REPORTING FORM 2025

Insert Name of Science Team: SIBER

Operating Period as an IMBeR Member:

- *Start Year: 2010*
- *End Year: present*

List of Authors: Greg Cowie and Raleigh Hood (Co-Chairs) with input from multiple SIBER SC members

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1. Ongoing activities, in line with the IMBeR Grand and Innovation Challenges

(Among other uses, information will be used to update the IMBeR Annual Report to SCOR)

1.a. Grand Challenge I

Understanding and quantifying the state and variability of marine ecosystems - with focus on Research Objectives 1 to 3:

***Research Objective 1**. Evaluate and predict the cumulative effect of multiple stressors*
***Research Objective 2**. Integration of climate change and climate variability*
***Research Objective 3**. Impacts on society – preparation for a changed future*

This Challenge, and research objectives 1 and 2, have been the primary focus of SIBER activity. The activity is centred on the 2nd International Indian Ocean Expedition, (IIOE-2), in the main involving open-ocean processes and research cruises. SIBER members also are heavily involved in IIOE-2 through steering committees and working groups, and through chairing national IIOE-2 commitees. Broader ongoing programmes relating to this Challenge include the IIOE-2's Eastern and Western Indian Ocean Upwelling Regime Initiatives (EIOURI and WIOURI).

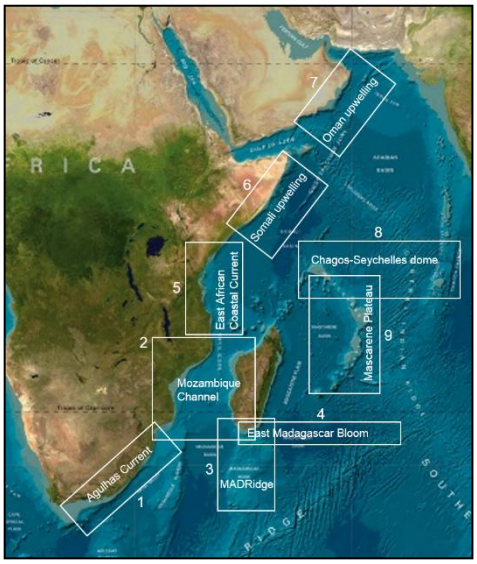


Figure x. The 9 regions forming the centre of the WIOURI programme.

The WIOURI programme is focused on 9 upwelling regions (Fig. 1), with emphasis on climate change and marine food security. The SOLSTICE-WIO programme (co-led by M. Roberts of SIBER; see 2022 SIBER report) is now complete but has been followed by projects focused on the Algulhas current upper reaches (CYCLOPS) and another focused on the Mozambique shelf (ReMoTURB; also led by M. Roberts). Both are multi-disciplinary and address ocean productivity, fisheries and coastal communities. The last of 3 RESILIENCE cruises (part of CYCLOPS; *RV Marion Dufresne*) took place in 2022 with a focus on oceanic fronts (Mozambique channel), the Durban eddy, and coastal-offshore interactions around the Isimangaliso MPA. Nearshore fieldwork on the ReMoTURB project was complimented by a research cruise for linked studies offshore of the Bazaruto Archipelago in May-June 2023 with the *RV Fridtjof Nansen*. **Further ReMoTURB studies were carried out in 2024.**

Figure x. Cruise track of the *RV Agulhas II* Monaco Explorations Indian Ocean Mission (Oct-Nov 2022).

The Indian Ocean Mission of the Monaco Explorations took place in Oct-Nov 2022 (involving SIBER SC members F. Marsac and J-F Ternon). It is the first element of a project that was endorsed by the United Nations Decade of Ocean Sciences for Sustainable development and IIOE-2. The cruise (Fig. 2) went from Cape Town (South Africa) to Mauritius, then Reunion, Seychelles (via Aldabra) and to Mauritius (via the Salha de Malha bank, where a multidisciplinary study of the ecosystem was conducted), then back to Cape Town. It involved over 150 participants of 20 different nationalities, including scientists, early-career researchers, and students at the onboard school, filmmakers and photographers, divers, artists, communicators, and the vessel crew. The expedition implemented a holistic approach based on a multidisciplinary programme including natural and social sciences.

The expedition's purpose was also to promote the contents, knowledge and resources resulting from the operations by encouraging the exchange and transmission of knowledge to as wide an audience as possible through a varied outreach programme, and extensive work continues. The various components were aimed at a broad public: schools, civil society, and decision-makers. Two documentary films were produced in 2023 for international distribution and other educational and artistic content. The offshore projects of the expedition included oceanographic stations (CTD and XBT), the deployment of 29 BioArgo floats, the deployment of drifters (19 of 3 months life expectancy, and 5 regular drifters with drogues from which 2 are still operational after 21 months at sea), and a full ecosystem study of the Salha de Malha Bank (physical and chemical oceanography, plankton and productivity, benthic biodiversity) on the bank and along its slopes. France has participated in the expedition with 45 scientists and 10 students**. A special issue is underway in Deep Sea Research Part II, to include 20 research papers (completion due in 2025).**

Other continuing French IO work follows the RESILIENCE cruises (2022), which focussed on physical/biogeochemical sub-mesoscale interactions at two sites in the south-west IO: the front between cyclonic and anticyclonic mesoscale eddies in the central Mozambique Channel, and at the boundaries around a semi-permanent cyclonic eddy (the Durban eddy) moving south-westward between the large Agulhas Current (offshore) and the east coast of South Africa. High-resolution sampling was done for currents, hydrology, phyto- and zooplankton, active acoustics, trace metals, CO_2, etc. The cruise involved about 40 scientists from France, Réunion, South-Africa and Mozambique, as well as a "floating university" (20 students, from these countries). Scientific papers are "in progress" – one (on high resolution distribution of phytoplankton at the eddies front) already submitted to the new IIOE-2 Special Issue in Deep Sea Research II.

The ReMoTURB project is ongoing (below) and the CYCLOPS/RESILIENCE projects are in final stages of data analysis and write-up There are also continuing publications arising from the Monaco Expedition.

Further cross-disciplinary IIOE-2 projects in the western and central IO that followed SIBER/IMBeR science themes are following from projects investigating *i*) oceanographic drivers of ecosystem response at basin-to-atoll scales (P. Hosegood), and *ii*) cetacean ecology (C. Embling) and *iii*) manta ecology (J. Harris). Manta studies (Fig. x) included a project focused on multiscale drivers of manta movement and behavior throughout the Maldives. **These projects are currently in final stages of data analysis and write-up.**

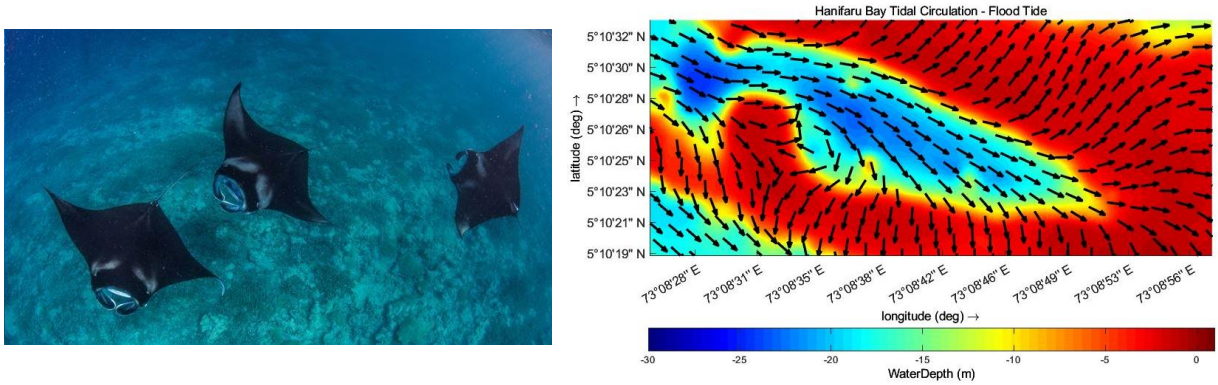
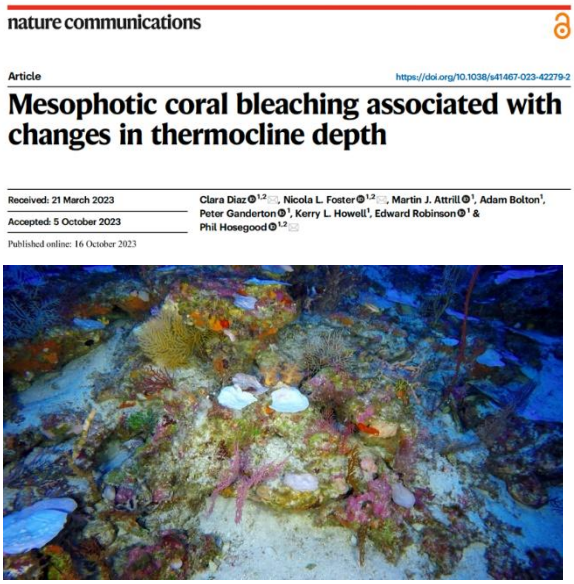


Figure x. Oceanographic drivers of manta habitat use in the Maldives, through a combination of extensive in-situ observations (ADCPs and temperature sensors) and numerical modelling.

There was also a continuation of mesophotic coral surveys through a Garfield Weston Foundation-funded project (2019-23). The deepest coral bleaching ever recorded (90 m) was found to be due to thermocline deepening caused by the IOD, with spatial variability attributed to internal waves (Diaz et al., 2023, *Nature Comms*., Fig. x). Surveys were recently completed (Jan/Feb. 2024) to establish the impacts of the 2023 IOD on deep bleaching. **Results of this project also are in final stages of analysis and publication.**

Recently funded UK projects (Foster and Diaz PIs will see continued work on mesophotic corals, including bleaching in association with the 23/24 El Nino event (Chagos), and wider studies of mesophotic coral vulnerability and resilience (2025-2030; Maldives, Seychelles and Mauritius.


nature communications

Article

https://doi.org/10.1038/s41467-023-42279-2

Mesophotic coral bleaching associated with changes in thermocline depth

Received: 21 March 2023

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Published online: 16 October 2023

Clara Diaz[1,2], Nicola L. Foster[1,2], Martin J. Attrill[1], Adam Bolton[1], Peter Ganderton[1], Kerry L. Howell[1], Edward Robinson[1] & Phil Hosegood[1,2]

Figure x. Mesophotic bleaching attributed to thermocline deepening.

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Following are reports from SIBER SC and community members on further 2024/2025 SIBER/IMBeR-relevant Indian Ocean activities from their respective countries. In some cases, these are as slides taken from presentations at the recent joint SIBER/IIOE-2 meetings in Mauritis. Contact details are provided if any clarification is needed.

1. Jenny Huggett (jenny.huggett@gmail.com) and Mike Roberts (Mike.Roberts@mandela.ac.za) -

South Africa:

ACEP Project: The role of the Agulhas Current on the Coastal Environment (Current to Coast) [PI T. Morris; SAEON, SA]

This recently IIOE-2 endorsed, 3-year project was launched in 2024 to investigate the role 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. Multidisciplinary sampling (physical, chemical, & biological EOVs and microplastics) is being conducted every 2-3 months along a ca. 45 nm transect extending out of Algoa Bay into the Agulhas Current, on the 15 m-long RV *Observer.* Four seasonal cruises have been conducted to date (May 2024, August 2024, November 2024, February 2025) with the 5th cruise set to take place in June 2025 onboard the *SA Agulhas II*, as part of the annual SEAmester cruises. Additional deployments

include a Sailbuoy and Seatrec Argo floats. This project falls within the African Coelacanth Ecosystem Programme (ACEP) and the GOOS Co-Design Program, for which the Agulhas Current is the Boundary Current exemplar.

Figure x: Map showing Algoa By sampling transect, the RV Observer, and Sailbuoy deployed during cruise on 8 May 2024.

Around Africa Expedition [OceanX, OceanQuest]

The state-of-the-art research and media vessel *OceanXplorer* returned to the Indian Ocean in early 2025 for the Around Africa Expedition. Led by non-profit organisations OceanX and OceanQuest, this was a pioneering collaborative expedition along the African coastline and an endorsed action programme of the United Nations Ocean Decade framework (2021–2030). This initiative aims to contribute to capacity building and scientific understanding of the ocean, with a focus on deep-sea ecosystems, seamount exploration, and ocean biodiversity. The first science leg from Moroni (Comoros) to Cape Town in Jan-Feb 2025 aimed to conduct seabed mapping and visual biodiversity surveys of Indian Ocean seamounts on the Madagascan Ridge and Agulhas Plateau. The guest science team onboard included 18 established and early-career researchers from South Africa, Madagascar, Mozambique, Kenya, Tanzania, Comoros, Portugal, Brazil, Germany and Saudi Arabia. The objectives of the expedition were to 1) map the geological characteristics of seamounts surveyed, 2) document the invertebrate and fish biodiversity observed, 3) conduct environmental DNA metabarcoding of sampled sponges and water, and 4) collect environmental parameter information from filtered water samples such as temperature, oxygen, salinity, nutrients, plankton and microbes. These objectives were met, with more than 33 000 km2 of seabed area being mapped in high resolution, including three seamounts, two of which had never been mapped before. The *OceanXplorer* will return to Southern Africa during mid-May to mid-June 2026 to focus further on Indian Ocean benthic biodiversity, and the *SA Agulhas II* will be chartered for a companion cruise.

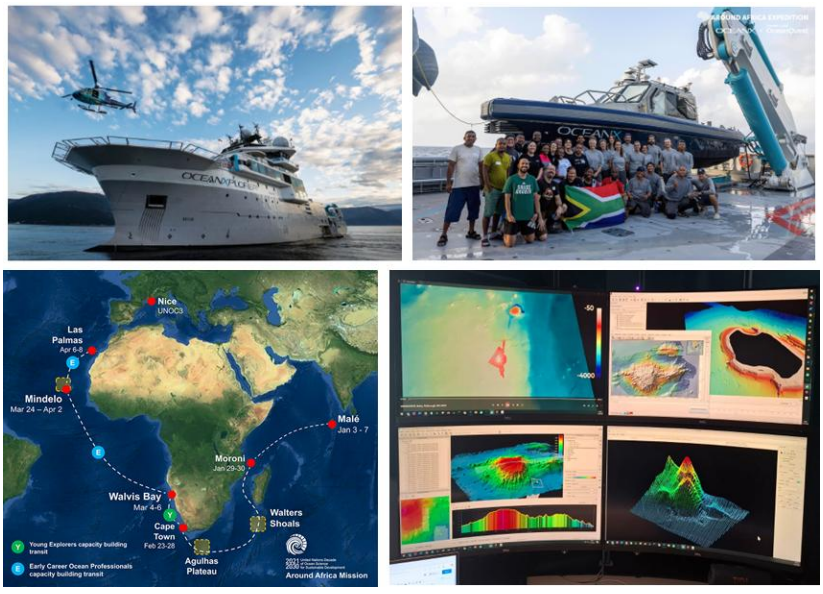
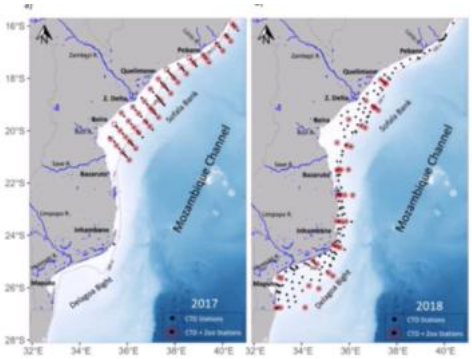
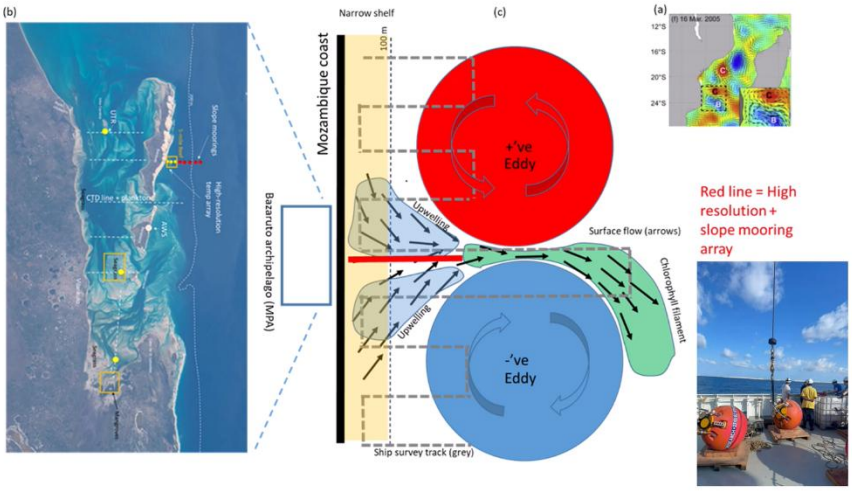


Figure x: In clockwise order from top left – the OceanXplorer vessel, the Science team on board the leg from Moroni to Cape Town (Jan-Feb 2025), seamount mapping displays, and a map showing the Around Africa Mission route. Images: OceanX, OceanQuest, J.

ReMoTURB: As outlined above, field studies and data analysis associated with the ReMoTURB project are ongoing. Multifaceted **s**tudies in the Mozambique channel have been supplemented by studies along the Mozambique shelf and, more recently, detailed studies around the Bazaruto archipelago. Broadly, these studies aim to investigate the impacts of features such as positive and negative eddies that propagate along the Mozambique of shelf and nearshore ecosystems.

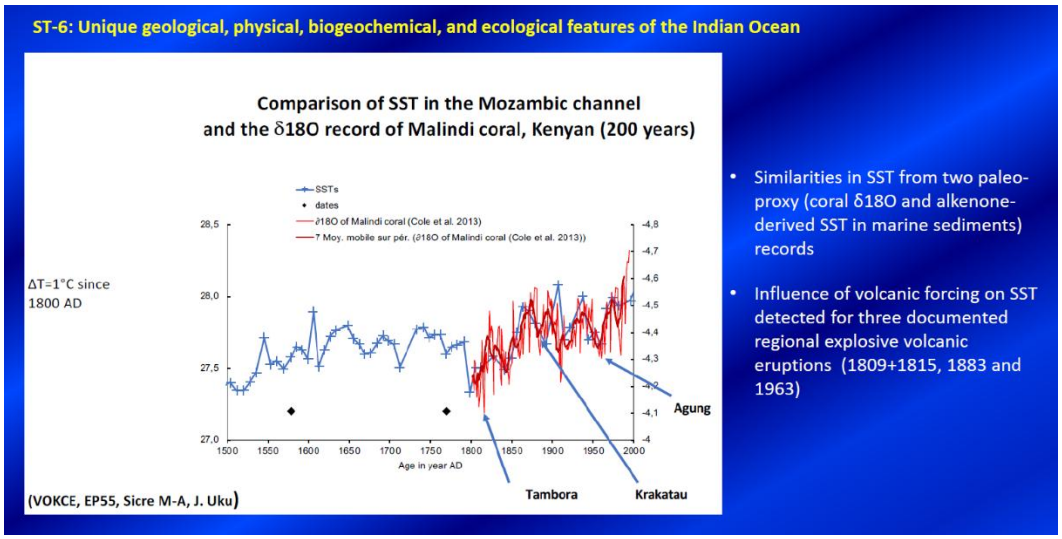
Dr Fridtjof Nansen

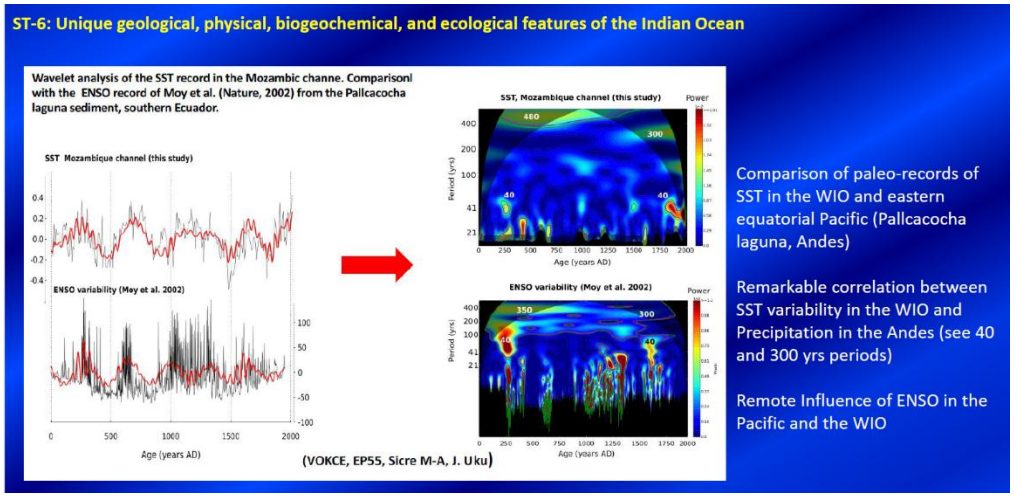




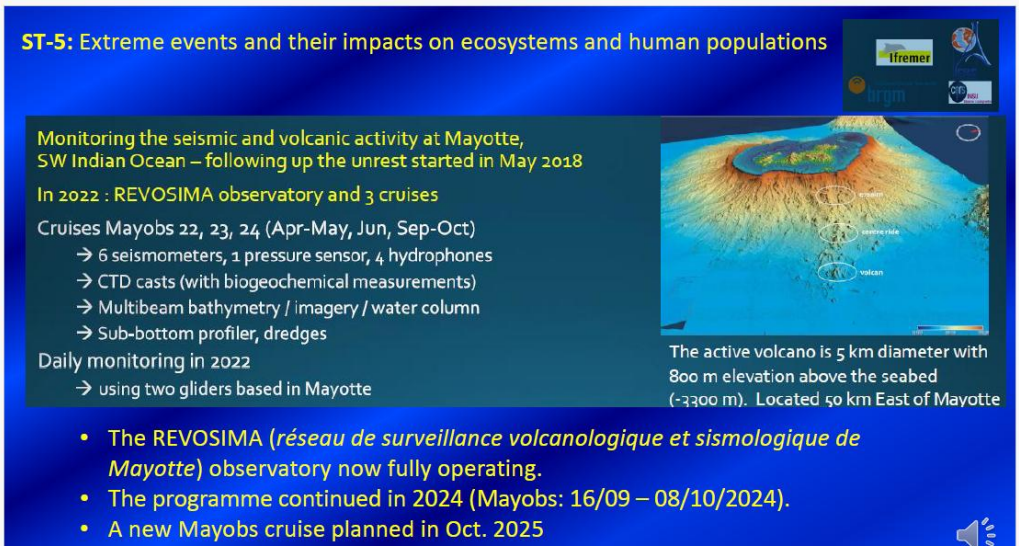
2. Jean-Francois Ternon (jean-francois.ternon@ird.fr) - France:

VOKCE (M-A. Sicre, Co-PI) is an ongoing IIOE-2 endorsed project (EP55), with the research component focused in part on use of different proxies for palaeoenvironmental assessments (Kenya, Mozambique Channel).

