

Second International Indian Ocean Expedition (IIOE-2)

Report to
Scientific Committee on Oceanic Research (SCOR)

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by

IIOE-2 Project Office

Indian National Centre for Ocean Information Services (INCOIS),
"Ocean Valley", Pragathi Nagar (BO), Nizampet (SO),
Hyderabad - 500 090, Telangana, India.

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1. Goal

The goal of IIOE-2 is to advance our understanding of the Indian Ocean and its role in the Earth System in order to enable weather-climate predictions and informed decisions in support of sustainable ocean development, climate resilience, and the well-being of humankind.

2. Preamble

The Second International Indian Ocean Expedition (IIOE-2) is a major global scientific program that engages the international scientific community in collaborative oceanographic and atmospheric research from coastal environments to the deep sea revealing new information on the Indian Ocean (i.e. its currents, its influence upon the climate, its marine ecosystems) which is fundamental for future sustainable development and expansion of the Indian Ocean's blue economy. The program was initially formulated for a period of five years (2015-2020) which was subsequently extended for another five years (till 2025) considering its importance. A large number of scientists from research institutions from around the Indian Ocean and beyond planned their involvement in IIOE-2 in accordance with the IIOE-2 Science Plan and its overarching six scientific themes of the program. IIOE-2 activities also include a significant focus on the capacity building of nations around the Indian Ocean to understand and apply observational data or research outputs for their own socio-economic requirements and decisions. In addition, an Early Career Scientists Network (ECSN) was also formed to facilitate the exchange of knowledge, translation of the science and information outputs for societal benefit, and the training of early career constituents from surrounding nations in these areas. Details on the IIOE-2's program, including its the governance structure, Steering Committee (SC), National committees, working groups and science themes are available at <https://iioe-2.incois.gov.in/IIOE-2/index.jsp>.

3. Governance

The IIOE-2 is co-sponsored by Intergovernmental Oceanographic Commission (IOC) of UNESCO, Scientific Committee on Oceanic Research (SCOR) and GOOS Regional Alliance for Indian Ocean (IOGOOS). Collectively these autonomous international bodies, each involved in the science in the Indian Ocean, takes responsibility for facilitating funding of the infrastructure of IIOE-2 including resourcing of the Project Office (PO) with node in India. A duly constituted Steering Committee (SC) sets the high-level policies and take responsibility for the delivery of the project

The principles underlying the structure and representativeness of the IIOE-2 Steering Committee (SC) were first specified in the Strategic Framework (https://iioe-2.incois.gov.in/IIOE-2/pdfviewer.jsp?docname=Strategic_Framework.pdf) for the implementation of IIOE-2.

A duly constituted Steering Committee (SC) sets the high-level policies and take responsibility for the delivery of the project. The IIOE-2 SC consists of a Core Group and a Stakeholder Group as structured below:

Steering Committee	Core Group	Co-Chairs			Coordinator of IIOE-2 PO as ex-officio member
		Representative from IOC	Representative from SCOR	Representative from IOGOOS	
		Strategic Executive Level			
	Co-Chairs of the Three Working Groups Co-Chairs of the Six Science Themes Chair, IOCINDIO Chair, IOC Africa Chair, IOC WESTPAC				
	Stakeholder Group	Regional Coordination Level			
		One representative per each IIOE-2 'National committee'			
		Science Delivery Level			
		One representative (i.e. PI) per each 'major' IIOE-2 scientific research initiative, including a representative of the Early Career Scientists Network			
<i>Schematic showing structure of the IIOE-2 Steering Committee</i>					

The Core Group is co-chaired by the nominated representatives from IOC, SCOR and IOGOOS and includes co-chairs of the three working groups and the six Science Themes. In addition, the Strategic Executive Level is composed of representatives of key Indian Ocean-related IOC Regional Bodies and Committees and coordinator of the IIOE-2 PO.

This Stakeholder Group comprises of a Regional Coordination Level consisting of representatives of IIOE-2 'National Committees'; and a Science Delivery Level, with a leading scientist (typically the Chair or the PI) from each major science initiative endorsed/implemented under the IOE-2's science framework.

The IIOE-2 Project Office (PO) is a nodal point executing IIOE-2 and has day-to-day responsibility for the coordination and implementation of IIOE-2. The IIOE-2 Project Office is presently hosted by the Indian National Centre for Ocean Information Services (INCOIS), Hyderabad, India. The PO facilitates all aspects of IIOE-2, particularly the science and associated infrastructure as well as capacity building, operational coordination, outreach/communication, data/information management, etc.

The updated detail so the IIOE-2 governance framework is available at <https://iioe-2.incois.gov.in/IIOE-2/Governance.jsp>.

4. The 8th Meeting of the Steering Committee of IIOE-2 (SC-8)

The 8th Meeting of the Steering Committee of IIOE-2 (SC-8) was held along with the annual integrated annual meetings of the Indian Ocean Global Ocean Observing System (IOGOOS) and its allied programs such as the Second International Indian Ocean Expedition (IIOE-2), Sustained Indian Ocean Bio-geochemical and Ecological Research (SIBER), IndoOS Resource Forum (IRF) and Indian Ocean Regional Panel (IORP), along with the Korea-US Indian Ocean Science (KUDOS) and Early Career Scientist Network (ECSN) workshop during May 5-9, 2025 at Labourdonnais Waterfront Hotel, Port Louis, Mauritius. The meeting was hosted by Department for Continental Shelf, Maritime Zones Administration & Exploration of Prime Minister Office, Republic of Mauritius. The details, including information booklet, agenda and Action Taken Report against recommendation of the SC-7 is available at <https://iioe-2.incois.gov.in/IIOE-2/SC8.jsp>. The deliberation from the leads of the core and stakeholder group is in the following sub-section.

4.1. National Committee

The representatives from 10 countries (Australia, France, Germany, India, Indonesia, Japan, Korea, South Africa, United States of America, United Kingdom) presented the national activities under IIOE-2. Dr T M Balakrishnan Nair presented the National Committee Report for India. Intan Suci Nurhati presented for Indonesia on behalf of Ocky Karna Radjasa. There was no presentation from China.

- **Australia: Lynnath Beckley**

Prof. Lynnath Beckley presented Australia's contributions to the Second International Indian Ocean Expedition (IIOE-2). Prof Beckley highlights the status of seven endorsed projects and their outcomes in terms of conference talks and publications showcasing Australia's significant involvement in IIOE-2. She mentioned the changes in the Australian IIOE-2 committee, which comprises about 21 representatives from diverse institutions nationwide. Notable miscellaneous other contributions include the Monaco expedition in the western Indian Ocean and the BLOOFINZ project are briefed. Dr. Beckley also noted the supporting services and infrastructure for IIO-2 activities from the Bureau of Meteorology, the Marine National Facility and Marine Parks. The significance of Geoscience Australia and event-based sampling strategies is discussed. Prof. Beckley concluded the report by highlighting updates on integrated marine observing systems (IMOS).

