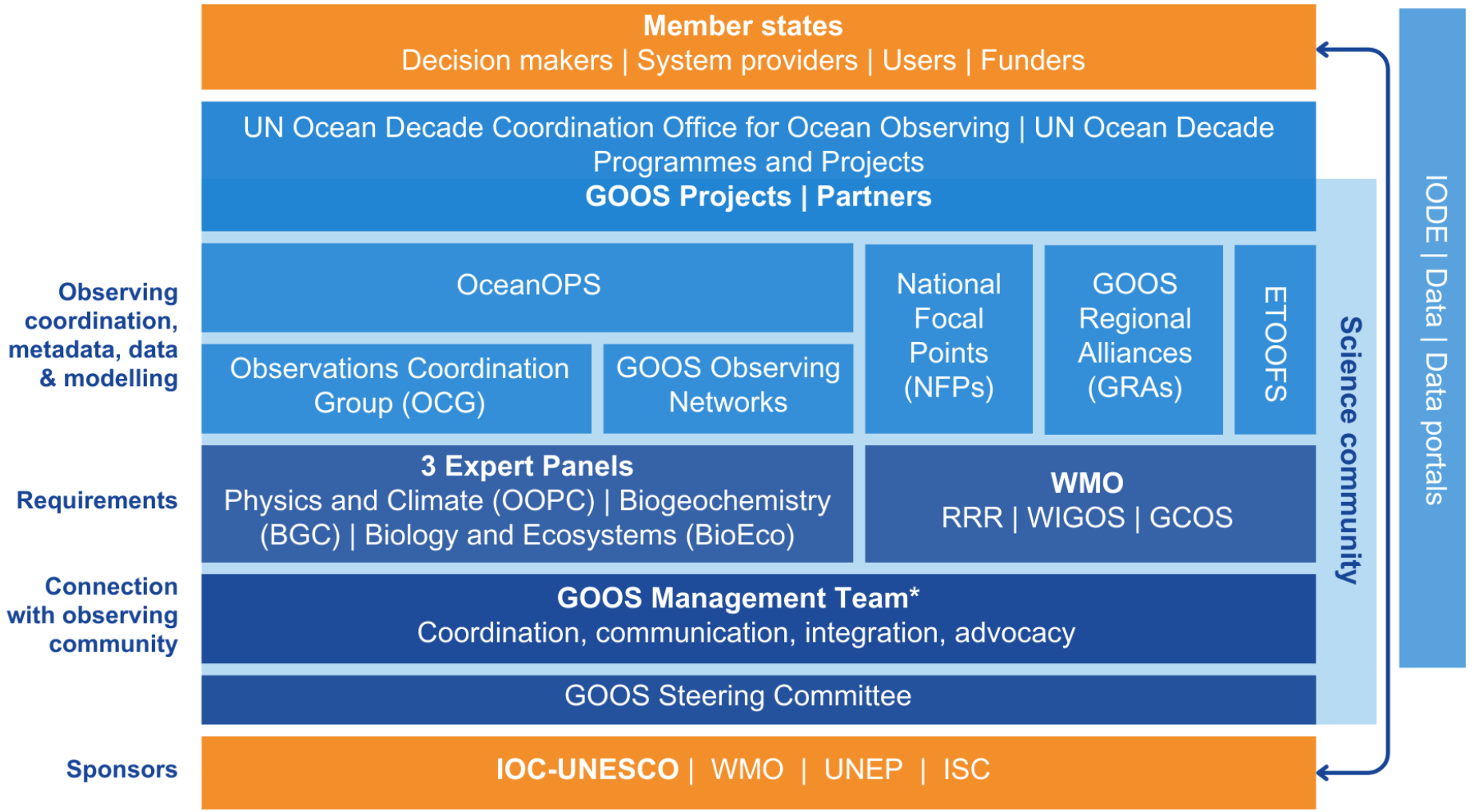
Data Buoy Cooperation Panel (DBCP) Capacity Building Workshop on Ocean Observations for Operational Services in the Indian Ocean Region