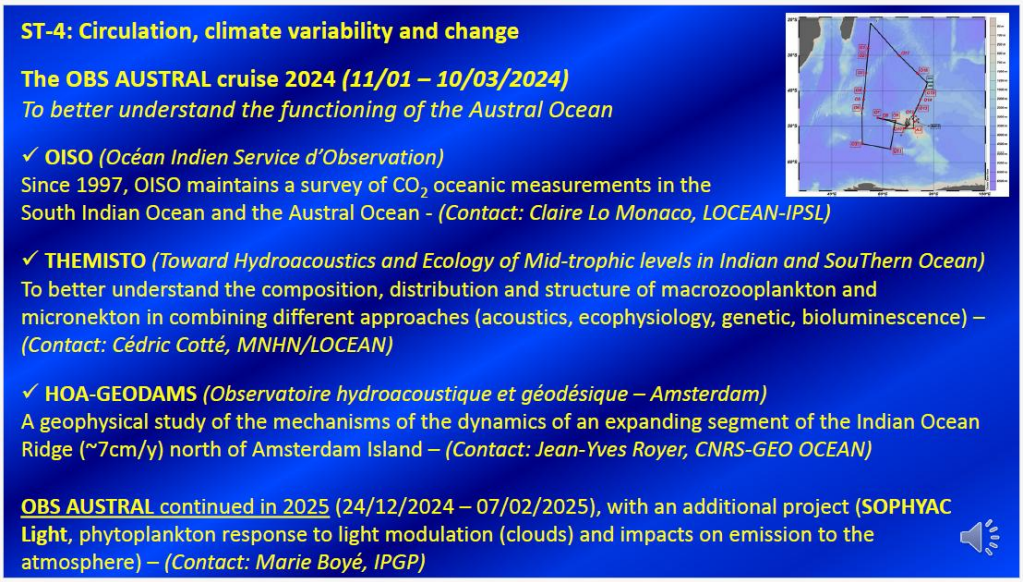




REVOSIMA is an ongoing French project focusing on seismic activity at Mayotte, in the SW Indian Ocean, and potential ecosystem impacts. Cruises and glider deployments started in 2022, with a further cruise in 2024 and another planned for 2025.

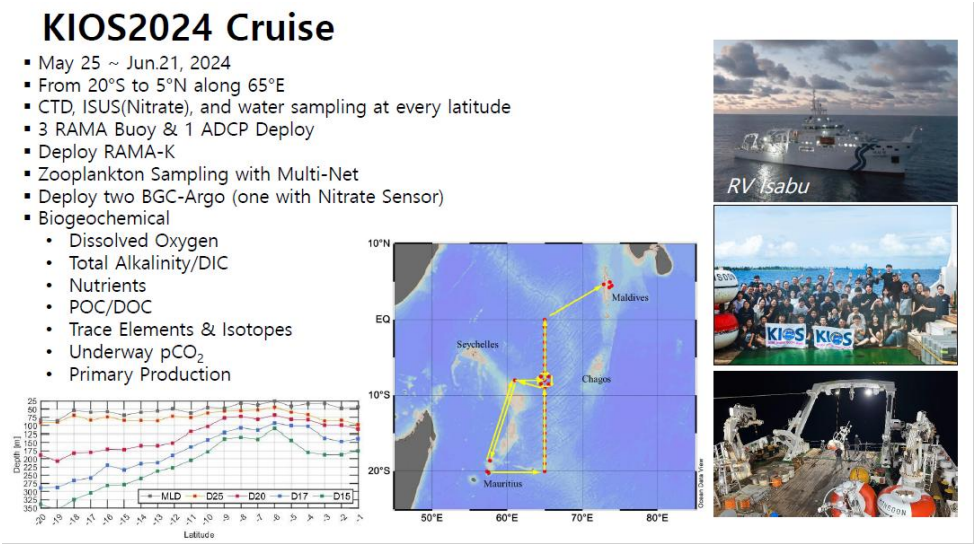


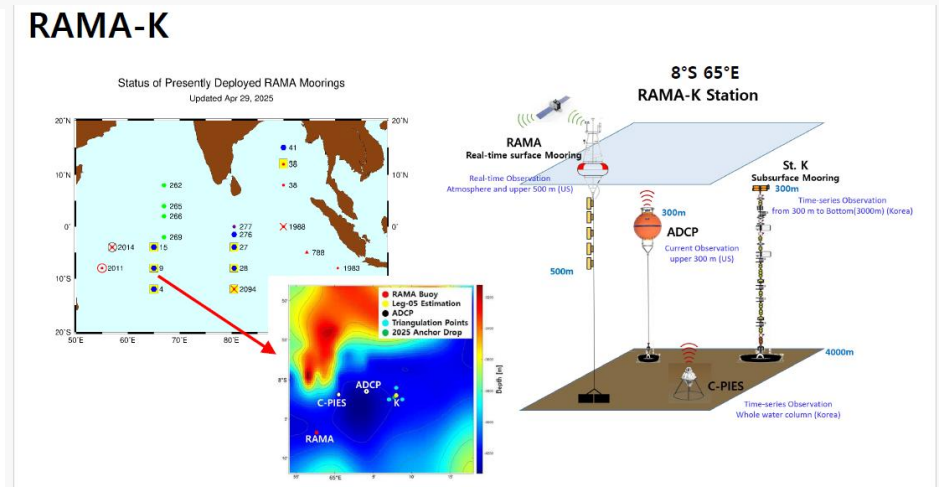
The OBS AUSTRAL cruises in 2024 and 2025 were part of a continuing French programme aimed at improving understanding of the Southern Indian/Austal Ocean.

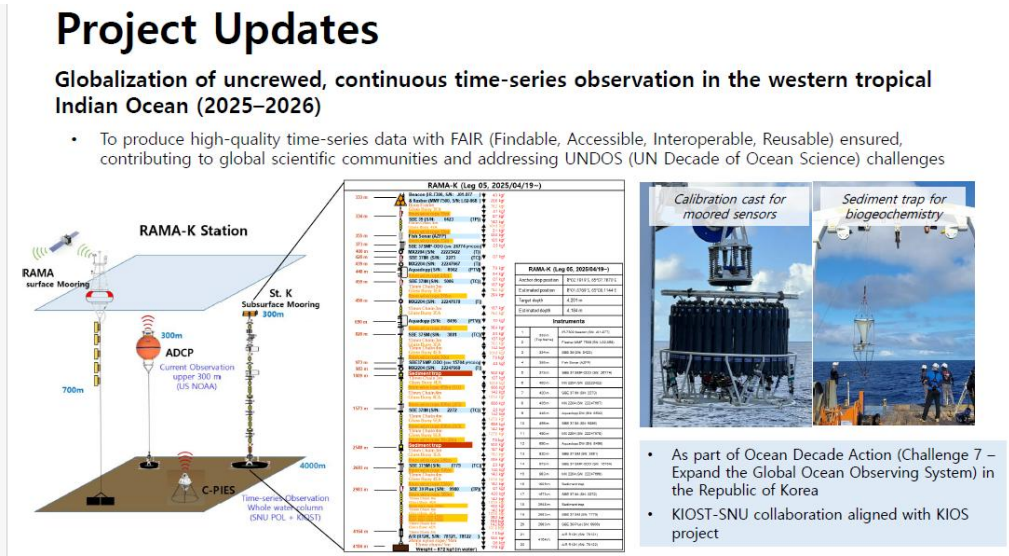


3. Dong-Jin Kang - Korea:

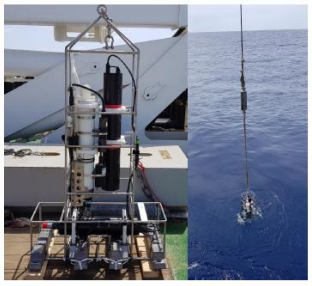
The KUDOS programme is a SIBER-fostered US-Korea collaboration that has become an important component of IIOE-2, with a major contribution from Korea in terms of ongoing cruises with the *RV Isabu,* which have focused on multidisciplinary research in the Western Indian Ocean, including glider deployments, but also on valuable deployments of observation platforms (e.g. RAMA-K). The KIOS 2024 cruise (Maldives-Mauritius) was followed by KIOS2025 (Sri Lanka-Mauritius) April 4-30, 2025, and a further cruise is planned for 2026 (also Sri Lanka-Mauritius).

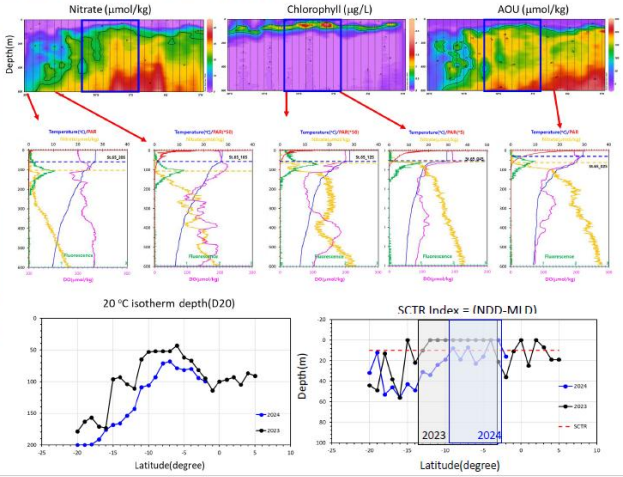






High Resolution Nutrient Observation



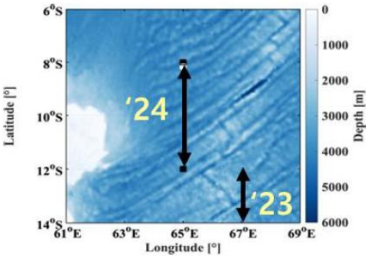


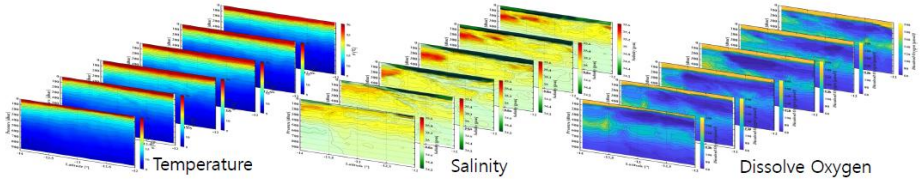
- SBE 19 plus V2, SBE 43 DO sensor, Wet Lab (FLUNTU): Chlorophyll and Turbidity, PAR sensor, ISUS Nitrate Sensor (Nitrate)
- Surface to 600 m
- Every Latitude

Underwater Glider

- Period: 2023 Mar. 11 – 2023 May 23 (74 days)
- 6 transit sections between12S and 14S along 67E
- From surface to 900m depth
- Observe D, T, S, DO, Fluor.

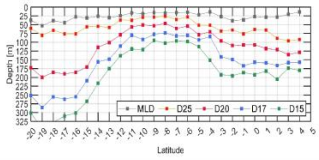
- Period: 2024 Jun. 10 – 2023 Aug. 2 (54 days)
- 4 transit sections between 8S and 12S along 65E
- From surface to 900m depth
- Observe D, T, S, DO, Fluor.

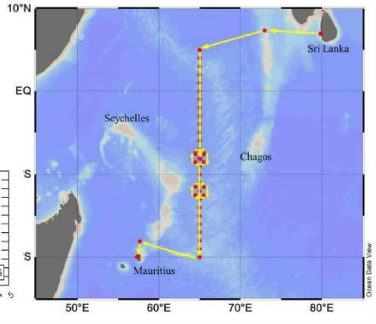




KIOS2025 Cruise

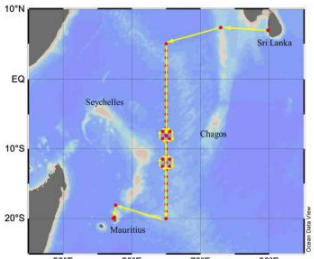
- April 4 ~ April 30, 2025
- From 5°N to 20°S along 65°E
- CTD, ISUS(Nitrate), and water sampling at every latitude
- 3 RAMA Buoy & 1 ADCP Deploy
- Zooplankton Sampling with Multi-Net
- Deploy two BGC-Argo (one with Nitrate Sensor)
- Biogeochemical
  - Dissolved Oxygen
  - Total Alkalinity/DIC
  - Nutrients (High Resolution)
  - POC/DOC
  - Underway pCO_2
  - Primary Production





Plan

- Cruise 2026
  - R/V Isabu
  - Some day during April ~ June (28 days)
  - Along 65°E from 20°S to 5°N (GO-SHIP Associated Line)
  - Replace 3 RAMA Buoys and 1 ADCP
  - Deploy 1 subsurface Mooring Line @ 8S, 65E(RAMA-K)
  - Deploy BGC Argos



4. Ocky Radjasa (ocky001@brin.go.id) and Dwi Susanto (dwisusa@umd.edu) - Indonesia:

Indonesia continued active involvement in Indian Ocean research in 2024/2025, including cruises associated with three programmes; the Java Trench Expedition (IDSSE), OceanX and TRIUMPH (a US-Indonesia-China Collaboration, Dwi Susanto SIBER SC, Co-PI).

Recent Cruises (2024)

- Java Trench Expedition (IDSSE)
  Deep biodiversity sea and geology
- Indonesian Mission (OCEANX)
  Multidisciplinary studies, including Southern Java upwelling
- TRIUMP (FIO, UMD)
  Indonesian Throughflow

TRIUMPH (**T**hroughflow **I**ndonesian Seas, **U**pwelling and **M**ixing **Ph**ysics) is an international collaborative project among scientists from Indonesia, China, and United States led by O. Radjasa, Z. Wei and R. Dwi Susanto. A cruise was conducted in Sept to October 2024. This is a multidisciplinary (physics, biology, and biogeochemistry) along the ITF pathways. Hence, the cruise involved scientists from various research agencies and universities. The cruise has successfully recovered moorings in the Makassar and Lombok Straits, and redeployed them, and some additional moorings deployed in the Sulawesi Sea and north of the Lombok Straits. In addition, TRIUMPH also measure mixing in the Lombok Strait to validate tidal mixing approach using remotely sensed data. We plan to carry out mooring recoveries and redeployment cruise by the end of this year.

Also, through collaboration between scientists from Diponegoro University, Semarang and University of Maryland led by A. Wirasatriya and R. Dwi Susanto, we have conducted coupled cruises to study extreme upwelling in the Alor Strait, Nusa Tenggara, Indonesia.

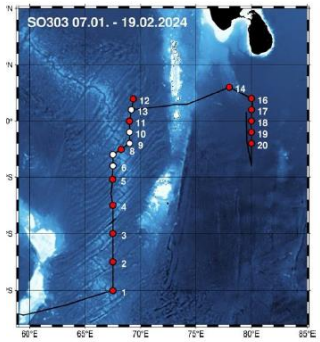
5. Birgit Gaye (birgit.gaye@uni-hamburg.de) - Germany:

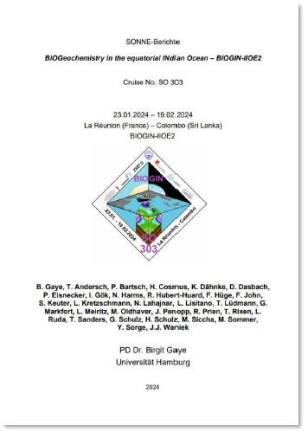
German activity in the Indian Ocean continued during 2024/2025 through a series of *FS Sonne* cruises**.**

Research Initiatives & Cruises - Germany

IIOE-2 2nd International Indian Ocean Expedition

BIOGeochemistry in the equatorial INdian Ocean – BIOGIN-IIOE2
Cruise No. SO 303
23.01.2024 – 19.02.2024
La Réunion (France) – Colombo (Sri Lanka)




SONNE-Berichte

BIOGeochemistry in the equatorial INdian Ocean – BIOGIN-IIOE2

Cruise No. SO 303

23.01.2024 – 19.02.2024
La Réunion (France) – Colombo (Sri Lanka)
BIOGIN-IIOE2

B. Gaye, T. Andersch, P. Bartsch, H. Cosmus, K. Dähnke, D. Dasbach, P. Eisnecker, I. Gök, N. Harms, R. Hubert-Huard, F. Hüge, F. John, S. Keuter, L. Kretzschmann, N. Lahajnar, L. Lisitano, T. Lüdmann, G. Markfort, L. Meiritz, M. Oldhaver, J. Panopp, R. Prien, T. Rixen, L. Ruda, T. Sanders, O. Schulz, H. Schulz, M. Sicoha, M. Sommer, Y. Sorge, J.J. Warnke

PD Dr. Birgit Gaye
Universität Hamburg

2024

Aims of the cruise were

(i) to investigate mixing processes between northern and southern hemisphere water masses and between water masses from the Arabian Sea and Bay of Bengal in the equatorial Indian Ocean and determine the isotopic signal transported with these water masses

(ii) to quantify the production of climate relevant trace gases

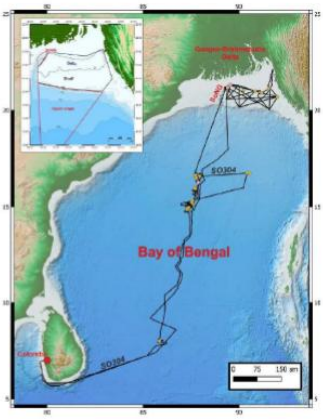
(iii) to quantify nitrification, nitrous oxide production and nitrogen fixation

(iv) to characterize the impact of equatorial currents on productivity and export of sinking particles

(v) to characterize the source and degradability of organic matter in different size classes from particulate to truly dissolved organic matter,

(vi) to characterize the bacterial community by DNA and RDNA analyses

SO304 BENGAL SHELF

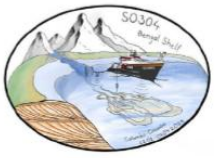


SONNE-Berichte

Interplay of Monsoon, Cyclones, Tectonics, Subsidence and Anthropogenic Impact: the Bengal Shelf as critical Land-Ocean-Atmosphere Interface and Archive

Cruise No. SO304

February 22 2024 – April 07 2024,
Colombo (Sri Lanka) – Colombo (Sri Lanka)
BENGAL SHELF



Volkhard Spiess, Tilmann Schwenk, Nikolas Römer-Stange, Elda Miramontes, Till J.J. Hanebuth, Pauline Cornard, Claire Routledge, Aike Albers, Yukarie Asakura, Emilia Athanassiadis, Anna Baltz, Renée Bernhard, Gregory Fackler, Greta Feddersen, Christian France-Lanord, Christian Hilgenfeldt, Brit Kokisch, Hermann Kudrass, Cecilia McHugh, Maximilian Merl, Maximilian Meyer, Sithum Pallepola Mudiyanselage, Leonardo Seeber, Hannah Skipper, Mohammad Solaiman, Muhammad Umar, Nikoleta Vitsou, Talea Wiederhold, Antonia Witzleb, Anja Zander

Chief Scientist: V. Spiess
Co-Chief Scientist: T. Schwenk

Institution: University Bremen

2024

SO305 BIOCAT-IIOE2

Biogeo**c**hemistry-**At**mosphere Processes in the Bay of Bengal: A contribution to the **I**nternational **I**ndian **O**cean **E**xpedition **2**

SONNE-Berichte

Biogeochemistry/atmosphere processes in the Bay of Bengal: A contribution to the 2nd International Indian Ocean Expedition

Cruise No. SO305

10 April – 22 May 2024
Colombo (Sri Lanka) – Singapore (Singapore)
BIOCAT-IIOE2

Hermann W. Bange, Ina Stoltenberg, Tjark Andersch, Damian Arévalo-Martínez, Elliot Atlas, Arun Babu Suja, Antoine Barbot, Theresa Barthelmeß, Kevin Becker, Dennis Booge, Laura Bristow, Anja Converetz, Rena Czeschel, Kirstin Dähnke, Shravan Deshmukh, Felix Duerkop, Paula Eisenecker, Anja Engel, Bert Engelen, Hendrik Feil, Victor Fernández-Juárez, Albert Frus, Martin Frank, Birgit Gaye, Martha Gledhill, Sandra Golde, Hendrik Grobelledemann, Edmund Hathorne, Silvia Henning, Isabell Hentschel, Hartmut Hermans, Riel Ingenioro, Mats Jacobsen, Rainer Kiko, Niko Lahajnar, Kira Lange, Carolin Löscher, Christa Marandino, Ciara McKellar, Julia Mickenbecker, Mario Müller, Thomas Müller, Leandro Nazzari, Lubrina Nielsen, Jule Ploeckhn, Mira Pohlker, Benjamin Pontiller, Laurent Poulain, Birgit Quack, René Rabe, Jon Ron, Sönke Rolfes, Tina Sanders, Isabell Schlangen, Leon Schmidt, Gesa Schulz, Marcel Sommer, Bo Thamdrup, Jannis Usinger, Laurenz van Bonn, Manuela van Pinxteren and Qingwen Zhong

Prof. Dr. Hermann W. Bange
GEOMAR Helmholtz Centre for Ocean Research Kiel

2024

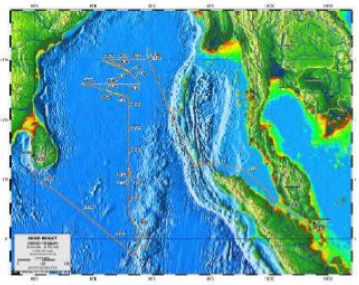
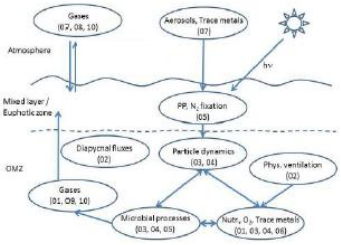
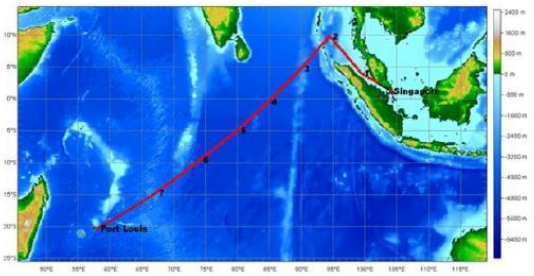


Fig. 3.2 Cruise track of RV SONNE Cruise SO305 BIOCAT-IIOE2.



