

# **First Intergovernmental Session of the IOC Sub-commission for the Central Indian Ocean (IOCINDIO-I)**

## **Global Ocean Observing System (GOOS) & Indian Ocean Regional Alliance IOGOOS**

**Dr. T. M. Balakrishnan Nair**  
Co-Chair, GOOS Steering Committee, Vice-Chair, ET-MOR WMO  
Director, INCOIS

**M. Nagaraja Kumar**  
Secretary, IOGOOS  
Acknowledgement: GOOS Office, IOC

# GOOS: A critical infrastructure for ocean observing



Climate | Forecasts and Warnings | Ocean Health

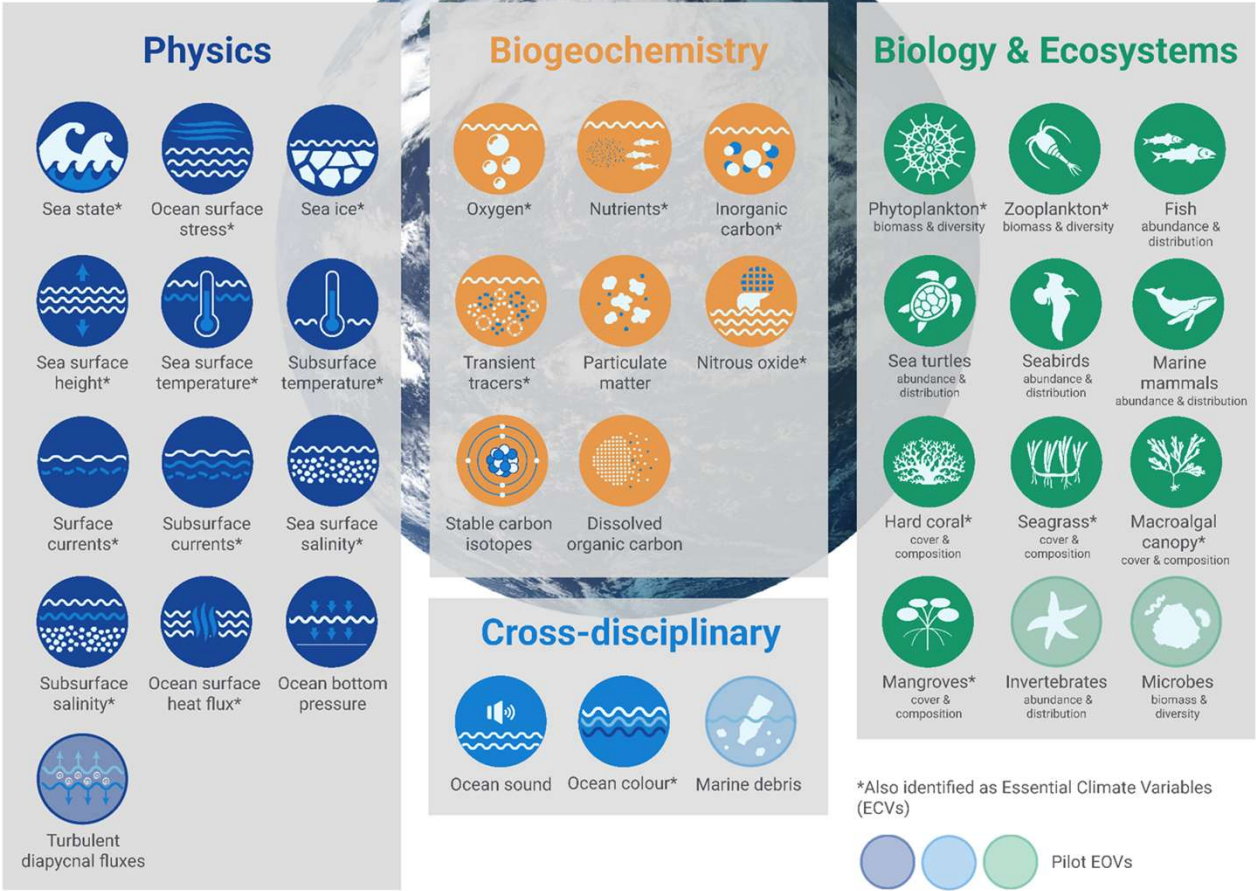
# 36 Essential Ocean Variables (EOVs)



