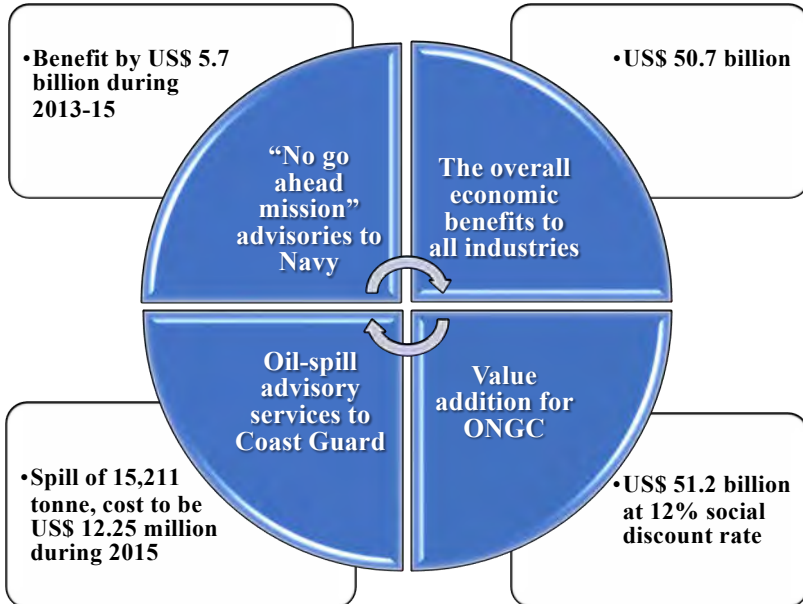
Satellite-Based Detection of Noctiluca Bloom in the Coastal Waters of the South-eastern Arabian Sea: A Case Study Implicating Monitoring Needs

Alakes Samanta¹ · Sanjiba K. Ballar Singh¹ · Anesh A. Lotlikar¹ · Sudheer Joseph¹ · T. M. Balakrishnan Nair

Economic & Environmental Benefits of Ocean Services



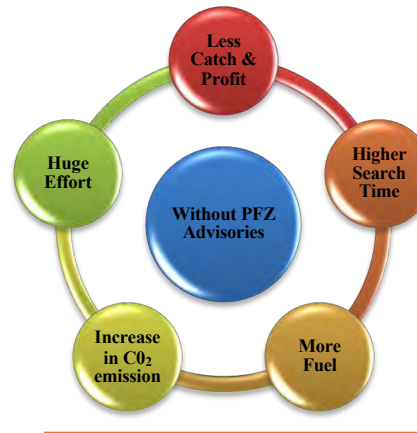
OSF



TEWS

The economic benefits of the Tsunami Early Warning Centre can be simply accessed by the list of under-sea earthquakes in the Indian Ocean Region for which a 'No Tsunami Threat' advisory issued by ITEWC, INCOIS avoids relocation and rehabilitation expenditure. Considering the expenditure incurred by Odisha government for evacuation and relocation of coastal population during Phailin, an expenditure of US\$ 4.75 billion would be required in the absence of "No Tsunami Threat" advisory."