SO305_2 EPOLIO

Emerging pollutants and mircroplastic abundance in surface waters of the Indian Ocean



SONNE-Berichte

Emerging Pollutants and Microplastic Abundance in Surface Waters of Indian Ocean

High-resolution seafloor Mapping and Magnetic field characterization of the Argo transform fault at the Central Indian Ridge

Cruise No. SO305/2

16.07.2024-05.08.2024,
Singapore (Singapore) – Port Louis (Mauritius)
E-POLIO & M2ARGO

Joanna J. Waniek, Ralf Prien, Janika Reineccius, Tassiana Serafim, Helena Osterholz, Ute Fensky, Christin Fechtel, Mareike Floth-Petersen, Tabea Mairon, Kendra Witt, Olaf Dellwig, Anne Köhler, Madleen Dierken, Martin Kolbe, Jenny Jeschek, Birgit Gaye, Jonas Leonhardt, Marc Metzke, Colin Devey, Benedikt Bauer, Janina Kreh, Isabel Kremin, Fei Zhou, Tobias Ziolkowski, Zhiyong Xie, Lijie Mi

Prof. Dr. Joanna Waniek
Leibniz Institute for Baltic Sea Research, Warnemünde (IOW)

2024

SO306 CoWIO: Cold Water Corals in the West Indian Ocean

Prof. Dr. Dierk Hebbeln

MARUM - Zentrum für Marine Umweltwissenschaften
Universität Bremen
Leobener Straße 8
D-28359 Bremen

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Short Cruise Report
R/V SONNE SO306

Port Louis, Mauritius – Durban, South Africa
08.08.2024 – 09.09.2024
Chief Scientist: Dierk Hebbeln
Captain: Tilo Birnbaum

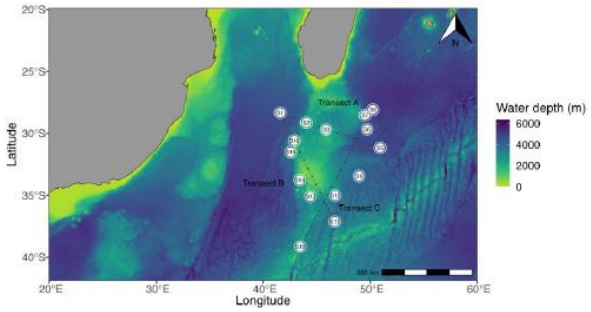
Track chart of RV SONNE cruise SO306.

INDICOM: a contribution to SO307

Composition, production, and recycling of recalcitrant organic matter in the bathypelagic Indian Ocean (INDICOM)

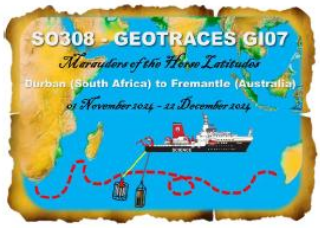
B. Pontiller[1], J. Karnatz[1], D. Pöhnl[1], C. Winguth[1], N. Koberwein[1,2], R. Flerus[1], T. Klüver[1], and A. Engel[1]

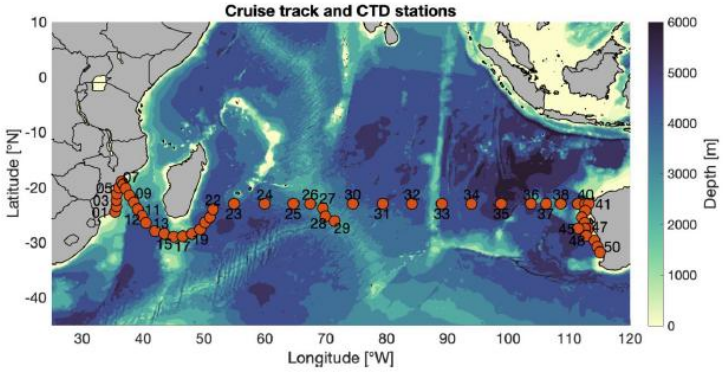
[1]GEOMAR Helmholtz Centre for Ocean Research Kiel, Germany
[2]Department of Functional and Evolutionary Ecology, Bio-Oceanography and Marine Biology Unit, University of Vienna, Austria



SO308 GEOTRACES GIO7– South Indian Ocean

F/S Sonne cruise by E. Achterberg, M. Frank and A. Koschinsky, 31 Oct. - 22 Dec. 2024.





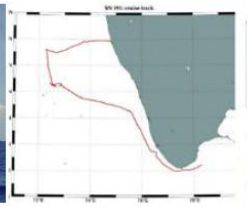
6. Balakrishnan Nair (bala@incois.gov.in) India:

There was also extensive SIBER-IMBeR relevant Indian Ocean research carried out by India in 2024-2025, including numerous open-ocean and coastal cruises (outlined below).

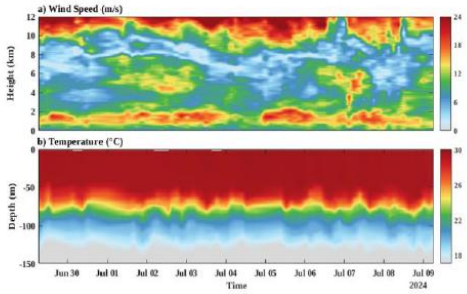
Summary of the cruises (2024-2025)

Project	Ship	Duration	Area
EKAMSAT	ORV Sagar Nishi	June - July 2024	Arabian Sea
DOM	ORV Sagar Nidhi	April 2024	Indian Ocean
DOM	Sindhu Sankalp	October 2024	Arabian Sea
DOM	ORV Sagar Nidhi	November 2024	Indian Ocean
DOM	ORV Sagar Nidhi	December 2024 – January 2025	Indian Ocean
DOM	M/V Vasiliy Golovnin	February – May 2025	Antarctic Waters

EKAMSAT Cruise onboard ORV Sagar Nidhi
(June 26 to July 15, 2024)

- Arabian Sea impacts Indian Ocean climate.
- EKAMSAT: India-US joint research on the Arabian Sea.
- EKAMSAT will conduct detailed oceanographic and atmospheric field campaigns.
- INCOIS conducted a 3-week Arabian Sea cruise (June-July 2024) on Sagar Nidhi (SN191).
- The cruise involved fine-scale measurements using advanced instruments.
- Water samples were collected for bio-geo-chemical studies.
- Focus was on the southeastern Arabian Sea and its role in the monsoon.
- A 12-day time series data was collected during contrasting monsoon phases.
- A glider was deployed to study the mixed layer heat budget.
- Concurrent VMP and L-ADCP data will help analyze mixing parametrization.



NCPOR Collaboration Cruise onboard ORV Sagar Nidhi (April 2024)

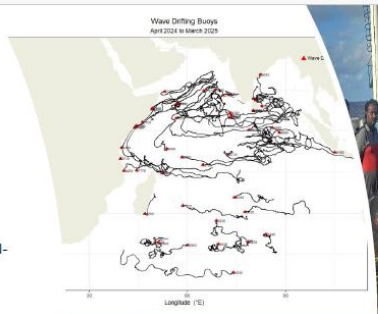
- In April 2024, NCPOR collaborated on ocean observation during the Sagar Nidhi cruise (SN-189) in the Indian Ocean.
- Two Slocum gliders (Serial No. 1128 and 1130) were deployed on April 27, 2024.
- The purpose of the deployment was to collect high-resolution subsurface ocean data.
- A previously deployed Slocum glider (Serial No. 1095) was successfully recovered on April 23, 2024.
- These glider operations enhance oceanographic research and understanding of ocean dynamics in the Indian Ocean region.


Slocum Glider 1131 Recovery Cruise Sindhu Sankalp October 2024

- In October 2024, a joint biogeochemical survey cruise was conducted by NIO on RV Sindhu Sankalp (Cruise No. SSK-176).
- This cruise involved collaboration and vessel sharing between INCOIS and NIO.
- A Slocum glider (Serial No. 1131) was successfully recovered on October 16, 2024, as part of this collaboration.
- Radiometer Operation for studying the optical properties of the Arabian sea and onboard data processing for validation BGC observations.
- Deployment of DWSBD wave drifters and Argo floats along the cruise track for Arabian sea wave and vertical ocean profiling observations.

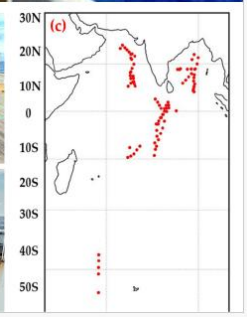
1130 Glider Recovery Cruise Off Mauritius November 2024

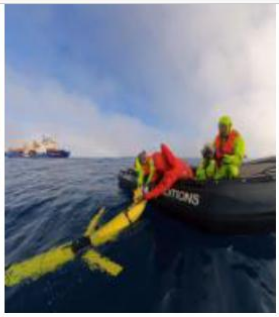
- In November 2024, research vessel Sagar Nidhi (Cruise No. SN-197, Leg-1) was shared with NIOT for joint operations in the Indian Ocean.
- A malfunctioning Slocum glider (serial no. 1130) was successfully recovered on November 30, 2024.
- NIOT's Autonomous Underwater Vehicle (AUV) team utilized the vessel for research on hydrothermal vents off the coast of Mauritius.
- This collaboration demonstrates efficient use of research platforms for diverse oceanographic research.
- Traditional and BGC Argo floats and DWSBD wave drifters were deployed along the cruise track for oceanographic observations.

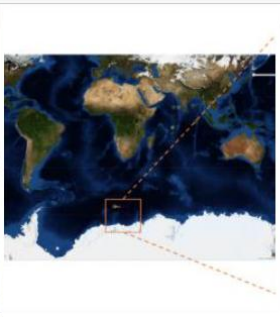


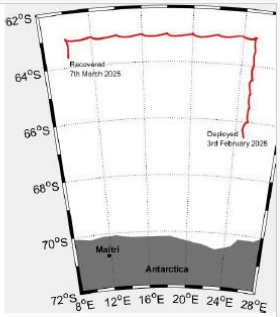
Glider Recovery Cruise Off Mauritius December 2024 – January 2025

- In December 2024, a Slocum glider (Serial No. 1129) was deployed off the coast of Mauritius during Cruise No. SN-197, Leg-3.
- In January 2025, a previously operating glider (Serial No. 1128) was recovered from the Andaman Sea's EEZ.
- These operations enhanced regional ocean observation through strategic glider deployments and recoveries.
- Along the cruise track, Classic and BGC Argo floats and DWSBD Wave Drifters were deployed for Central Indian Ocean Observations.





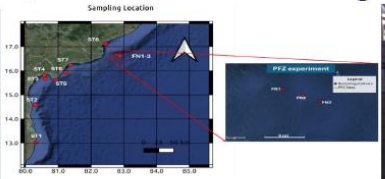


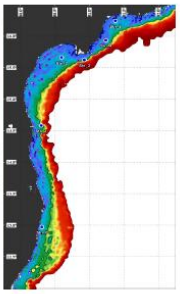


Glider Observations Over Southern Ocean (Antarctica)
Feb 2025 – Apr 2025 onboard M/V Vasiliy Golovnin

- Antarctica Expedition: February 2025
- Part of the 44th Indian Scientific Expedition to Antarctica.
- Collaboration with NCPOR.
- Slocum glider (Serial No. 1126) deployed on February 3, 2025.
- Deployment in waters off Antarctica.
- Extending observational capabilities to polar regions.

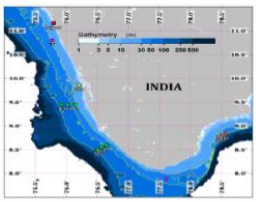
Coastal Ocean Expedition: (Jellyfish Aggregations)
June 14-25, 2024 onboard CRV Sagar Manjusha

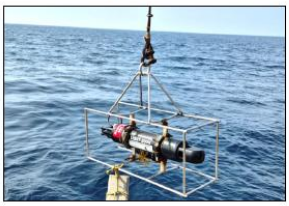


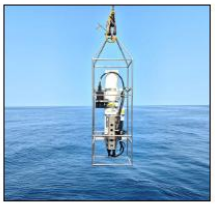


- Objective: Understand jellyfish aggregation conditions in Western Bay of Bengal.
- INCOIS developing JAAS due to multi-sector impacts. Western Bay of Bengal is a key area with frequent aggregations and fisheries.
- Exploratory survey (Chennai to Kakinada, June 14-25, 2024) on ORV Sagar Manjusha.
- Sampling off Chennai, Nellore, and Uppada, among other locations. Time-series sampling at Uppada to study aggregation drivers, tides, and day-night cycles.
- Measured environmental parameters (temp, salinity, pH, DO, BOD, DIC, TSM). Measured biological (phyto- and zooplankton) and optical parameters.
- Measured meteorological parameters (rainfall, wind). Analysis aims to explain jellyfish aggregations and characterize PFZ front.

Validation of Coastal Water Quality Observatory Sensors
off Kochi Dec 7-18, 2024, onboard CRV Sagar Anveshika (SA-053)







- Validation of sensors on autonomous coastal Water Quality observatory (off Kochi).
- Study biogeochemistry across the PFZ line. Investigate optical complexity of coastal waters in the Gulf of Mannar.
- INCOIS researching new marine ecological services (e.g., jellyfish swarming) and validating/upgrading existing services.
- Two observatories deployed off Kochi and Visakhapatnam.
- Seawater samples collected to analyse Inorganic macronutrients, pigments, chlorophyll size fractionation
- Parameters: DO, BOD, DIC, POC, CDOM, TSM, Total Alkalinity, pH, Phytoplankton and zooplankton taxonomy, turbidity
- Aparatus: IOP and ADCP and Onboard Sea water sample analyser.

There was also further development of the Indian MOSAIC coastal observing programme (led by A. Lotliker, SIBER SC) towards establisment of six moorings, fitted with an array of physical and biogeochemical sensors (Fig. 9). Sensors have now been secured for the remaining moorings, which will be deployed in 2023 and 2024. The central objectives are to establish sustained coastal observatories to monitor and understand coastal processes, to assess the health of the coastal and estuarine waters, and for model validation, assimilation, and forecasting of water quality parameters. Stakeholders will include fishermen and fishery resource managers, the tourism industry, ecologists, environmentalists and the wider marine science research community.

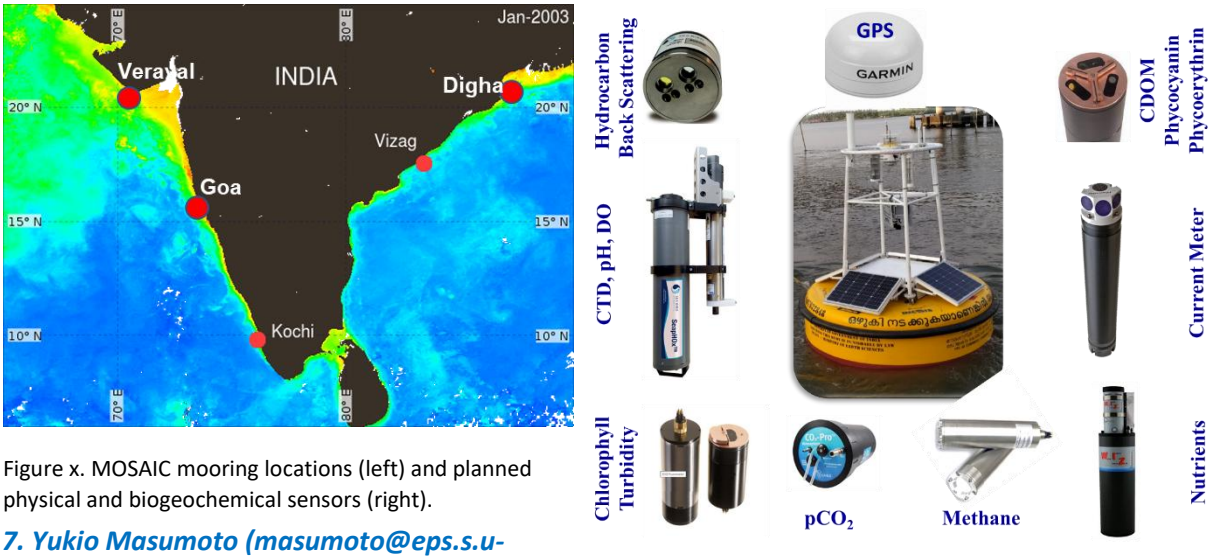
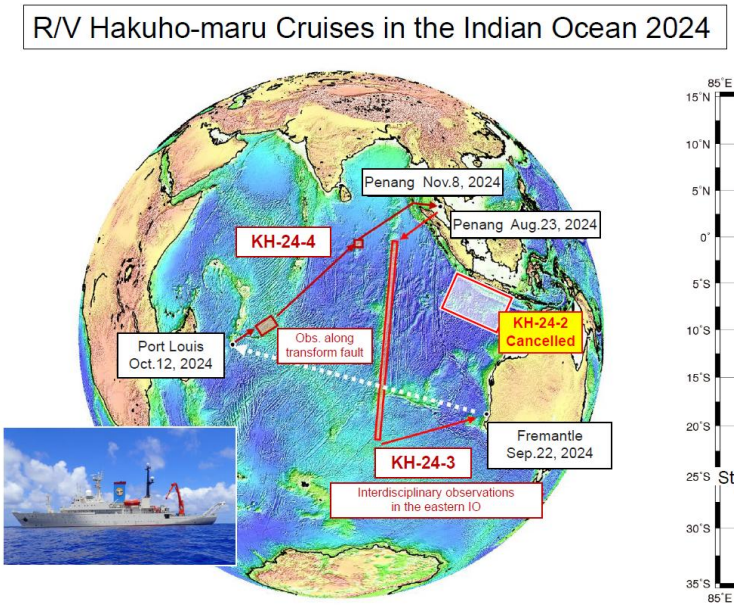
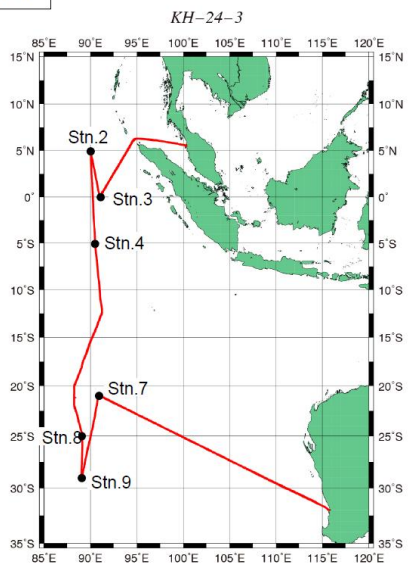


Figure x. MOSAIC mooring locations (left) and planned physical and biogeochemical sensors (right).

7. Yukio Masumoto (masumoto@eps.s.u-tokyo.ac.jp) - Japan:

Japan's involvement in Indian Ocean research and the IIOE-2 in 2024/2025 included two cruises with the RV Hahuko-Maru, from Penang to Fremantle (KH-23-3; EIOURI) and Port Louis to Penang (KH-24-4 (geophysics).





8. Lynnath Beckley (L.Beckley@murdoch.edu.au> and Eric Raes (Eric Raes <eraes@minderoo.org>)– Australia

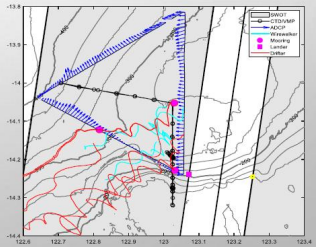
Updates on Australian IIOE-2 endorsed projects (2 complete, others in data analysis and write-up stages) were presented by Lynnath Beckley at the SIBER/IIOE-2 meeting in Mauritius, May 5-9, 2025.

- IIOE2-EP47 Quantifying vertical & lateral ocean transport due to sub-mesoscale fronts and eddies (2023)
- IIOE2-EP48 Valuing the Gascoyne Marine Park (2022)
- IIOE2-EP40 Biodiversity assessment of Australia's Indian Ocean Territories (2021 & 2022)
- IIOE2-EP33 Marine biodiversity of the Cape Range canyon (2020)
- IIOE2-EP06 110°E repeat line (2019)
- IIOE2-EP08 Challenger ocean glider Indian Ocean mission (2016-2018)
- IIOE2-EP24 Physical drivers of Large Marine Ecosystem of the Arafura Sea (2016)

EP47: Quantifying vertical & lateral ocean transport due to sub-mesoscale fronts & eddies

Nicole Jones (UWA)

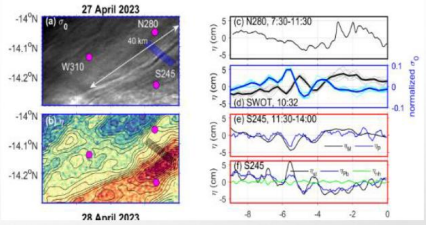
- Large multi-institutional team to gather *in situ* measurements for interpretation of SWOT rapid phase sea surface height data
- Used RV *Solander* at field site in Browse basin of NW Shelf
- Successful field campaign in April-May 2023, coinciding with fast-sampling phase (1 pass/day) of new SWOT satellite
- Collected moorings & ship-based data over 6 weeks. Used wave-powered autonomous profiling wire-walker as well as turbulence microstructure, CTD, ADCP, turbidity & Chla measurements



EP 47 continued

Progress:

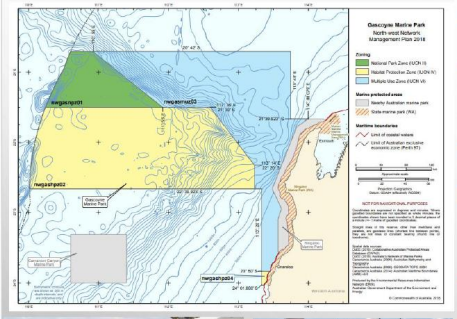
- Development of methods for separation of internal tide & eddies from the total observed SWOT SSH anomaly
- Diagnosis of non-linear internal waves signature in SWOT data through comparison with moored observations (see figure)
- Examination of diurnal warm layer formation & collapse
- Development of methods for estimation of surface currents from inversion of satellite SST & sea surface elevation data (SWOT)
- Papers from this work are at various stages of drafting/ peer-review

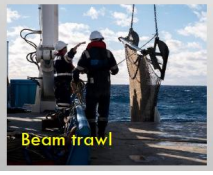


Mode-1 nonlinear internal waves observed on 27 April 2023. Panels (a–b) Zoomed-in SWOT maps of backscatter (σ0) and SSH anomaly (η) data, respectively; (c) Momentum-derived SSH (ηM) from mooring N280; (d) SWOT backscatter & sea SSH anomaly data extracted along the lines marked in (a,b); (e) pressure-derived SSH (ηP) from mooring S245; (f)individual components of pressure-derived SSH, including steric height (ηst), height due to pressure (ηP b), & nonhydrostatic height (ηnh).