United Nations  
Climate Change



International  
Legally Binding  
Instrument on  
Plastic Pollution  
2024



Convention on  
Biological Diversity

Kunming-Montreal Global  
Biodiversity Framework

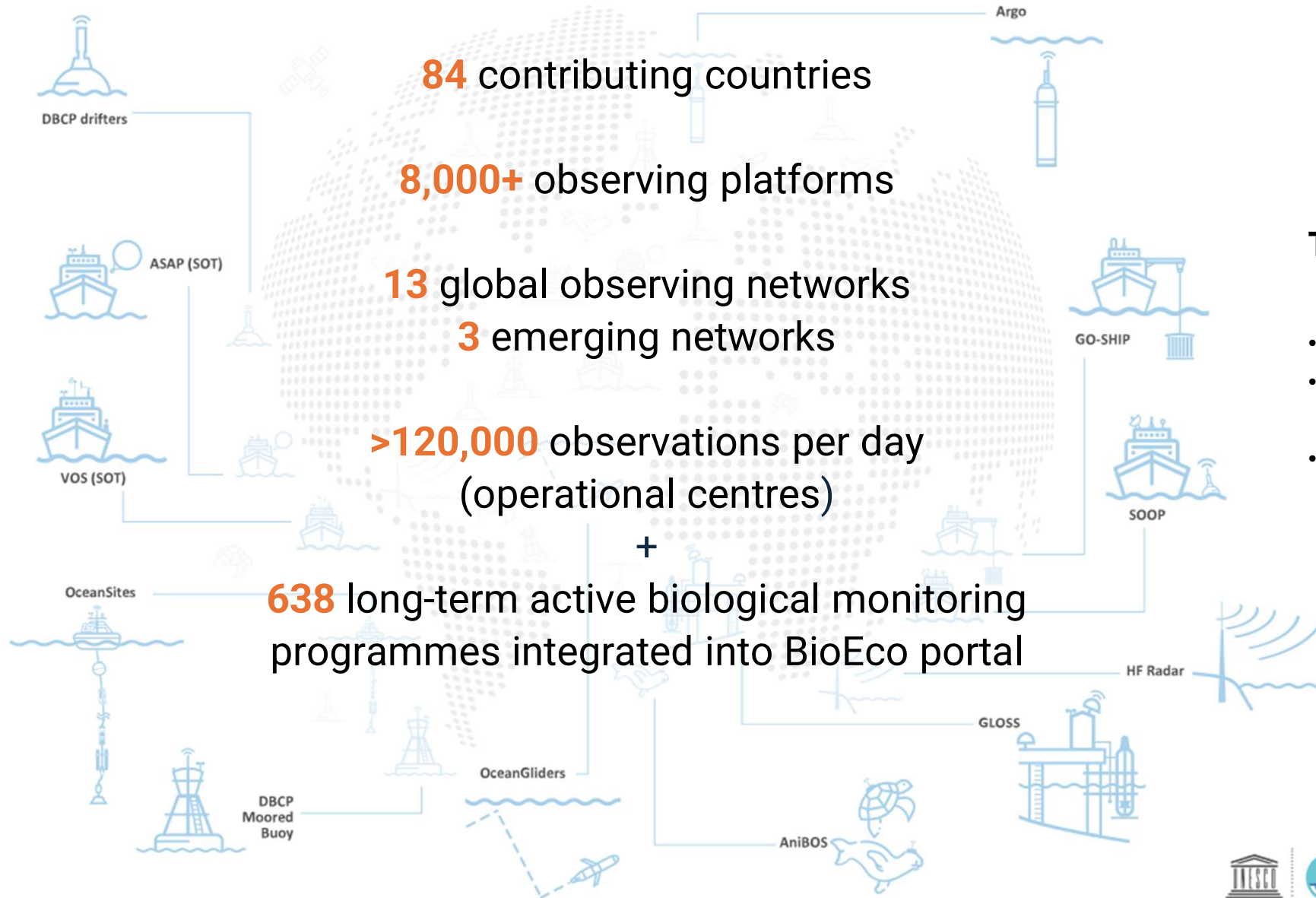


THE LAW  
OF THE SEA

+ Biodiversity  
Beyond  
National  
Jurisdiction  
Agreement



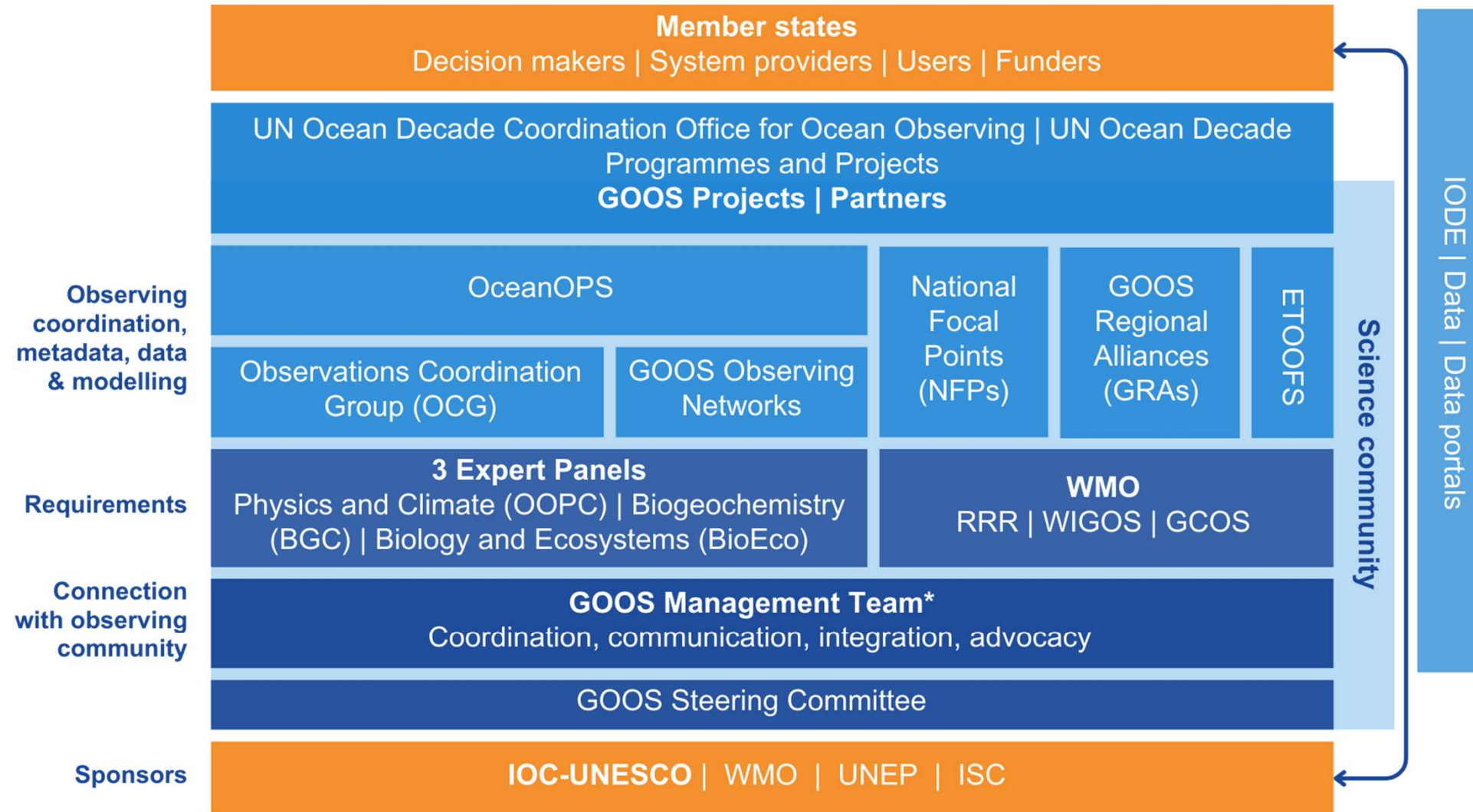
# GOOS Today



## Three emerging observing networks

- Fishing Vessel Observing Network (FVON)
- Surface Ocean CO<sub>2</sub> Reference Observing Network (SOCONET)
- SMART (Science Monitoring And Reliable Telecommunications) Cable

# GOOS Structure





# The Global Ocean Observing System

## 2030 Strategy

Sustained observations for a wide range of applications



Ocean Observing Value Chain



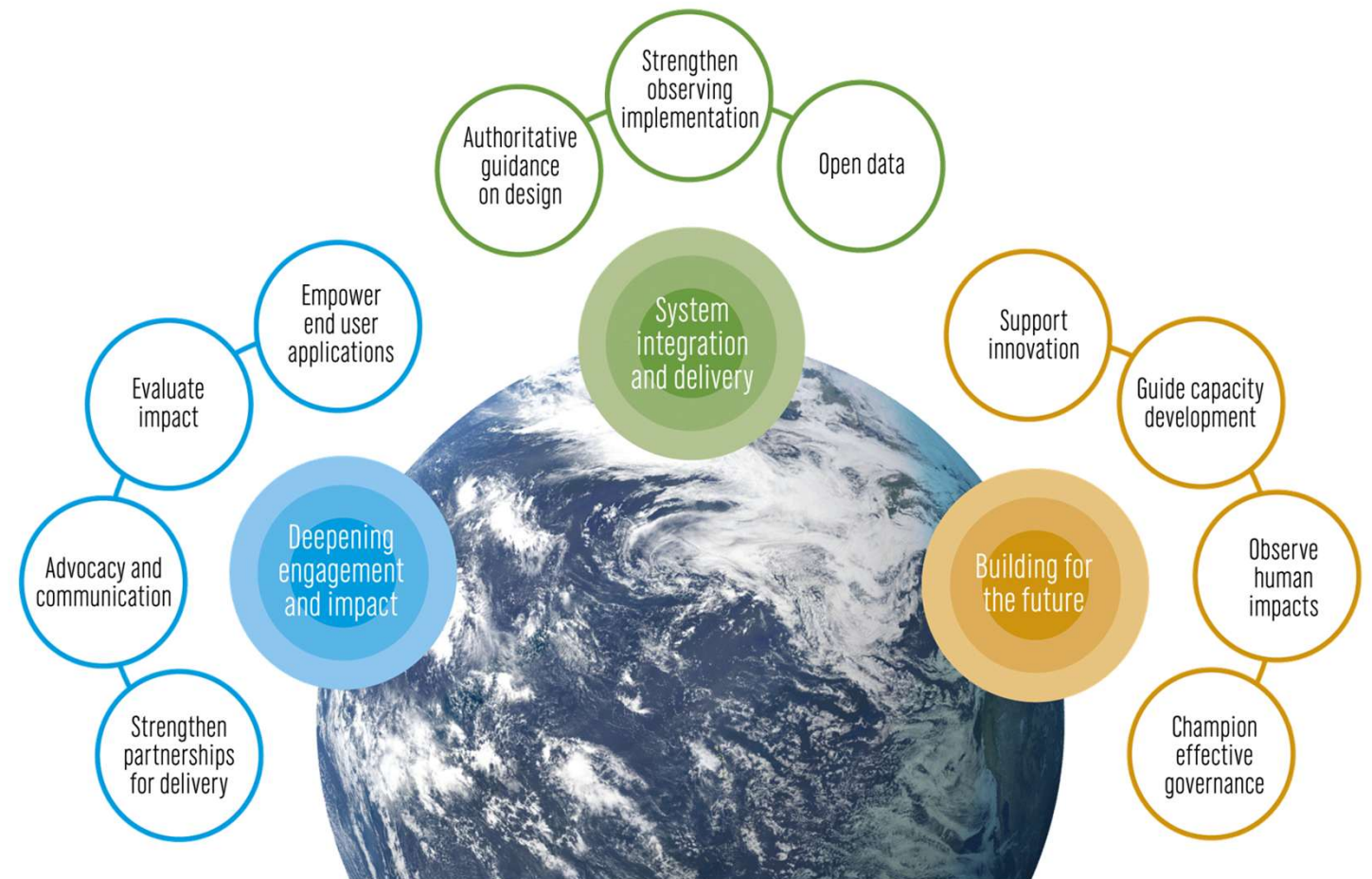
# The GOOS 2030 Strategy: Goals

## Vision

A truly global ocean observing system that delivers the essential information needed for our sustainable development, safety, wellbeing and prosperity

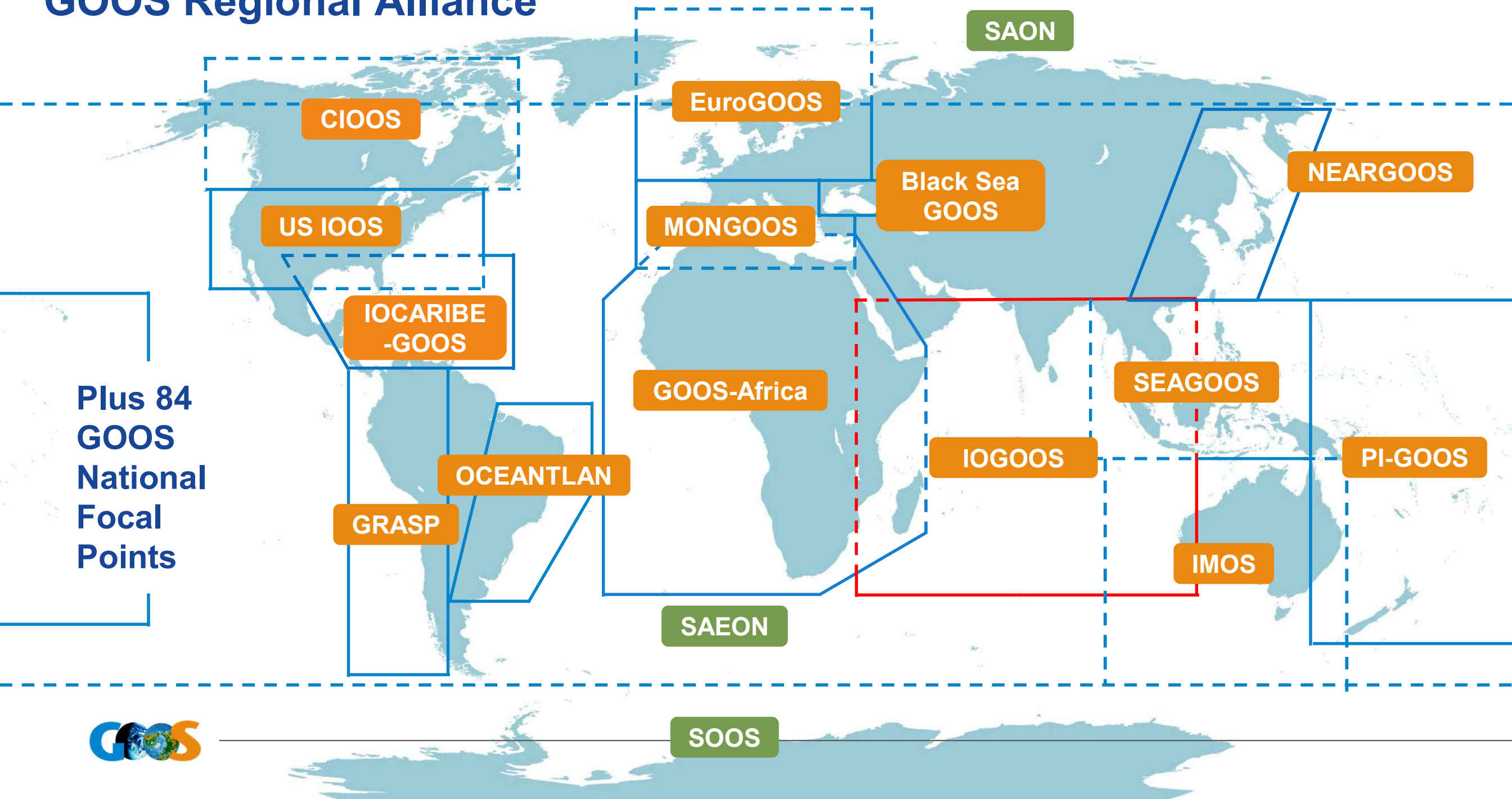
## Mission

To lead the ocean observing community and create the partnerships to grow an integrated, responsive and sustained observing system