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

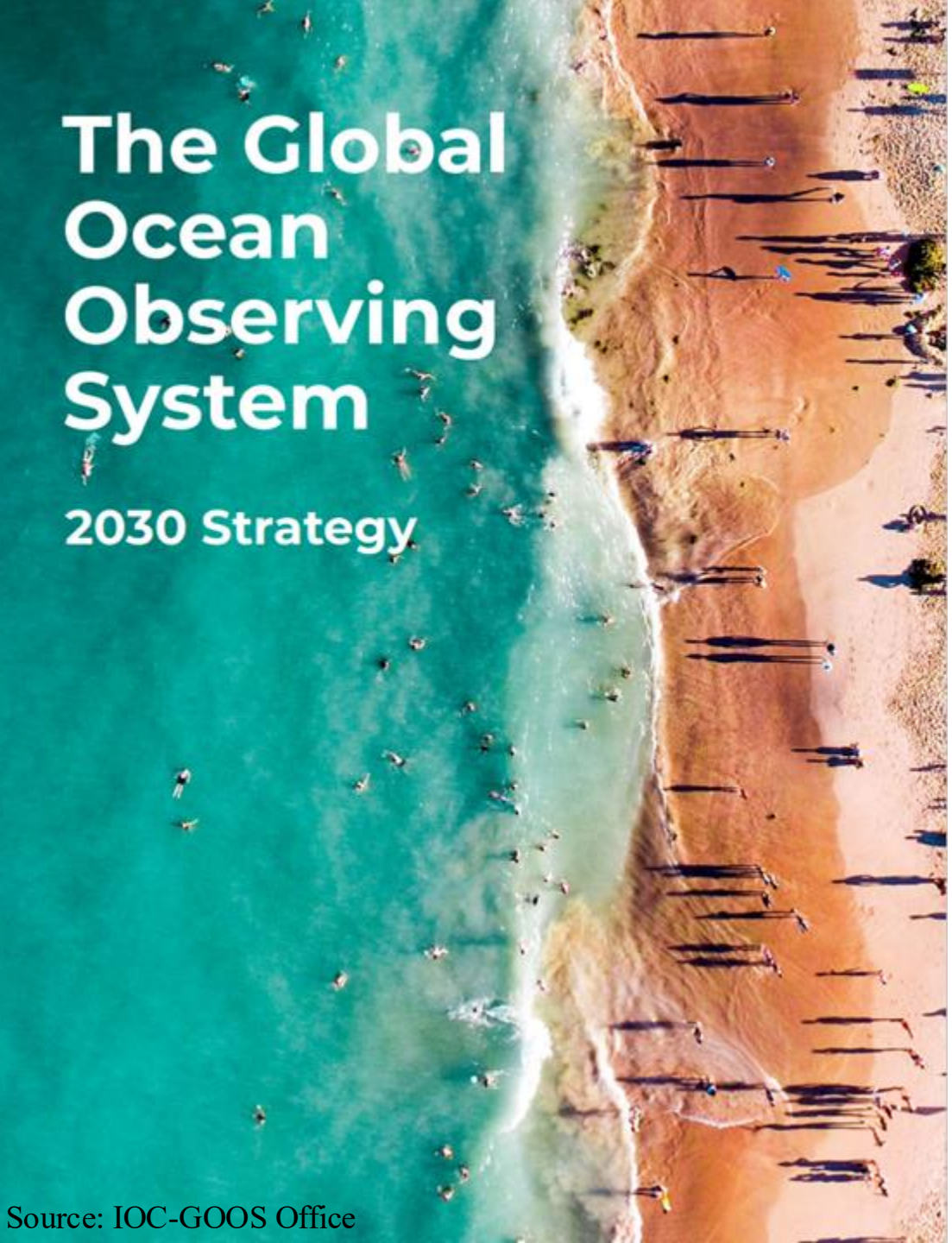
Presented by

M. Nagaraja Kumar
Secretary, IOGOOS

GOOS Structure



Source: IOC-GOOS Office



Source: IOC-GOOS Office

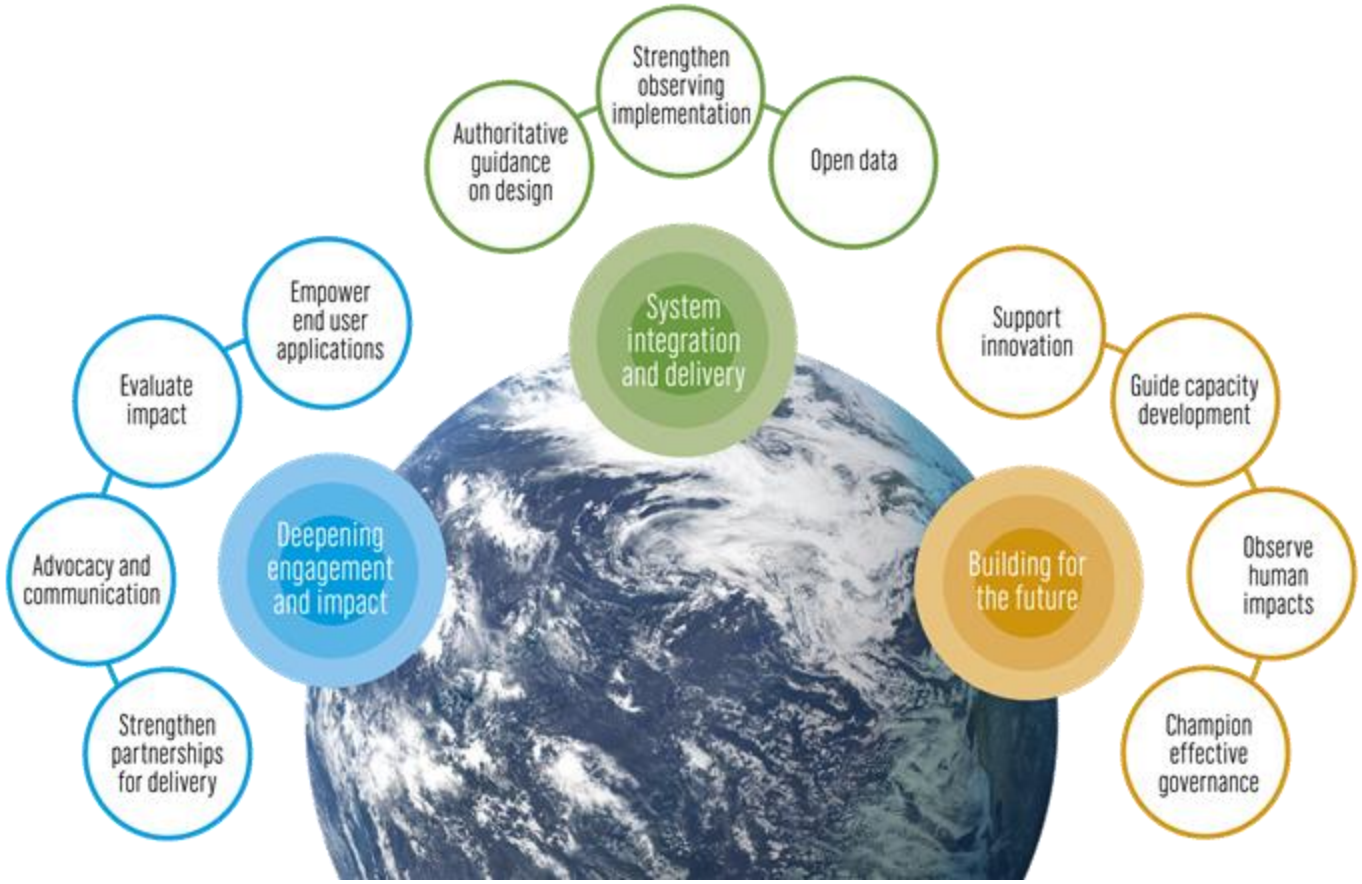
Sustained observations for a wide range of applications

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

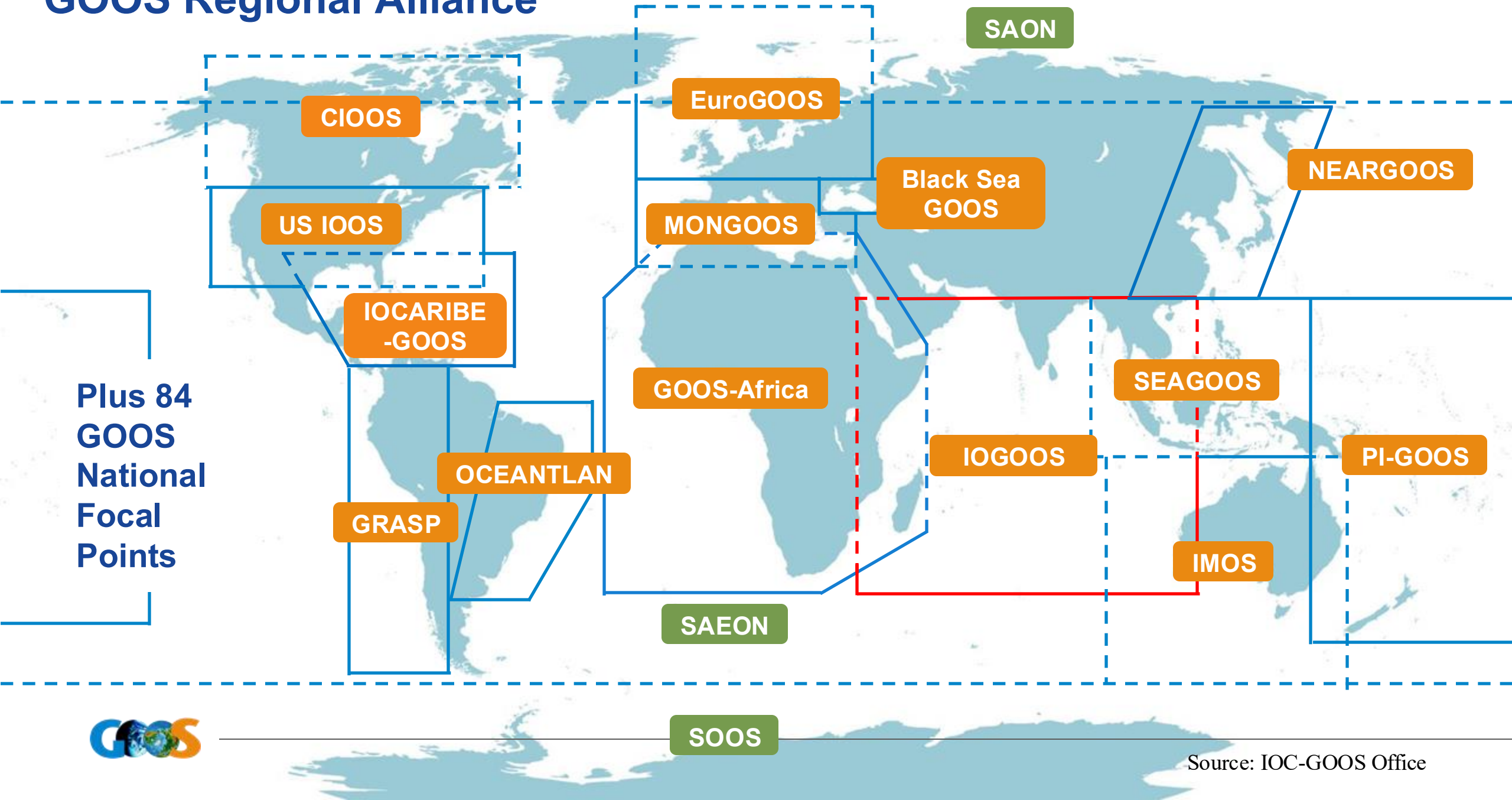
Mission
To lead the ocean observing community and create the partnerships to grow an integrated, responsive and sustained observing system