EP48: Valuing Australia's new Gascoyne Marine Park

John Keesing (CSIRO)

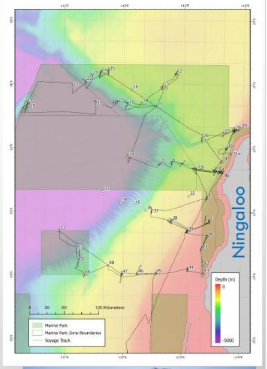




- RV *Investigator* voyage (Nov – Dec 2022)
- Explored bathymetry from shallow coral reefs at Ningaloo to >5000m Cuvier abyssal plain
- Described types & distribution of habitats
- Quantified fish & invertebrate biota of mesophotic reefs, Exmouth plateau, steep slope & canyons
- Refined biogeographic boundaries of region
- Used deep towed video camera & trawl nets from shallow shelf slope to abyssal depths >5000m
- Taxonomic analysis of samples nearing completion
- Publications starting to flow

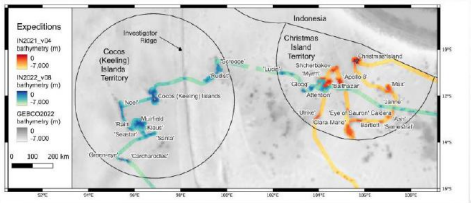
EP 48 continued

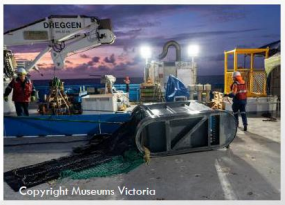
- Untiedt, C., Keesing, J., *et al*. 2023. Deep-water benthic habitats of the Gascoyne and Carnarvon canyon Marine Parks & adjacent shelf areas. Report from the RV *Investigator* survey (IN2022_v09): Benthic habitat descriptions & deep tow camera video analysis. CSIRO Report to Parks Australia. 126 pp.
- Keesing, J. *et al*. 2024. Deep-water benthic habitats & biodiversity of the Gascoyne and Carnarvon canyon Marine Parks & adjacent areas. Report from the RV *Investigator* survey (IN2022_v09): Report 2: Biodiversity of invertebrates & fishes. CSIRO. 210 pp.
- Bessey, C. *et al*. 2025. Design & validation of an open–close device for integrated environmental DNA sampling detects a depth gradient in Indian Ocean deep-sea fish assemblages. *Ecol. & Evolution*, *15*(2), 70902.
- Mah, C.L. 2025. New Australian deep-sea Goniasteridae (Asteroidea; Valvatacea). *Memoirs of Museum Victoria* 84: 49–88.
- O'Neill, H.L. *et al*. 2023. Sharks checking in to the sponge hotel. *J. Fish Biology*. doi: 10.1111/jfb.15554
- White, W.T. *et al*. 2023. Species in disguise: a new species of hornshark from northern Australia. *Diversity*, *15* (7): 849.
- Well-illustrated article on biodiversity discoveries published in *Australian Geographic* magazine. www.australiangeographic.com.au/topics/science-environment/2023/06/delivered-from-the-deep/



EP40: Biodiversity assessment of Australian IO Territories

Tim O'Hara (Museum Victoria)

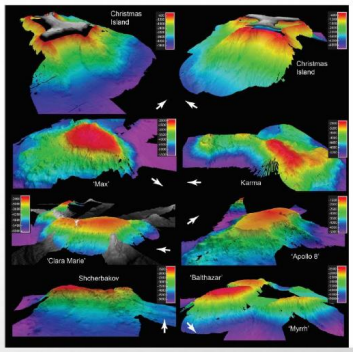


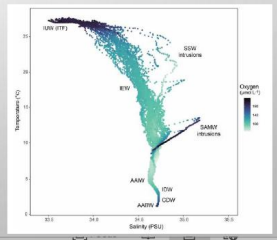


- Two voyages on RV *Investigator*
- Christmas Island sector (July 2021), Cocos Island sector (October 2022)
- Multi-beam mapping, towed video, benthic sampling of seamounts with sled & trawl
- Bathymetry data at AusSeabed; sub-bottom profiler, hydrochemistry & CTD data at MNF
- Zoological specimens dispersed to Australian museums & experts
- Publications starting to flow

[OFFICIAL]

EP 40 continued

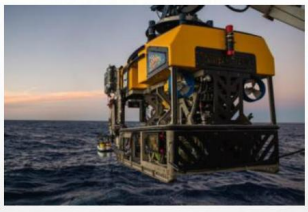




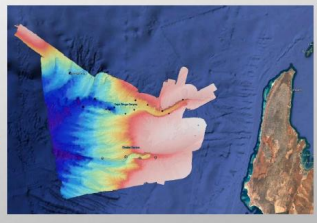
- O'Hara, T. 2024. Geomorphology & oceanography of central-eastern Indian Ocean seamounts. *Deep-Sea Research* II, 218: 105415
- Catalogue published online documenting animal species from IOT voyages. https://museumsvictoria.com.au/collections-research/journals/museum-victoria-science-reports/
- Kupriyanova, E.K. & Flaxman, B. 2024. Abyssal Serpulidae (Annelida) of the Australian Indian Ocean Territories. *Records of the Australian Museum*, 76 (4): 211-242.
- Flaxman, B. & Kupriyanova, E.K. 2024. New species of *Laetmonice* (Aphroditidae, Annelida) from bathyal & abyssal depths around Australia. *Records of the Australian Museum*, 76 (4): 195-210
- Mackenzie, M. *et al*. 2024. A report of sea cucumbers collected on the first dedicated deep sea biological survey of Australia's Indian Ocean Territories around Christmas & Cocos (Keeling) Islands (Echinodermata: Holothuroidea). *Memoirs of Museum Victoria*, 83: 207-316.
- Mah C.L., 2025. New Australian deep-sea Goniasteridae (Asteroidea; Valvatacea). *Memoirs of Museum Victoria* 84: 49–88

EP33: Marine biodiversity of the Cape Range canyon

Nerida Wilson (CSIRO, ex-WAM)



- Characterize marine biodiversity via ROV sampling in deep canyons adjacent to world heritage listed Ningaloo Reef
- RV F*alkor* & 20 ROV *Subastion* dives for biological samples (2020)
- Multi-beam bathymetry processed; data archived in many portals
- Taxonomic work continuing in museums
- ublications ongoing



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EP 33 continued

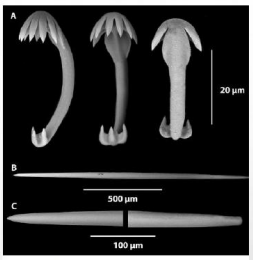
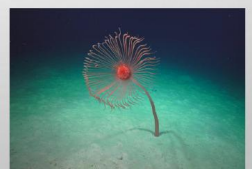
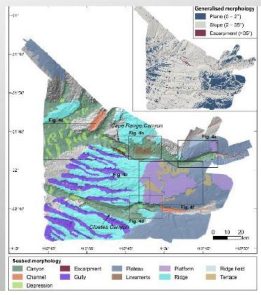


Fig. 16. *Nullarbora ningalooa* sp. nov. (A). Unguiferate anisoc

- Etkins, M & Wilson, N.G. 2024. New carnivorous sponges (Porifera: Cladorhizidae) from Western Australia, collected by ROV. *Scientific Reports* 14: 22173
- Przeslawski,R. & Christenhusz, M. 2022. Deep-sea discoveries. *Zoological Journal of the Linnean Society,* 194 (4): 1037-1043
- Przeslawski, R. 2022. Broad distribution of spider shaped *lebensspuren* along the Australian continental margin *Frontiers in Marine Science* doi: 10.3389/fmars.2022.1086193
- Post, A. *et al*. 2022. Modern dynamics, morphology & habitats of slope-confined canyons on the NW Australian margin. M*arine Geology,* 443, doi: 10.1016/j.margeo.2021.106694
- Wilson, N., Kirkendale, L. et al. (2022). An illustrated guide to the fauna of the Ningaloo canyons. *Western Australian Museum*





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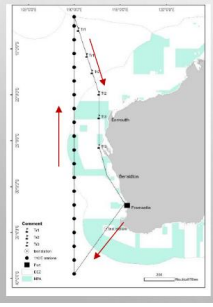
EP06: A coupled bio-physical, ecosystem-scale examination of Australia's IIOE 110°E line

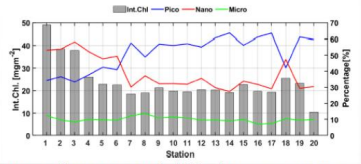
Lynnath Beckley (Murdoch Uni)



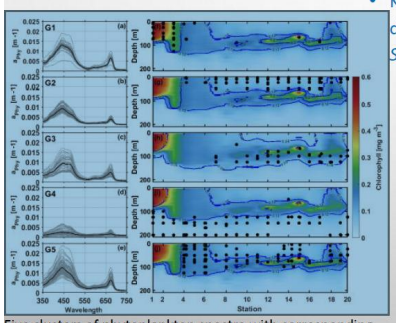
- RV *Investigator* voyage in May-June 2019 to revisit 110° E line
- Oceanography, optics, biogeochemistry, microbes, pelagic ecology & processes
- 12 papers published in "Revisiting 110° E" special issue of *Deep-Sea Research II*
- 10 other papers published so far (3 new this year)
- Several student theses, many conference presentations & public talks
- Ongoing manuscripts:
  - Physical/BGC changes through full water column (>5,000m) since 1963
  - Change between 1963 – 2019 at < 500m depth
  - Ocean carbon
  - Phytoplankton primary production
  - DNA amplicon 16s and 18s biogeography
  - Rock lobster phyllosoma genetics, abundance & distribution
  - Mesopelagic food web isotope analyses (fishes & zooplankton)

12

EP06 continued

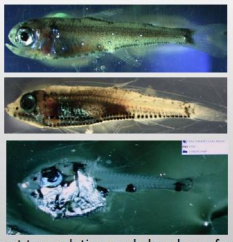


Water-column integrated Chl & relative proportions

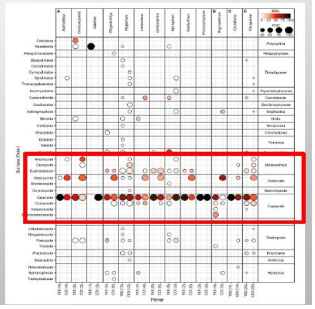


Five clusters of phytoplankton spectra with corresponding positions of spectra on transect

- Parida, C. & Antoine, D. 2025. Phytoplankton communities distribution along a physical gradient in the eastern Indian Ocean based on their pigments & absorption properties. *Deep-Sea Research* II. 220: 105460
- Van der Reis, A. *et al*. 2024. Insight into the diet of early stages of meso-pelagic fishes in the Indian ocean using DNA metabarcoding. *Deep-Sea Research* II 218: 105426
- Kiko, R., Picheral, M., Antoine, D. *et al*. 2022. A global marine particle size distribution dataset obtained with the Underwater Vision Profiler 5. *Earth System Science Data* 14 (9): 4315-4337



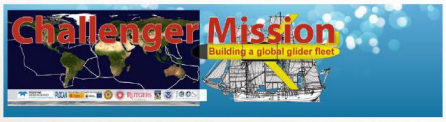
Gut content taxa relative read abundance for COI & 18S primers & frequency of occurrence per fish genus



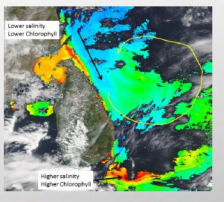
Complete

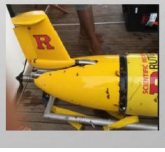
EP08: Indian Ocean Challenger ocean glider mission

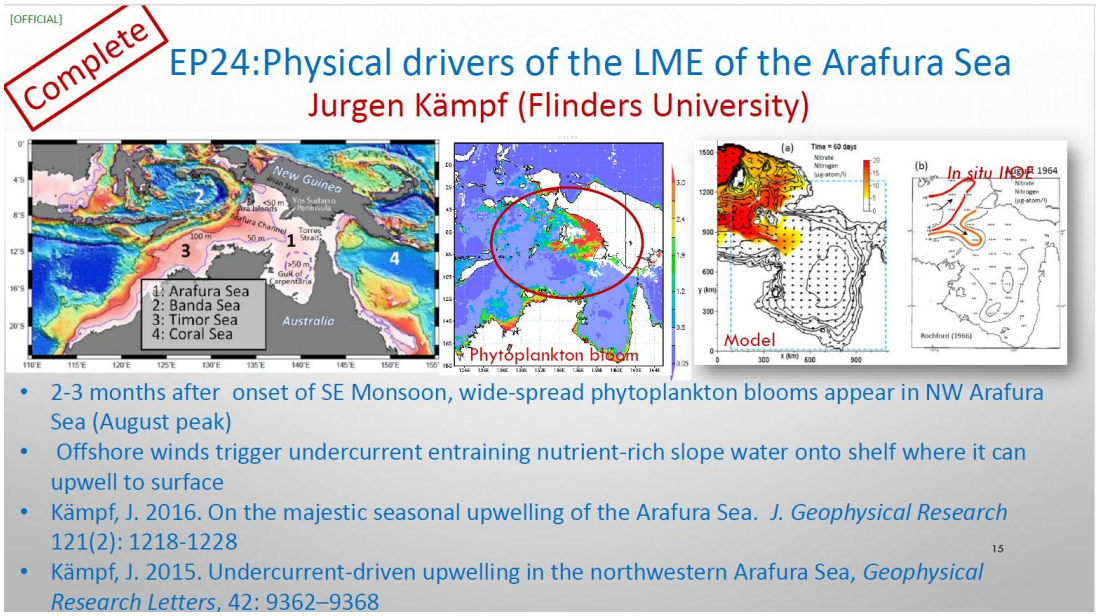
Pattiaratchi (UWA) & Glenn (Rutgers)



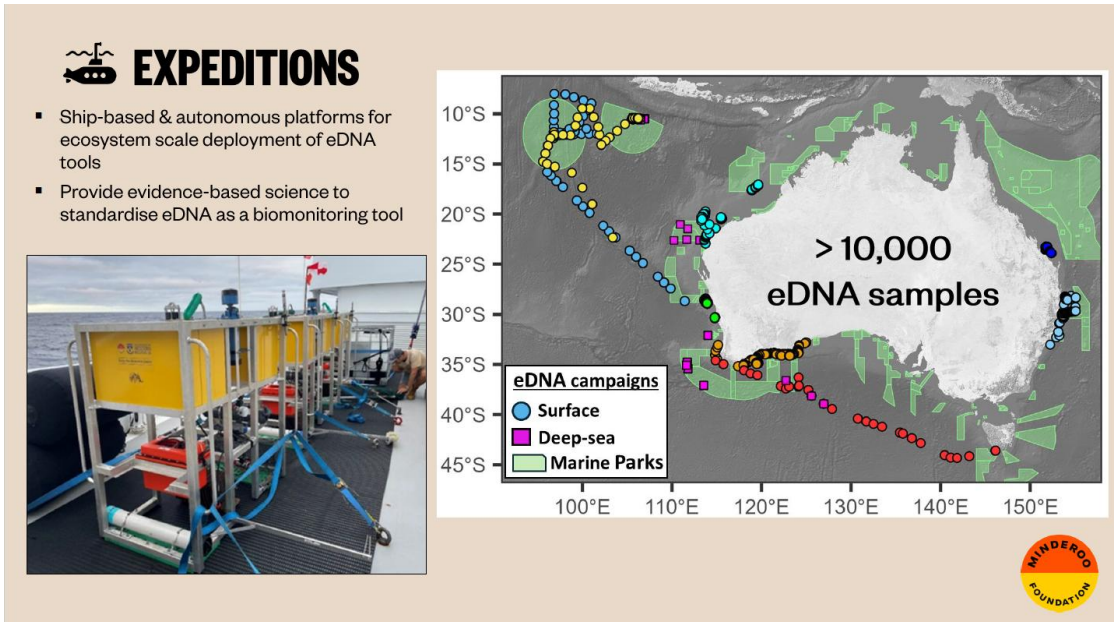
- Teledyne Webb Slocum electric glider
- Planned circumnavigation of IO
- First leg completed
  - Left Fremantle, WA 30 Sept 2016
  - Arrived Mirissa, Sri Lanka 3 Sept 2017
  - 330 days at sea for 7,570 km
- Re-launched 12 August 2018 but wildlife altercation 18 Sept 2018
- Piloted back to Sri Lanka; recovered 3 Nov 2018
- Proof of concept
- Data in AODN – No publications







Eric Raes (SIBER SC) provided an update on the Minderoo Foundation's activities in waters around Australia, towards the development of eDNA as a biomonitoring tool. It has so far included sampling from both coastal and open-ocean waters, both surface and deep-sea, and in Marine Parks, and is contributing to the global (UN Decade) genomics programme (OBON; Ocean Biomolecular Observing Network).



9. Raleigh Hood (rhood@umces.edu) and Mike Landry (mlandry@ucsd.edu) - USA

US activities in the eastern IO included the MINTIE project (NSF), focused on the Indonesian throughflow (ITF), with voyages in 2024 and beyond on an Indonesian research vessel. As outlined above, US involvement in Indian Ocean research in 2024-2025 has also been through international collaborative projects such as EKAMSAT (US-India), TRIUMPH (US-Indonesia-China) and KUDOS (US-Korea).

TRIUMPH (**T**hroughflow **I**ndonesian Seas, **U**pwelling and **M**ixing **Ph**ysics) is an international collaborative project among scientists from Indonesia, China, and United States led by O. Radjasa, Z. Wei and R. Dwi Susanto, has been conducted in Sept to October 2024. This is a multidisciplinary

(physics, biology, and biogeochemistry) along the ITF pathways. Hence, the cruise involved scientists from various research agencies and universities. The cruise has successfully recovered moorings in the Makassar and Lombok Straits, and redeployed them, and some additional moorings deployed in the Sulawesi Sea and north of the Lombok Straits. In addition, TRIUMPH also measures mixing in the Lombok Strait to validate tidal mixing approach using remotely sensed data. We plan to carry out mooring recoveries and redeployment cruise by the end of 2025.

In collaboration between scientists from Diponegoro University, Semarang and University of Maryland led by A. Wirasatriya and R. Dwi Susanto, we have conducted couple cruises to study extreme upwelling in the Alor Strait, Nusa Tenggara, Indonesia.

The BLOOFINZ (Bluefin Larvae in Oligotrophic Ocean Foodwebs, Investigations of Nutrients to Zooplankton) project (M. Landry, SIBER SC), conducted as part of IIOE-2 in January-March 2022, was developed as a biogeochemically/ecologically focused component of the SIBER-initiated EIOURI program. The project is now in the data analysis and write-up stage, with a special issue of DSR II in planning. The project contributes to Grand Challenge I in being a full ecosystem-level study (physics to fish, system state and variability) of the poorly known area between Indonesia and NW Australia that has two unique features of the Indian Ocean: the only known spawning region for Southern Bluefin Tuna (SBT) and the only low latitude connection between major oceans (Indonesian Throughflow) through which excess heat flow from the western Pacific drives rapid IO warming. The goals of BLOOFINZ are to understand the biogeochemistry, productivity and food webs supporting larval SBT in the spawning region and to assess SBT recruitment vulnerability to climate change. The research therefore relates to specific challenge objectives 1-3 in its focus on climate change impacts on a highly valued but endangered commercial stock.

1.b. Grand Challenge II

Improving scenarios, predictions and projections of future ocean-human systems at multiple scales - with focus on Research Objectives 4 to 6:

***Research Objective 4**. Development of integrated data systems and approaches for predictions and projections*
***Research Objective 5**. Development of predictive models and projections for use at regional scales*
***Research Objective 6**. Development of alternative scenarios to bridge the gap between physical climate sciences and humanities*

SIBER activities most relevant to this Challenge have been the deployment of observing/monitoring systems as part of the programmes outlined above (WIOURI, EIOURI and India's MOSAIC programmes) as well as the Australian observing programme (IMOS) and the ongoing multi-national INDOOS programme. Together, these programmes provide essential data for local to regional modelling efforts aimed at the impacts of climate change on processes, ecosystems and resources, and implications for coastal communities. In addition, a new IIOE-2 endorsed Indian Ocean multiscale numerical modelling effort (P. Hosegood, UK, co-PI; 2022-25) aims to implement numerical models at local (atoll), regional (archipelago) and basin (Indian Ocean) scales and to explore how physical oceanography drives ecosystem response and species behaviour throughout the Indian Ocean. The US (NSF) has also funded a biogeochemical modeling program focused on oxygen minimum zones, physical drivers, biogeochemical feedbacks and coastal hypoxia.

A UK-South Africa collaborative programme (Plymouth and Capetown universities) is focused on multi-scale numerical modelling across the Indian Ocean. The 2022 – 2026 project will is implementing numerical models at local (atoll), regional (archipelago) and basin (Indian Ocean) scales. The aims are to explain how physical oceanography drives ecosystem response and species behaviour throughout the Indian Ocean. Topics range from assessments of manta aggregation is

driven by topographic eddy generation (Maldives) *to* investigating dynamics driving change at basin-scale, esp. Indonesian Throughflow influence and marine heatwaves.

1.c. Grand Challenge III

Improving and achieving sustainable ocean governance - with focus on Research Objectives 7 to 9:

***Research Objective 7**. Develop knowledge on best practices for multilevel governance approaches to ocean climate adaptation and mitigation*
***Research Objective 8**. Develop understanding on key ingredients for transformation towards more sustainable, equitable and inclusive governance approaches to fisheries and aquaculture*
***Research Objective 9**. Support implementation of post-2020 biodiversity targets for marine spatial planning and marine protected areas*

A regional Marine Spatial Planning Strategy for the Western Indian Ocean [PI A. Lombard; NMU, SA]. In response to regional challenges to the management of human activities and marine resources in the Western Indian Ocean (WIO), as well as the fast tracking of marine spatial planning (MSP) and blue economy initiatives globally, parties to the United Nations Environment Programme's (UNEP) Nairobi Convention* requested in March 2019 that a regional MSP strategy be developed for the WIO. A regional strategy has now been developed, with input from the MSP Technical Working Groups of the 10 member countries and wider stakeholders, invited through a public participation process. In keeping with global best practice, the strategy adopts an ecosystem-based approach to MSP, and based on eight guiding principles, defines a vision, a goal and 11 objectives. Nine strategic priorities are identified, to be addressed with a systems-thinking approach (similarly proposed by the UN in 2014 for green economy policymaking). This approach is currently novel in MSP strategies and holds promise for regional decision-making for healthy oceans and people. Here we propose to work with member countries and other interested partners and stakeholders to develop this regional marine spatial plan, by focusing on regional aspects that cannot be dealt with effectively by single countries acting alone (for example, shared fisheries resources, connectivity in marine protected areas, and protection of biodiversity beyond national jurisdiction (BBNJ)). Although the Nairobi Convention does not include all the countries of the Indian Ocean, the 10 western countries (including island states) are included. This project has recently been endorsed by the IIOE-2.