Strategic Objectives

# GOOS Regional Alliance





# Indian Ocean Global Ocean Observing System



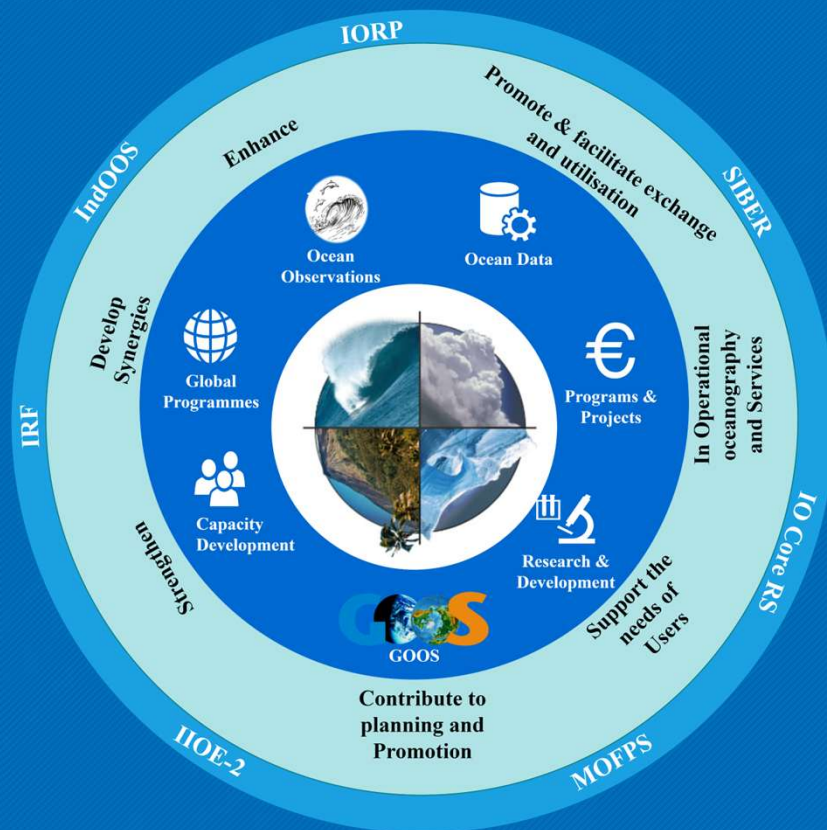
- ❖ A Regional alliance of IOC-GOOS
- ❖ Formally established on November 5, 2002.
- ❖ 19 organizations from 10 countries have become Members of IOGOOS
- ❖ IOGOOS Secretariat hosted by INCOIS for a period of six years beginning November 7, 2002.
- ❖ Currently 29 organizations from 17 countries became Members of IOGOOS (Australia, Bangladesh, France, India, Indonesia, Iran, Kenya, Kuwait, Madagascar, Malaysia, Maldives, Mauritius, Mozambique, South Africa, Sri Lanka, Tanzania, USA)
- ❖ Governance: Chair and four Officers of IOGOOS representing CIO, WIO, EIO, IORP, SIBER projects and IOC PRPO (former).

<https://incois.gov.in/iogoos/home.jsp>





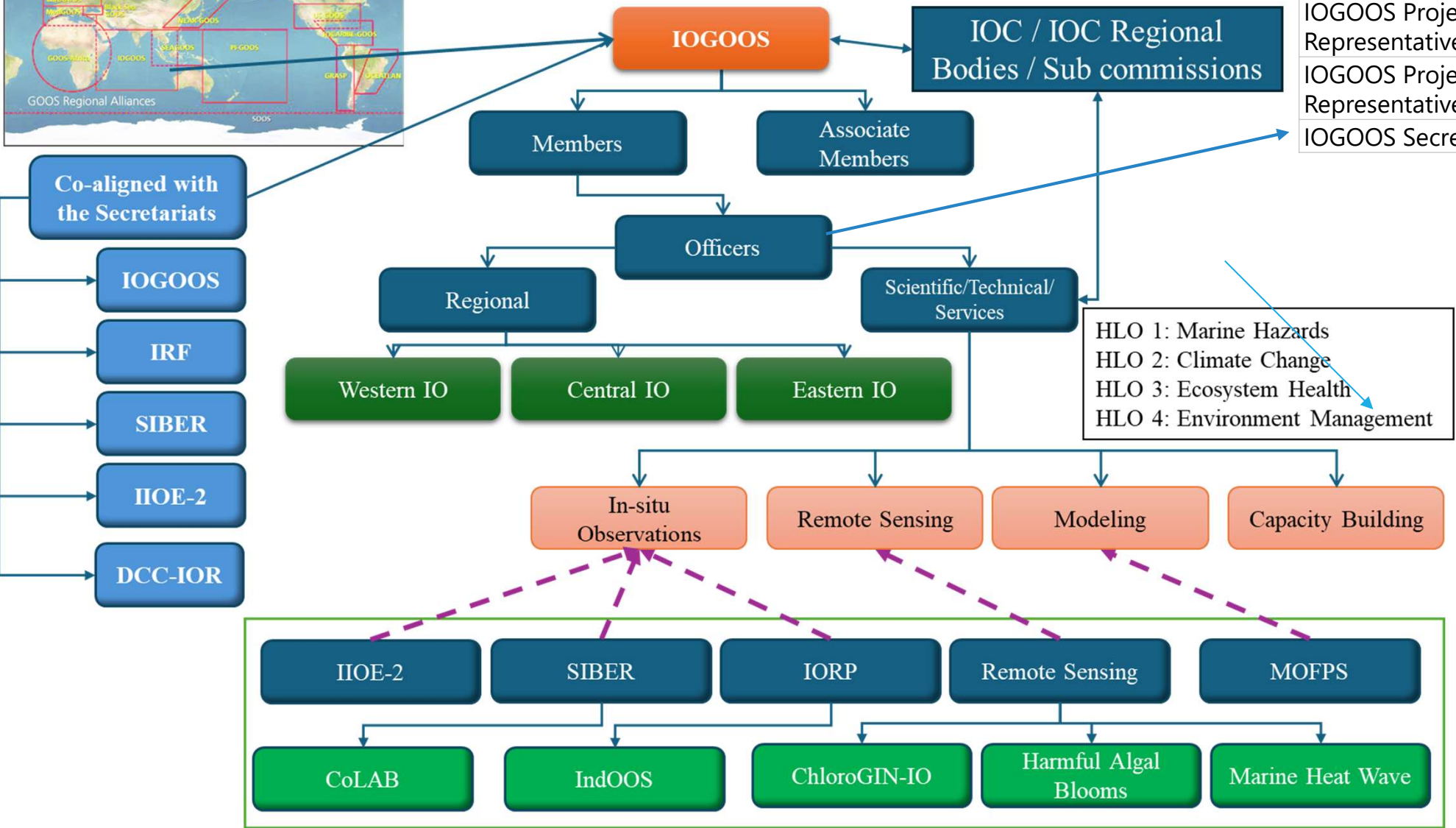
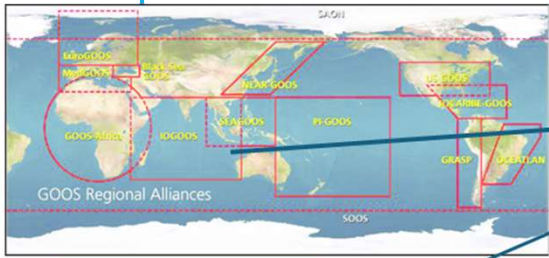
# IOGOOS - Aims & Objectives



- ❖ Enhance the Ocean Observing System in the region,
- ❖ Promote and facilitate efficient and effective management, exchange and utilization of oceanographic data,
- ❖ Promote programmes and projects in operational oceanography and ocean services in the region meeting the requirements of end-users,
- ❖ Strengthen capacity building for enhancing the capabilities in the region,
- ❖ Encourage research to support the needs of Users,
- ❖ Develop synergies with other ocean programmes and regional GOOS bodies, and
- ❖ Contribute to international planning and promotion of GOOS



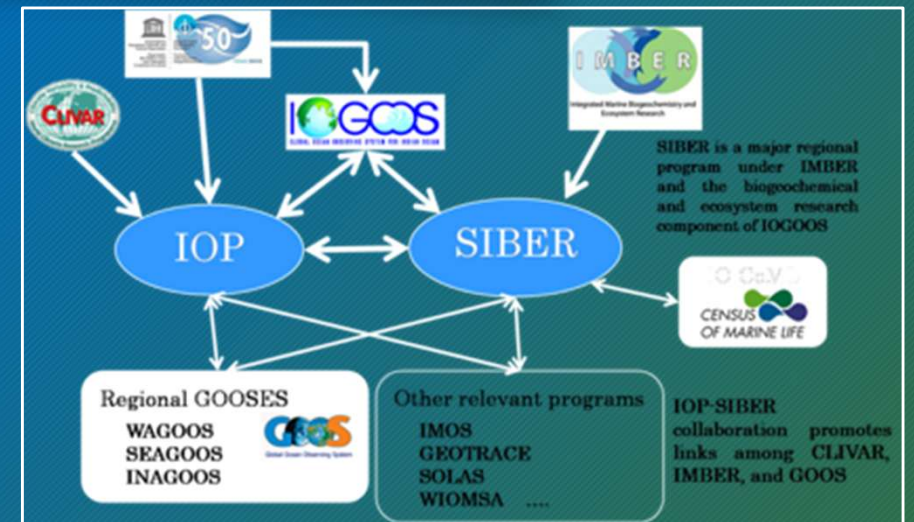
# IOGOOS GOVERNANCE



Region	Person	Designation
Central Indian Ocean	Vacant	Chair
Eastern Indian Ocean	Dr. Brett Molony	Officer
Western Indian Ocean	Dr. Faiza Al Yamani	Officer
IOGOOS Project Representative	Dr. Jenny Huggett	Officer
IOGOOS Project Representative	Dr. Juliet Hermes	Officer
IOGOOS Secretariat	Mr. M. Nagaraja Kumar	Secretary

# Ocean Observations - IORP, SIBER, IRF

- IOGOOS GRA is a co-sponsor and partner in IORP, SIBER, IRF and IIOE-2
- Indian Ocean Regional Panel (IORP) – Physical Observation systems
- Sustained Indian Ocean Biogeochemical and Ecological Research (SIBER) – Biogeochemical observation systems
- IRF – A high-level members meeting to facilitate the allocation and alignment of resources in the Indian Ocean to achieve a sustained, basin-wide ocean observing system. Activities include
  - Implementation of IndOOS
  - Facilitate and coordinate resources
  - Encourage scientific and technological initiatives
- Scientists and Institutions from within and outside IO have been major contributors to the design and implementation of IndOOS since 2006
- SIBER International Program Office co-located with IOGOOS Secretariat