- **France: Jean-François Ternon**

Dr Jean Francois Ternon presented the IIOE-2 National Committee report from France, highlighting the updates of diverse French projects covered under six scientific themes of the IIOE-2. The project, Vulnerability of Kenyan Coastal Ecosystems under climate and non-climatic stress (IRP VOKCE), contributes to ST-1 and ST-6. While Bio-physical coupling at sub-mesoscale in the Southwest Indian Ocean: the RESILIENCE project is included in ST-2. The report also provided information on other projects such as OISO (carbon observations since 1997), THEMISTO (mesozooplankton and micronekton ecology), and HOA-GEODAMS (hydroacoustic and geophysical monitoring of ridge

dynamics near Amsterdam Island). The REVOSIMA observatory is now fully operating for monitoring of volcanic and seismic activity. The report concluded by detailing future endeavours such as the Deep-Sea Research Special Issue, articles on all 8 scientific projects of the Monaco Exploration, and the Final Science to Policy Workshop planned in Mauritius (November 2025).

- **Germany: Birgit Gaye on behalf of Hermann Bange**

Prof. Birgit Gaye presented the German National Committee Report summarising ongoing and planned research initiatives and cruises. The committee was established in 2016 by the German SCOR committee, which comprises distinguished members from various institutions. Notable projects include EASI, focusing on East Antarctic Ice Sheet Instabilities, and BIOGIN-IIOE2, investigating biochemistry in the equatorial Indian Ocean. Funded projects like INDOCRISIS and SAMOVAR aim to understand oceanic responses to climate change and monsoon variability. The Bengal shelf cruise investigated the interplay of monsoon, tectonics, and subsidence of anthropogenic impact. Biogeochemistry-Atmosphere Processes in the Bay of Bengal: A contribution to the International Indian Ocean Expedition 2 (BIOCAT-IIOE-2) aim to understand the nitrogen cycling and atmospheric interactions of trace gases. The other completed cruises include Emerging pollutants and microplastic abundance in surface waters of the Indian Ocean (EPOLIO), CoWIO: Cold Water Corals in the West Indian Ocean and GEOTRACES GIO7– South Indian Ocean. Additionally, the report discussed the collaborations between institutions and publications, including the IO Book and articles by prominent researchers.

- **India: T.M. Balakrishnan Nair**

Dr. T.M. Balakrishnan Nair presented the national committee report for India at the IIOE-2 SC8 meeting. The report highlighted India's active contributions to Indian Ocean research through MoES institutions, research cruises, and IIOE-2 project office India activities. The report covered the multiple cruises conducted in 2024-2025, which included EKAMSAT and glider deployment and recovery across the Arabian Sea, the coast of Mauritius, the central Indian Ocean, and the Southern Ocean. Coastal expeditions addressed jellyfish aggregations in the Bay of Bengal and sensor validation for water quality observatories off Kochi. The report also provided details about the number of upcoming cruises under EKAMSAT and the deep ocean mission. The IIOE-2 Project Office India maintained the active IIOE-2 website, metadata portal and endorsed project that align with IIOE-2. The office is also involved in active outreach activities through the Indian Ocean Bubble and the monthly newsletter. The presentation emphasized that these efforts strengthen India's capacity in observational oceanography and contribute significantly to the objectives of IIOE-2.

- **Indonesia: Intan Suci Nurhati on behalf of Ocky Karna Radjasa**

Dr Intan Suci Nurhati presented Indonesia's report on the International Indian Ocean Expedition-2 (IIOE-2) on behalf of Ocky Karna Radjasa. It covered the updates on Ocean observation, ocean literacy and various research on biogeochemistry. Key highlights include Indonesia Cable-Based Tsunameter (INACBT), Strategic Maritime Observing

System and Ocean Literacy Program to Strengthen Socio-Economic Resilience in Coastal Areas. Presentation detailed about three scientific cruises carried out in 2024, including Java Trench Expedition (IDSSE) for deep-sea biodiversity and geology, Indonesian Mission (OCEANX) for Multidisciplinary studies, and southern Java upwelling and TRIUMP (FIO, UMD) for studies on Indonesian Throughflow. The report discussed the Indonesia Marine Biogeochemistry Forum, a collaborative platform for advancing marine biogeochemistry research in Indonesia, which acts as a bridge for SIBER activities. Additionally, the recent publication and ongoing work on sources of oxygen-depleted waters and upwelling-induced oxygen-depleted waters in the Sumatra-Java coasts are also covered. A Pan-CLIVAR meeting will be held from 22-26 September 2025 in Bali, Indonesia, bringing together CLIVAR members from all panels, Research Foci, and SSG, as well as representatives from WCRP core-projects and external partners.

- **Japan: Yukio Masumoto**

The third term of the IIOE-2 National committee, chaired by Dr Yukio Masumoto, started in October 2023 for another 3 years to cover the period of IIOE-2. The committee was established in 2017 and has actively promoted Indian Ocean research. The committee aims to advance IIOE-2 within Japan, facilitate outreach activities, and discuss future research directions. The recent activities include R/V Hakuho-Maru cruise, research promotion using existing data and numerical models, and organisation of Indian Ocean Sessions at JpGU and OSJ Fall Meeting. The committee also conducted an expedition in collaboration with the Mauritius government under the MOU between AORI and CSMZAE. The report highlighted various research activities and publications. The notable research work includes Interdecadal modulation of Ningaloo Nino/ Nina strength by the AMO, Oceanic processes for interannual SST variability in the Somali Current region, and Modulation of Surface Seawater CO₂ System at 80°E: Impacts of the Positive IOD in 2019. Through its initiatives, the committee drives progress in Indian Ocean science and nurtures partnerships across the global oceanographic community.

- **Korea – Dong-Jin Kang**

Dr Dong-Jin Kang presented the IIOE-2 National Committee report for Korea. The IIOE-2 activities through the KIOS project are led by the Korean Institute of Ocean Science & Technology (KIOST). The report highlighted recent cruises, the status of the RAMA mooring, and project updates. Notable other endeavours include underwater gliders and high-resolution nutrient observations. Publications cover diverse topics, such as Particulate Organic Carbon Export Fluxes, acoustic characterisation of fish and macroplankton, marine heatwaves, and microplastics. The report also emphasized active involvement in capacity building and public outreach through YouTube, the IIOE-2 Newsletter, and a seminar organised by the Korea Science Journalists Association. The conclusion outlined future plans, including scientific expeditions, financial support for KIOS, and international collaboration and workshops.