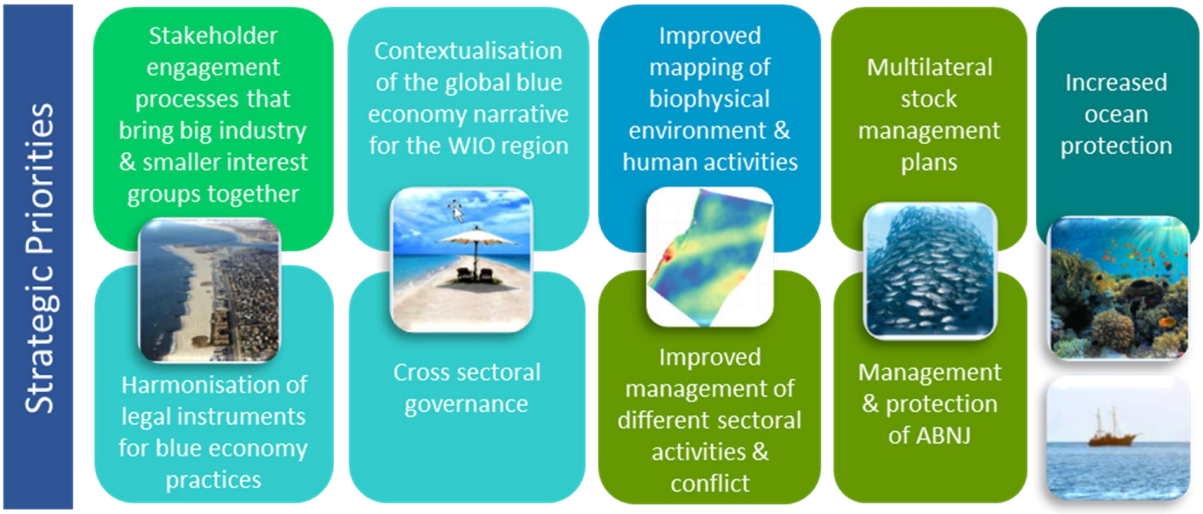


Figure x: Strategic priorities for the regional MSP for the Western Indian Ocean.

The IIOE2-endorsed NEKTON Maldives programme (www.nektonmission.org/missions/maldives) continued (2022-24), and follows similar previous work in the Seychelles. The mission included

extensive 0-1000m biological surveys and seafloor mapping, as well as diverse sampling and instrument deployments. Parallel to these field studies has been NEKTON involvement in development of the Western Indian Ocean Resilience & Prosperity Initiative (WIO-RPI), a new WIO-wide ocean policy and strategy. It has been developed in consultation with regional stakeholders (science, blue economy, governance, policy) and endorsed by all 10 WIO governments (Nairobi Convention COP10, Nov '21). The four main aims are to enhance marine science necessary to inform decisions on sustainable management of marine resources, to harness a sustainable blue economy, to strengthen natural resilience and restoration, and to advance ocean governance.

1.d. Innovation Challenge 3

To advance understanding of ecological feedbacks in the Earth System

Many of the SIBER/IIOE-2 research activities and cruises outlined above have understanding of ecosystem response and ecological feedbacks at the core of linked cross-disciplinary projects.

1.e. Innovation Challenge 4

To advance and improve the use of social science data for ocean management, decision making and policy development

Collection and use of social science data are written into the IIOE-2 Science plan and implementation strategy, overseen through IIOE-2 Science Theme 1 ("Human Benefits and Impacts") and Working Group 6 ("Translating Science for Society") (https://iioe-2.incois.gov.in/IIOE-2/index.jsp).

1.f. Innovation Challenge 5

Interventions to change the course of climate impacts

Add text…

1.g. Innovation Challenge 6

Sustainable management of Blue Carbon ecosystems

The SIBER and IIOE-2 science plans have carbon cycling and sequestration in the coastal and open Indian Ocean as core to many of the key science questions and themes. They are central to several of the ongoing SIBER/IIOE-2 activities outlined above and to projects/cruises scheduled for coming years.

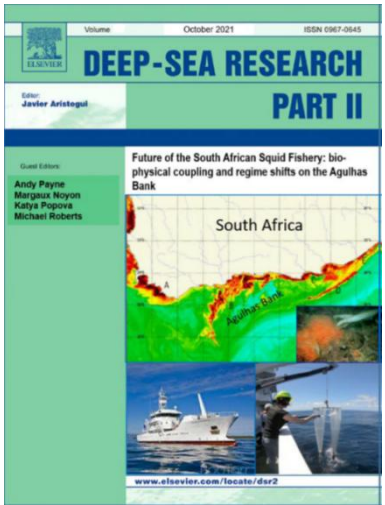
2. Selected highlights

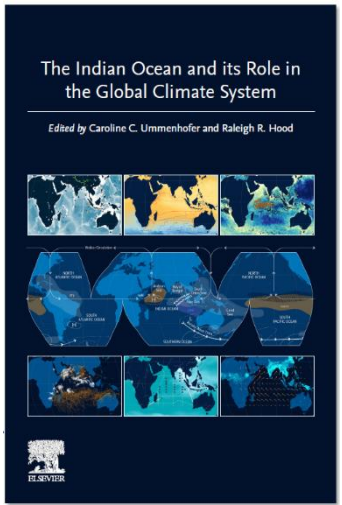
2.a. Selected scientific highlights since last report (1-5)

Last report was submitted to SCOR, August 2024

We view the major SIBER highlights to be the following (details of each are provided in this report).

1. Contributions of SIBER SSC members to IIOE-2, both through governance (national committees and involvement in IIOE-2 working groups etc) and motivating, leading and/or involvement in Indian Ocean collaborative research.
2. SIBER-led research cruises/projects, including SOLSTICE-WIO and ReMoTurb (Roberts), TRIUMPH (EIOURI, Susanto and Radjasa) MOSAIC (Lotliker) etc.
3. SIBER continues to lead publication of results of Indian Ocean research. This has included a series of SIBER-led IIOE-2 DSR II special volumes, with seven volumes already





completed and an eighth currently near completion. Also, a collection of synthesis papers on the Indian Ocean (Ummenhofer and Hood, SIBER SC, eds.) is now published as a 20-chapter book.

4.

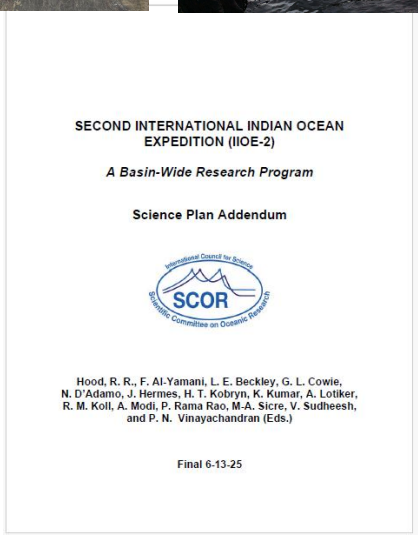
5. A further SIBER highlight in 2024 and 2025 (ongoing) has been continued development of the Coastal Observation Lab in a Box (COLaB) initiative (a collaboration between SIBER and the CLIVAR Indian Ocean Resource Panel, co-led by G. Cowie and J. Hermes). The project involves development of portable packages of low-cost instrumentation, and protocols for standardised physical, biological and biogeochemical observations, to be applicable in diverse coastal settings (wetlands to shelf edge) and without need of major infrastructure (research vessel or formal laboratory). The instrument packages and methods will be accompanied by modelling and data management tools, and in-person and online training. Important progress has been made over the last year through involvement in and Ocean Best Practices task team and a series of in-person and hybrid workshops. COLaB recently received endorsement by the UN Decade of Ocean, in association with the UN Decade *CoastPredict* program. Pilot COLaB activities were carried out in Ghana and Kenya in July and September 2024 (respectively), with a full regional training camp in Mozambique now scheduled for the first half of 2026. Coastal observations and marine science capacity building have now been incorporated as key elements of the Amended IIOE-2 Science Plan 2026-2030 (see below). Following the joint IIOE-2/SIBER meetings in Mauritius in May 2025, negotiations have begun to hold COLaB training activities in other locations across the Indian Ocean, including Indonesia (confirmed) and Malaysia, the Andaman islands, Seychelles/Mauritius, Kenya and others.

COLaB
Coastal Observation Lab in a Box

2021 2030 United Nations Decade of Ocean Science for Sustainable Development

VOKCE-COLaB training camp, Mida Creek (Kenya), Sep. 2024

6. Following agreement at the IIOE-2 SC meeting in Perth, Western Australia (Feb 6-10 2023) that the expedition should be extended beyond 2025, R. Hood and G. Cowie attended a workshop in Hyderabad, India (Nov-Dec 23). Decisions were reached as to proposed priorities for an extended IIOE-2. Since then, R. Hood has recently completed an Addendum to the IIOE-2science plan for the 2025-2030 period, with SIBER science themes at the core and with contributions from numerous SIBER SC members.



SECOND INTERNATIONAL INDIAN OCEAN EXPEDITION (IIOE-2)

A Basin-Wide Research Program

Science Plan Addendum

SCOR

Hood, R. R., F. Al-Yamani, L. E. Beckley, G. L. Cowie, N. D'Adamo, J. Hermes, H. T. Kobryn, K. Kumar, A. Lotiker, R. M. Koll, A. Modi, P. Rama Rao, M-A. Sicre, V. Sudheesh, and P. N. Vinayachandran (Eds.)

Final 6-13-25

2.b. Publications since last report

Please add all publications since last report to the table below (see notes for details on "Class" and "Activity" fields).

***Publication** with DOI*	***Class 1, 2, 3***	***Activity****
Van der Reis, A*. et al. 2024*. Insight into the diet of early stages of meso-pelagic fishes in the Indian ocean using DNA metabarcoding. *Deep-Sea Research II 218: 105426*	*2*	*IIOE-2/SIBER SSC member led voyage*
Bessey, C. *et al*. 2025. Design & validation of an open–close device for integrated environmental DNA sampling detects a depth gradient in Indian Ocean deep-sea fish assemblages. *Ecol. & Evolution, 15(2), 70902.*	*3*	*IIOE-2*
Etkins, M & Wilson, N.G. 2024. New carnivorous sponges (Porifera: Cladorhizidae) from Western Australia, collected by ROV. *Scientific Reports 14: 22173*	*3*	*IIOE-2*
Parida, C. & Antoine, D. 2025. Phytoplankton communities distribution along a physical gradient in the eastern Indian Ocean based on their pigments & absorption properties. *Deep-Sea Research II. 220: 105460*	*2*	*IIOE-2/SIBER SSC member led voyage*
O'Hara, T. 2024. Geomorphology & oceanography of central-eastern Indian Ocean seamounts*. Deep-Sea Research II, 218: 105415*	*3*	*IIOE-2*
Benthuysen, J. et al. 2025. Observing heatwaves using ocean gliders to address ecosystem challenges through a co-ordinated national program*. Oceanography doi: 10.5670/oceanog.2025e101*	*3*	*Australian heatwaves*
Spillman, C. et al. 2025. What makes a marine heatwave forecast useable, useful and used*? Progress in Oceanography doi.org/10.1016/j.pocean.2025.103464*	*3*	*Australian heatwaves*
Smith, K.E. et al. 2025. Ocean extremes as a stress test for marine ecosystems and society*. Nature Climate Change 15: 231-235*	*3*	*Australian heatwaves*
Landry, M.R., M. Décima, M.R. Stukel and A. Gutiérrez-Rodríguez. (2024) Trophic flows to mesozooplankton support the conventional paradigm of pelagic food web structure in ocean ecosystems. *ICES J. Mar. Sci.* https://doi.org/10.1093/icesjms/fsae131.	*2*	Indian Ocean research led by SIBER SC member
Landry, M.R., A.L. Freibott, J.L. Beatty and K.E. Selph. (2024) Phytoplankton biomass responses to a marine heat wave align with altered nitracline depth. *Limnol. Oceanogr.* 69: 1683-1694. https://doi.org/10.1002/lno.12624.	*2*	Climate-relevant research led by/involving SIBER SC member
Landry, M.R., A.L. Freibott, M.R. Stukel, K.E. Selph., A.E. Allen and A. Rabines (2024) Phytoplankton growth and grazing dynamics during anomalous heat wave and suppressed upwelling conditions in the southern California Current. *Deep-Sea Res. I* 210. https://doi.org/10.1016/j.dsr.2024.104353.	*2*	Climate-relevant research led by/involving SIBER SC member
Quintanilla, J.M., R. Borrego-Santos, E. Malca, R.	*2*	BLOOFINZ-related

Swalethorp, **M.R. Landry**, T. Gerard, J. Lamkin, A. García and R. Laiz-Carrión. (2024) Maternal effects and trophodynamics drive interannual larval growth variability of Atlantic Bluefin Tuna (*Thunnus thynnus*) from the Gulf of Mexico. *Animals,* **14**, 1319. https://doi.org/10.3390/ani14091319.		contribution involving SIBER SC member
Chen, T.-C., M. Kahru, **M.R. Landry**, M.D. Ohman, A.R. Thompson and M.R. Stukel. (2024) Multi-trophic level responses to marine heatwave disturbances in the California Current Ecosystem. *Ecol. Lett.* https://doi.org/10.1111/ele.14502.	*2*	Climate-relevant research involving SIBER SC member
Landry, M.R., M.R. Stukel, N. Yingling, K.E. Selph, S. Kranz, C.K. Fender, R. Swalethorp and R. Bhabu. (In review) Microbial food web dynamics in tropical waters of the bluefin tuna spawning region off northwestern Australia. *Deep-Sea Res. II.*	*2*	BLOOFINZ research led by SIBER SC member (Project P.I.)
Selph, K.E., Yingling, N., Traboni, C., **Landry, M.R.** (In review) Lysosomal vacuole-containing organisms are a majority of the eukaryotic microbial community in oligotrophic Argo Basin waters (Eastern Indian Ocean) during austral summer 2022. *Deep-Sea. Res. II.*	*2*	BLOOFINZ research involving/led by SIBER SC member (Project P.I.)
Stukel, M.R., T. Biard, M. Decima, C.K. Fender, O. Kehinde, T.B. Kelly, S.A. Kranz, M. Laget, **M.R. Landry**, K.E. Selph and N. Yingling. (In review). Sinking carbon export in the oceanic Argo Basin off northwestern Australia. *Deep-Sea Res. II.*	*2*	BLOOFINZ research involving/led by SIBER SC member (Project P.I.)
Yingling, N., K.E. Selph, **M.R. Landry,** S.A. Kranz, M. Johnson and M.R. Stukel. (In review) Phytoplankton nutrient uptake, community composition and biomass in the eastern Indian Ocean off northwest Australia. *Deep-Sea Res. II***.**	*2*	BLOOFINZ research involving/led by SIBER SC member (Project P.I.)
Davies, C.H., R.S. Eriksen, S. Jayasinghe and **M.R. Landry**. (In review) Plankton assemblages across a coastal to oceanic gradient of Northern Australia and responses to a storm perturbation in the Argo Basin. *Deep-Sea Res. II*.	*2*	BLOOFINZ research involving/led by SIBER SC member (Project P.I.)
Swalethorp, R., E. Malca, A. Shiroza, L. Kim, M. Décima, J. Quinitanilla, R. Borrego-Santos, C.H. Davies, D. Die, L.E. Beckley, C. Traboni, G.F. Cawley, K.A. Walsh, **M.R. Landry** and R. Laiz-Carrión. (In review) Selective feeding in Southern Bluefin Tuna (*Thunnus maccoyii*) larvae on appendicularians in their eastern Indian Ocean spawning region. *Deep-Sea Res. II.*	*2*	BLOOFINZ research involving/led by SIBER SC member (Project P.I.)
Décima, M., R. Swalethorpe, G.F. Cawley, C. Traboni, C.H. Davies and **M.R. Landry**. (In review) Zooplankton trophic processes in the eastern Indian Ocean off northwest Australia. *Deep-Sea Res. II*.	*2*	BLOOFINZ research involving/led by SIBER SC member (Project P.I.)
Traboni, C., Cawley, G.F., Selph, K.E., **M.R. Landry** and M. Décima. (MS) Exploring the roles of trophic mode and microbial prey size in grazing pathways of tropical oligotrophic waters of the eastern Indian Ocean. *Deep-Sea Res. II.*	*2*	BLOOFINZ research involving/led by SIBER SC member (Project P.I.)
Each data file (including metadata) at the BCO-DMO data repository has a unique doi publication number. About 16 data files from the BLOOFINZ-IO cruise RR2201 were	*2*	BLOOFINZ research involving/led by SIBER SC member

submitted/posted in the current year.		(Project P.I.)
Annasawmy Pavanee, Chandelier Guillaume, Le Mézo Thomas (2025). **Unravelling Major Questions in Micronekton Ecology and Their Role in the Biological Carbon Pump Through Integrative Approaches and Autonomous Monitoring**. *Oceanography*, 38(1 suppl.), 76-81. Publisher's official version : https://doi.org/10.5670/oceanog.2025e118 , Open Access version : https://archimer.ifremer.fr/doc/00945/105656/	*2*	Research involving/led by SIBER SC member (Project P.I.)
Metzl Nicolas, Lo Monaco Claire, Barut Guillaume, **Ternon Jean-Francois** (2025). **Contrasting trends of the ocean CO2 sink and pH in the Agulhas current system and the Mozambique Basin, South-Western Indian Ocean (1963-2023).** *Deep-sea Research Part Ii-topical Studies In Oceanography*, 220, 105459 (13p.). https://doi.org/10.1016/j.dsr2.2025.105459 *(this paper is part of a IIOE-2 DRS2 special Issue)*	*2*	Research involving/led by SIBER SC member (Project P.I.)
Penven Pierrick, **Ternon Jean-Francois**, Noyon Margaux, Herbette Steven, Cambon Gildas, Comby Caroline, L'Hegaret Pierre, Malauene Bernardino S., Claire Menesguen, Nehama Fialho, Rauntenbach Gustav, Rufino Yula, Sudre Floriane (2025). **Characterizing the Central Structure of a Mesoscale Eddy-Ring Dipole in the Mozambique Channel From In Situ Observations**. *Journal Of Geophysical Research-oceans*, 130(3), e2024JC021913 (22p.). Publisher's official version : https://doi.org/10.1029/2024JC021913 , Open Access version : https://archimer.ifremer.fr/doc/00942/105362/ *(this paper has been awarded as an AGU research spolight, with a publication in EOS: Sidik, S. M. (2025), Tracking some of the world's fiercest ocean currents, Eos, 106, https://doi.org/10.1029/2025EO250119. Published on 27 March 2025)*	*2*	Research involving/led by SIBER SC member (Project P.I.)
Chenillat Fanny, Deshaies Eloise, Arens Aline, Penven Pierrick (2024). **Role of mesoscale eddies in the biogeochemistry of the Mozambique Channel**. *Frontiers In Marine Science*, 11, 1402776 (11p.). Publisher's official version : https://doi.org/10.3389/fmars.2024.1402776 , Open Access version : https://archimer.ifremer.fr/doc/00915/102738/	*2*	Research involving/led by SIBER SC member (Project P.I.)
Amjad F, Ahusan M, Amir H, de Villiers NM, Gress E, Mah CL, Naeem S, Rico-Seijo N, Samaai T, Afzal MS, Woodall LC, Stefanoudis PV (2024) An underwater imagery identification guide for shallow, mesophotic and deep-sea benthos in Maldives. Biodiversity Data Journal 12: e120128. https://doi.org/10.3897/BDJ.12.e120128	*3*	SIBER/IMBeR relevant research
Gittings JA, Darmaraki S, Dall'Olmo G, Tang W, Theodorou I, Llort J, Brewin RJW, Jebri F, Srokosz M, Livanou E, Cassar N, Nencioli F, Raitsos DE (2024) An exceptional phytoplankton bloom in the southeast Madagascar Sea driven by African dust deposition. PNAS Nexus 3:10, 386. https://doi.org/10.1093/pnasnexus/pgae386	*3*	SIBER/IMBeR relevant research

Payne RP, Samaai T, Janson L, Kerwath SE, Gibbons MJ (2025) Eleven new heteroscleromorph Demospongiae (Porifera), and a new record of the tetractinellid *Ancorina corticata*, from Walters Shoal, a shallow seamount on the Madagascar Ridge in the South West Indian Ocean (SWIO). Zootaxa 5575: 1–56. https://doi.org/10.11646/zootaxa.5575.1.1	*3*	SIBER/IMBeR relevant research
Rawoot A, Govender A, Groeneveld JC, Willows-Munri S, Cedras R (2024) Strengthening the DNA barcode reference library for marine copepods in South Africa. https://doi.org/10.2989/1814232X.2024.2418573	*3*	SIBER/IMBeR relevant research
Fernandez, S., […], **Marandino, C.**, et al.: Surface ocean-lower atmospheric processes in the Indian Ocean: Current understanding, knowledge gaps and future directions, *Elementa: Science of the Anthropocene*, 2024.	*3*	SIBER/IMBeR relevant research
Mohtadi, M (2025). Monsoon reconstructions for South and East Asia. In S. Elias (Ed.), Encyclopedia of Quaternary Science (Third edition) (pp. 158-170). Oxford: Elsevier. doi:10.1016/B978-0-323-99931-1.00234-82024	*3*	SIBER/IMBeR relevant research
Lu, F, Mohtadi, M, Pausata, FSR (2024). Dynamics of the intertropical convergence zone during the early Heinrich Stadial 1. Nature Communications, 15(1), 9753. doi:10.1038/s41467-024-53999-4	*3*	SIBER/IMBeR relevant research
Mohtadi, M, Abram, NJ., Clemens, SC, Pfeiffer, M, Russell, JM, Steinke, S, & Zinke, J (2024). Paleoclimate evidence of Indian Ocean variability across a range of timescales. In CC Ummenhofer & RR Hood (Eds.), The Indian Ocean and its Role in the Global Climate System (pp. 445-467): Elsevier, doi:10.1016/B978-0-12-822698-8.00007-X	*3*	SIBER/IMBeR relevant research
Jiaqing Xue, Wenjun Zhang, HualongZhu, ChengSun, Yutong Zhang, Jing-Jia Luo & **ToshioYamagata** **Interdecadal modulation of Ningaloo Nino/ Nina strength by the AMO** Feb 25, 2025, Nature Communications (https://doi.org/10.1038/s41467-025-57160-7)	*3*	SIBER/IMBeR relevant research
Murata, A., Kouketsu, S., Sasaoka, K., & Arulananthan, K. (2024). **Modulation of Surface Seawater CO2 System at 80°E: Impacts of the Positive IOD in 2019** *Journal of Geophysical Research: Oceans,129, e2024JC021177. https://doi.org/10.1029/2024JC021177*	*3*	SIBER/IMBeR relevant research
Keesing, J. et al. 2024. Deep-water benthic habitats & biodiversity of the Gascoyne and Carnarvon canyon Marine Parks & adjacent areas. Report from the RV Investigator survey (IN2022_v09): Report 2: Biodiversity of invertebrates & fishes. CSIRO. 210 pp.	*3*	SIBER/IMBeR relevant research
Bessey, C. et al. 2025. Design & validation of an open–close device for integrated environmental DNA sampling detects a depth gradient in Indian Ocean deep-sea fish	*3*	SIBER/IMBeR relevant research