Strategic Objectives

Source: IOC-GOOS Office

GOOS Regional Alliance



Plus 84 GOOS National Focal Points

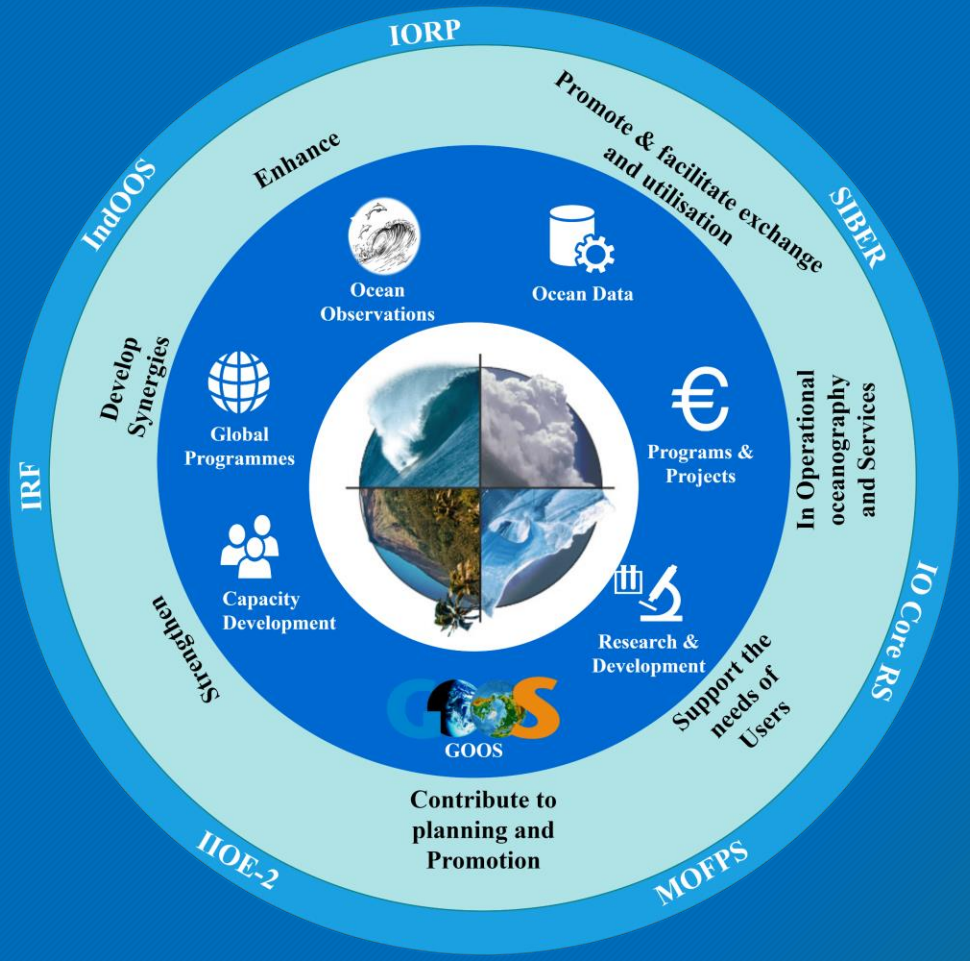
Source: IOC-GOOS Office

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).

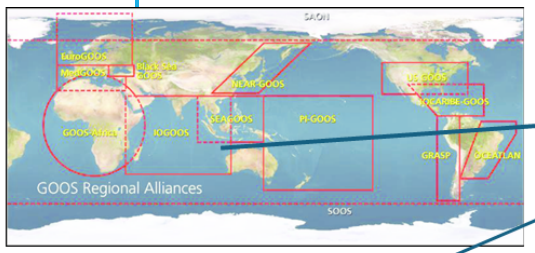
https://incois.gov.in/iogoos/home.jsp

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,
- Encourage research to support the needs of Users,
- Develop synergies with other ocean programmes and regional GOOS bodies, and
- Strengthen capacity building for enhancing the capabilities in the region,
- 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

IOGOOS

IOC / IOC Regional Bodies / Sub commissions

Members

Associate Members

Officers

Regional

Scientific/Technical/ Services

Western IO

Central IO

Eastern IO

HLO 1: Marine Hazards
HLO 2: Climate Change
HLO 3: Ecosystem Health
HLO 4: Environment Management

In-situ Observations

Remote Sensing

Modeling

Capacity Building

Co-aligned with the Secretariats

- IOGOOS
- IRF
- SIBER
- IIOE-2
- DCC-IOR

IIOE-2

SIBER

IORP

Remote Sensing

MOFPS

CoLAB

IndOOS

ChloroGIN-IO

Harmful Algal Blooms

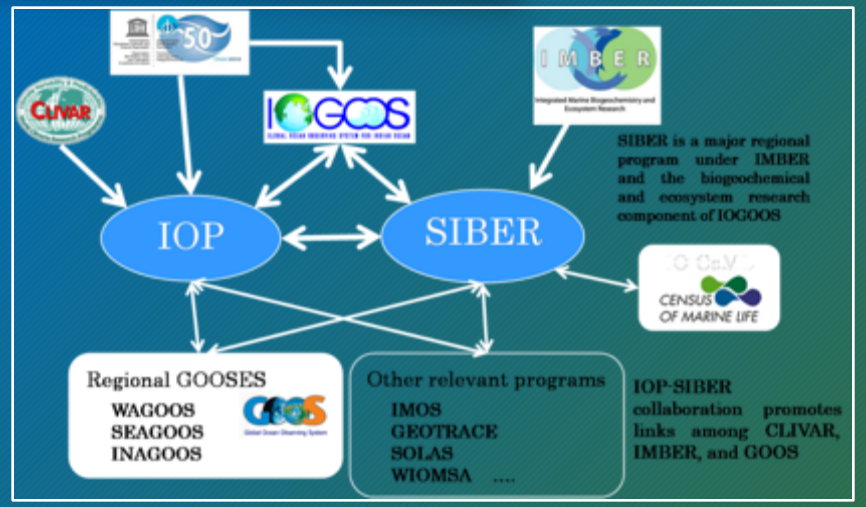
Marine Heat Wave

IOGOOS was ahead of other GRAs as it not just focused on Observations but also in applications / services beneficial for the region

The concept of 'Co-Design" was introduced in early 2002 and the programs and projects were evolved through this co-design process