- **South Africa: Jenny Huggett**

The South African Initiatives in support of IIOE-2, presented by Dr Jenny Huggett, highlighted the South African-led /co-led Endorsed Projects and collaborations. Project EP-

56, A Regional Marine Spatial Plan for the Western Indian Ocean (WIO MSP), aim to create an inclusive and holistic MSP process that produces a regional marine spatial plan to support the sustainable management of ocean and coastal ecosystems for all. While the project EP-57, The role of the Agulhas Current on the Coastal Environment, aims to investigate the influence of the Agulhas Current, and in particular processes and anomalous physical events (such as meanders, trapped cyclonic eddies and upwelling), on the adjacent coastal region and downstream in Algoa Bay. Multiple cruises and deployment of the Seatrec Argo float and Uncrewed Surface Vehicle are carried out as part of this project. Further regional research cruises in the WIO by a possible joint exercise between 3 Departments, including Forestry, Fisheries & Environment (DFFE), Science and Innovation (DSI) and Higher Education & Training (DHET). The United Nations Ocean Decade framework (2021-2030) endorsed an action programme called The OceanX and OceanQuest 'Around Africa Expedition' contributes to the capacity building and scientific understanding of the ocean. Additionally, different levels of microplastic monitoring projects and SGD reporting contribute comprehensive understanding of the region's marine environment. The report also discussed Pelagic High Seas Ocean eCoregionalisation in the Indian Subantarctic (PHOCIS) project, which aims to develop a spatial understanding of the pelagic ecosystem in the epi- and mesopelagic zones across the CCAMLR subantarctic Indian Ocean region. The report concluded with a briefing on the 13th WIOMSA Scientific Symposium, which will be held at Mombasa, Kenya, from 28th September – 3rd October 2025.

- **United States of America: Raleigh Hood**

Prof. Raleigh Hood presented the national committee report for the United States, highlighting US IIOE-2 Steering Committee activities, Korea–US Bilateral activities, and RAMA 2.0 activities. The Steering Committee aims to track US research activities in the Indian Ocean and submit proposals to ONR, NSF, NOAA, and NASA to conduct research in the Indian Ocean. The report provides the details of the IIOE-2 website hosted by the US Ocean Carbon Biogeochemistry Program and the Science plan of the steering committee. The US has 10 endorsed projects and discussed the update of completed and upcoming projects. The presentation further briefed the updates of KUDOS, which has institutionalised KUDOS cruises into 2026 and is supporting RAMA and other international collaborative efforts. The report concluded with details on RAMA.2, in which seven deployments in 2024 were conducted with support from India and Korea, and more than 15 moorings are now functioning.

- **United Kingdom: Greg Cowie**

Dr Greg Cowie presented the National report for the United Kingdom. The University of Plymouth led the United Kingdom in the Indian Ocean research, and the national committee report highlighted the progress and outcome of four projects in the Indian Ocean. As part of the Oceanographic drivers of ecosystem variability in the Chagos Archipelago, three research cruises were conducted with extensive physical oceanography, mesophotic coral, fisheries acoustics, and multibeam surveys. Another project on multi-scale numeric modelling aims to explain how physical oceanography drives ecosystem response and

species behavior throughout the Indian Ocean. The report also discussed the other notable projects, such as Mesophotic bleaching during the 2024-2025 El Niño event, and Vulnerability and resilience of mesophotic coral ecosystems (MCEs) to climate change. The report concluded with an emphasis on capacity building, including cost-effective observational methods and training programs in Ghana and Kenya.

4.2. Working Group

The updates of three working groups (WG) of IIOE-2 are highlighted below:

- *WG-1: Science and Research – Raleigh Hood*

The IIOE-2 Working Group I report outlined the progress in international participation and research initiatives, the status of working groups, scientific themes and Cruises/ RAMA activities, and the products associated with IIOE-2. The research initiative consists of 52 endorsed projects involving 20 countries and focuses on the Indian Ocean upwelling, maritime continents, and KUDOS. A new initiative called Coastal Observation Lab in a Box (COLaB) was introduced to provide low-cost instruments for training for physical, biological and biogeochemical coastal observations in the region. According to the IPO website, 16 Official IIOE-2 research cruises have been completed thus far, and more than 75 Official Cruises are completed, ongoing and planned. Seven deployments in 2024 with support from India and Korea were carried out as part of RAMA.2, and more than 15 moorings are functioning now. More than 80 papers have been published in special issues on IIOE-2 in DSR II and also published an interdisciplinary Elsevier book of synthesis chapters on the Indian Ocean. The report concluded with details on the IIOE-2 Science Plan Addendum, which was presented to SCOR at their annual meeting in Shanghai in October 2024.

- *WG-2: Data and Information Management – E. Pattabhi Rama Rao*

The Co-Chair of IIOE-2 WG-2, E. Pattabhi Ramarao, highlighted Terms of Reference on Data and Information Management, progress of working group II activities, details on the Metadata portal, and future plans on Data and Information Management. As part of working group 2 activities, the Regional Coordination Unit for IIOE-2 Data and Information Management was established at ESSO-INCOIS, Hyderabad. Data Policy reviewed and finalised in consultation with Raleigh, IODE Co-Chair and Head, IODE, Nick and Satya and presented to SC-4 in Apr 2021. Data Policy was approved in the SC-5 Meeting in Mar 2022. Metadata portal developed and posted metadata of 12 cruises, and Metadata format, user guide, along with Login Credentials have been sent to all the PIs of the Cruises endorsed by IIOE-2 and requested to submit the Metadata as per the data policy of IIOE-2. PIs of the endorsed project are requested to follow up on the status of projects and Metadata submission with a few questionnaires. The report detailed the 12 of 57 endorsed projects, which submitted the Metadata to the portal. Modification of the IIOE-2 Metadata Portal to include support for JSON-LD (JavaScript Object Notation for Linked Data) is completed. The report also discussed the list of core measurements with units for the IIOE-2 scientific activities. The report concluded with the plans, including continuing the collection of

metadata and data from the endorsed projects, developing quality control/quality assurance procedures and developing and updating data and information management capacity

- *WG-3: Operational Coordination – N. Kiran Kumar on behalf of Rajan Sivaramakrishnan*

The WG-3 report of IIOE-2 was presented by N. Kiran Kumar on behalf of Rajan Sivaramakrishnan. The report highlighted the detailed Terms of Reference of WG-3 Operational Coordination. Additionally report focused on the activities carried out as part of operational and coordination. Management of the central web-based expedition planning and progress utility linked to the IIOE-2 website. Development of a WebGIS application for endorsed projects along with the Buoy Observations Network. WG-3 & Project Office has developed a webpage to publish all the IIOE-2 endorsed projects with respect to science themes, endorsement form, etc. A new website has been operational for the Early Career Scientist Network (ECSN) and shared with all the members of ECSN. A new Website has been operational for Coastal Observation Lab in a Box (COLaB) and shared with all the members of SIBER. The Indian Ocean Bubble Issue and online newsletter highlighting IIOE-2 events contribute to the outreach activities. The report also discussed the major constraints, like non-submission of plans/ progress of studies by many of the PIs and non-availability of bathymetric data collected during the cruises. The report concluded with the details of IIOSC- 2025, which will be held at INCOIS, Hyderabad, India, from 1st to 5th of December, 2025.