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Mah, C.L. 2025. New Australian deep-sea Goniasteridae (Asteroidea; Valvatacea). Memoirs of Museum Victoria 84: 49–88.	*3*	SIBER/IMBeR relevant research
O'Hara, T. 2024. Geomorphology & oceanography of central-eastern Indian Ocean seamounts. Deep-Sea Research II, 218: 105415	*3*	SIBER/IMBeR relevant research
Kupriyanova, E.K. & Flaxman, B. 2024. Abyssal Serpulidae (Annelida) of the Australian Indian Ocean Territories. Records of the Australian Museum, 76(4): 211-242.	*3*	SIBER/IMBeR relevant research
Flaxman, B. & Kupriyanova, E.K. 2024. New species of Laetmonice (Aphroditidae, Annelida) from bathyal & abyssal depths around Australia. Records of the Australian Museum, 76 (4): 195-210	*3*	SIBER/IMBeR relevant research
Mackenzie, M. et al. 2024. A report of sea cucumbers collected on the first dedicated deep sea biological survey of Australia's Indian Ocean Territories around Christmas & Cocos (Keeling) Islands (Echinodermata: Holothuroidea). Memoirs of Museum Victoria, 83: 207-316.	*3*	SIBER/IMBeR relevant research
Mah C.L., 2025. New Australian deep-sea Goniasteridae (Asteroidea; Valvatacea). Memoirs of Museum Victoria 84: 49	*3*	SIBER/IMBeR relevant research
Etkins, M & Wilson, N.G. 2024. New carnivorous sponges (Porifera: Cladorhizidae) from Western Australia, collected by ROV. Scientific Reports 14: 22173	*3*	SIBER/IMBeR relevant research
Parida, C. & Antoine, D. 2025. Phytoplankton communities distribution along a physical gradient in the eastern Indian Ocean based on their pigments &absorption properties. Deep-Sea Research II. 220: 105460	*3*	SIBER/IMBeR relevant research
Kiko, R., Picheral, M., Antoine, D. et al. 2022. A global marine particle size distribution dataset obtained with the Underwater Vision Profiler 5. Earth System,Science Data 14 (9): 4315-4337	*3*	SIBER/IMBeR relevant research
Purba, Noir P.; Ghelby M. Faid, Wang Zheng, Mohd. Fadzil Akhir, Weidong Yu, Rangga A. Mulya, Fadli Syamsudin, Ibnu Faizal, Buntora Pasaribu, Teguh Agustiadi, Bayu Priyono, Muhammad Fadli, Priyadi D. Santoso, Wahyu W. Pandoe, Huiwu Wang, Shujiang Li, Zexun Wei, **R. Dwi Susanto**, Dwiyoga Nugroho, and Adi Purwandana, (2025) Two Centuries of Oceanographic Data in the Indonesian Seas and Surroundings: Historical Trends, Gaps, and Future Challenges, *Earth System Science Data,* https://doi.org/10.5194/essd-2025-196.	*2*	Research led by/involving SIBER SC member
Sartimbul, A., I Gusti Ayu Diah Hendiari, I Wayan Arthana, Gde Raka Angga Kartika, Victor Adi Winata, Widodo Setiyo Pranowo, **Raden Dwi Susanto**, Erfan Rohadi, Nurul Muslihah, Defri Yona, Feni Iranawati (2025), Sardinella lemuru is known as the native pelagic fish of the Bali Strait. However, its Possible Relation to Ocean Circulation, *Jurnal Ilmiah Perikanan dan Kelautan*, 17 (2), 296, Universitas Airlangga, Indonesia.	*2*	Research led by/involving SIBER SC member

Xu, Tengfei, Shujiang Li, Yingyi Yang, Yaohua Zhu, A. Kuswardani, Yonggang Wang, Guanlin Wang, Xiaoqing Xu, Fei Teng, Agus Setiawan, Priyadi Dwi Santoso, Teguh Agustiadi, Mukti Trenggono, ***R. Dwi Susanto****, Zexun Wei, (2025) Mooring Observed Cross Equator Propagation of Kelvin Waves Through the Makassar Strait, J. Geophysical Research-Oceans, 130, e2024JC022310.* *https://doi.org/10.1029/2024JC022310*	*2*	Research led by/involving SIBER SC member
Rosid, Mohammad Syamsu; Hendri Irwandi, Terry Mart, **Raden Dwi Susanto**, Albertus Sulaiman, Evaluation of Lake Toba's water level decline in Indonesia over the past six decades, *Environmental Challenges*, 18 (2025), 101071, https://doi.org/10.1016/j.envc.2024.101071	*2*	Research led by/involving SIBER SC member
Siallagan, Zen Ladestam; Muhammad Fadli, Charlie Ester de Fretes, Rafidha Dh Ahmad Opier, **R Dwi Susanto**, Zexun Wei, V Sri Harjati Suhardi, Husna Nugrahapraja, Ocky Karna Radjasa, Fenny M Dwivany, Metagenomic analysis of deep-sea bacterial communities in the Makassar and Lombok Straits, *Scientific Reports*, 14(1), 25472, 2024. https://doi.org/10.1038/s41598-024-74118-9	*2*	Research led by/involving SIBER SC member
Susanto, R. D*., Zexun Wei, Priyadi Dwi Santoso, Guanlin Wang, Muhammad Fadli, Shujiang Li, Teguh Agustiadi, Tengfei Xu, Bayu Priyono, Ying Li, Guohong Fang. Field measurements of turbulent mixing south of the Lombok Strait, Indonesia, Geoscience Letters, (2024) 11 (1), 36, https://doi.org/10.1186/s40562-024-00349-3.*	*2*	Research led by/involving SIBER SC member
Setiawan, Riza Yuliratno; ***R. Dwi Susanto,*** *Takanori Horii, Inovasita Alifdini, Eko Siswanto, Qurnia Wulan Sari, Anindya Wirasatriya, and Candra Aryudiawan, The Fujiwara effect on ocean biophysical variables in the southeastern tropical Indian Ocean region, Journal of Marine Systems, 245, (2024), 103990, https://doi.org/10.1016/j.jmarsys.2024.103990.*	*2*	Research led by/involving SIBER SC member
Radjasa, Ocky K*.; Ray Steven; Yosua Natanael; Husna Nugrahapraja; Septhy K. Radjasa; Tati Kristianti; Maelita R. Moeis; Joko P. Trinugroho; Ari Dwijayanti; Mutiara R. Putri; Charlie Ester de Fretes; Zen L. Siallagan; Muhammad Fadli; Rafidha D. A. Opier; Viana Rahmawati; Meirifa Rizanti; Zalfa Humaira; Ary S. Prihatmanto; Nugroho D. Hananto;* ***R. Dwi Susanto****; Agus Chahyadi; Elfahmi -; Neil Priharto; Kamarisima (2024), From the depths of the Java Trench: genomic analysis of Priestia flexa JT4 reveals bioprospecting and lycopene production potential, BMC genomics, 25(1), 1259, 25(1), 1259, 2024. https://doi.org/10.1186/s12864-024-11115-2.*	*2*	Research led by/involving SIBER SC member
Manullang Corry Yanti, Mufti Petala Patria, Agus Haryono, Sabiqah Tuan Anuar, ***Raden Dwi Susanto****, Malik Sudin Abdul, Muhammad Fadli, Zexun Wei, (2024b), Ingestion of microplastics in the planktonic copepod from the Indonesian throughflow pathways, Sains Malaysiana, 53 (8), 1873-1887. http://doi.org/10.17576/jsm-2024-5308-12*	*2*	Research led by/involving SIBER SC member
Particulate Organic Carbon Export Fluxes across the	*3*	SIBER/IMBeR

Seychelles-ChagosThermocline Ridge in the western Indian Ocean using 234Th as a Tracer. Front. Mar. Sci., 10. 2024. https://doi.org/10.3389/fmars.2023.1288422		relevant research
Contribution of aged organic carbon to suspended particulate organic carbon in the Western Indian Ocean. Front. Mar. Sci., 11. 2024. https://doi.org/10.3389/fmars.2024.1336132	*3*	SIBER/IMBeR relevant research
Crucial Role of Bacterial Processes in the Net Community Production of the Amundsen Sea Polynya Disclosed by a Modeling Study. J. Geophys. Res. Biogeosci., 129. 2024 https://doi.org/10.1029/2023JG007718	*3*	SIBER/IMBeR relevant research
Acoustic Characterization of fish and macroplankton communities in the Seychelles-ChagosThermocline Ridge of the Southwest Indian Ocean. Deep-Sea Res. II, 213. 2024. https://doi.org/10.1016/j.dsr2.2023.105356	*3*	SIBER/IMBeR relevant research
Marine Heatwaves in the East Asian Marginal Seas Facilitated by Boreal Summer IntraseasonalOscillations. J. Geophys. Res. Oceans., 129. 2024. https://doi.org/10.1029/2023JC020602	*3*	SIBER/IMBeR relevant research
Machine Learning-Based Anomaly Detection on Seawater Temperature Data with Oversampling. J. Mar. Sci. Engin. 12. https://doi.org/10.3390/jmse12050807	*3*	SIBER/IMBeR relevant research
Distribution characteristics of microplastics in the surface mixed layer of the western Indian Ocean. Deep-Sea Res. II. 218. https://doi.org/10.1016/j.dsr2.2024.105424	*3*	SIBER/IMBeR relevant research
Latitudinal Influences on Sound Scattering Layer Characteristics in the Southwestern Indian Ocean: Insights into Oceanographic Environmental Interactions. Front. Mar. Sci., 11. 2024. https://doi.org/10.3389/fmars.2024.1481531	*3*	SIBER/IMBeR relevant research
Particulate Organic Carbon Export Fluxes across the Seychelles-ChagosThermocline Ridge in the western Indian Ocean using 234Th as a Tracer. Front. Mar. Sci., 10. 2024. https://doi.org/10.3389/fmars.2023.1288422	*3*	SIBER/IMBeR relevant research

2.c. Events, Meetings, and Workshops

List all international and national events, meetings and workshops. Describe the level of participation: e.g. chairing session/workshop, organising meeting. Include Endorsed Projects committee meetings and workshops.

Australian Marine Science Conference. 2024. Hobart, Tasmania. Oral presentation: L.E.Beckley - Marine biodiversity observations during the second International Indian Ocean Expedition build towards global ocean sustainability

Australian Marine Science Conference. 2024. Hobart, Tasmania. Oral presentation: R.T.Evans-Powell et al. Implications of big, old, fat, fecund, female fish (BOFFFFs) for assessing a demersal teleost stock.

Australian Marine Science Conference. 2024. Hobart, Tasmania. Oral presentation: A. Sutton & L.E. Beckley - Rare opportunity to compare krill assemblages 60 years apart in the eastern Indian Ocean

BLOOFINZ Workshop, SIO, La Jolla, CA, 17-19 Sept. 2024

Organized and hosted by M.R. Landry. Workshop goals were to present and organize results of component studies for presentation at ASLO ASM and a special volume of *Deep-Sea Research II.*

ASLO Aquatic Sciences Meeting, Charlotte, NC, 26-31 March 2025.
M.R. Landry was co-chair of Oral Sessions *SS24A and B - Biogeochemistry and food webs of oligotrophic ocean regions and potential climate-change impacts on habitat quality for the larvae of large pelagic fishes".* Nine of the 12 presentations in that session were from the BLOOFINZ study.

INDITUN Workshop, IEO-SCIC, Malaga, Spain, 22-25 April 2025 (Instituto Español de Oceanografía, Centro Oceanográfico de Málaga)
INDITUN is a collaboration, separately funded by the Spanish Ministry of Science (R. Laiz- Carrión, P.I.), to do advanced trophic and inter-species/inter-regional comparative analyses of tuna larvae collected on the BLOOFINZ cruise. M.R. Landry participated and presented at the workshop and leads the effort that will include a number of INDITUN papers in the *Deep-Sea Res. II* volume.

International Indian Ocean Science Conference (IIOSC), Port Louis, Mauritius, 5-9 May 2025
M.R. Landry presented a talk, "BLOOFINZ-INDITUN: Food webs supporting larvae of Southern Bluefin Tuna in their eastern Indian Ocean spawning region" at the Kudos session.

IMBeR Future Ocean 3 Conference and SSC Meeting, Shanghai, China, 13-16 May 2025
M.R. Landry presented a talk, "BLOOFINZ-INDITUN: Food webs supporting larvae of Southern Bluefin Tuna in their eastern Indian Ocean spawning region" in Session 12: SIBER and the Second International Indian Ocean Expedition.

Indian Ocean Regional Decade Conference 2024: Bridging Billions to Barcelona, Hyderabad, India, 1–3 February 2024.

- J. Huggett presented "Ocean observations off Southern Africa and priorities for the Indian Ocean" in Challenge: 7 Expand the Global Ocean Observing System
- J. Huggett presented an "Overview of SIBER and WIOMSA" in the IOCINDIO-led Special Session: Synergizing Regional Frameworks of the IOR.

ICES-PICES 7th International Zooplankton Production Symposium, Hobart, Australia, 17–22 March 2024.

- J. Huggett co-convened a Workshop on "Reference sequence databases for global zooplankton biodiversity: Optimization, applications & user guidelines"

3. International collaboration and links

Lynnath Beckley: USA, South Africa, Mozambique, India, Indonesia, New Zealand

Mike Landry: The BLOOFINZ/INDITUN collaboration involves participants from 11 US research institutions and 11 non-US research institutions in Australia, Spain, France, New Zealand, China/Hong Kong, Italy, Japan and Chile.

4. Input to management, policy and SOCIETY* over the last year

Add anything that is not covered under "1.c. Grand Challenge III"
**As previous reporting forms requested 'input to management and policy' only, please add any 'input to society' not captured in previous reports*

Lynnath Beckley was Member of Scientific Advisory Group for the establishment of the Australian South Coast Marine Park (1000 km of coastline) established in December 2024

Lynnath Beckley continues to be a member of the International Steering Committee for the Indo-Pacific Fish Conference (2001-2025) serving as Chair of the Executive from 2017-2023

5. Education, outreach and Capacity Development

Lynnath Beckley gave talk to the community of Augusta near Cape Leeuwin, WA on the Biological oceanography of the Leeuwin Current and arranged and facilitated talks on Sandy Beaches, Dhufish ecology etc by other scientists during the year.

The IIOE-2-endorsed VOKCE (Vulnerability of Kenyan Coastal Ecosystems under climate and non-climatic stress) project (M-A Sicre, Co-PI) included two elements of education and capacity building. Firstly, a training camp with 8 Kenyan early career scientists was held jointly with COLaB at Mida Creek (see above). It involved training in "old-school" hydrographic and biogeochemical methods, from small boats and using a makeshift laboratory. It also included testing of new open-source instruments against commercial counterparts. A second element was collection of sediments from various Kenyan coastal sites as part of an ongoing study of PAH contamination.

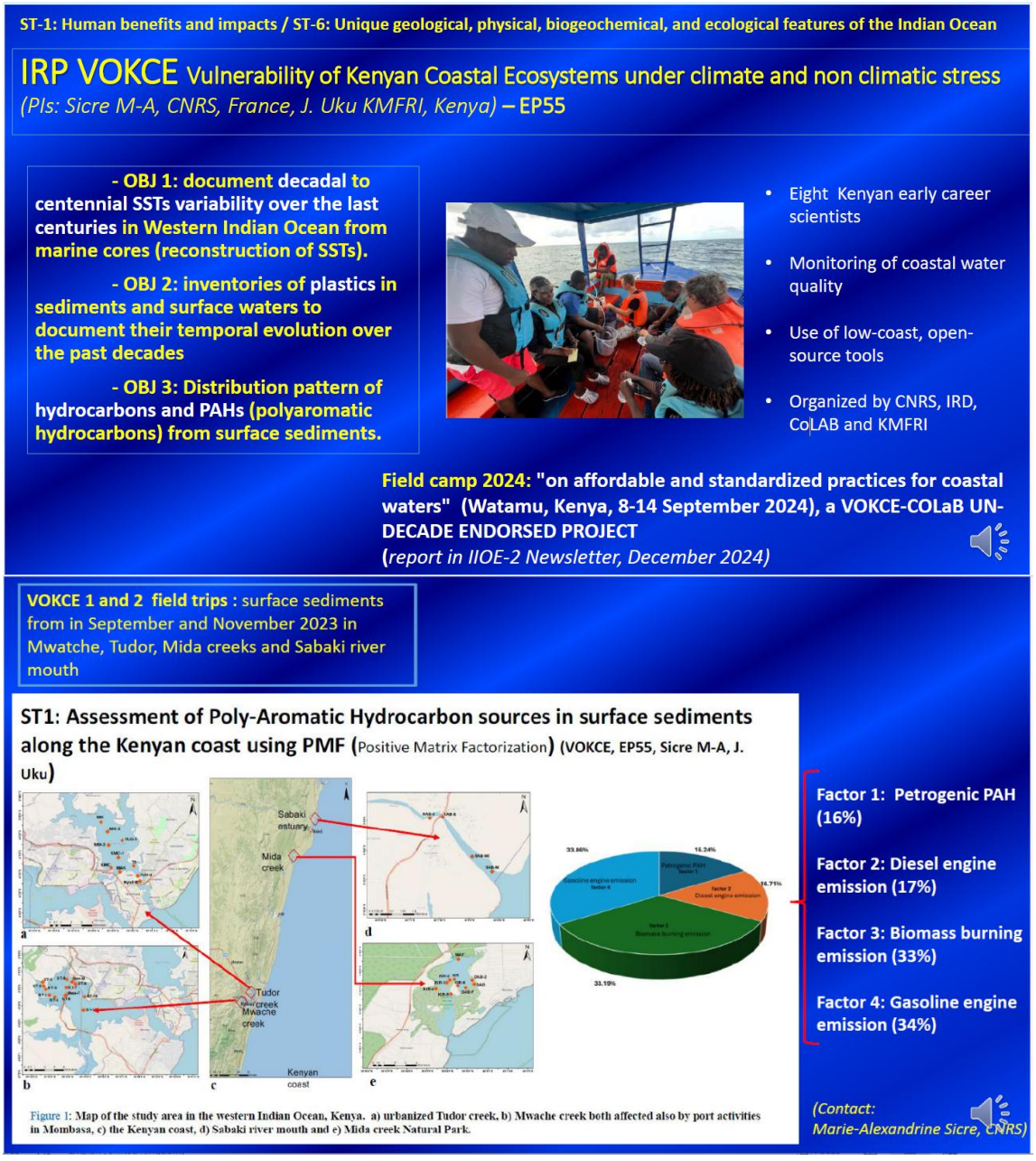
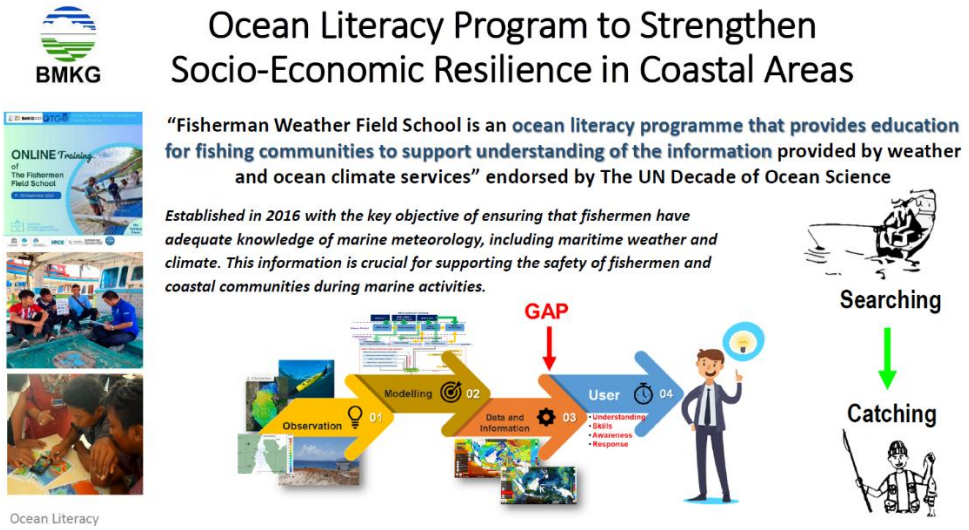
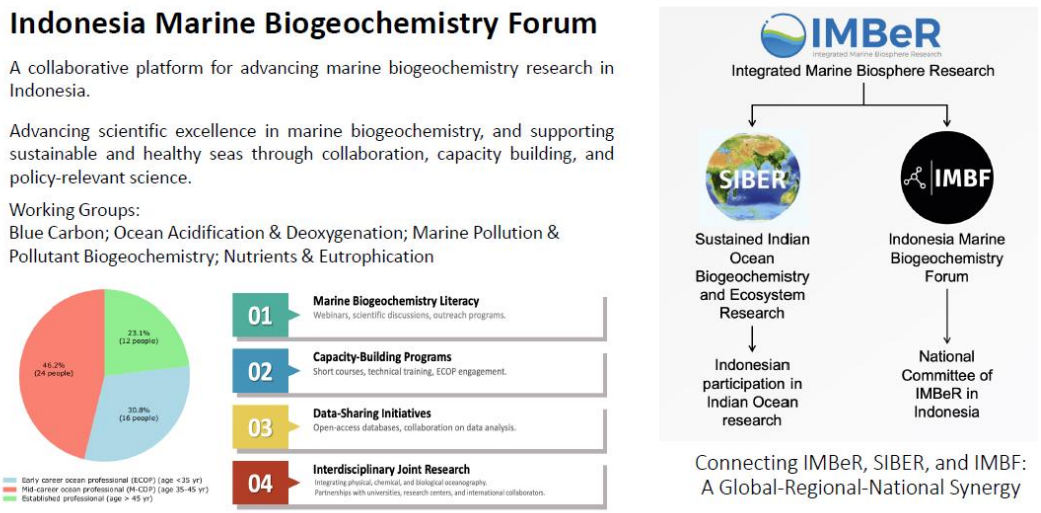


Figure 1: Map of the study area in the western Indian Ocean, Kenya. a) urbanized Tudor creek, b) Mwache creek both affected also by port activities in Mombasa, c) the Kenyan coast, d) Sabaki river mouth and e) Mida creek Natural Park.

Indonesian Education/Outreach activities include the following:





6. Planned activities

SIBER plans for the 2026-2030 period will remain centrally focused on the final phase of IIOE-2, through motivating and leading new international collaborations and research projects, through capacity development and training (COLaB), and through continued active involvement in IIOE-2 management and governance.