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

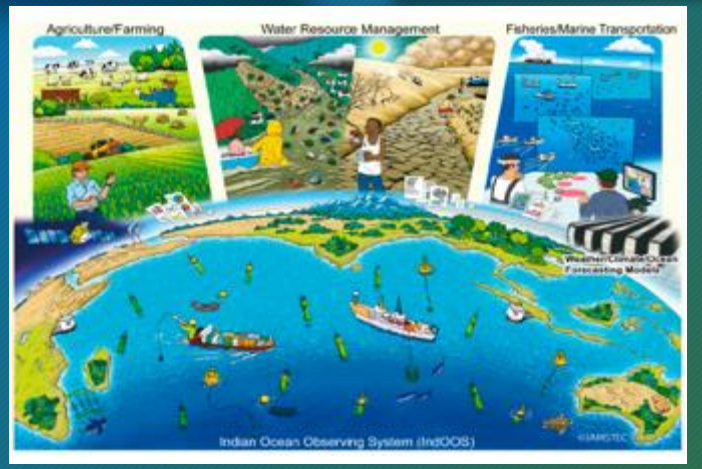
- **> 50 Nations around (mostly developing ones)**
- **1.5 Billion Population**
- **Rapid growth in blue economies and opportunities to harness ocean resources and services**
- **Agriculture Farming dependent on Monsoon**
- **Marine Fisheries dependent on ocean conditions**
- **Coastal populations vulnerable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

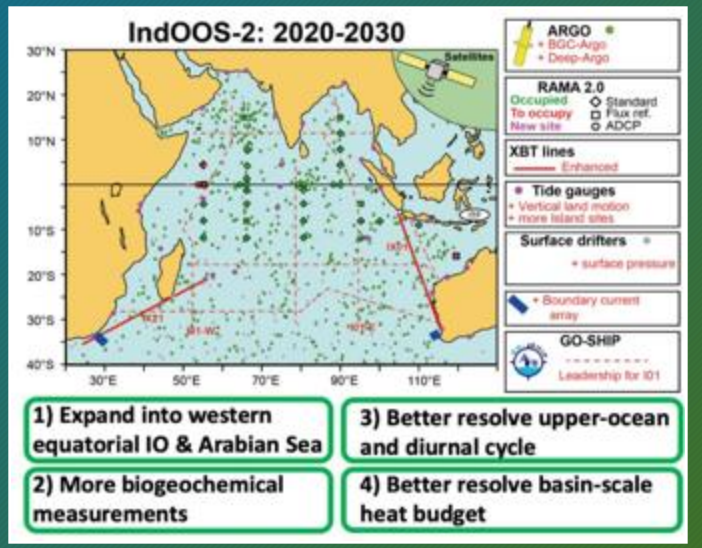
Science Drivers

- 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



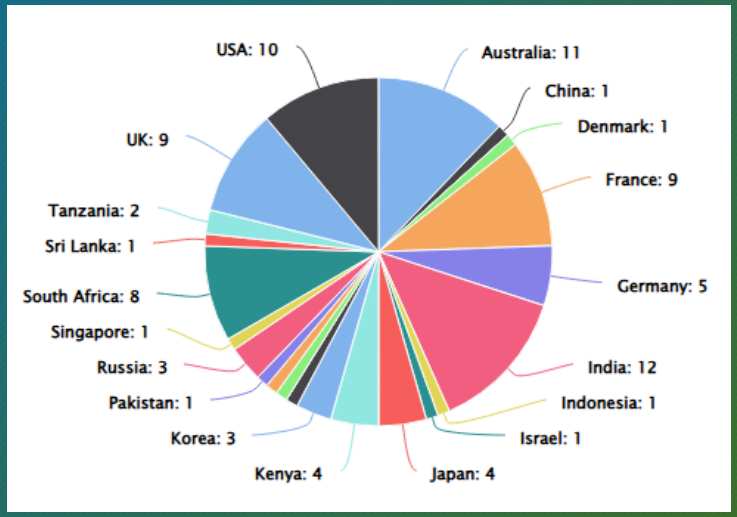


IndOOS-2
A roadmap to sustained observations of the Indian Ocean for 2020-2030

Ocean Observations – IIOE-2

- 2nd 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).

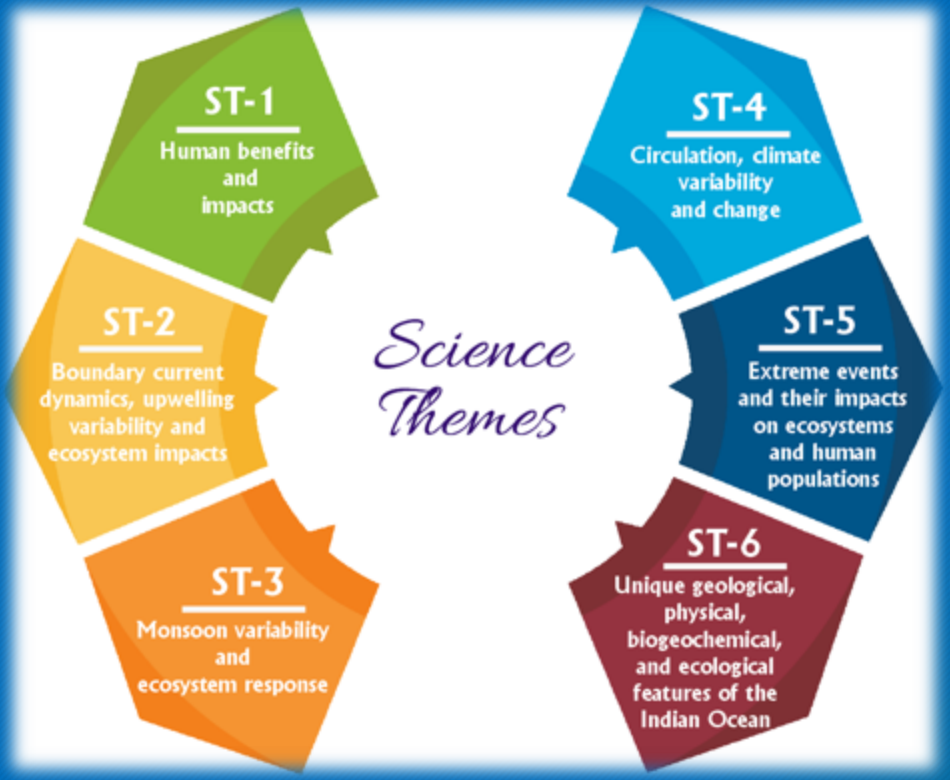

WebGIS Application for IIOE-2



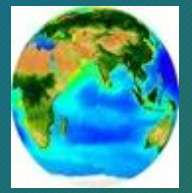
Ocean Science and Research

2nd International Indian Ocean Expedition 2015-2025

Science Themes & Working Groups



SIBER Science Plan



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

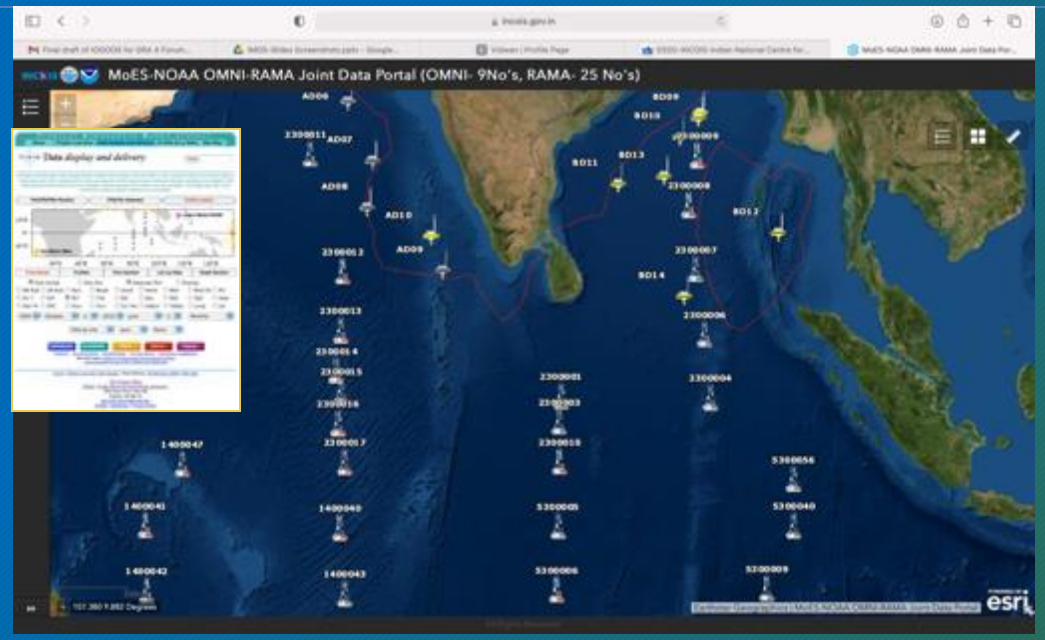
Theme 4: Controls and fates of phytoplankton and benthic production in the Indian Ocean