# Ocean Observations - IndOOS

## Societal Needs in the Indian Ocean Region

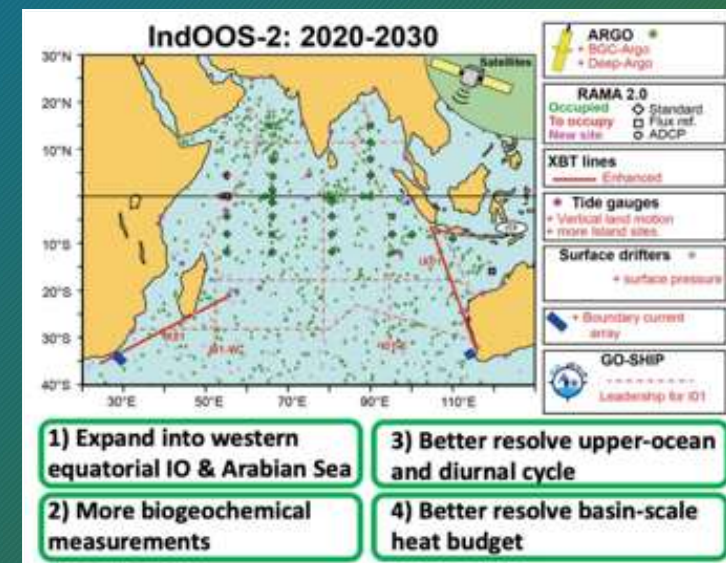
- > 50 Nations around (mostly developing ones)
- 1.5 Billion Population
- Rapid growth in blue economies and opportunities to harness ocean resources and services
- Agriculture Farming dependent on Monsoon
- Marine Fisheries dependent on ocean conditions
- Coastal populations vulnerable to extreme weather events and climate change

## Science Drivers

- Oxygen Minimum Zones (OMZs)
- Upwelling and Subduction Zones,
- Major Heat flux components
- Tropical modes of the MJO
- Monsoon Intra-seasonal Oscillation
- IO Dipole (IOD) & IO Basin Mode (IOBM)
- Subtropical modes of Ningaloo Nino and Subtropical IOD,
- Cyclogenesis and Climate Change

## Operational Drivers

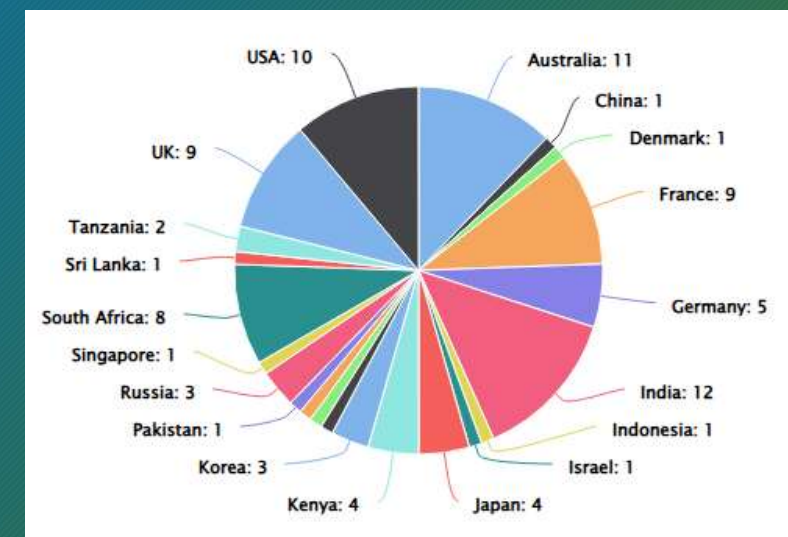
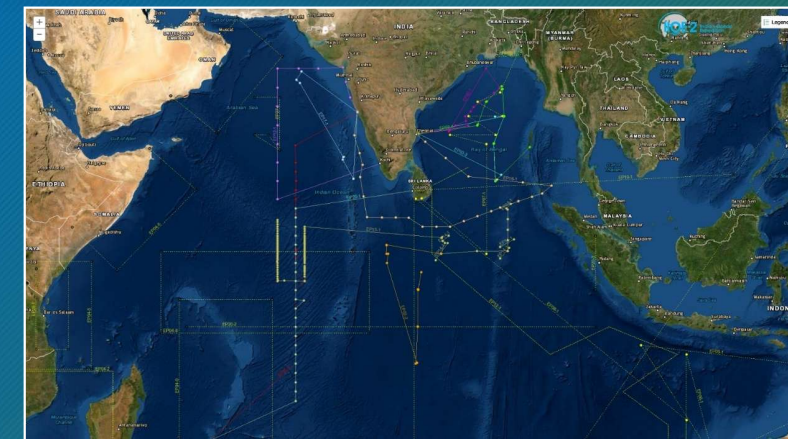
- Need for accurate and timely ocean forecasting services
- Improvement of Surface Fluxes
- Ocean data Assimilation Systems
- Operational Sub seasonal-to-Seasonal (S2S) Forecasting





# Ocean Observations - IIOE-2

- 2<sup>nd</sup> International Indian Ocean Expedition (IIOE-2) - To advance our understanding of the Indian Ocean and its role in the Earth System in order to enable informed decisions in support of sustainable development and the well-being of humankind”
- IOC, SCOR and IOGOOS – Joint Sponsors / Patrons
- Program Office (JPO) at India (earlier IOC PRPO acted as joint PO)
- Endorsed 57 scientific projects that align with the IIOE-2 objectives ([http://www.iioe-2.incois.gov.in/IIOE-2/Endorsed\\_Projects.jsp](http://www.iioe-2.incois.gov.in/IIOE-2/Endorsed_Projects.jsp)).



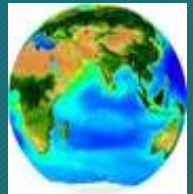


# Ocean Science and Research

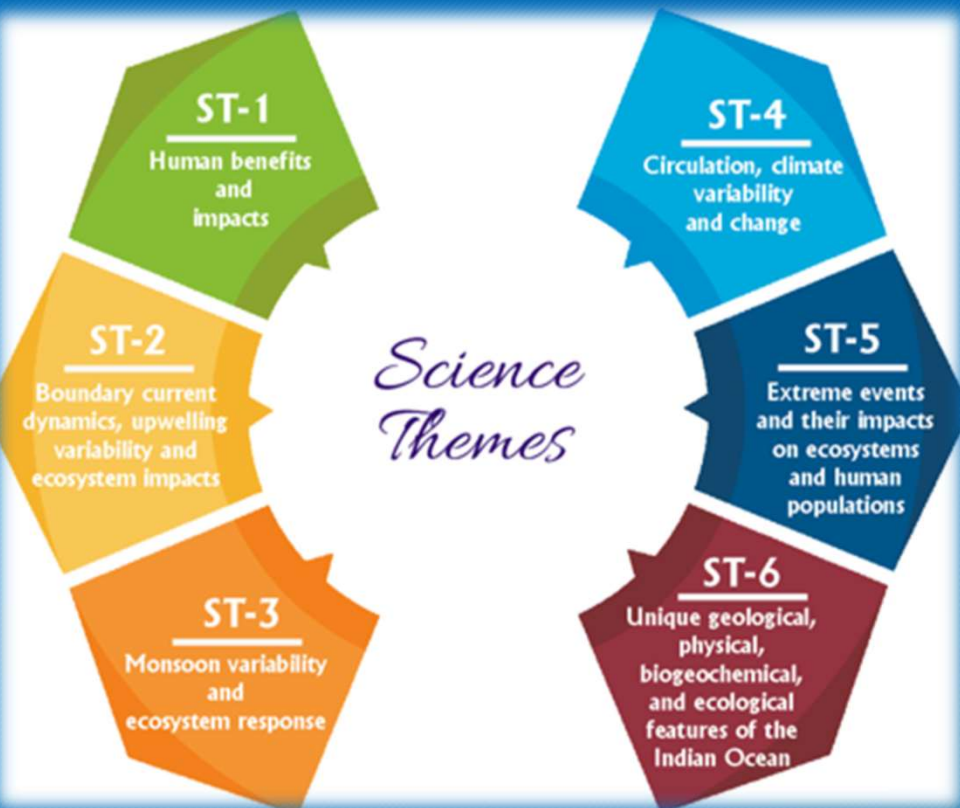


## Science Themes & Working Groups

## SIBER Science Plan



### Science Themes



**Theme 1:** Boundary current dynamics, interactions and impacts

**Theme 2:** Dynamic variability of the equatorial zone, southern tropics and Indonesian Throughflow and their impacts on ecological processes and biogeochemical cycling