6.a. Activities and Outreach and how they link to the Challenges (including, but not limited to convening sessions, meetings, summer schools, workshops, etc)

Lynnath Beckley – Chair of Australian National Committee for IIOE-2 which has representatives from about 20 institutions. Regular communication by email, reporting on IIOE-2 meetings and personal face-face meetings with institutional representatives. Further, regular reporting to leaders of endorsed research project and assistance to prospective project leaders.

6.b. Upcoming papers (Community-Position-Review-etc)

Add text…

7. Funding

7.a. Funding from external sources

7.b. Funding proposals in progress or planned

Do you want this to be released in the online version of this report? ☐ Yes ☐ No

8. Changes to Organisational Structure

The SIBER steering committee membership remained unchanged in the last year. However, Makio Honda (Japan) recently announced a decision to stand down, and we are in the process of finding a replacement. It was also agreed at the recent meeting in Mauritius that new members would be sought, especially from the Early Career Scientist community and from Indian Ocean rim, island and marginal sea nations.

9. Images / Figures

*****It is always good to have some recent photos / figures / infographics to create more exposure for the Regional Programmes, Working Groups, etc. These can range from those suitable for a very scientific audience, to those that would engage the general public. IMBeR would use these, on the website (e.g. http://www.imber.info/ and http://www.imber.info/en/news), in tweets (@imber_ipo), in presentations, etc. In addition, Future Earth (one of our sponsors) regularly asks us to provide high quality images for their glossy reports. These can highlight the activities of IMBeR and their other Global Research Projects (see pdfs of past Future Earth reports here https://futureearth.org/publications/annual-reports/)*

*So, please provide any images that you might think are useful. These can be pasted in this document or emailed as an attachment to imber@ecnu.edu.cn.*****

Beckley photos:

A selection of photographs by Micheline Jenner, onboard photographer during Voyage IN2019_V03.

Photo 1. The scientific complement of Voyage IN2019_V03 arranged as IIOE-2 on the foredeck of the RV *Investigator*.

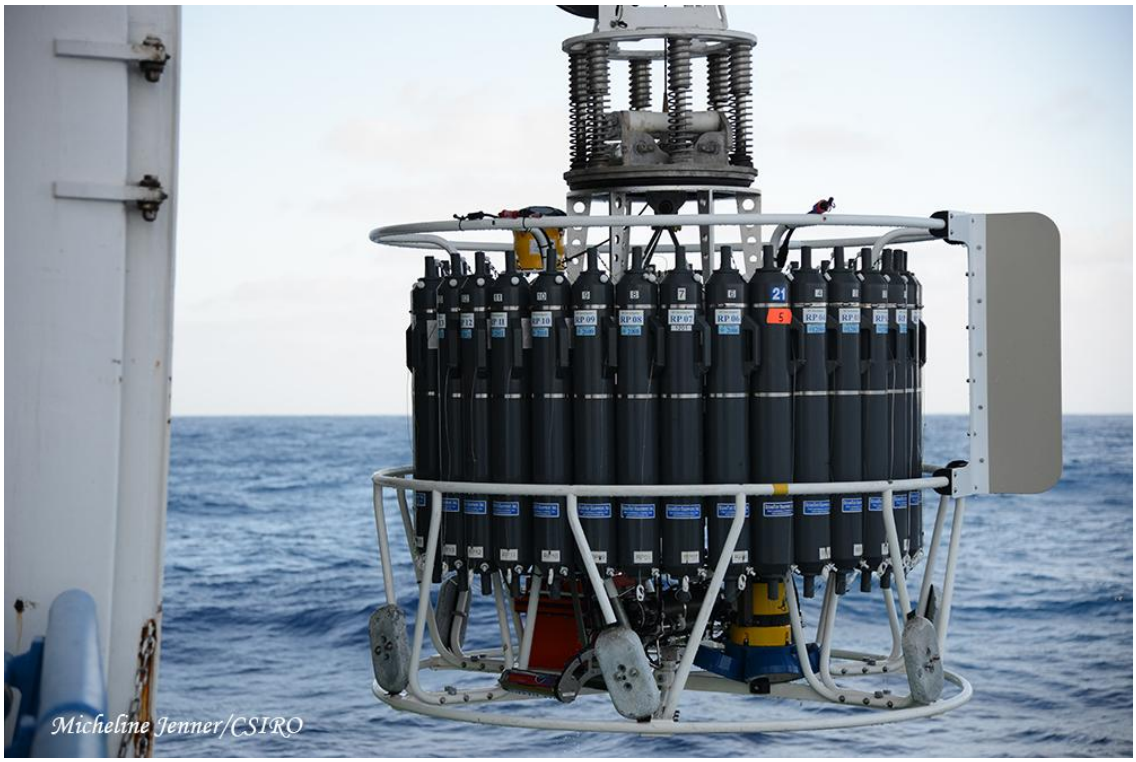


Photo 2. Casts of the CTD with its rosette of Niskin bottles to depths exceeding 5000m was a key activity at each of the stations along 110°E line during voyage IN2019_V03. Note the ADCP and UVP5 near the base of the rosette.

Photo 3. Water samples from the Niskin bottles on the CTD rosette were taken for hydrochemistry, microbes, phytoplankton and onboard experiments on Voyage IN2019_V03.

Photo 4. Retrieval of the Indian Ocean Standard net, a replica of the net used in the first International Indian Ocean Expedition during the 1960s, after a vertical haul on Voyage IN2019_V03.

Photo 5: Retrieval of the Inherent Optical Properties package after a vertical deployment during Voyage IN2019_V03.

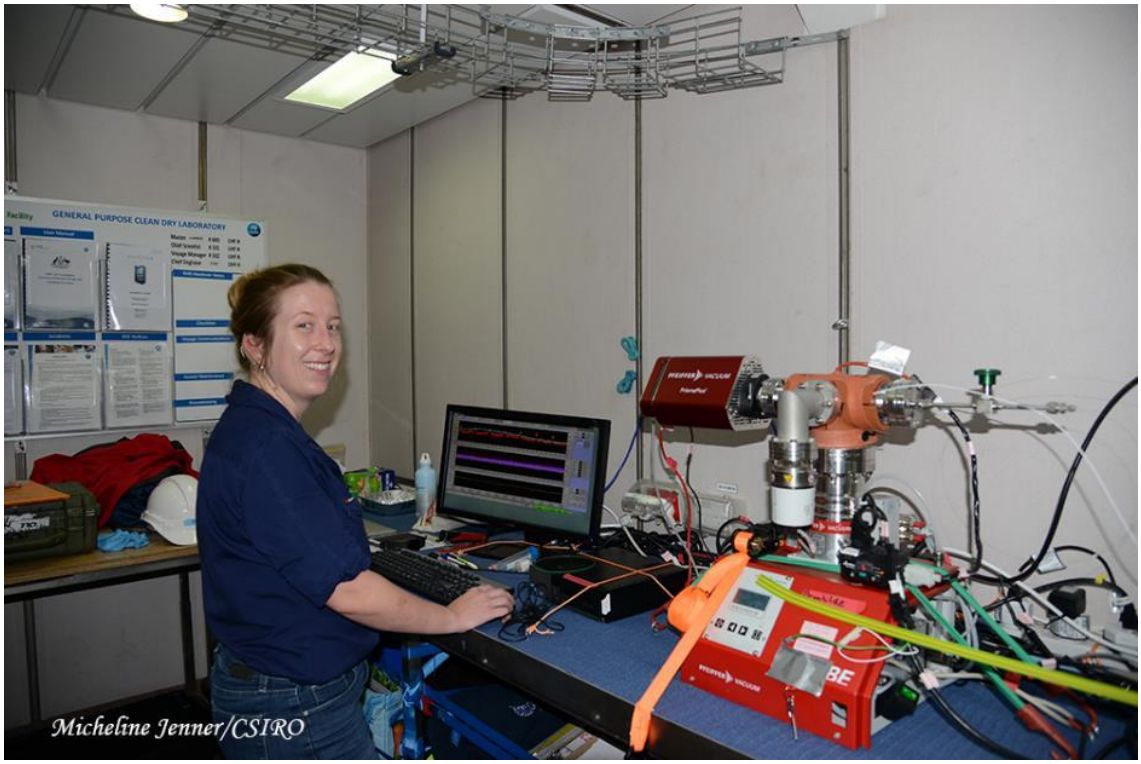


Photo 6. Dr Charlotte Robinson attending the Oxygen/Argon mass spectrometer for measuring net community production via the underway, throughflow seawater supply during Voyage IN2019_V03.

Photo 7. Prof Michael Landry with his incubation chambers for determining phytoplankton growth rates and microzooplankton grazing at different light levels during Voyage IN2019_V03.

Photo 8. Operating the EZ net from the operations room to collect depth-stratified samples of mesopelagic fishes and zooplankton during Voyage IN2019_V03.

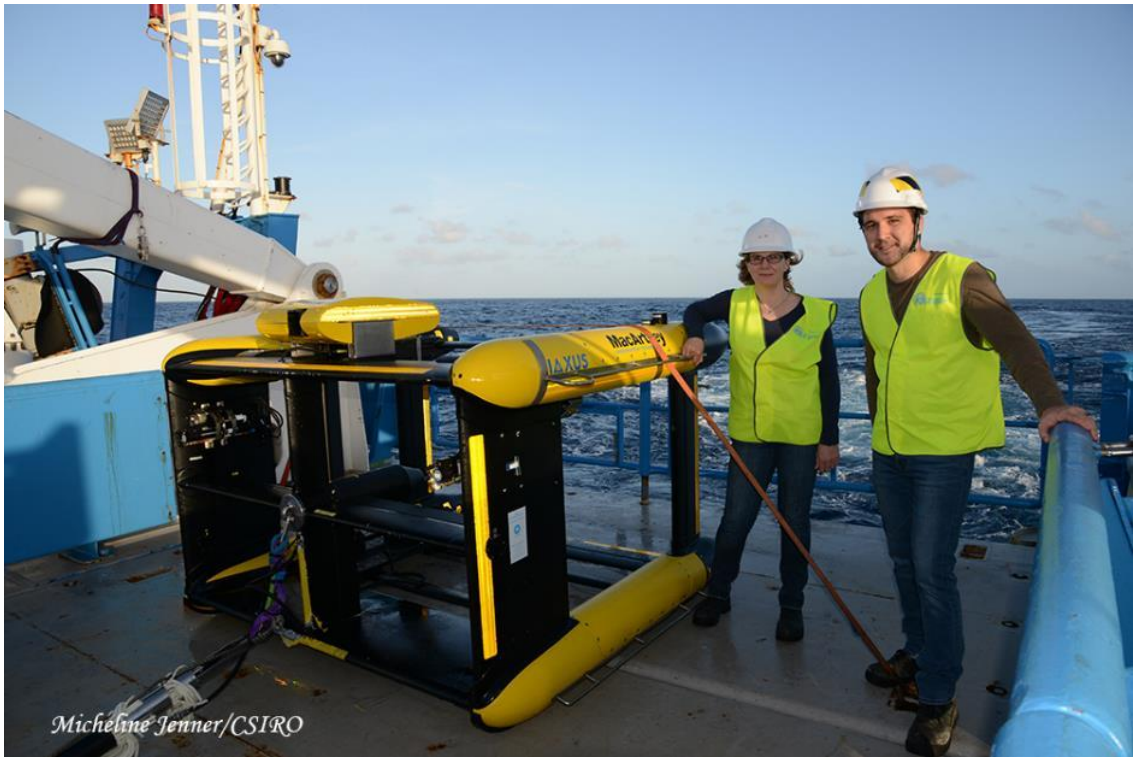


Photo 9. Dr Helen Phillips and PhD student Earl Duran prior to deployment of the Triaxus on one of the sections during Voyage IN2019_V03.

Photo 10. Onboard sorting of neuston net samples for fishes, phyllosoma and other zooplankton for genetics and food web analyses during Voyage IN2019_V03.

Photo 11. Dr Pilar Olivar identifying mesopelagic fishes sampled using the EZ net during Voyage IN2019_V03.

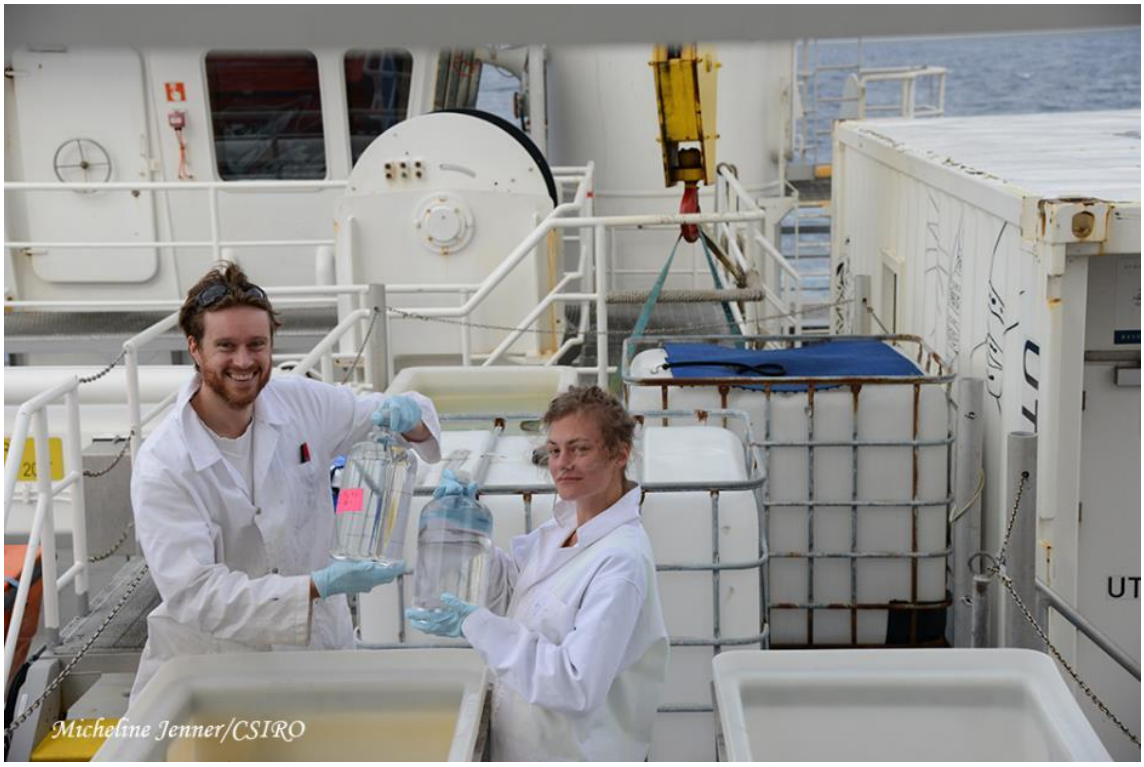


Photo 12: Dr Eric Raes and PhD student Cora Hörstmann undertaking Nitrogen uptake incubations on board the RV Investigator during Voyage IN2019_V03.

Photo 13. Dr Jessica Benthuysen and PhD student Maxime Marin preparing to deploy a weather drifter during Voyage IN2019_V03.

Photo 14. PhD student, Amaranta Focardi filtering water from different depths to map the microbial community along the 110°E line during Voyage IN2091_V03.

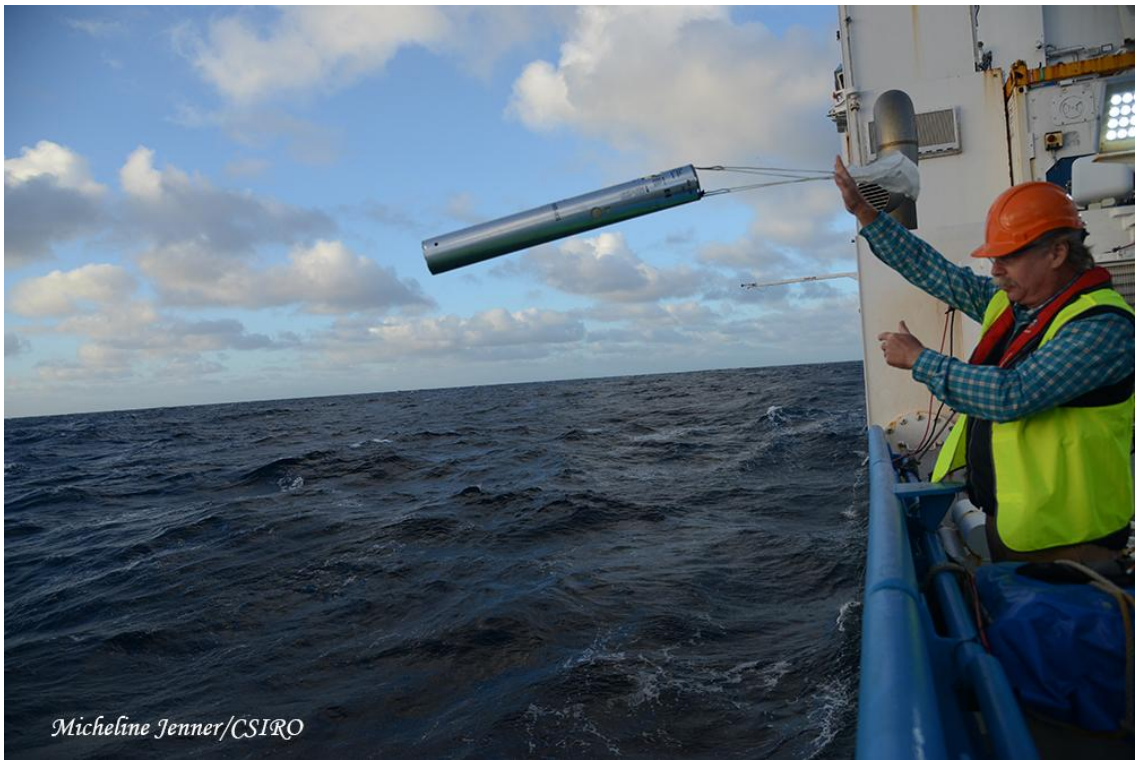


Photo 15. Curt Jenner deploying a sonobouy to monitor underwater noise and detect location of whales during voyage IN2019_V03.

Photo 16. Claire Davies and Prof Raleigh Hood onboard RV Investigator using a fluorometer to measure chlorophyll in samples collected during voyage IN2019_V03.

Photo 17. Prof David Antoine examining the optics data from deployment of a radiometer during Voyage IN2019_V03.

Photo 18. PhD student, Camille Grimaldi using a sorting flow cytometer aboard the RV Investigator during Voyage IN2019_V03.

Photo 19. PhD student, Peta Vine preparing filters for pigment analysis about the RV Investigator during Voyage IN2019_V03.

Photo 20. Micheline Jenner, whale researcher and onboard photographer pointing to a whale blow from the observation deck of RV *Investigator* during Voyage IN2019_V03.

10. Notable achievements over the IMBeR decade (2016-2025)

General:

SIBER has been central to IIOE-2 from the initial conceptualisation and then leading the writing of its science plan and implementation strategy to present-day active involvement in its governance. SIBER SC members have also been extremely active in IIOE-2 science (which now includes over 50 endorsed projects), from its launch in 2015, both through direct leadership of or involvement in major research projects and cruises (see below), and through leading and/or contributing to new international collaborative research efforts (e.g. US-Korea KUDOS programme) and observing programmes (e.g. BIO-ARGO and MOSAIC).

Some of the many aspects of ocean science receiving attention in the IIOE-2 include: met-ocean extremes such as monsoonal forcings and resultant seasonal ocean currents; vertical mixing; ocean-wide movement of large masses of water (such as cross-basin equatorial currents); links between ocean and weather (e.g., storms, wave, cyclones, Madden Julian Oscillations, Indian Ocean Dipole, Indian Ocean links to La Niña and El Niño); coastal boundary currents adjacent to rim countries and the Indian Ocean's role in the global conveyor belt of heat and other ocean properties. The bio-physical ecology underpinning fisheries production; seabed/seamount and habitat mapping; the influence of vertical oxygen dynamics in fish ecology; biodiversity assessment; impacts of marine heat waves; and many other aspects including acidification, temperature stress to corals, and links between transport and settlement of larvae are some of the more ecological aspects being investigated.

Complemented by a high-level examination of the requirements of an Indian Ocean Observing System out to 2030 (Beal et al., 2020), the IIOE-2 is achieving major advances in understanding societally important phenomena relating to major bio-physical characteristics and coupled ocean-meteorological processes in the Indian Ocean. The following provides several examples of specific programs, research expeditions and achievements motivated under IIOE-2.

Selected major IIOE-2/SIBER highlights:

10.1 A COUPLED BIO-PHYSICAL, ECOSYSTEM-SCALE, EXAMINATION OF AUSTRALIA'S INTERNATIONAL INDIAN OCEAN EXPEDITION 110°E LINE (IIOE2-EP06)

The fifth Special Issue of the DSRII Series on IIOE-2 was focused on a single research voyage undertaken in May-June 2019 with the Australian RV *Investigator* (Figure 9; Beckley et al., 2022). The voyage revisited an oceanic transect line along the 110°E meridian in the south-east Indian Ocean which was first studied from 1962 to 1963 during the First International Indian Ocean Expedition (e.g., Rochford, 1969; Tranter and Kerr, 1977).

With the huge progress in technology and techniques in recent years and contemporary 21st century understanding, investigating the 110°E line again after nearly six decades enabled updated bio-physical information to be obtained and more ecological processes to be explored along a latitudinal gradient in the south-east Indian Ocean. The fifth Special Issue includes 11 papers covering the results of some of the wide-ranging investigations conducted during the 2019 voyage. In addition to the physical oceanography, it highlights genomic and trophic process studies as well as traditional biological oceanographic studies ranging from plankton through to whales. This Special Issue contributed significantly to the research themes and goals of the IIOE-2 (Hood et al., 2015). The compiled papers highlight the complex oceanography, biological diversity and trophic processes in the region. They demonstrate a low nutrient ecosystem, dominated by recycling processes supporting picophytoplankton, small mixotrophic zooplankton, predatory copepods and mesopelagic fishes. Overall, the papers reflect a stepwise improvement in the understanding of the pelagic ecosystem in the oligotrophic south-east Indian Ocean.