4.3. Science Theme

The co-chairs of the six science themes (ST) presented the latest updates. The details of the endorsed projects under various science themes are available at https://iioe-2.incois.gov.in/IIOE-2/Endorsed_Projects.jsp. The significant updates are highlighted below:

- *Theme-1: Human Impacts and Benefits – by Halina Kobryn*

Theme 1 of the IIOE-2 initiative encompasses a diverse array of research endeavours to understand how human-induced ocean stressors impact the biogeochemistry and ecology of the Indian Ocean and how this affects human populations. The report highlighted the status of the endorsed project under this theme. 16 projects that list the human benefits and impacts component, six are completed, five are ongoing, and two are new. However, CIs of three projects did not respond to requests for updates. Completed projects have yielded valuable insights into marine ecosystems, while ongoing projects continue to expand our understanding and support conservation efforts. The future task includes cross-checking the outcomes of all endorsed projects against the research questions embedded in the science plan to identify any remaining gaps. Understanding additional research questions embedded in the research plan will further guide efforts to ensure the sustainability of the marine environment.

- *Theme-2: Boundary current dynamics, upwelling variability and ecosystem impacts – by P. N. Vinayachandran*

The ST-2 focused on boundary current dynamics, upwelling variability, and ecosystem impacts in the Indian Ocean, and the report covered the recent cruises and research highlights. The cruise SO305 - BIOCAT-IIOE-2 with RV Sonne took place in April/May 2024 with an interdisciplinary measurement program that combined physical, chemical, biogeochemical and biological measurements in the Bay of Bengal. The main goal is to improve our understanding of the physical processes that impact the development and maintenance of the Oxygen Minimum Zone (OMZ) in the Bay of Bengal. R/V Hakuho-maru cruises were conducted with interdisciplinary observations in the Eastern Indian Ocean. Other research highlights included studies on submesoscale processes associated with the East India coastal current, the role of submesoscale dynamics on phytoplankton distributions, and river plume cyclone interaction. The report also discussed the other relevant publications which contribute to ST-2 of IIOE-2.

- *Theme-3: Monsoon variability and ecosystem response – by Adrian Matthews*

The ST-3 focused on the Monsoon variability and ecosystem response. This theme aims to understand the factors controlling monsoon variability, impact on ocean physics, chemistry and biogeochemistry in the Indian Ocean, and its effects on ecosystems, fisheries and human populations. The report highlighted the endorsed projects, recent cruises, and significant scientific findings associated with ST-3. The progress of work includes the INDO-US collaborative study, EKAMSAT, and BoBBLE were discussed. Other notable projects and scientific work, such as observations over the Tropical Western Indian Ocean, Recent and Future Trends in the Arabian Sea Oxygen Minimum Zone, and BIOSCape - Mapping of phytoplankton functional types (PFTs) from space in support of coastal resource management and decision support activities, are briefed. The report also emphasized the establishment of the International Joint Laboratory on estuarine and coastal research between China & Pakistan, the scientific studies in the Marginal Sea – the Arabian Gulf, and the contribution of Oman to monsoonal variability and ecosystem responses. Monsoonal variability and fisheries are also discussed in the ST-3 report, in which the ongoing activities are highlighted. Establishment of Arabian Sea Fisheries Management Coordination Committee, collection of databases on fishermen, fishing fleet, size, fishing type, gears and technology adopted, and health camps are a few activities that come under monsoon variability and fisheries. Overall, the activities under ST-3 contribute to understanding the complex dynamic nature of monsoon variabilities and their impacts on ecosystems as well as on human life.

- *Theme-4: Circulation, climate variability and change – by Helen Phillips*

The report highlighted the project and science updates on ST-4, co-chaired by Dr Helen Phillips and Prof. Amit Tandon. The ST-4 focuses on circulation, climate variability and change in the Indian Ocean. There are 31 endorsed projects aligned with ST4, well distributed across countries, 7 projects endorsed since 2020 and two projects since SC 7 of IIOE-2. Project updates feature ongoing investigations, such as the role of the Agulhas Current on coastal ecosystems, and the KIOST Indian Ocean Study. The report discussed the project Hydrodynamics and biogeochemistry of the Indian Ocean sector of the Southern Ocean, and also the achievements of Indian Scientific Expeditions to the Southern Ocean.

Scientific updates delve into topics like Mixed Rossby Gravity (MRG) waves at the equatorial Indian Ocean, Measurements and Modelling of the Indonesian Throughflow, and Enhancing Knowledge of the Arabian Sea Marine environment through Science and Advanced Training (EKAMSAT). The report detailed the status of EKAMSAT cruises and scientific work. The outlook emphasises rejuvenating the committee, reviewing endorsed projects and encouraging new ones and broad sharing of works.

- *Theme-5: Extreme events and their impacts on ecosystems and human populations – by Roxy Mathew Koll*

The ST-5, Extreme events and their impacts on ecosystems and human populations, presented by Roxy Mathew Koll from the Indian Institute of Tropical Meteorology, highlighted the status of the endorsed project under ST-5. There are 8 projects endorsed under ST-5, and all 58 endorsed projects under IIOE-2 are contacted for relevant inputs for ST-5. A total of 7 relevant inputs were received out of 30 total responses. The project EP13 on Eastern Indian Ocean Upwelling Research Initiative provides insights into extreme events like the extreme 2019 IOD and marine heatwave over the eastern Indian Ocean. The project EP23, The influence of the Indian Ocean sector of the Southern Ocean dynamics and biogeochemistry on the tropical weather and climate, also provides insights into extreme events like warming and acidification, with their impacts on the ecosystem and human life. The report overviewed the different endorsed projects' insights on extreme events and their consequences, which include projects EP26, EP32, E42, EP43, and EP55. The presentation emphasized the significance of sustained ocean observations and regional partnerships in understanding and mitigating the impacts of extreme events.