**Theme 3:** Physical, biogeochemical and ecological contrasts between the Arabian Sea and the Bay of Bengal

**Theme 4:** Controls and fates of phytoplankton and benthic production in the Indian Ocean

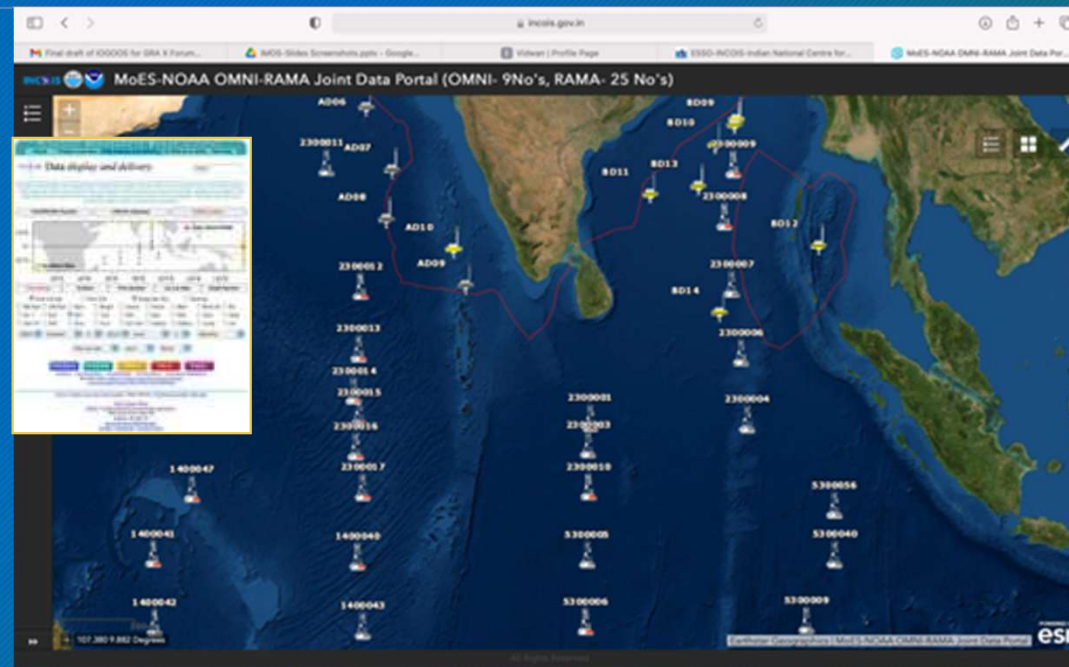
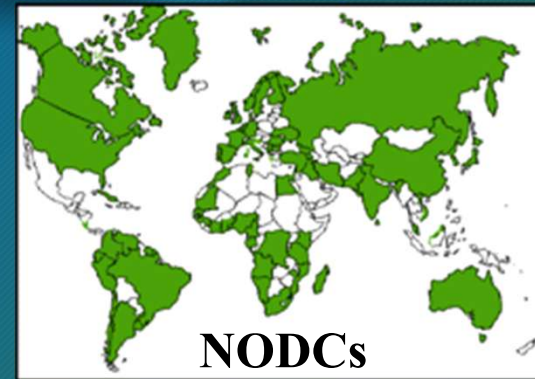
**Theme 5:** Climate and anthropogenic impacts on the Indian Ocean and its marginal seas

**Theme 6:** The role of higher trophic levels in ecological processes and biogeochemical cycles



# Ocean Data Management

- Several NODCs in the region (IODE – UNESCO/IOC) – BORI, IMOS, INCOIS, etc
- IndOOS and IIOE-2 data portals to make oceanographic data from the region discoverable and widely accessible
- IIOE-2 Metadata Portal enables search and discovery of metadata of completed & forthcoming/planned cruises under IIOE-2
- NOAA-MoES joint Data portal for RAMA-OMNI Moorings





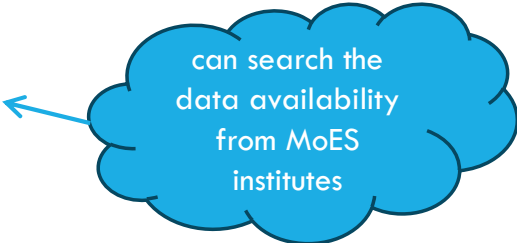
# OCEAN OBSERVATIONS IN INDIAN OCEAN

- ☐ EKAMSAT (India-US Collaboration)
  - ☐ Facilitated the participation of representatives from Bangladesh, Mauritius and Sri Lanka

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

☐ EARTH SYSTEM SCIENCE DATA PORTAL (<https://incois.gov.in/essdp/>)

☐ In-situ Data (<https://incois.gov.in/portal/datainfo/insituhome.jsp>)



☐ Remote Sensing Data ([https://incois.gov.in/portal/remotesensing/TERA\\_display.html](https://incois.gov.in/portal/remotesensing/TERA_display.html))

☐ Indian Ocean Core Remote Sensing Project – ChloroGIN-IO Products and HAB Info Products (<https://incois.gov.in/portal/ChloroGIN/>)



☐ LIVE ACCESS SERVER (<https://las.incois.gov.in/>)

☐ Integration of the data with ERDDAP

ERDDAP > List of All Datasets

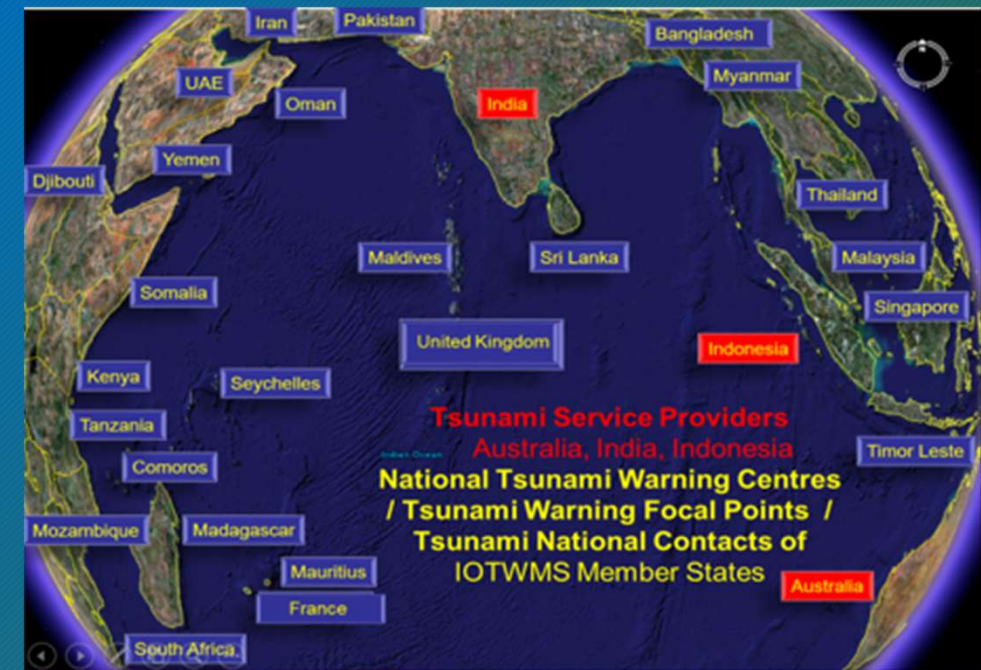
19 matching datasets, listed in alphabetical order.

Grid DAP Data	Sub-set	Table DAP Data	Make A Graph	W M S	Title	Sum-mary	Meta-data	Back-ground Info	RSS	E mail	Institution	Dataset ID
	set	data	graph		* The List of All Active Datasets in this ERDDAP *	?	M	background			INCOIS	allDatasets
data			graph	M	AMSR2 3day Global	?	M	background	?		INCOIS	AMSR2_3day_Global
data			graph	M	AMSRE Monthly Global Data	?	M	background	?		INCOIS	AMSRE_MONTHLY_GLOBAL
data			graph	M	Daily ASCAT global wind field	?	M	background	?		ifremer	ascat_daily_datasets
data			graph	M	Daily-OI-V2, final, Data (Ship, Buoy, AMSR-E, AVHRR, GSFC-ice)	?	M	background	?		INCOIS	NOAA_AVHRR_AMSR_datasets
data			graph	M	Data from a local source.	?	M	background	?		NOAA	NOAA_AVHRR_datasets
data			graph	M	INCOIS ARGO 10 Day data Kessler-McCreary Methodology	?	M	background	?		INCOIS	incois_argo_10day_McCreary
data			graph	M	INCOIS ARGO 10 day data Variational Analysis Methodology	?	M	background	?		INCOIS	incois_argo_10d_VAM
data			graph	M	INCOIS ARGO Monthly data Kessler-McCreary Methodology	?	M	background	?		INCOIS	incois_argo_mnt_McCreary
data			graph	M	INCOIS ARGO Monthly data Variational Analysis Methodology	?	M	background	?		INCOIS	incois_argo_mnt_VAM
data			graph	M	INCOIS argo SST data Weekly	?	M	background	?		INCOIS	incois_argo_sst_weekly
data			graph	M	INCOIS Oceansat2 OCM Data	?	M	background	?		INCOIS	incois_oceansat2_datasets
data			graph	M	INCOIS Quikscat Daily Data	?	M	background	?		INCOIS	incois_quikscat_daily_datasets
data			graph	M	INCOIS Quikscat Monthly Data	?	M	background	?		INCOIS	incois_quikscat_mnt_datasets

# Ocean Forecasting & Services - Tsunami

## ICG/IOTWMS

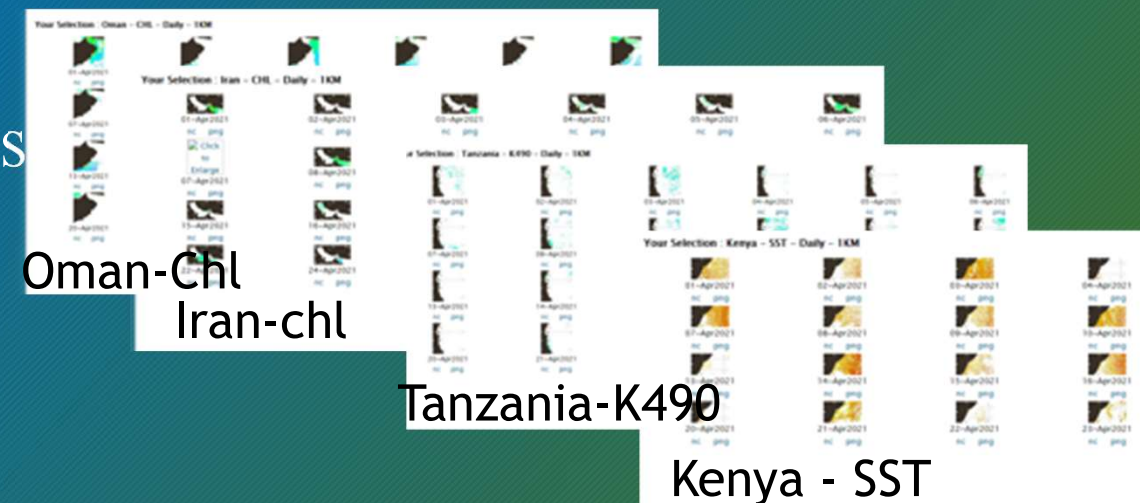
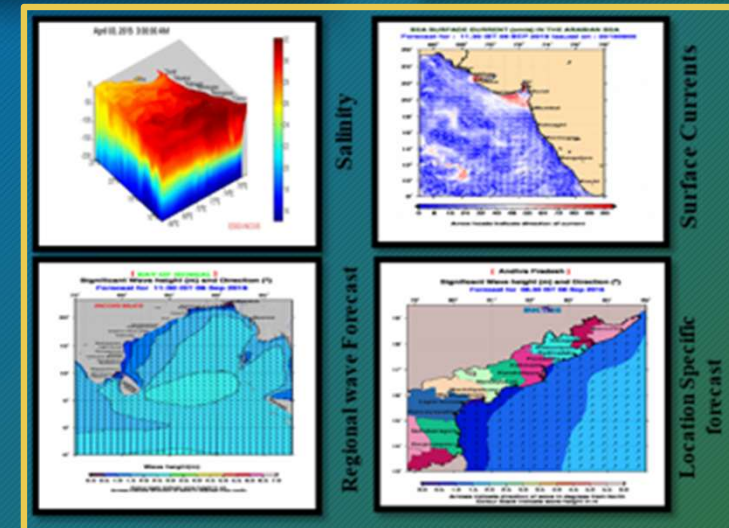
- The Intergovernmental Coordination Group for the Indian Ocean Tsunami Warning and Mitigation System (ICG/IOTWMS) was formed in response to the tragic tsunami on 26 December 2004
- Governed by the IOC/UNESCO
- Providing Tsunami advisories to all Indian Ocean rim countries through 3 TSPs (Australia, India and Indonesia)
- The Intergovernmental Coordination Group meets regularly to establish and implement working plans in the Indian Ocean region. To address specific technical issues, it has formed three working groups and two task teams:
  - Working Group 1 - Tsunami Risk, Community Awareness and Preparedness
  - Working Group 2 - Tsunami Detection, Warning and Dissemination
  - Subregional Working Group for the North West Indian Ocean
  - Task Team on Tsunami Preparedness for a Near-Field Tsunami Hazard
  - Task Team on Scientific Tsunami Hazard Assessment of the Makran Subduction Zone
  - Task Team on Exercise Indian Ocean Wave