PFZ

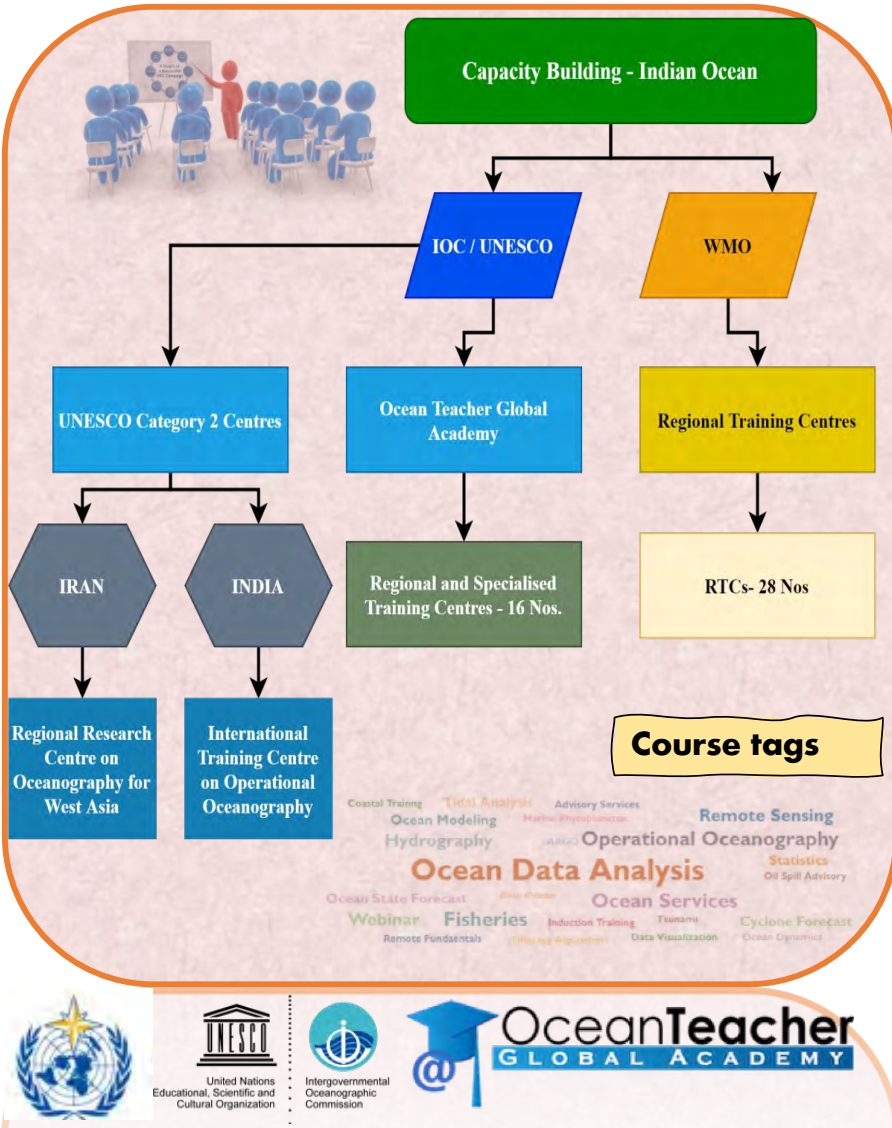


Clear Demarcation of the Benefits

National Agricultural Innovation Project (NAIP)	<ul style="list-style-type: none"> •32 fishing boats in Raigad Dt., Maharashtra could save the diesel of 18492 gallons of diesel in a month •CO₂ cutting down by 330,000 lbs
Validation Experiments	<ul style="list-style-type: none"> •Saving of diesel varied from 5.67 g to 341.7 g •Reduction of CO₂ emission from 3.45 t to 0.06t
National Council for Applied Economic Research	<ul style="list-style-type: none"> •Savings in diesel consumption computed an annuity of US\$49.49 billion or •Present value of around US\$ 38.94 billions over the 25-year useful life
Central Marine Fisheries Research Institute (CMFRI)	<ul style="list-style-type: none"> •At 15% adoption level, fishermen can save up to 237,754.8 of gallons of Diesel •Lesser Green House Gas (GHG) emission of approximately 2412 tonne

Annual Economic Benefit US\$ 46.57 to 68.49 billion	Additional profit in hands of fishers US\$ 4.1 billion annuity with investment of US\$ 4.38 million	Reaching entire fishermen community Marine fisheries GDP increase from 3.9% - 7.8 % per annum
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Capacity Building: Ocean Colour & Applications

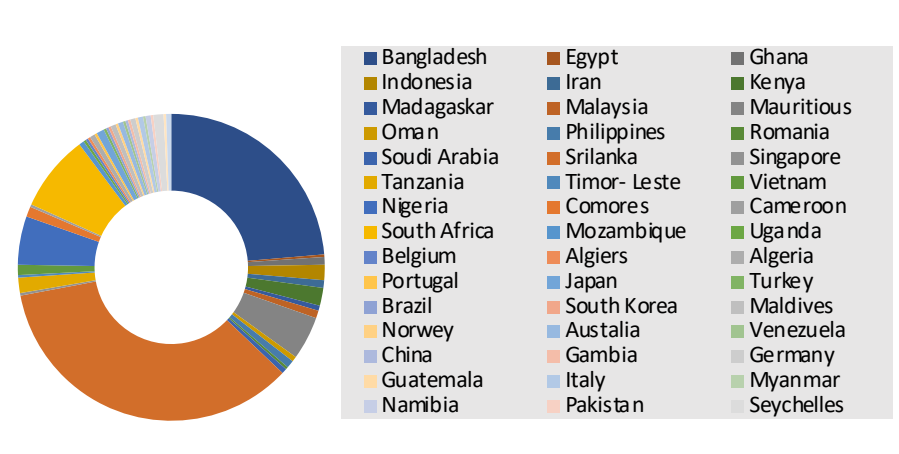


13 Courses

1082 people trained from 48 Countries



Foreign Participation in ITCOOcean Courses



Capacity Building: Ocean Colour & Applications



Forthcoming Training Opportunities:

- POGO – ITCOcean Training on “Ocean Observations for Coastal Applications” during January 29 – February 07, 2024
- IOCCG Summer Lecture Series on “Frontiers in Ocean Optics and Ocean Colour Science” during November 4 – 16, 2024
- ITEC – ITCOcean Training Program on “Fishery Oceanography for the Ocean Decade (F.O.O.D.) – 2024” during January 18 – February 07, 2024



POGO – ITCOcean Training Program on
"Ocean Observations for Coastal Applications"
29 January – 07 February 2024

Organized by
International Training Centre for Operational Oceanography (ITCOcean) ESSO-INCOIS, Hyderabad, India
in collaboration with
CEMACS (Malaysia), SUST (Bangladesh), SQU (Oman) and Andhra Uni., Visakhapatnam



Frontiers in Ocean Optics and Ocean Colour Science: 4-16 November 2024

Overview

The 6th edition of the advanced IOCCG Summer Lecture Series is scheduled for **4-16 November 2024** in Hyderabad, India. The course will be held at the **International Training Centre for Operational Oceanography (ITCOcean)** at the Indian National Centre for Ocean Information Services (INCOIS).

As in **previous years**, this high-level training course will be dedicated to the fundamentals of ocean optics, bio-optics and ocean colour remote sensing. Several distinguished research scientists will provide lectures on cutting edge research, with focus on current critical issues in ocean colour science. Students will have ample opportunity to meet with lecturers for in-depth discussions on various pre-selected topics, as well as on their own scientific research.

Note that the Lecture Series is an advanced training course targeted at students conducting ocean color research, and is not suitable for beginners with limited knowledge of remote sensing. The course will address theoretical aspects and advanced science questions, rather than only practical applications.



Fishery Oceanography for the Ocean Decade
F.O.O.D. - An ITEC Training Programme
18 January - 07 February 2024

REGISTER NOW

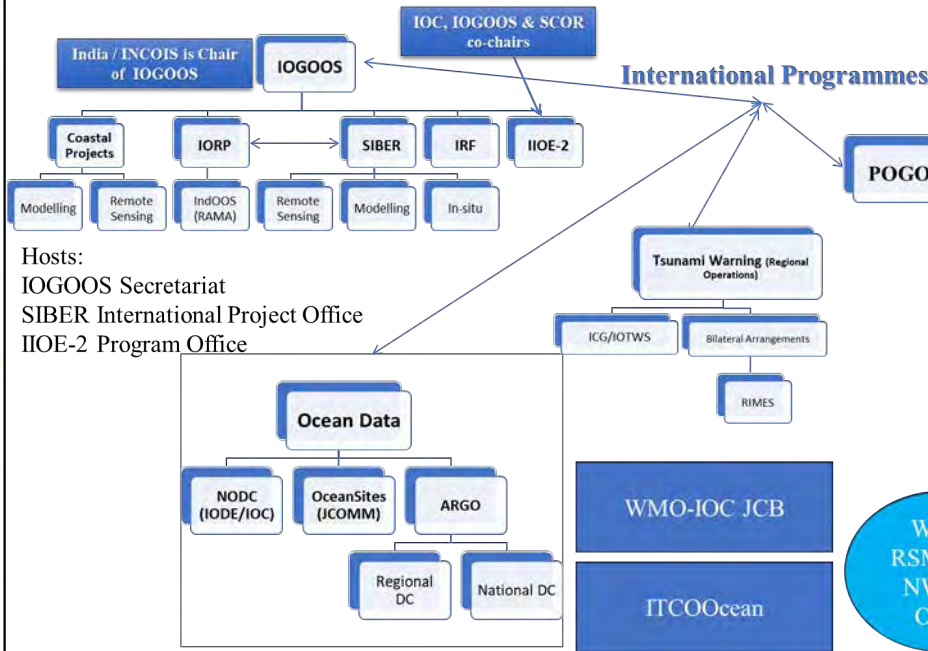
at
International Training Centre for Operational Oceanography (ITCOcean - A UNESCO Cat2 Centre)
Indian National Centre for Ocean Information Services (INCOIS)
Ministry of Earth Sciences (MoES), Govt. of India
Hyderabad, Telangana, India.

incos_official | INCOISofficial | ESSO_INCOIS | INCOISofficial Hyderabad | www.incois.gov.in