EP06: A coupled bio-physical, ecosystem-scale, examination of Australia's IIOE 110°E line

PI: Lynnath Beckley, Australia

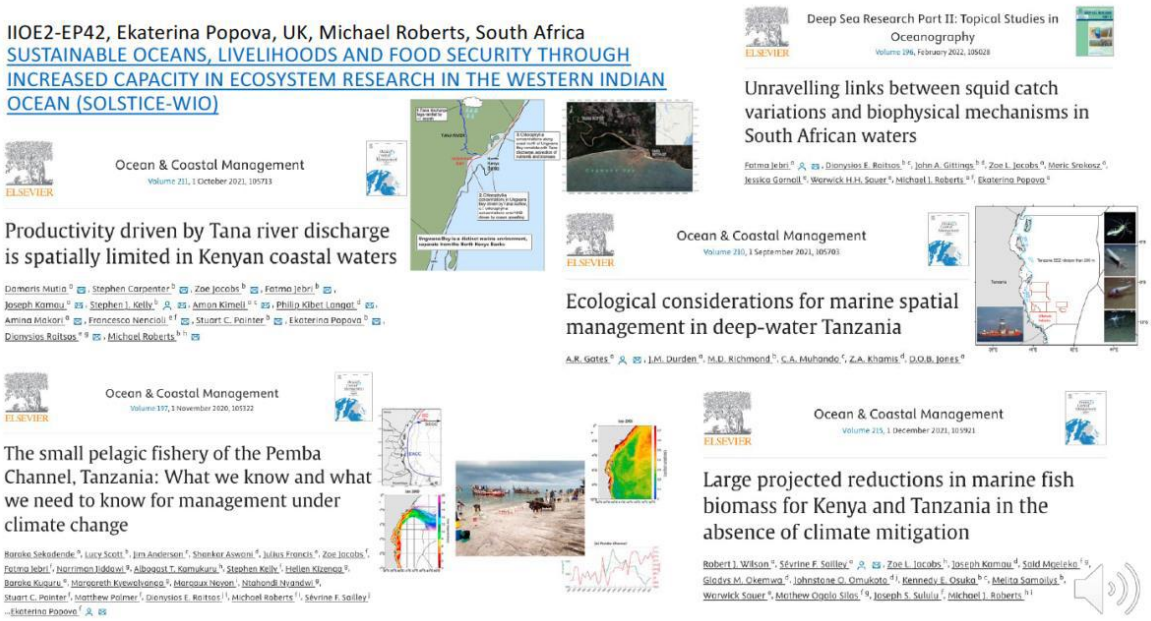
- Status: Completed with publications ongoing
- RV *Investigator* (May-June 2019) in SE Indian Ocean along 110° E (3,000 km transect)
- Investigated physical, biogeochemical & ecological features & processes (viruses- whales)
- Examined ecosystem-scale change from 1960's IIOE benchmark, characterised microbes, determined pelagic food web structure & related phytoplankton to bio-optical data
- Special Issue *Deep-Sea Research II* with 12 papers in 2022; 10 other papers published to date
- Many presentations, posters, theses & website iioe-2.incois.gov.in/IIOE2/VOYAGE/13062019.jsp

10.2 SUSTAINABLE OCEANS, LIVELIHOODS AND FOOD SECURITY THROUGH INCREASED CAPACITY IN ECOSYSTEM RESEARCH IN THE WESTERN INDIAN OCEAN (SOLSTICE-WIO) (IIOE2-EP42) https://solstice-wio.org/

SOLSTICE-WIO was a six-year collaborative project funded by the UK Global Challenges Research Fund (GCRF). This project brought together recent advances in marine technologies, local knowledge and research expertise to address some of the challenges facing the Western Indian Ocean region in a cost-effective way via technology transfer, collaborative environmental and socio-economic research and hands-on training. SOLSTICE-WIO demonstrated its approach through three case studies, identified by the local project partners as important for food security and economic development in three WIO countries: 1) Kenya: Emerging fishery of the North Kenyan Bank: the next frontier for food security of the coastal population (led by Kenya Marine and Fisheries Research Institute); 2) Tanzania: Pemba Channel small pelagics: threats and opportunities of climate change

(led by the Institute of Marine Sciences in Zanzibar); and 3) South Africa: Ecosystem shifts and fishery collapse: South African Chokka squid fishery (led by Nelson Mandela University).

To date, SOLSTICE-WIO has generated numerous publications (Figure x with examples), including a Special Issue in the journal *Ocean & Coastal Management* entitled "East African Coastal Current: At the Frontier of Climate Change and Food Security", and a Special Issue in the journal *Deep-Sea Research Part II* entitled "Dynamics of the Agulhas Bank, South Africa - ecosystem shifts and future trends in the squid fishery". Papers from this project have also been published in several other journals, including *Frontiers in Marine Science, Scientific Reports, Marine Policy, and Food Security*. SOLSTICE-WIO has also produced several policy briefs, practice notes and a wealth of outreach materials, including a Solstice MOOC (Massive Open Online Course) and a webinar series.



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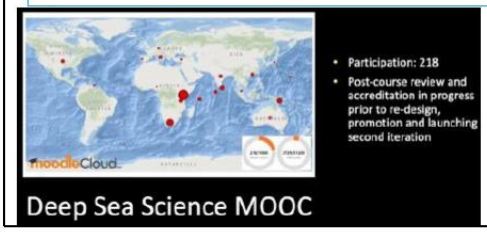
Mission consisted of six research cruises in six distinct regions of the Indian Ocean from West (Mozambique Channel and Seychelles), to Central (Chagos and Maldives) and East (Andaman and Sumatra). The Mission combined four major activities: scientific research, capacity development, advancement of policy and public engagement. A primary emphasis of the Mission was on understanding the distribution of species and biodiversity from the surface to 3000m depth and its environmental drivers.

The Nekton Indian Ocean Mission worked with Indian Ocean rim nations to survey their deep reefs and collect data on physical, chemical and biological parameters (community data, species lists, field ID guides, function and resilience across location and depth). These data have provided better understanding of the diversity of life at depth and its importance to humans in the face of a changing world, and they have facilitated modelling to support the conservation and sustainable management of sites. To date this project has generated many papers (see figure below, with citations) and presentations.

IIOE2-EP22, Dr Oliver Steeds, UK (ongoing, 2018-2027)
NEKTON INDIAN OCEAN MISSION 2018-2021.
(*https://nektonmission.org/missions/indian-ocean*)

- Region: **Seychelles, Maldives, Comoros**, further locations under development, worked with IO nations to survey their deep reefs (to 500m depth),
- Themes 1, 2, 3, 4 and 6.
- Data collection: **physical, chemical and biological** parameters (community data, species lists, field ID guides, function and resilience across location and depth), **13 papers, ~31 presentations (reported on in 2024)**

2025 update:
1. 3 papers submitted, 1 published
2. **First WIO Deep-Sea Science Massive Open Online Course**, launched by the University of Seychelles, Nekton, WIOMSA and Minderoo Foundation



3. **Knowledge Exchange Fellowship** organised by Maldives Marine Research Institute and Nekton
4. **New expedition** in development
5. Students working on data associated with the mission
6. New Nekton website promoting the Indian Ocean Mission (incl podcasts)

Stefanoudis, P. V., Talma, S., Fassbender, N., Swanborn, D., Ochieng, C. N., Mearns, K., Komakoma, J. D., Otwoma, L. M., Mbije, N. E., Osuka, K. E., Samoilys, M., Shah, N., Samaai, T., Trotzuk, E., Tuda, A., Zivane, F., Wagner, D., & Woodall, L. C. (2023). Stakeholder-derived recommendations and actions to support deep-reef conservation in the Western Indian Ocean. *Conservation Letters*, 16(1), e12924. https://doi.org/https://doi.org/10.1111/conl.12924

10.4 DINITROGEN FIXATION IN THE INDIAN OCEAN: AN INTERBASIN AND SEASONAL COMPARISON (IIOE2-EP41)

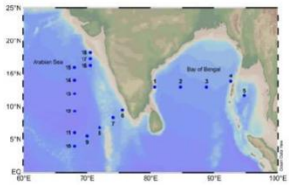
The goal of DINDE (Dinitrogen Fixation in the Indian Ocean: an inter-basin and seasonal comparison) was to decipher the role of N_2 fixation in the two sub-basins of the Indian Ocean, focusing on the two most unknown seasons: winter monsoon and inter-monsoon. DINDE examined the magnitude of N2 fixation rates according to environmental variability, untangling the diversity of local diazotroph assemblages and their metabolic controls. Moreover, DINDE isolated strains with the aim of discovering diazotroph species unique to the Indian Ocean. Constraining N_2 fixation in the Indian Ocean is vital to improve the predictability of net primary productivity and future role of ocean as a climate change mitigator.

The *in situ* work was performed during four oceanographic cruises (two per basin in each target season, two in German vessels and two in Indian vessels). The project was carried out by the French and Indian collaborating scientists, with sample analyses shared among the two labs according to their expertise and equipment. Results show that diazotrophy is highly heterogeneous among sub-basins and seasons in the Indian Ocean, impacted by unique circulation and biogeochemical settings of each region. Several papers from this project have been published, and others have been submitted or are in preparation (see figure below, with citations).

EP41: Dinitrogen fixation in the Indian Ocean: an inter-basin & seasonal comparison (DINDE)

PI: Mar Benavides, France

- Status: Completed
- Earth system models show uncertainty in net PP predictions due to poor understanding & response to changes in parameterisation of N_2 fixation in models
- Cruises in Arabian Sea, Bay of Bengal & Indian sector of Southern Ocean. Undertook N_2 fixation measurements & detailed biogeography of diazotrophic species
- Results show that diazotrophy is highly heterogeneous among sub-basins & seasons in Indian Ocean
  - Chowdhury, S. et al. 2024. Fronts divide diazotroph communities in the southern Indian Ocean. *FEMS Microbiology Ecology* 100 (8): fiae095.
  - Chowdhury, S. *et al*. 2023. Diazotrophy in the Indian Ocean: Current understanding and future perspectives. *Limnology and Oceanography Letters*. doi: 10.1002/lol2.10343.
  - Saxena, H. *et al*. 2023. The Bay of Bengal: An enigmatic diazotrophic niche. *J. Geophys. Res. Biogeosci.* 128. doi: 10.1029/2023jg007687



10.5 BoBBLE: BAY OF BENGAL BOUNDARY LAYER EXPERIMENT

BoBBLE was a joint India-UK field experiment conducted in the southern Bay of Bengal during the summer monsoon of 2016. Although not an officially endorsed project under IIOE-2, BoBBLE was motivated by Indian Scientists who are core members of the IIOE-2 community and was considered to be an early core IIOE-2 project. The primary goal of this experiment was to produce new, high-quality, comprehensive observational data sets of ocean state and atmospheric fluxes through a dedicated field campaign in a key under-observed region, the southern Bay of Bengal. The cruise was conducted on board *ORV Sindhu Sadhana* (CSIR-NIO, Goa) from 23rd June – 24th July 2016. Both oceanic and atmospheric parameters were measured during the cruise. In the ocean, 148 CTD profiles, 930 underway-CTD (uCTD) profiles, 64 turbulence profiles, 37 radiometer profiles, 161 Argo profiles and 915 glider profiles were measured. In addition, continuous monitoring was carried out using Autosal and ADCP. Biological and chemical properties were measured using water samples. Atmospheric measurements were made using an automated weather station and an eddy covariance system. Radiosonde profiling was carried out twice every day. Among the instruments used, VMP and uCTD deployments were combined ship-aircraft observations of both atmosphere and ocean were carried out at one location 10oN, 85oE (AR location in figure below).

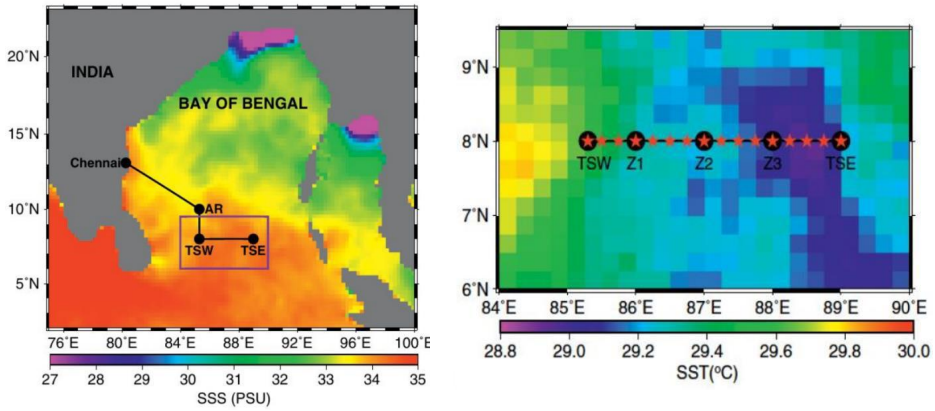


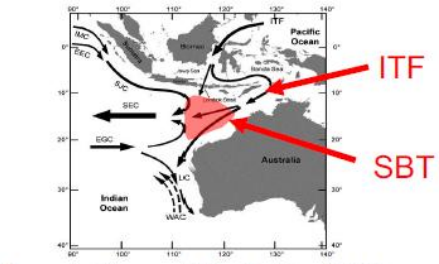
Figure x: A map of the Bay of Bengal and the cruise track of the BoBBLE field progam (left panel) sea surface salinity (SSS shading) is from SMAP. The section along which observations were made during BoBBLE (right panel). The positions (black circles of TSW, Z1, Z2, Z3, and TSE) represent glider deployment locations. Argo float deployments, IOP, radiometer, and VMP profiling as well as water sampling were also carried out at these locations. Stars indicate locations where additional CTD profiles were measured during the return leg of the cruise. At TSE, CTD profiles were measured from 4 to 15 July, 2016. Shading indicates SST from the Advanced Microwave Scanning Radiometer for Earth Observing System (AMSR-E) (Vinayachandran et al., 2018). Figures courtesy of P. N. Vinayachandran.

unravelled their underlying mechanisms. These include the high salinity core and its impact on physics, optics, and biogeochemistry. The presence of double diffusive mixing in this region, dynamics of summer monsoon current, processes controlling sub surface chlorophyll maximum, and oxygenation of Bay of Bengal by the high salinity core and Persian Gulf water are some of the key findings. The results from BoBBLE have been published in 28 journal papers, a special session at the IUGG 2017 in South Africa, an invited keynote presentation at IUGG 2023 in Berlin, and several other conferences worldwide.

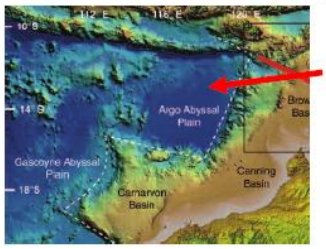
10.6 SIBER/INDITUN-BLOOFINZ (Bluefin Larvae in Oligotrophic Ocean Foodwebs, Investigations of Nutrients to Zooplankton) is a SIBER-led project in the final stage of completion with a *Deep-Sea Res. II* volume of 20+ papers and several additional contributions currently being written. BLOOFINZ cruise data files are publicly available with frequent updates and additions at BCO-DMO data repository sites *https://www.bco-dmo.org/deployment/916293* and *https://www.bco-dmo.org/project/819488*.

The BLOOFINZ project, conducted as part of IIOE-2 in January-March 2022, was developed as a biogeochemically/ecologically focused component of the SIBER-initiated EIOURI program. This project contributes to Grand Challenge I in being a full ecosystem-level study (physics to fish, system state and variability) of the poorly known area between Indonesia and NW Australia that has two

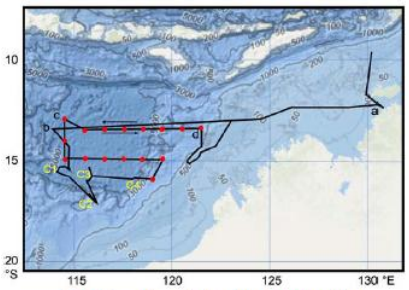
unique features of the Indian Ocean: the only known spawning region for Southern Bluefin Tuna (SBT) and the only low latitude connection between major oceans (Indonesian Throughflow) through which excess heat flow from the western Pacific drives rapid IO warming. The goals of BLOOFINZ are to understand the biogeochemistry, productivity and food webs supporting larval SBT in the spawning region and to assess SBT recruitment vulnerability to climate change. The research therefore relates to specific challenge objectives 1-3 in its focus on climate change impacts on a highly valued but endangered commercial stock.



Currents: Murgese & De Deckker (2005)
Spawning area: Matsuura et al. (1997)



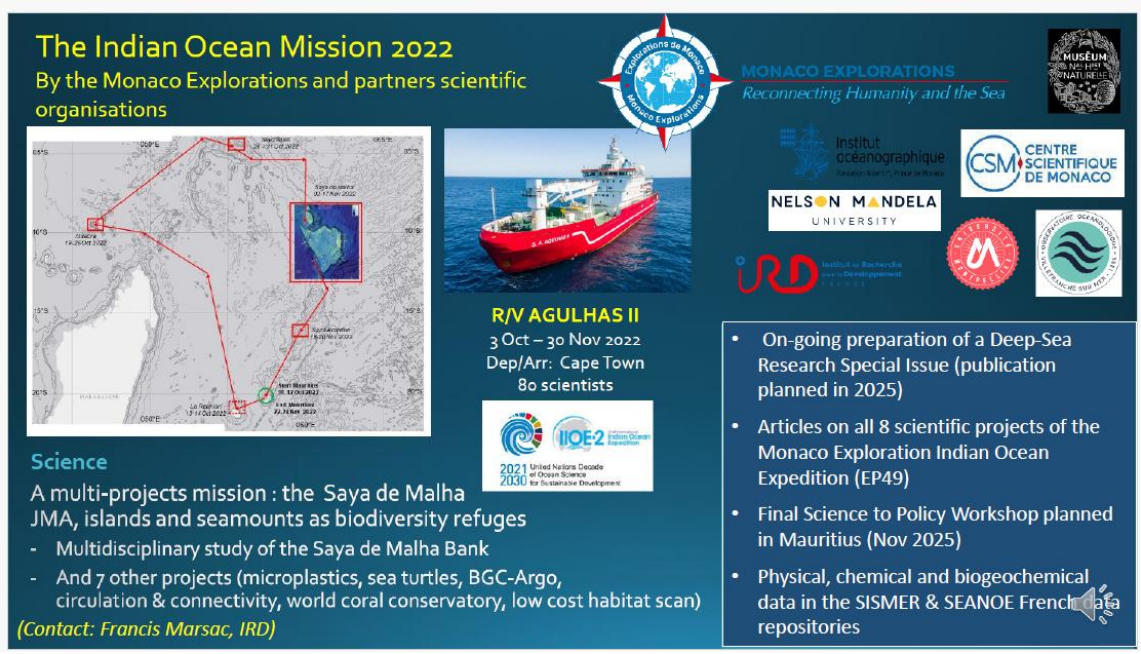
R/V Roger Revelle
RR2201, Jan-Feb 2022



Cruise track in Argo Basin

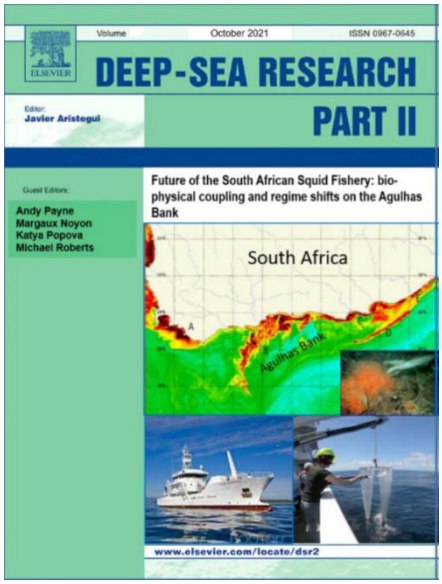
10.7 THE MONACO EXPEDITION: The Indian Ocean Mission of the Monaco Explorations took place in Oct-Nov 2022 (involving SIBER SC members F. Marsac and J-F Ternon). It is the first element of a project that was endorsed by the United Nations Decade of Ocean Sciences for Sustainable development and IIOE-2. The cruise went from Cape Town (South Africa) to Mauritius, then Reunion, Seychelles (via Aldabra) and to Mauritius (via the Salha de Malha bank, where a multidisciplinary study of the ecosystem was conducted), then back to Cape Town. It involved over 150 participants of 20 different nationalities, including scientists, early-career researchers, and students at the onboard school, filmmakers and photographers, divers, artists, communicators, and the vessel crew. The expedition implemented a holistic approach based on a multidisciplinary programme including natural and social sciences.

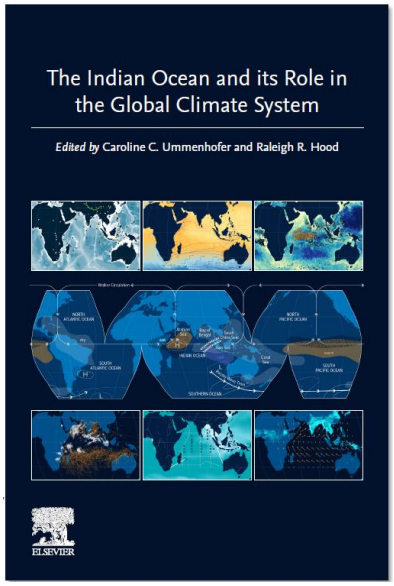
The expedition's purpose was also to promote the contents, knowledge and resources resulting from the operations by encouraging the exchange and transmission of knowledge to as wide an audience as possible through a varied outreach programme, and extensive work continues. The various components were aimed at a broad public: schools, civil society, and decision-makers. Two documentary films were produced in 2023 for international distribution and other educational and artistic content. The offshore projects of the expedition included oceanographic stations (CTD and XBT), the deployment of 29 BioArgo floats, the deployment of drifters (19 of 3 months life expectancy, and 5 regular drifters with drogues from which 2 are still operational after 21 months at sea), and a full ecosystem study of the Salha de Malha Bank (physical and chemical oceanography, plankton and productivity, benthic biodiversity) on the bank and along its slopes. France has participated in the expedition with 45 scientists and 10 students**. A special issue is underway in Deep Sea Research Part II, to include 20 research papers (completion due in 2025).**



11. A list of Synthesis Products

SIBER continues to lead publication of results of Indian Ocean research (see previous annual SIBER reports). In addition to an AGU monograph and a special volume of *Biogeosciences*, this has included a series (ongoing) of SIBER-led IIOE-2 DSR II special volumes, with over 80 papers published, a seventh volume in press, and an eighth (focusing on the Landry et al BLOOFINZ project) in preparation (20 manuscripts anticipated).





Also, a collection of synthesis papers on the Indian Ocean (Ummenhofer and Hood, SIBER SC, eds.) was published as a 20-chapter book was published in 2024 (above right).

12. Reflections

Lynnath Beckley: I greatly value the original efforts of IMBeR as it led to the confluence of ideas about the Indian Ocean through early SIBER meetings pre-IIOE-2. At the SIBER meeting in 2012 in Cape Town, I presented a case for a voyage to repeat the 110°E line that I was planning as Australia was soon to launch the RV Investigator with capacity to undertake such voyages. This, combined with the observation from Ed Urban that we should have a conference to celebrate the 50th anniversary of IIOE, precipitated the proposals to the IOC in Paris in the springtime!

13. Recommendation for future work

SIBER's efforts over the next five years will remain centrally focussed on IIOE-2. The objectives are laid out in the recently completed Addendum to IIOE-2 Science Plan (Hood et al, 2025).

14. Anything not covered above

Add text…

15. Appendices

Add appropriate meeting / workshop reports and include URLs (this helps to track where online content is missing)

Add text…