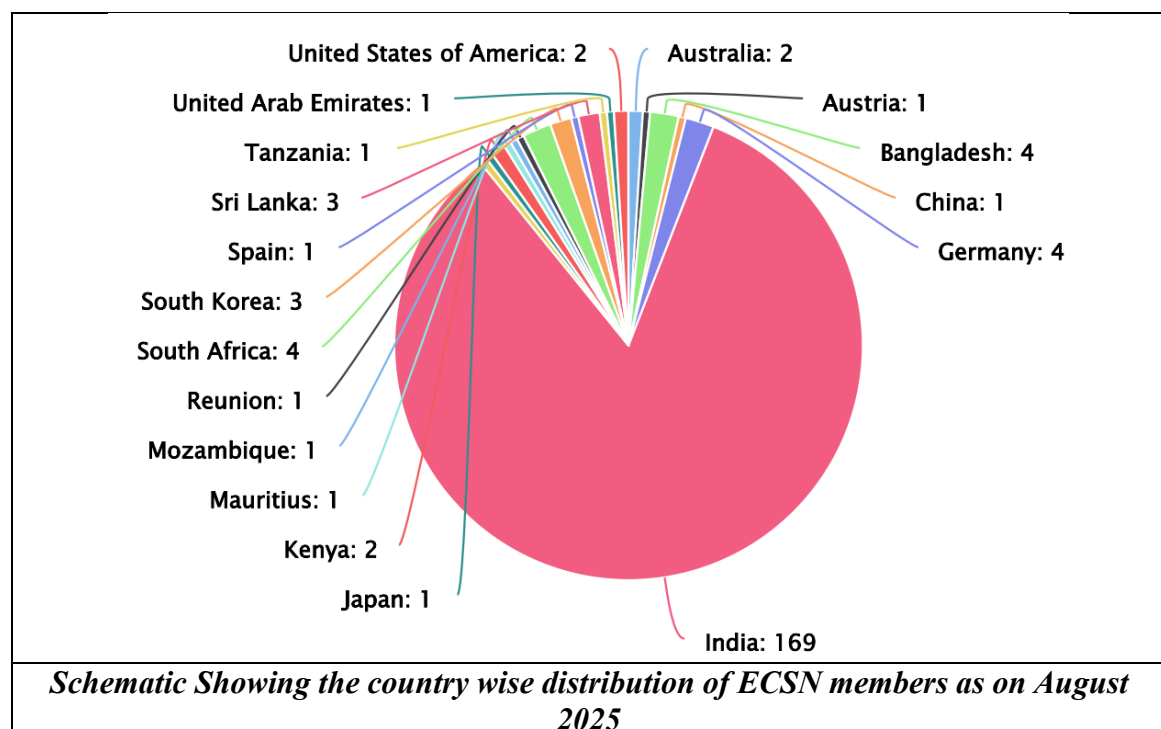
- *Theme-6: Unique geological, physical, biogeochemical and ecological characteristics of the Indian Ocean – by Lynnath Beckley*

The ST-6 focused on the Unique geological, physical, biogeochemical and ecological characteristics of the Indian Ocean. More than 50% of the endorsed projects under IIOE-2 contributed to the ST-6. Three additional projects were added since SC-7 of IIOE-2 to make a total of 31 endorsed projects for the ST-6. The report highlighted the status, progress, key results & publications of the endorsed projects. These projects are highly variable, from small modelling projects to large ones like SOLSTICE, NEKTON & Monaco Expedition. The new project EP56 focuses on the regional Marine Spatial Plan for the WIO. EP55 investigate on vulnerability of Kenyan coastal ecosystems under climatic stress (VOKCE), which includes climate science using paleo-reconstruction and assessing non-climate stressors. The EP53, EXPAND, aims to quantitatively understand the impact of the IO subtropical gyre expansion on biological N fixation & subsequent productivity. Many projects covering the unique biodiversity of canyons, seamounts, ridges & banks in the IO and biogeochemistry projects are often linked with GO-SHIP or GEOTRACES. Overall, these projects contribute crucial insights into the complex dynamics and biodiversity of the Indian Ocean, addressing key scientific and environmental challenges.

4.4. Early Career Scientist Network

The Early Career Scientists Network (ECSN) of IIOE-2 is a collaborative and supportive community that aims to foster professional development, knowledge exchange, and collaborations among emerging scientists, including graduate students, postdoctoral researchers, junior faculty members or researchers within the first decade of their research career. Encompassing diverse domains of ocean sciences, the network facilitates the sharing of expertise and methodologies, to bridge early career researchers (ECRs) working on the Indian Ocean and promote interdisciplinary research. We are dedicated to nurturing the new generation of scientists from the Indian Ocean-rimmed countries to advance the understanding of the Indian Ocean's diverse and interconnected marine systems. The core committee visualizes and develops agenda, takes decisions, executes activities, empowers ECRs, provides opportunities, and maintains the vibrancy of the ECSN (<https://iioe-2.incois.gov.in/ecsn/corecomitee.jsp>). The Advisory Committee Establishes the core committee, mentors and supports the progress, reviews activities, and provides specialized knowledge and input (<https://iioe-2.incois.gov.in/ecsn/advisory.jsp>).

Dr Aditi Modi, co-chair of IIOE-2 ECSN presented the status report during IIOE-2 SC-8 meeting. The presentation was focussed on the objectives of the ECSN followed by the membership status. As of now, total 203 members are enrolled in ECSN with each member with the unique ID. The IIOE-2 project office is supporting ECSN with a dedicated web page to disseminate the information.



The members of ECSN continues with the monthly seminar series on Indian Ocean featuring Theme: Ocean insights - Indian Ocean Seminar Series, co-authored book chapters on Indian Ocean observing systems, contributed to the Second International Indian Ocean Expedition (IIOE-2) Science Plan Addendum and also participated in several cruises in the Indian Ocean. In addition, the members of the ECSN contributed to IIOE-2 and EGU special synthesis reports, conducted IPCC and Ocean Decade review, executing Indo-

French collaborative project endorsed by IIOE-2 and contributed to online course on Fishery Oceanography for Future Professionals. The details on the ECSN and their activities are available at <https://iioe-2.incois.gov.in/ecsn/index.html>.

4.5. Reviewing membership of working groups and science themes

The IIOE-2 PO periodically reviews the membership of the Working Groups (WG) and the Science Themes (ST). The PO has communicated to co-chairs and members of the each WG and ST to provide willingness to continue the membership. The status of the membership is available at https://iioe-2.incois.gov.in/documents/IIOE-2/IIOESC2024/IIOE2_ST_WG-MembershipStatus.pdf. The IIOE-2 SC-8 asked the co-chairs to identify the new members, in the place of one who are not willing to continue and communicate to the PO. The PO will then compile the information and forward to the IIOE-2 co-chairs for the approval and further implementation.

5. Endorsement of Scientific Projects

Total 62 researched projects have been endorsed under IIOE-2, out of which seven were endorsed during September 2024 to August 2015 which include: (1) A regional marine spatial plan for the Western Indian Ocean, (2) The role of the Agulhas Current on the coastal environment, (3) Advancing predictions of marine heatwaves, (4) R/V Hakuho-Marui Eastern Indian Ocean cruise 2024 (KH-24-3), (5) Mechanism and potential of carbon storage in the upper-mesopelagic layer of tropical East Indian Ocean, (6) Trends and ecosystem responses in marginal seas of the northwestern Indian Ocean: A synthesis of biogeochemical and biological data and (7) Deriving key ocean circulation variables to enhance IMOS observation off Western Australia. The details about the endorsed project is available at https://iioe-2.incois.gov.in/IIOE-2/Endorsed_Projects.jsp.