# Ocean Forecasting & Services

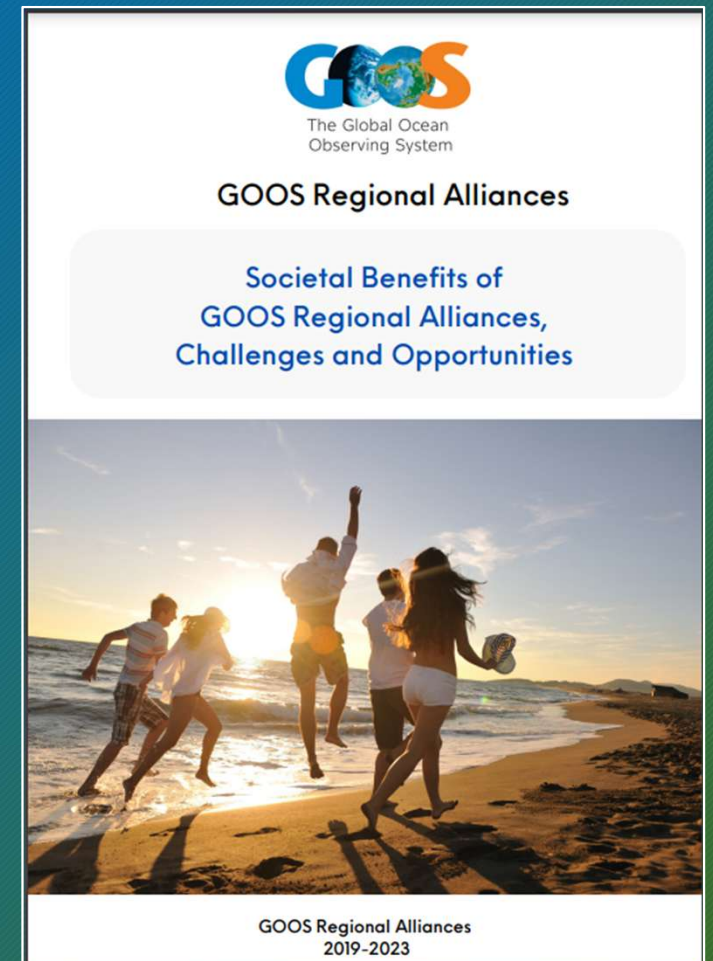
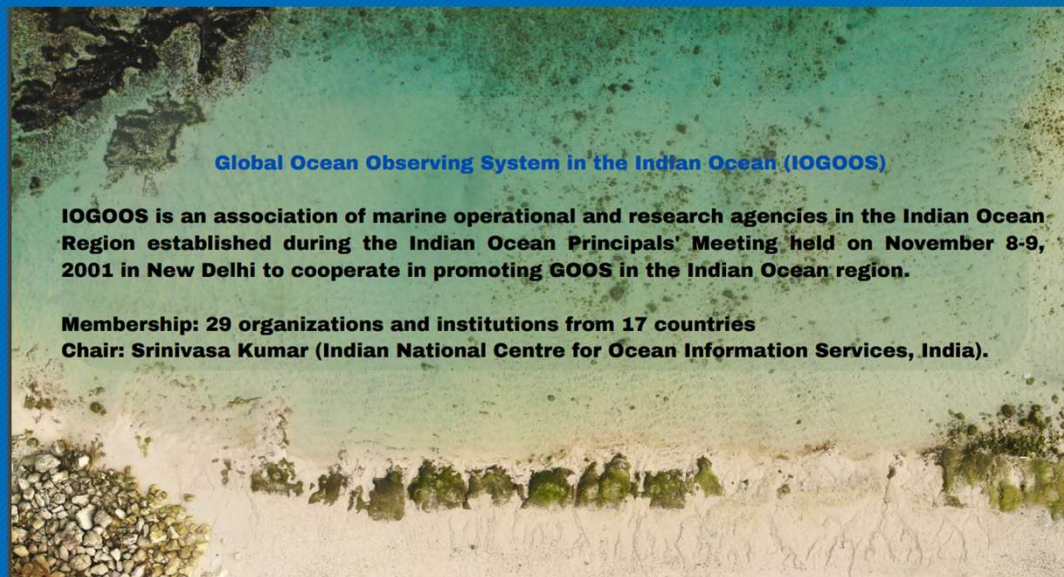
- Several countries in the region generate national and regional ocean forecast products
  - Ocean State, High Waves, Swell Surges, Storm Surges, Oil Spills, Search & Rescue, Currents, Climate Indices, Fisheries, etc.
- Modeling & Ocean Forecasting and Process Studies (MOFPS) – IOGOOS Proj
  - To enhance ocean forecasting capacities for the Indian Ocean and modelling applications at sub-regional and local scales
  - Identifying the key priority user requirements in respect to parameters that models can focus on and also regions requiring model products
  - Capacity building in the use and applications of models
  - Organised Virtual Training Workshop in Dec 2021 to re-engage MS
- ChloroGIN-IO IOGOOS Project
  - Near-real-time satellite products to member states India, Iran, Kenya, Maldives, Oman, Sri Lanka, Tanzania, Thailand
  - Products: CHL, SST, K490, ANGSTROM, AOT, BRS, CDOM, FLH, IPAR, PAR, PIC, POC





# Case study in “Societal Benefits of GOOS Regional Alliances, Challenges and Opportunities”

- ❑ IIOE-2 as one of the success story under Ocean Observing and Monitoring;
- ❑ IndOOS under Data Management and Services;
- ❑ SIBER under Analysis, Modeling and Forecasting Systems;
- ❑ ChloroGIN Data Products under Products and Applications
- ❑ IndOOS Resource Forum under Institutional and Governance







CAPACITY BUILDING





# Capacity Development

- Several Training Programmes – **Sponsors: INCOIS, ITEC, ITCOOcean, OTGA, POGO**
- Conducted several CB activities for Indian Ocean member states in Operational Oceanography
- ITCO Ocean, India is an RTC under OTGA and Trained 1947 trainees from 103 countries through 64 International trainings
- Future: Ocean Observation platforms and Ocean Decade themes

ITCOcean:

<https://incois.gov.in/ITCOcean/index.jsp>

RCOWA:

<http://www.inio.ac.ir/Default.aspx?tabid=2768>





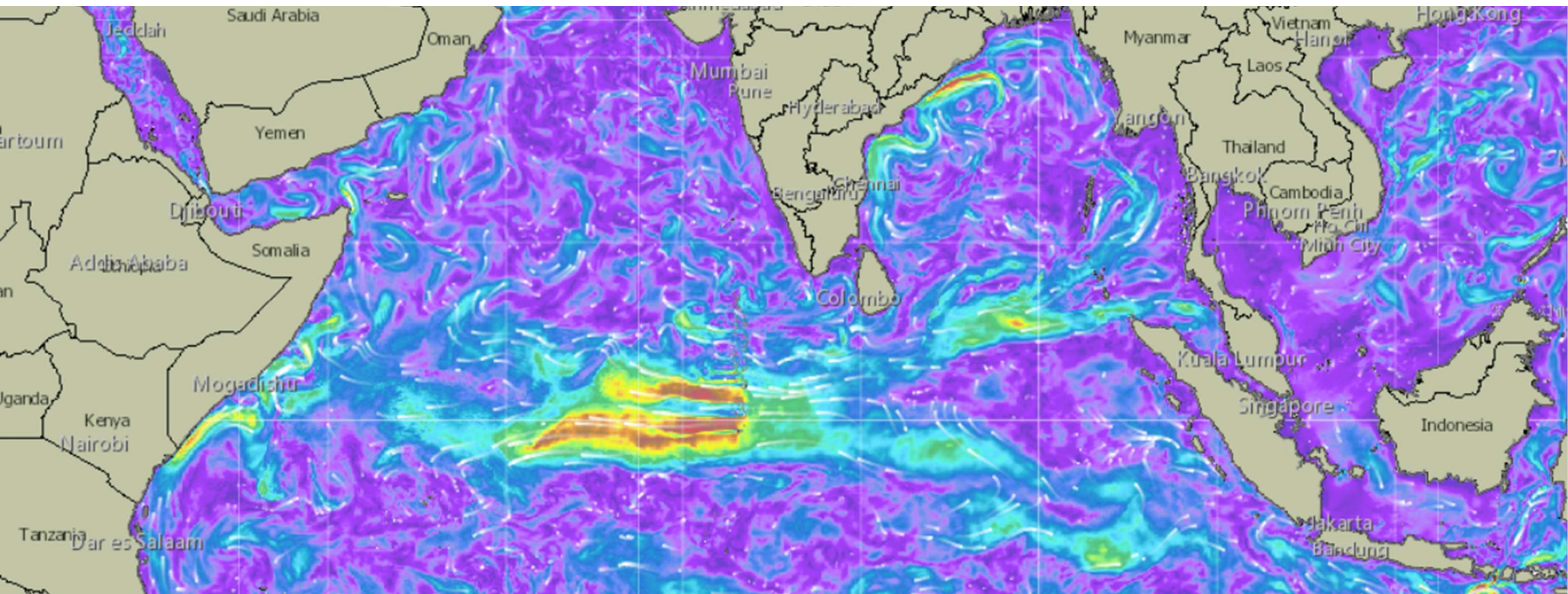
# INDIAN Ocean Prediction Training cum workshop