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



IODE International Oceanographic Data and Information Exchange

United Nations Educational, Scientific and Cultural Organization

Intergovernmental Oceanographic Commission

IOGOOS

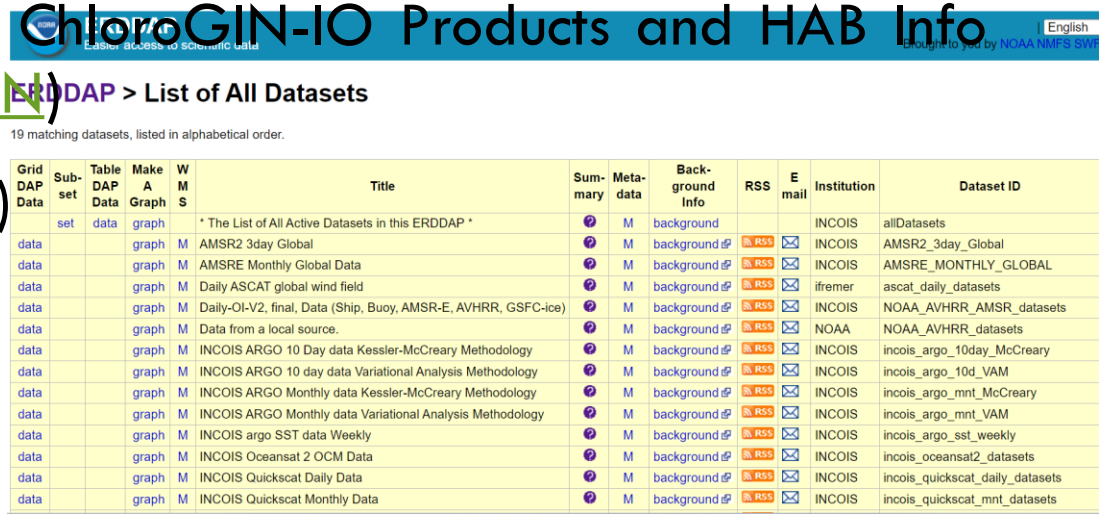
Digital Ocean

Argo

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)
- 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

can search the data availability from MoES institutes



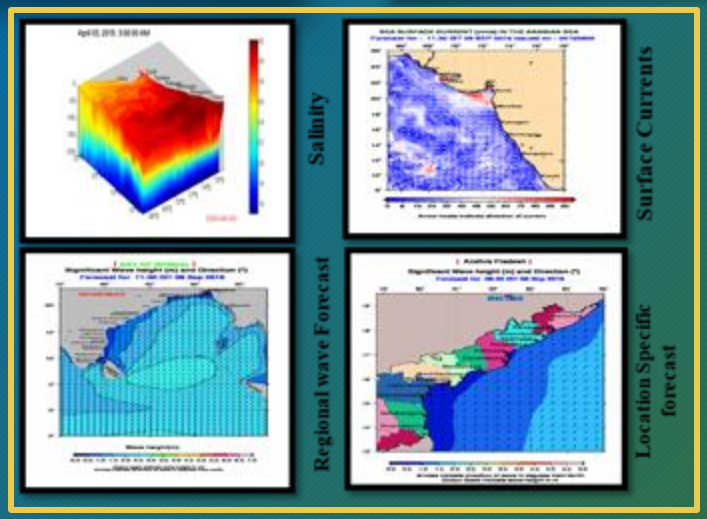
ERDDAP > List of All Datasets

19 matching datasets, listed in alphabetical order.

Grid DAP Data	Sub-set	Table DAP Data	Make A Graph	WMS	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	RSS		INCOIS	AMSR2_3day_Global
data			graph	M	AMSRE Monthly Global Data		M	background	RSS		INCOIS	AMSRE_MONTHLY_GLOBAL
data			graph	M	Daily ASCAT global wind field		M	background	RSS		ifremer	ascat_daily_datasets
data			graph	M	Daily-OI-V2, final, Data (Ship, Buoy, AMSR-E, AVHRR, GSFC-ice)		M	background	RSS		INCOIS	NOAA_AVHRR_AMSR_datasets
data			graph	M	Data from a local source.		M	background	RSS		NOAA	NOAA_AVHRR_datasets
data			graph	M	INCOIS ARGO 10 Day data Kessler-McCreary Methodology		M	background	RSS		INCOIS	incois_argo_10day_McCreary
data			graph	M	INCOIS ARGO 10 day data Variational Analysis Methodology		M	background	RSS		INCOIS	incois_argo_10d_VAM
data			graph	M	INCOIS ARGO Monthly data Kessler-McCreary Methodology		M	background	RSS		INCOIS	incois_argo_mnt_McCreary
data			graph	M	INCOIS ARGO Monthly data Variational Analysis Methodology		M	background	RSS		INCOIS	incois_argo_mnt_VAM
data			graph	M	INCOIS argo SST data Weekly		M	background	RSS		INCOIS	incois_argo_sst_weekly
data			graph	M	INCOIS Oceansat 2 OCM Data		M	background	RSS		INCOIS	incois_oceansat2_datasets
data			graph	M	INCOIS Quickscat Daily Data		M	background	RSS		INCOIS	incois_quickscat_daily_datasets
data			graph	M	INCOIS Quickscat Monthly Data		M	background	RSS		INCOIS	incois_quickscat_mnt_datasets