6. Products and Publications

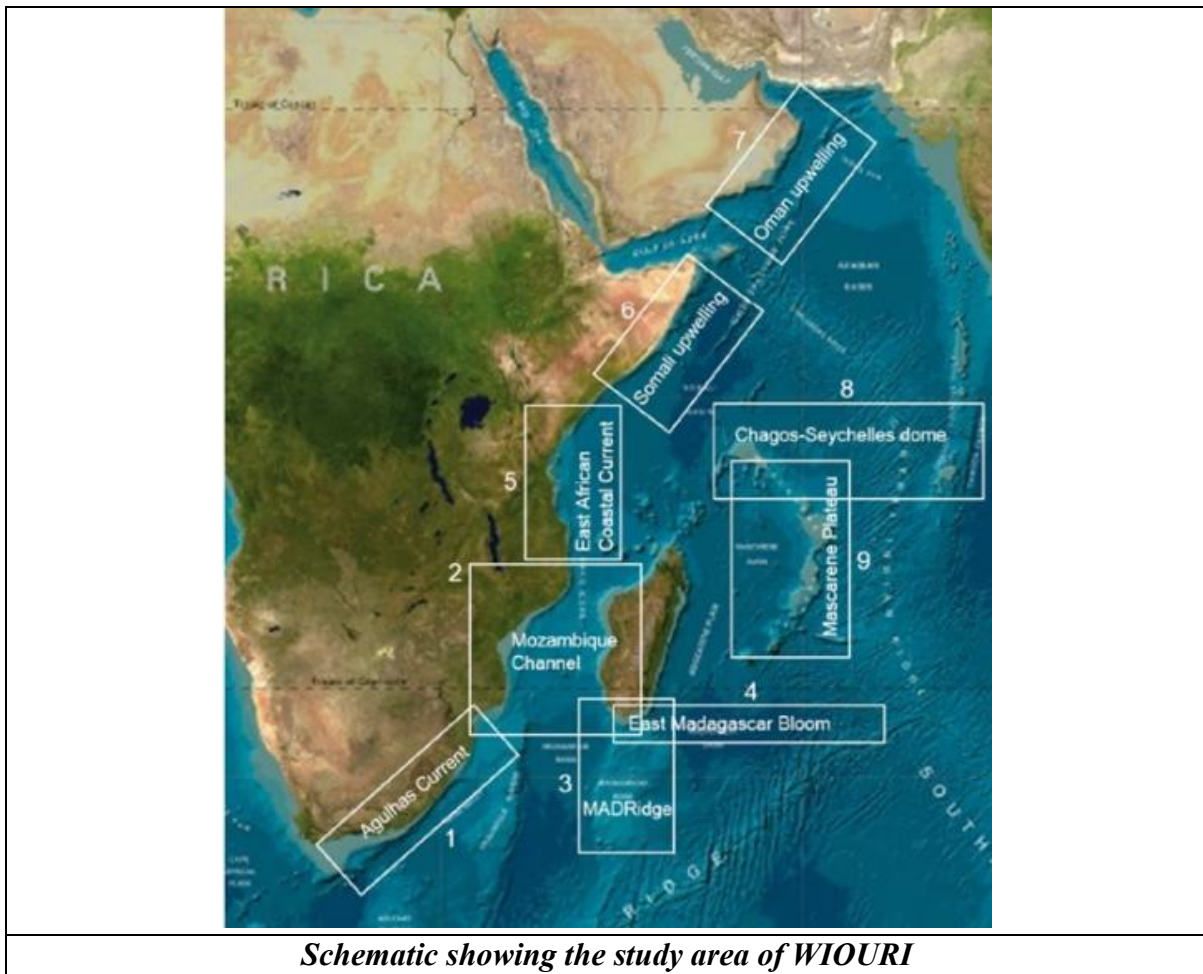
The IIOE-2 project office continued with the monthly newsletters bi-annual Indian Ocean Bubble. Total twelve newsletters were published during September 2024 to August 2025 (https://iioe-2.incois.gov.in/IIOE-2/Publications.jsp?mode_pub_id=NL) and two volumes of The Indian Ocean Bubble () during August 2024 (https://iioe-2.incois.gov.in/IIOE-2/pdfviewer_pub.jsp?docname=IIOE-2-DOC_OM_301.pdf) and December 2024 (https://iioe-2.incois.gov.in/IIOE-2/pdfviewer_pub.jsp?docname=IIOE-2-DOC_OM_309.pdf) highlighting significant outcome of IIOE-2. In addition, Volume 7 of The Deep Sea Research -II Special Issue Series on IIOE-2 is completed with 20 manuscripts accepted, and Volume 9 of DSR-II has opened for the submission.

7. IIOE-2 Research Initiatives

7.1. The Western Indian Ocean Upwelling Research Initiative (WIOURI)

The Western Indian Ocean Upwelling Research Initiative (WIOURI) is a research program under the Second International Indian Ocean Expedition (IIOE-2) focused on studying upwelling processes and their impacts in the western Indian Ocean. Led by investigators Dr. Michael Roberts, WIOURI investigates the hydrodynamics, biogeochemistry, and ecology of upwelling systems, contributing to the understanding of heat and mass transport

and their link to climate variability in the region. The varying forms of upwelling under WIOURI have been distinguished into nine Regional Upwelling Projects (RUPs) which includes: (1) Agulhas Current driven upwelling, (2) Upwelling in the Mozambique Channel, (3) Madagascar Ridge and seamounts upwelling, (4) Southeast Madagascar shelf and SICC chlorophyll bloom, (5) Upwelling in the East African Coastal Current (EACC) and influence of major islands (Mafia, Zanzibar, Pemba), (6) Upwelling Somalia Current system, (7) Oman/Arabian Sea upwelling system, (8) Chagos-Seychelles upwelling dome and Chagos Ridge, and (9) Mascarene Plateau induced upwelling.



The key findings from each of the nine RUPs identified under the WIOURI are as follows

RUP 1: Agulhas Current Driven Upwelling: Cyclonic eddies and Natal pulses along the continental margin drive slope upwelling and enhance chlorophyll concentrations, supporting rich biological productivity along South Africa’s southeast coast.

RUP 2: Mozambique Channel Upwelling: Upwelling hotspots in northern and southern sectors are linked to eddy dipoles and boundary current interactions, influencing fish catch variability.

RUP 3: Madagascar Ridge and Seamounts (MADRidge): Shallow seamounts like Walter Shoal act as biodiversity hotspots due to enhanced nutrient delivery and retention, supporting seabird and pelagic fish activity.

RUP 4: Southeast Madagascar Shelf and SICC Chlorophyll Bloom: Seasonal blooms are influenced by the South Indian Counter Current (SICC), with productivity modulated by the Southwest Madagascar Coastal Current.

RUP 5: East African Coastal Current (EACC) and Island Influence: Shelf break-induced upwelling enhances productivity and supports artisanal fisheries, especially during northeast monsoon seasons.

RUP 6: Somali Current System: One of the strongest upwelling systems globally, supporting high primary productivity and fish biomass. Upwelling can be modulated by offshore thermocline signals.

RUP 7: Oman/Arabian Sea Upwelling System: Intense seasonal upwelling supports one of the most productive fisheries in the Indian Ocean, with implications for regional food security.