## Empowering the Next Wave of Indian Ocean Prediction: IOPredict-2024

- December 04-13, 2024
- Member countries: India, Malaysia, South Africa
- Other countries: Brazil
- Sponsors: IOGOOS, ITCOOcean / INCOIS.
- 123 Participants from 04 countries
- Funds: 15,982 USD for 05 International Participants







# MODELLING FOR OCEAN FORECASTING AND PROCESS STUDIES (MOFAPS)





# MODELLING FOR OCEAN FORECASTING AND PROCESS STUDIES (MOFPS)

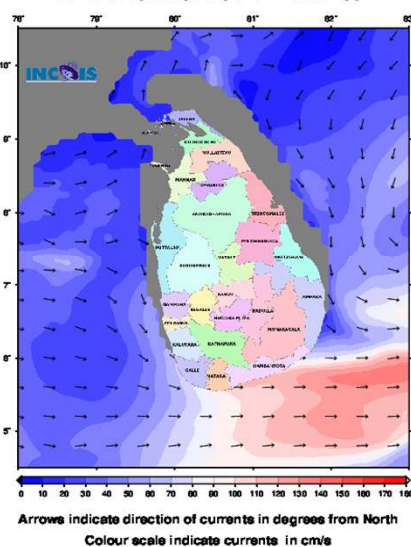
- ❖ Increased interest in the region
- ❖ Aligning with the ‘UN Ocean Decade’ through OceanPredict Program
- ❖ The detailed survey form designed in June 2023  
<https://forms.office.com/r/CZME07EK8P>
  - General Information (Name, Affiliation, Field of work, Products user or not, etc.) and more specific information on the products being used, modelling parameters and models used, modelling and observation capabilities of the institutes, requirements of the member institutes, etc.
- ❖ Collaboration with OceanPredict DCC
  - Members are part of Regional Team for Indian Ocean
  - Co-hosted virtual meeting of the 1<sup>st</sup> Regional Teams meeting with ocean modelling products stakeholders

# Ocean Services for Member States

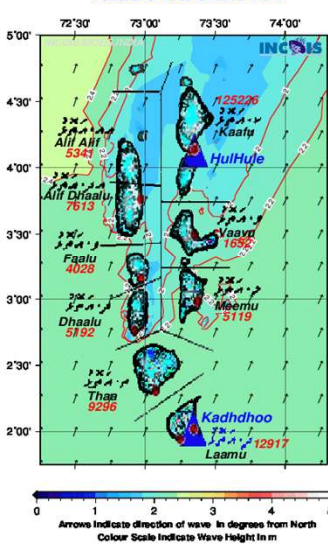
INCOIS provides Ocean Services to Regional Integrated Multi-Hazard Early Warning System for Africa and Asia (RIMES) countries (Maldives, Seychelles, Sri Lanka, Comoros, Madagascar and Mozambique) – 3-day forecast

	Parameters									
Country	Wave	Wave period	Swell	Swell period	Wind	Sea Surface Temperature	Mixed Layer Depth	Surface Currents	Location Specific stations	High Wave Alert
Maldives (3 regions separately)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	21	Yes
Seychelles	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	18	Yes
Sri Lanka	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	22	Yes
Comoros	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	15	Yes
Madagascar	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	15	Yes
Mozambique	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	16	Yes

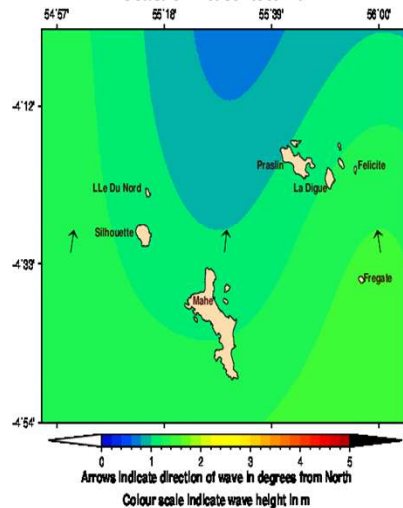
[ Sri Lanka ]  
Forecast for 20.30 SLST 09 Jun 2022  
Currents Speed (cm/s) and Direction (°)



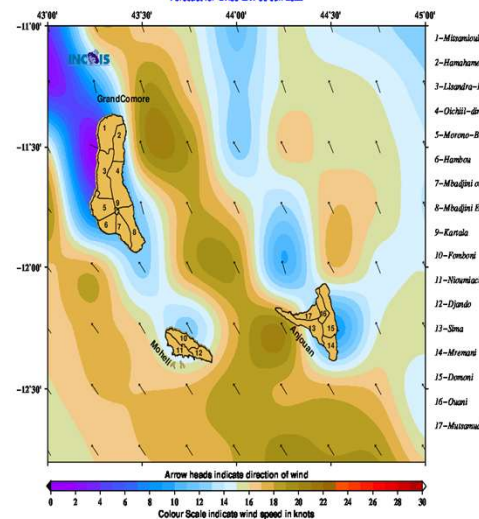
Significant Wave Height(m) and Direction (°)  
Forecast for 23.30 IST 09 JUN 2022



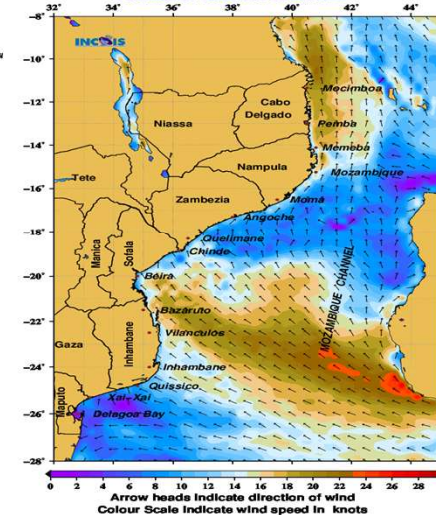
[ Seychelles Island ]  
Swell Wave Height (m) and Direction (°)  
Forecast for 22:00 SCT 09 Jun 2022



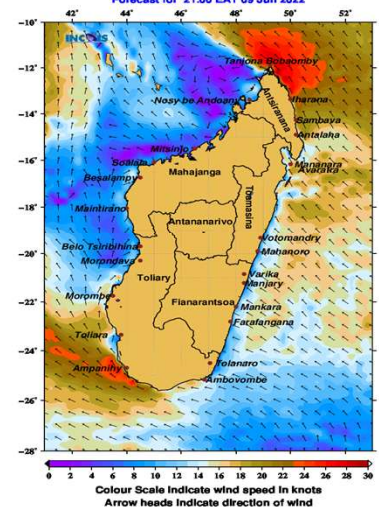
COMOROS  
Wind Speed (knots) and Direction(°)  
Forecast for 21.00 EAT 09 Jun 2022



MOZAMBIQUE  
Wind speed (knots) and Direction(°)  
Forecast for 20.00 CAT 09 Jun 2022



MADAGASCAR  
Wind speed(knots) and Direction(°)  
Forecast for 21.00 EAT 09 Jun 2022





# WEB PORTAL FOR OCEAN PREDICTION



Regional Specialized Meteorological Centre (RSMC)  
for Numerical Ocean Wave Prediction  
and Global Numerical Ocean Prediction  
Indian National Centre for Ocean Information Services (INCOIS)



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[Ocean Prediction](#)

The Indian Ocean is a vast stretch of seawater and a source of sustenance and livelihood for millions of people in the countries that border it. The marine resources of the Indian Ocean and the concept of the blue economy play a significant role in supporting the socioeconomic development and well-being of the populations living in this region.

Indian National Centre for Ocean Information Services (INCOIS) is an autonomous organization under the Ministry of Earth Sciences, Government of India. It was established in 1999 and has provided various ocean-related services since then. INCOIS started its wave forecast services from (25-05-2006) and augmented it with essential ocean variables from ocean general circulation models from (03-03-2015). INCOIS generates early warning advisories based on the state of the seas surrounding the Indian subcontinent and serves several island countries. These services are critical for the operational activities of offshore sea goers and onshore activities such as coastal tourism, ports and harbors etc.

INCOIS operationally runs a suite of wave and ocean general circulation models at different resolutions to provide early warning services to maritime stakeholders. Users of forecasts are equipped to take informed decisions based on the sea state conditions, avoiding loss of life and property. Thus, INCOIS services extensively contribute to the development of the blue economy in the region through its forecasts and advisory services. Forecasts of essential ocean variables at different time scales are thus crucial for a broad spectrum of users ranging from fishermen to offshore industries. Recognizing the role played by INCOIS in issuing forecasts for the region, the WMO Executive Council at its seventy-sixth session (EC-76) adopted the designation of RSMC Indian National Centre for Ocean Information Services (INCOIS) (India) for numerical ocean wave prediction and global numerical ocean prediction.