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




Oman-Chl

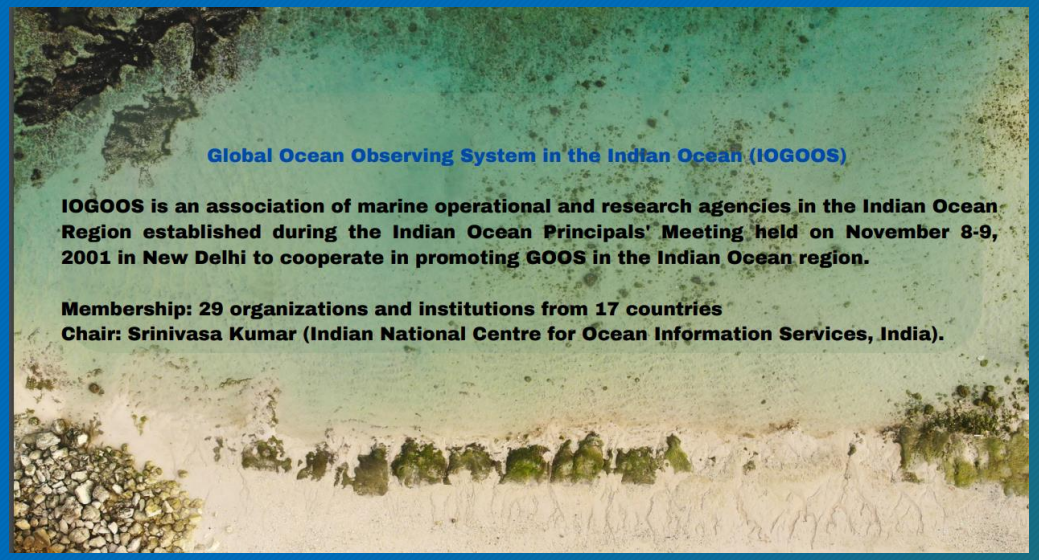
Iran-chl

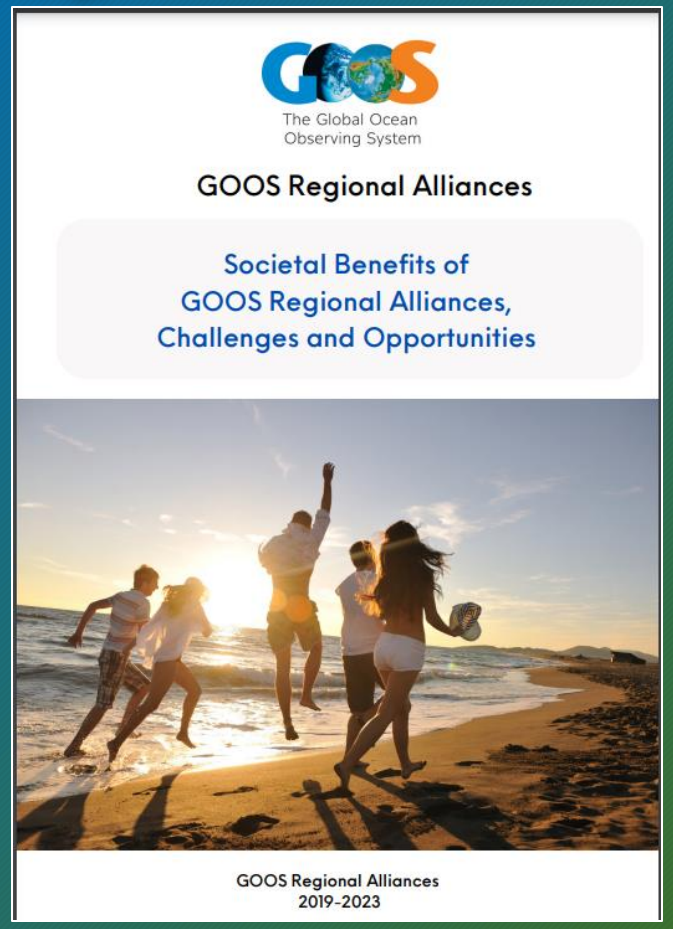

Tanzania-K490

Kenya - SST

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

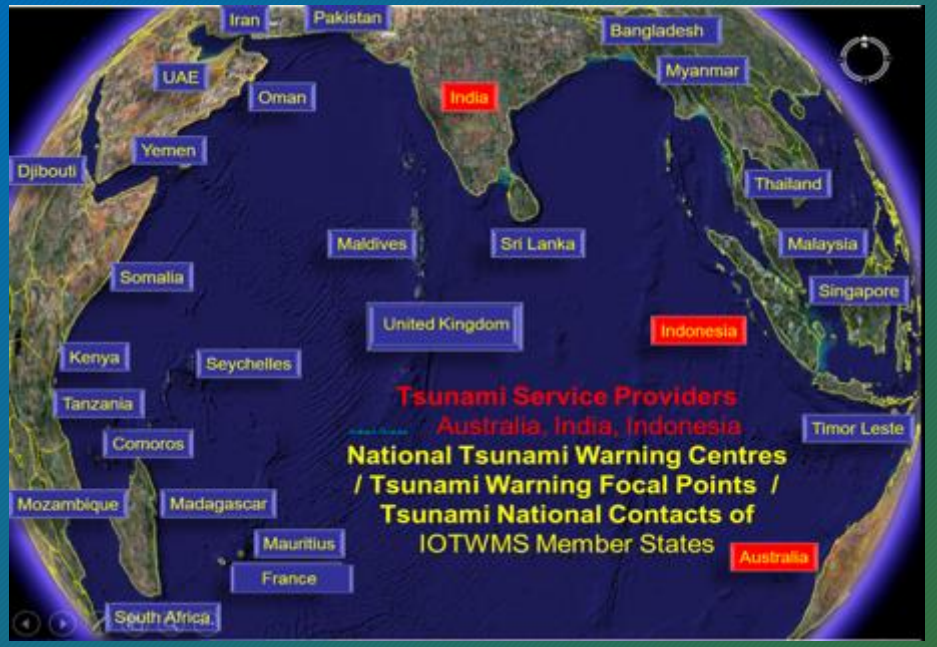




Ocean Forecasting & Services - Tsunami

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



CAPACITY BUILDING

IOGOOS
GLOBAL OCEAN OBSERVING SYSTEM FOR INDIAN OCEAN

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, Ocean Forecasting and Ocean Decade themes

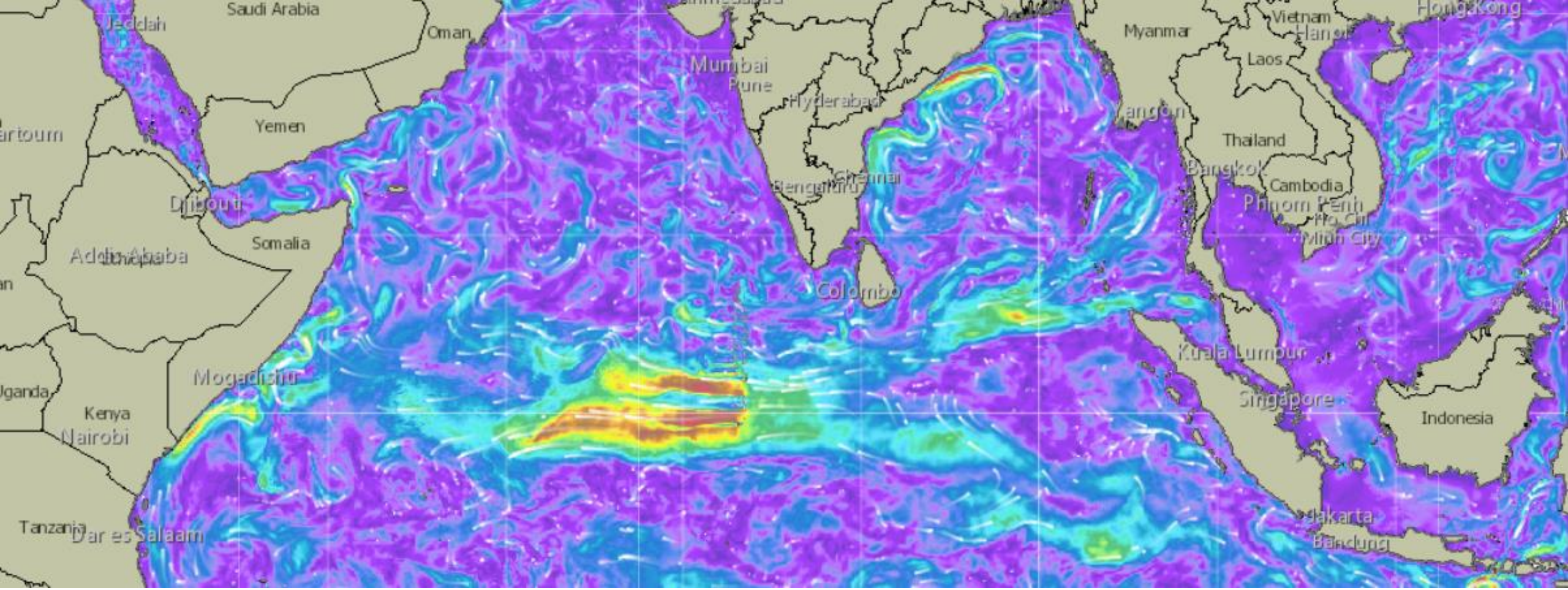
ITCOocean: https://incois.gov.in/ITCOocean/index.jsp