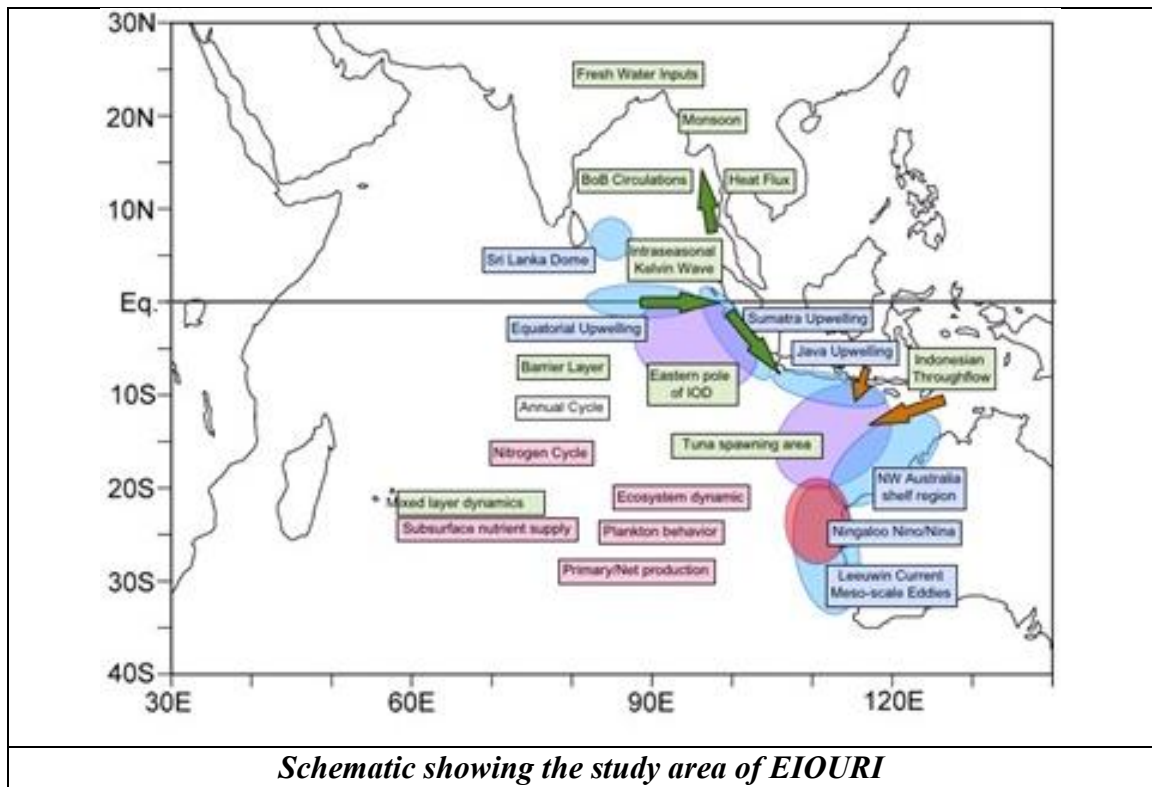
RUP 8: Chagos-Seychelles Upwelling Dome and Ridge: Upwelling dome enhances nutrient availability in an otherwise oligotrophic region, supporting pelagic ecosystems and migratory species.

RUP 9: Mascarene Plateau Induced Upwelling: Upwelling around the plateau contributes to localized productivity and supports deep-sea ecosystems, with potential for conservation focus

The significant findings of the WIOURI is published in several scientific journals including special issues in Deep Sea Research II, focusing on synthesis papers and ecosystem modelling.

7.2. The Eastern Indian Ocean Upwelling Research Initiative (EIOURI)

The Eastern Indian Ocean Upwelling Research Initiative (EIOURI) is a multinational research project under the International Indian Ocean Expedition-2 (IIOE-2) that investigates the physical and biogeochemical aspects of upwelling in the Eastern Indian Ocean, particularly along the coasts of Sumatra and Java. The initiative involves scientists from countries including Australia, China, Indonesia, Japan, and the USA to understand how these upwelling processes impact the global ocean and climate system, especially in the context of climate change. EIOURI aims to foster a better understanding of heat and mass transport, predict climate variability, and support sustainable ocean management through collaborative research and the sharing of oceanographic data.



Due to the COVID-19 pandemic, international activities of EIOURI were paused in 2020. Despite this, individual research efforts continued. EIOURI aims to revive its activities by 2025, updating its Science Plan with recent findings and observing system advances. The focus areas include upwelling processes, bio-physical relationships, biogeochemistry, and human impacts like sustainable fisheries and marine conservation. To facilitate discussions and collaborations, special EIOURI sessions were planned at international conferences such as JpGU 2024 and AOGS 2024. Additionally, a new R/V Hakuho-Maru cruise was conducted during August/September 2024, focusing on coastal upwelling structures off Java Islands. This cruise, a "re-try" from a cancelled 2020 expedition, aims to contribute to IIOE-2/EIOURI objectives, aligning with the initiative's goal of advancing understanding in the Indian Ocean.

The significant findings from EIOURI is summarized below

Upwelling drivers: Upwelling in the Sumatra-Java-Alor region is primarily driven by southeast monsoon winds, but is modulated by Kelvin waves, Madden-Julian Oscillation (MJO), and Indian Ocean Dipole (IOD) events. The Indonesian Throughflow (ITF) plays a dual role by seeding the upwelling zone with nutrients and complicating SST based detection due to warm water advection.

Intraseasonal and Interannual Variability: Upwelling shows strong intraseasonal variability linked to MJO and coastally trapped waves that propagate from the equator to the Indonesian coast. Positive IOD events intensify upwelling by enhancing thermocline shoaling and increasing nutrient availability.

Subsurface and Mesoscale Processes: Subsurface upwelling is often masked at the surface due to barrier layers and cloud-radiation feedbacks, making SST a poor sole

indicator. Mesoscale eddies and filaments generated by ITF outflow enhance offshore transport of biologically enriched water, creating local productivity hotspots.

Biogeochemical and Ecological Impacts: Upwelling significantly boosts chlorophyll concentrations and primary productivity, especially along the Java coast from July to October and Sumatra coast from November to December. Enhanced productivity supports plankton blooms, diatom proliferation, and higher trophic levels, including key fisheries.

Socioeconomic Relevance: Seasonal upwelling influences artisanal and industrial fisheries, with peak landings observed in Cilacap (Java) during upwelling months. The region is also a spawning ground for Southern Bluefin Tuna, linking upwelling to global fishery dynamics.

Modelling and Climate Projections: Coupled climate models (e.g., CMIP) struggle to resolve the fine-scale dynamics of EIO upwelling due to its complex feedback mechanisms. Future projections require better representation of ITF, monsoon variability, and subsurface nutrient transport.

The significant findings of the EIOURI is published in several scientific journals.