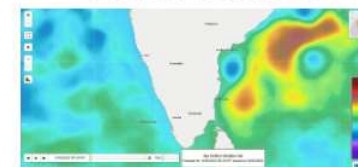
## Waves



[View](#)
[Data Download](#)

Model Name	Domain	Resolution	Forcing	Mixing	DA
WAVEWATCH-III	Four nested grids covering Global Ocean	Global Ocean (1 x1 deg), Indian Ocean (0.5 x0.5 deg), Northern Indian Ocean (0.25 x0.25 deg) and coastal (10 Km x10 Km)	ECMWF forecast winds (0.25x0.25deg)	NA	Optimal Interpolation method; Assimilates Sig. Wave Height (SWH) from SARAL/AltiKa, Jason-3, Sentinel-3a and Sentinel-3b and all available in-situ SWH observations in the Indian Ocean

## Ocean Prediction



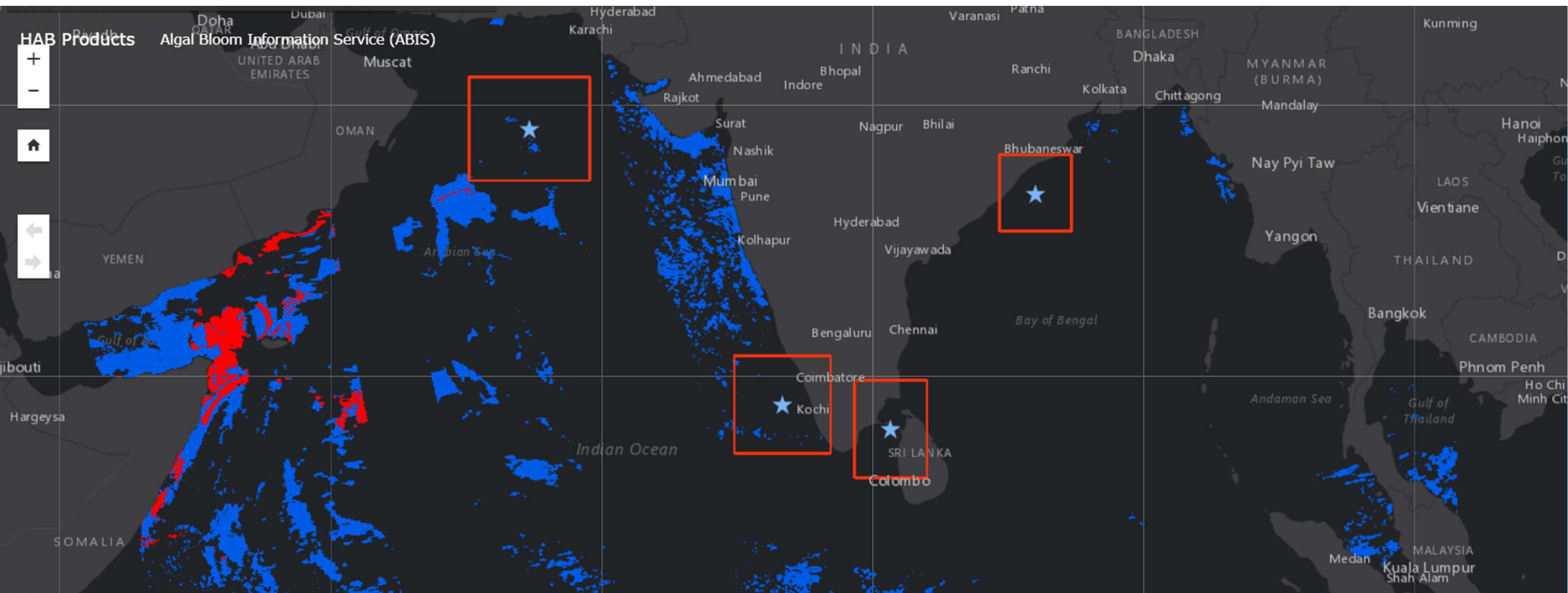
[View](#)
[Data Download](#)

Model Name	Domain	Resolution	Forcing	Mixing	DA
HYbrid Coordinate Ocean Model (HYCOM) version-2.35	20E-120E & 43S-30N	6.9 km (1/16) degree nested to a 25 km (1/4) Global Hycom	Atmospheric forcing: GFS Rivers: NRL climatology	KPP mixing	Method: Tendral Statistical Interpolation (Reduced Order Kalman Filter) Variables: AVHRR-SST, + L2 & L3 Along Track altimeter data. Argo profiles of Temperature & Salinity

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<https://incois.gov.in/oceanservices/rsmc.jsp>

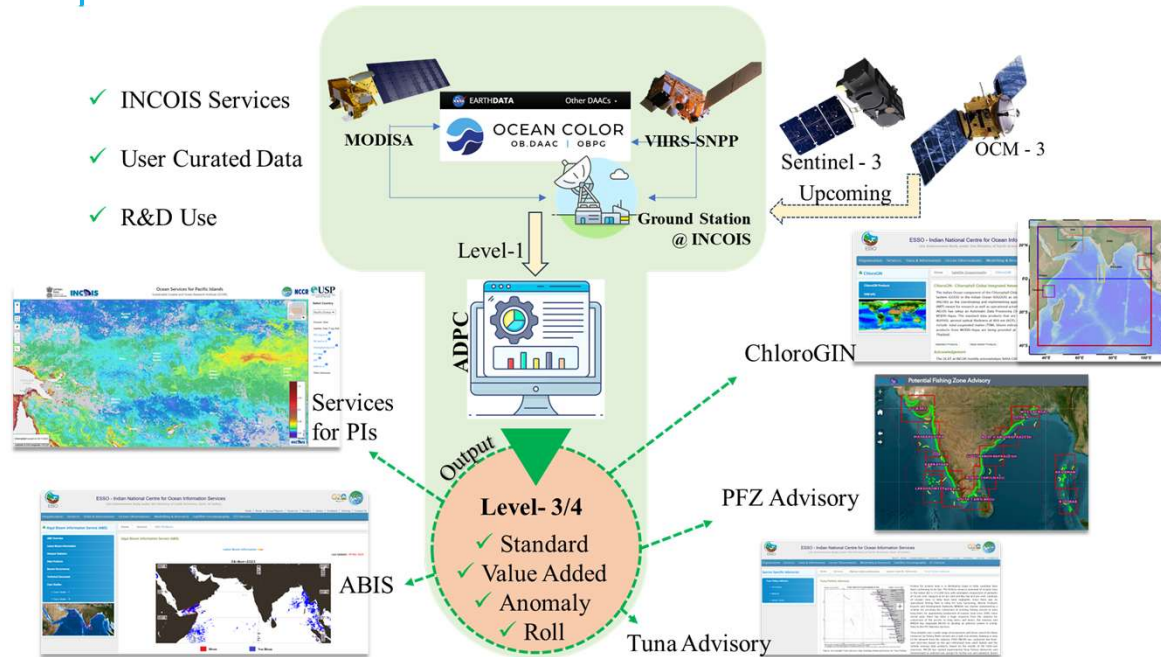


# INDIAN OCEAN CORE REMOTE SENSING PROJECT



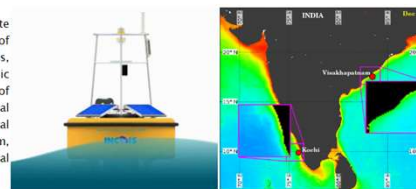


# REMOTE SENSING PRODUCTS / SERVICES - UPDATES



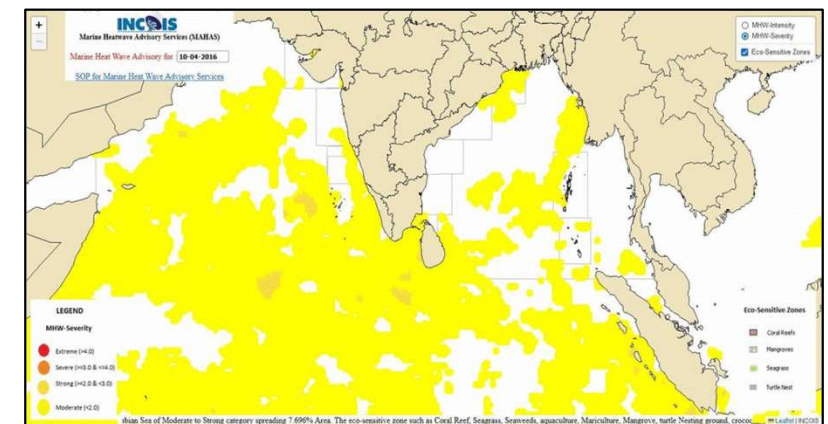
Water Quality Nowcast System

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...](#)



- ❑ Continued to provide the RS Data products to Member institutes (India, Sri Lanka, Iran, Kenya, Maldives, Oman, Tanzania and Thailand)
- ❑ Satellite remote sensing-based advisories on Harmful Algal Bloom (<https://incois.gov.in/portal/hab.jsp>)
- ❑ Integrated the satellite-based information into the 'Water Quality Nowcast System' of INCOIS
- ❑ Marine Heat Wave Services for the Northern Indian Ocean

## Marine Heat Wave Services



# IOC-GOOS SUPPORT TO IOGOOS

WP components		Status
WP 1: Numerical Modelling for Ocean Prediction	'IOPre-dict-2024' workshop, 9-13 December 2024, Hyderabad, India	Completed
WP 2: Integrated annual meetings of IOGOOS and its allied projects and programs	IOGOOS Workshop and integrated annual meetings, 5-9 May 2025, Port Louis, Mauritius	Now
WP 3: International Indian Ocean Science Conference (IIOSC)-2025	2025Q4, Hyderabad, India	Upcoming

71,881 USD provided to IOGOOS in 2024-2025 biennium.



# FUTURE PLANS

- ☐ **International Indian Ocean Science Conference (IIOSC)-2025**
- ☐ **Ocean Literacy Programs under UN Ocean Decade framework in partnership with DCC-IOR and INCOIS**
- ☐ **Revise IOGOOS Strategy (sync to GOOS priorities and align UNOD) and Work Plans**
- ☐ **Implementation of addendum to the IIOE-2 science plan and revised implementation strategy aligned with the UN Decade of Ocean Science for Sustainable Development**
- ☐ **Connect science with social science for effective policymaking**
- ☐ **Better connections among GRAs on collaborative activities (Observing systems and capacity building activities) and Sharing of scientific knowledge and experience**

# IIOSC 2025



**International Indian Ocean  
Science Conference**  
01-05 December, 2025  
Hyderabad, India

**International Indian Ocean Science  
Conference (IIOSC) – 2025**  
**01-05 December 2025**  
**Hyderabad, India**



**International Indian Ocean  
Science Conference**  
01-05 December, 2025  
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## IIOSC 2025

International Indian Ocean Science Conference 2025

**01-05 December 2025**  
INCOIS, Hyderabad, India

FLASH UPDATES

### About US



#### Background

The Second International Indian Ocean Expedition (IIOE-2) was launched in December 2015 at the culmination of the Indian Ocean Conference at Goa to mark the completion of 50 years of the first International Indian Ocean Expedition. The IIOE-2 is a multi-national, multi-institutional programme to advance our understanding of the physical, chemical, biological, geological, and climatological aspects of the Indian Ocean to enhance its role in the socio-economy of the region.

#### Important Dates

- 📅 **Announcement : April 25 2025!**
- 📅 **Call for Abstracts: Submit before August 04, 2025.**
- 📅 **Registration Opens: September 01, 2025.**
- 📅 **Last Date for Online Registration: October 15, 2025.**
- 📅 **Conference: 01 & 05 December, 2025**



THANK YOU