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

United Nations Educational, Scientific and Cultural Organization
Intergovernmental Oceanographic Commission
OceanTeacher GLOBAL ACADEMY

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 (MOFPS)

IOGOOS
GLOBAL OCEAN OBSERVING SYSTEM FOR INDIAN OCEAN

2008:Planning; 2009-2014: several meetings (A regional country by country, gap/needs analysis (reported) Community of practice established)

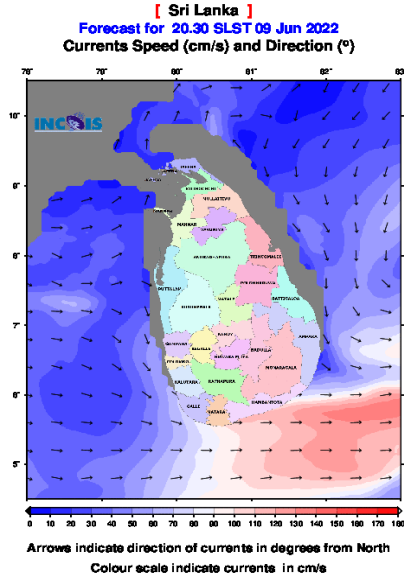
MODELLING FOR OCEAN FORECASTING AND PROCESS STUDIES (MOFPS)

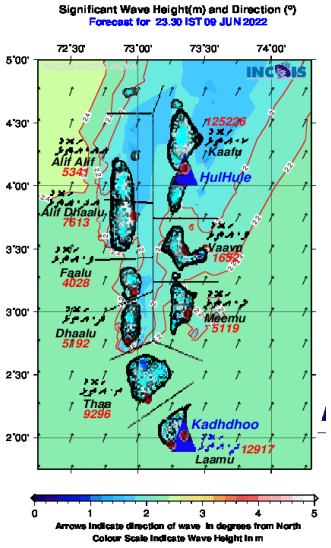
- Increased interest in the region
- Aligning with the 'UN Ocean Decade" through OceanPredict Program
- The detailed survey form designed in June 2023
  https://forms.office.com/r/CZME07EK8P
  - General Information (Name, Affiliation, Filed of work, Products user or not, etc.) and more specific information 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 1st Regional Teams meeting with ocean modelling products stakeholders

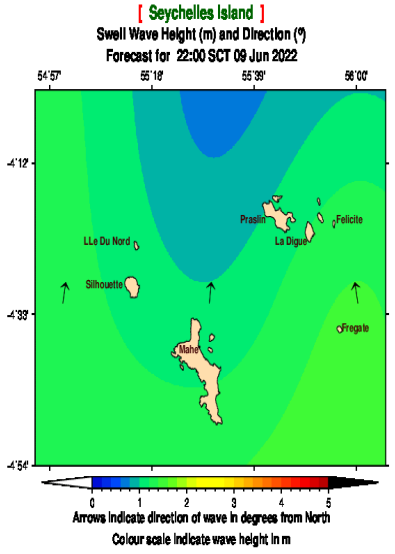
Ocean Services for Member States

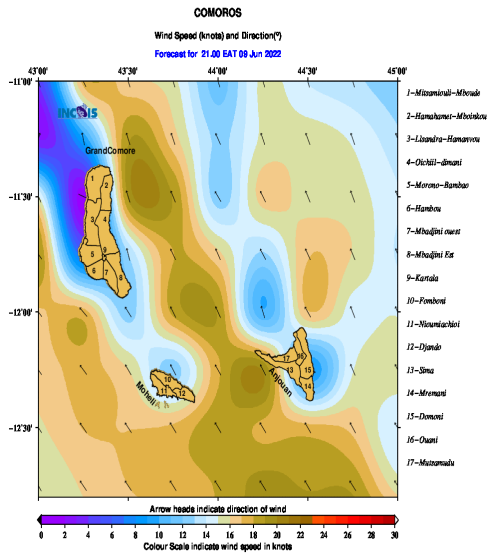
INCOIS provides Ocean Services to Regional Integrated Multi-Hazard Early Warning System for Africa and Asia (RIMES) countries (Maldives, Seychelles, Sri Lanka, Comoros, Madagascar and Mozambique) – 3-day forecast

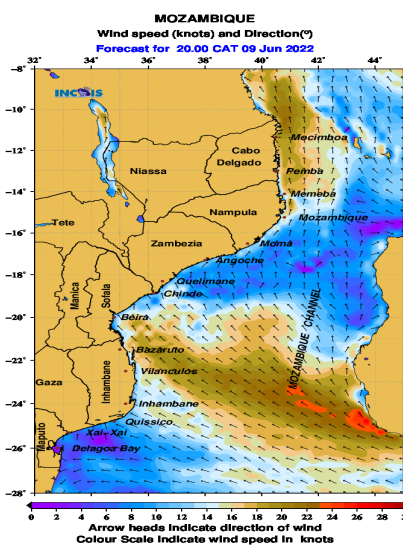
	Parameters									
Country	**Wave**	**Wave period**	**Swell**	**Swell period**	**Wind**	**Sea Surface Temperature**	**Mixed Layer Depth**	**Surface Currents**	**Location Specific stations**	**High Wave Alert**
Maldives (3 regions separately)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	21	Yes
Seychelles	Yes	Yes	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

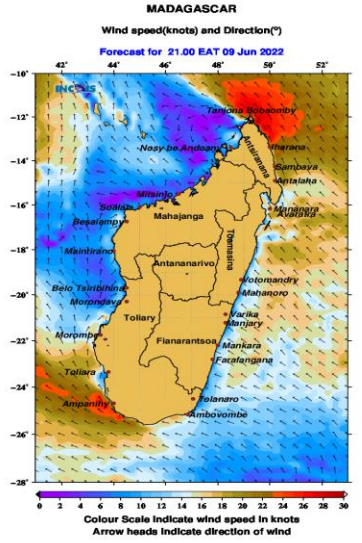












WEB PORTAL FOR OCEAN PREDICTION

Regional Specialized Meteorological Centre (RSMC)
for Numerical Ocean Wave Prediction
and Global Numerical Ocean Prediction

Indian National Centre for Ocean Information Services (INCOIS)

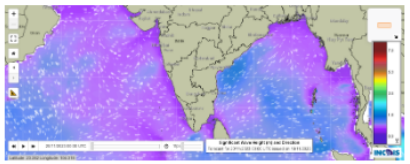
Home Publications Waves Ocean Prediction

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.