International Interface

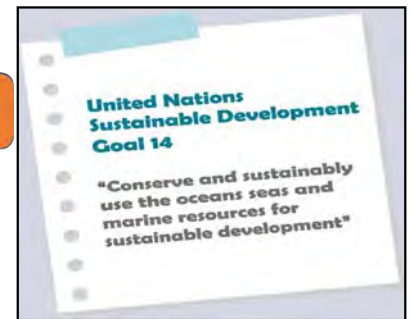


- Pollutants
- Ecosystems
- Food from the Ocean
- Ocean economy
- Ocean-climate nexus
- Ocean-related risks
- Ocean observing system
- Ocean digital representation
- Capacity development
- Behaviour change



Hosts:
 IOGOOS Secretariat
 SIBER International Project Office
 IIOE-2 Program Office

- UN Ocean Decade
- DCC for Indian Ocean Region (DCC-IOR)
- Ocean Prediction DCC
- Coast Predict
- GEOS
- G20 Climate Sustainability WG
- WMO RSMC for NWP & OWP



- Ocean Decade Outcomes**
- Clean Ocean
 - Healthy and resilient Ocean
 - Productive Ocean
 - Predicted Ocean
 - Safe Ocean
 - Accessible Ocean
 - Inspiring and engaging Ocean

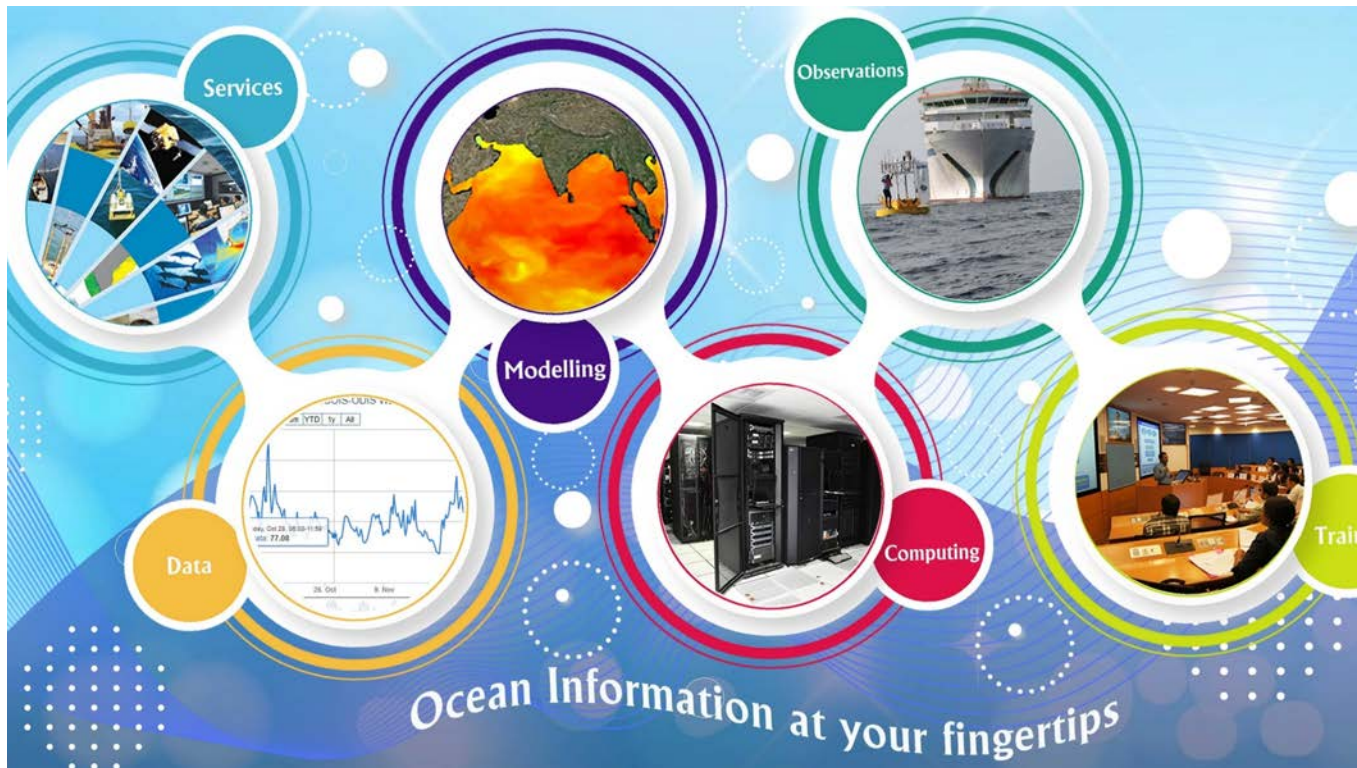
ISPRS, RIMES

IOC-UNESCO EC & VC
 UN Decade 2021-30 - NDCC
 DCC for Indian Ocean Region



The Blue Economy





**Thank you for your kind
attention**

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