7.3. Korea-US InDian Ocean Scientific Research Program (KUDOS) & Korea Indian Ocean Study (KIOS)

The Korea-US Indian Ocean Scientific (KUDOS) Research Program and the Korea Indian Ocean Study (KIOS) are collaborative scientific initiatives involving the Korea Institute of Ocean Science and Technology (KIOST) and the US National Oceanic and Atmospheric Administration (NOAA). These programs focus on the physical, biogeochemical, and ecological dynamics of the Indian Ocean, with a particular emphasis on the Seychelles-Chagos Thermocline Ridge and are part of the IIOE-2. KIOS also involves international collaboration beyond the US, extending to other global scientists in the IIOE-2 context.

The KUDOS workshop held on 9th May 2025 in Port Louis, Mauritius, and was part of the integrated meetings of IOGOOS and its allied programs. This workshop brought together ocean scientists and regional stakeholders to discuss collaborative research efforts in the Indian Ocean, particularly focusing on climate variability, ocean circulation, and upwelling systems. The workshop emphasized strengthening Korea-US partnerships in Indian Ocean research, especially in the context of the UN Decade of Ocean Science for Sustainable Development (2021–2030). The presentations included Definition of Seychelles-Chagos Thermocline Ridge: A revisit, Extreme Suppression of the upwelling in the Seychelles-Chagos Thermocline Ridge in December of 2019 and 2023, Cyclone-Driven Phytoplankton Shifts in the tropical Indian Ocean: Implications for Future Ecosystem Dynamics, Unraveling the dynamics of zooplankton of the southwestern Indian Ocean, Spatial variability of microplastics in the epipelagic zone of Seychelles-Chagos Thermocline Ridge during the positive Indian Ocean Dipole, BLOOFINZ-INDITUN: Food webs supporting larvae of Southern Bluefin Tuna in their eastern Indian Ocean spawning region, Marine Heatwaves in the SCTR Region and Their Subsurface Characteristics and Observations on Subantarctic Mode Water properties and its seasonal and interannual variability in tropical western Indian Ocean. In addition, there were

discussion on cruise campaigns and training opportunities for early-career researchers from Indian Ocean rim countries.

8. Extension of IIOE-2 till 2030

An addendum to IIOE-2 science plan and revised implementation strategy has been drafted by Raleigh Hood and Nick D'Adamo, respectively, in association with the SC members to extend the tenure till 2030. This Addendum to the Second International Indian Ocean Expedition (IIOE-2) Science Plan is motivated by several factors. These include the impacts of the COVID-19 pandemic that resulted in a three-year hiatus in in-person meetings and research cruises, and the loss of key IIOE-2 personnel. Moreover, although IIOE-2 has been highly successful, it has not yet achieved all of its stated objectives. In particular, there is still work that needs to be done to fully examine the biogeochemical and ecological impacts of anthropogenic influences on the ocean and how these will, in turn, impact coastal marine environments and human populations. There is also a need to focus more on coastal monitoring and management, data sharing, scientific engagement of Indian Ocean rim countries, and capacity development. This Addendum to the IIOE-2 Science Plan builds upon concepts and strategies formulated and discussed at three SCOR and IOC-sponsored meetings (convened in Perth, Western Australia, February 6-7, 2023; in Hyderabad, India, November 28-30, 2023; and in Lombok, Indonesia, March 4-5, 2024). These meetings included scientists from Indian Ocean rim nations, eastern Asia, Europe and North America. The meeting in Hyderabad was dedicated to the development of this Addendum, providing several key presentations, discussion notes and an outline for this document.

The IIOE-2 Science Plan places considerable emphasis on the biogeochemical and ecological impacts of anthropogenic influences on the ocean and how these will, in turn, impact coastal marine environments and human populations. The plan also emphasizes the need for coastal monitoring, data sharing, scientific engagement of Indian Ocean rim countries, and capacity development. Knowledge gaps and challenges articulated here include the need for more coastal monitoring and metadata sharing in exclusive economic zones (EEZs) of Indian Ocean rim nations; the need to engage with and promote marine spatial planning (MSP) efforts in the Indian Ocean and promote early career scientists.

This Addendum also highlights four new initiatives that will greatly facilitate addressing these needs: the Sustained Indian Ocean Biogeochemistry and Ecosystem Research (SIBER) program, the Korea-US Indian Ocean Scientific Imperatives (KUDOS) program, the emerging Coastal Observations in a Box (COLaB) project, and a new Marginal Seas Research Initiative (MSRI).

The outlines of these documents were presented at the SCOR annual meeting in Qingdao, October 2024. The comments received against the proposals were addressed during the IIOE-2 SC-8 meeting.

9. International Indian Ocean Science Conference 2025 (IIOESC-2025)

The IIOE-2 was formally launched in December 2015 at the culmination of the Indian Ocean conference at Goa to mark the anniversary of 50 years since the first International

Indian Ocean Expedition. The IIOE-2 program was initially formulated for a period of five years (2015-2020) but was subsequently extended for another five years until 2025. Over the past decade, the IIOE-2 community has contributed significantly to the understanding of the Indian Ocean in terms of observation, research and capacity development through 60 endorsed projects across the six defined scientific themes. There have been many international collaborations, and, in addition, the Early Career Scientist Network (ECSN) has gained momentum with exchange of ideas and capacity development.

International Indian Ocean Science Conference 2025 (IIOSC-2025) aims to showcase the progress and scientific knowledge gained during the past decade of IIOE-2 (2015-2025). The conference invites presentations focussing on nine defined themes which include the six themes of the IIOE-2 science plan and additional themes based on the proposed addendum. It will provide an opportunity for the scientists working on different facets of the Indian Ocean to present their research and discuss their ideas, outstanding issues, identify the knowledge gaps and plan a way forward to address such issues. The more details are available at <https://iiosc2025.incois.gov.in/iiosc2025/index.jsp>.

The IIOSC-2025 is hosted by Indian National Centre for Ocean Information Services (INCOIS), Hyderabad, India with the financial support from Ministry of Earth Sciences (MoES), Govt. of India, IOC, IOGOOS and SCOR. The International Scientific Planning Committee (ISPC), chaired by the Secretary, MoES and having members from IIOE-2 SC core group, finalized the registration fees, technical session and planning. The abstract submission date is closed and total 375 abstracts were received. The abstracts were evaluated by the session conveners and the intimations on acceptance were sent to the participants. The registration is expected to open on 15th September 2025.

10. Request to SCOR

We request that SCOR allocates \$15,00,000.00 to support the next joint steering committee meeting (SC-9) that will take place in person in South Korea and will be hosted by the Korea Institute of Ocean Science and Technology (KIOST) during 16-20 March 2026 (tentatively) at Busan, Korea.



Meeting/Workshop Participants



<https://iioe-2.incois.gov.in/IIOE-2/Signup.jsp>

----- **IIOE-2 Programme Office (PO)** -----

Aneesh A Lotliker, Ph.D.

Coordinator

Indian National Centre for Ocean Information Services (INCOIS),

"Ocean Valley", Pragathi Nagar (BO), Nizampet (SO),

Hyderabad - 500 090, Telangana, India.

Ph: +91-40-23886038

Email: iioe-2@incois.gov.in; aneesh@incois.gov.in