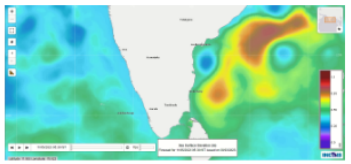
Waves



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

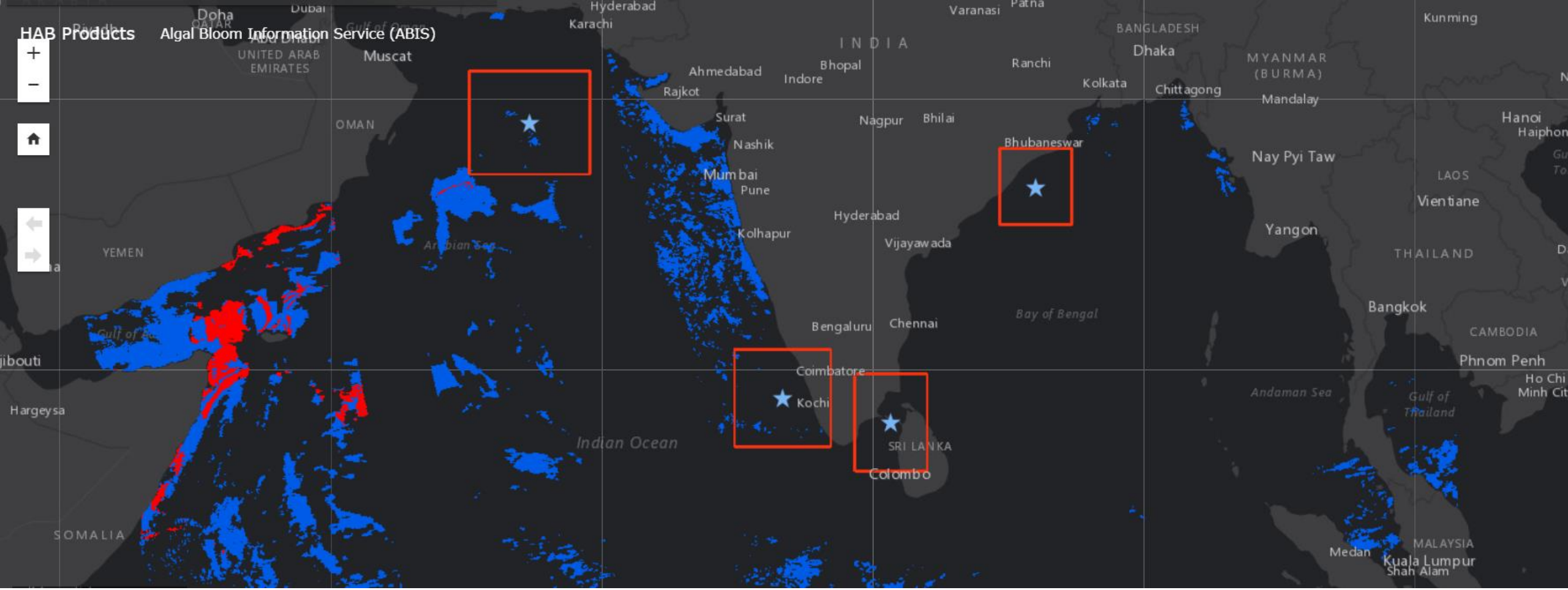
Ocean Prediction



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

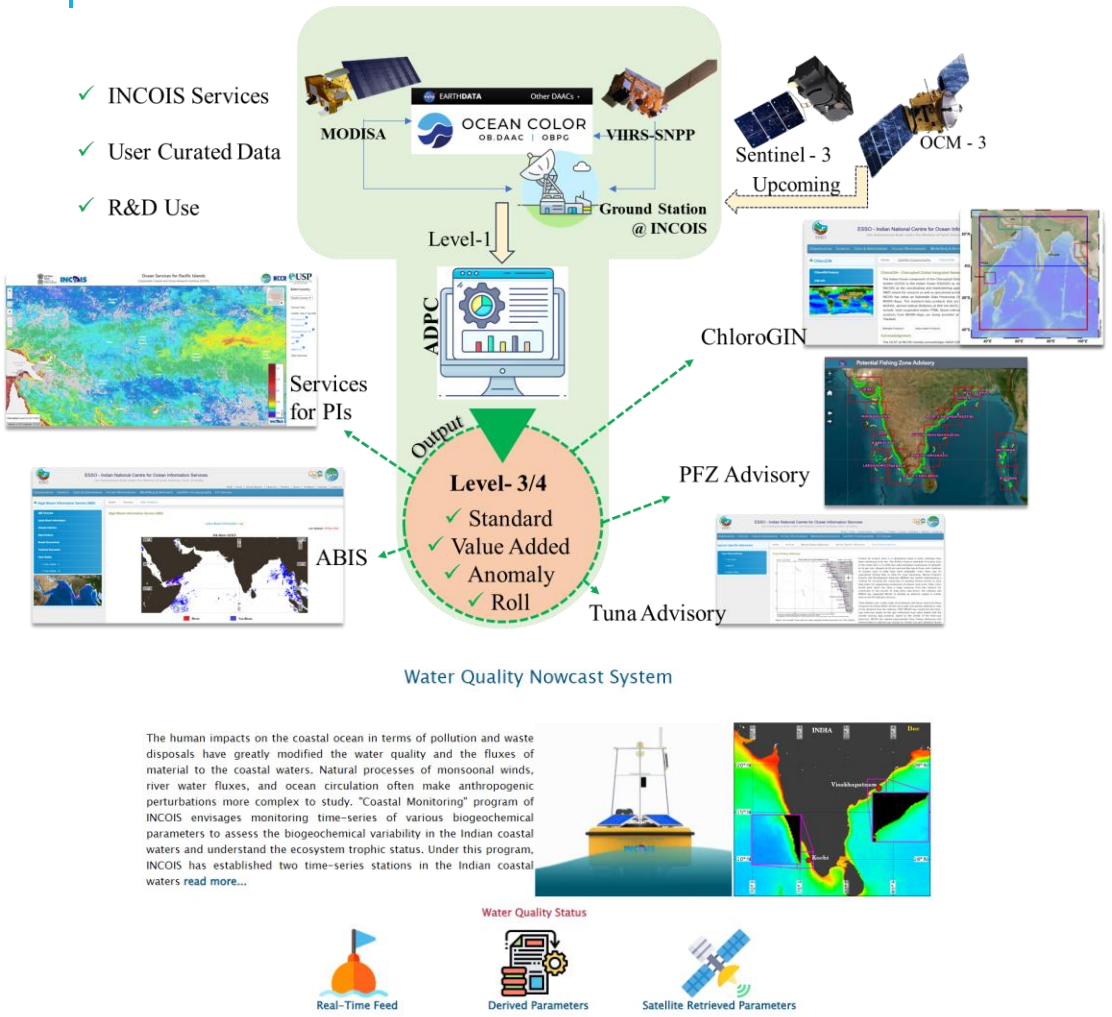
https://incois.gov.in/oceanservices/rsmc.jsp



INDIAN OCEAN CORE REMOTE SENSING PROJECT

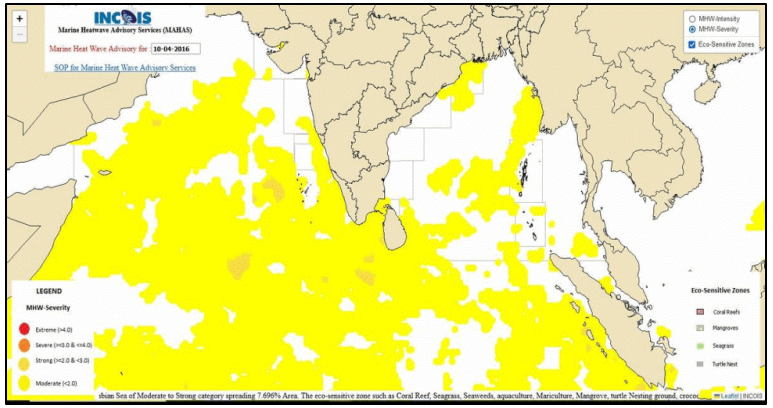
IOGOOS
GLOBAL OCEAN OBSERVING SYSTEM FOR INDIAN OCEAN

REMOTE SENSING PRODUCTS / SERVICES - UPDATES



- 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



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
IIOSC-2025

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

THANK YOU