IIOE-2 2nd International Indian Ocean Expedition 2015-2025

Newsletter

(A basin-wide research program co-sponsored by IOC-UNESCO, SCOR and IOGOOS)

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To advance our understanding of interactions between geologic, oceanic and atmospheric processes that give rise to the complex physical dynamics of the Indian Ocean region, and to determine how those dynamics affect climate, extreme events, marine biogeochemical cycles, ecosystems and human populations.

International Indian Ocean Science Conference (IIOSC)-2022

The much-awaited International Indian Ocean Conference (IIOSC) was held VIRTUALLY during 14-18 March, 2022. The conference was initially planned to be held in Goa during March 2020 but was postponed due to the COVID-19 outbreak. The major goal of the conference was to assess the progress and the scientific knowledge gained during the second phase of International Indian Ocean Expedition (IIOE). The IIOSC served as a great platform for scientists working on different facets of the Indian Ocean to present their ideas and discuss outstanding issues, identify knowledge gaps and plan a way forward to address these issues. The conference was hosted by the Indian National Centre for Ocean Information Services (INCOIS) of the Ministry of Earth Sciences in partnership with CSIR-National Institute of Oceanography (NIO), National Centre for Polar and Ocean Research (NCPOR) and Goa University.

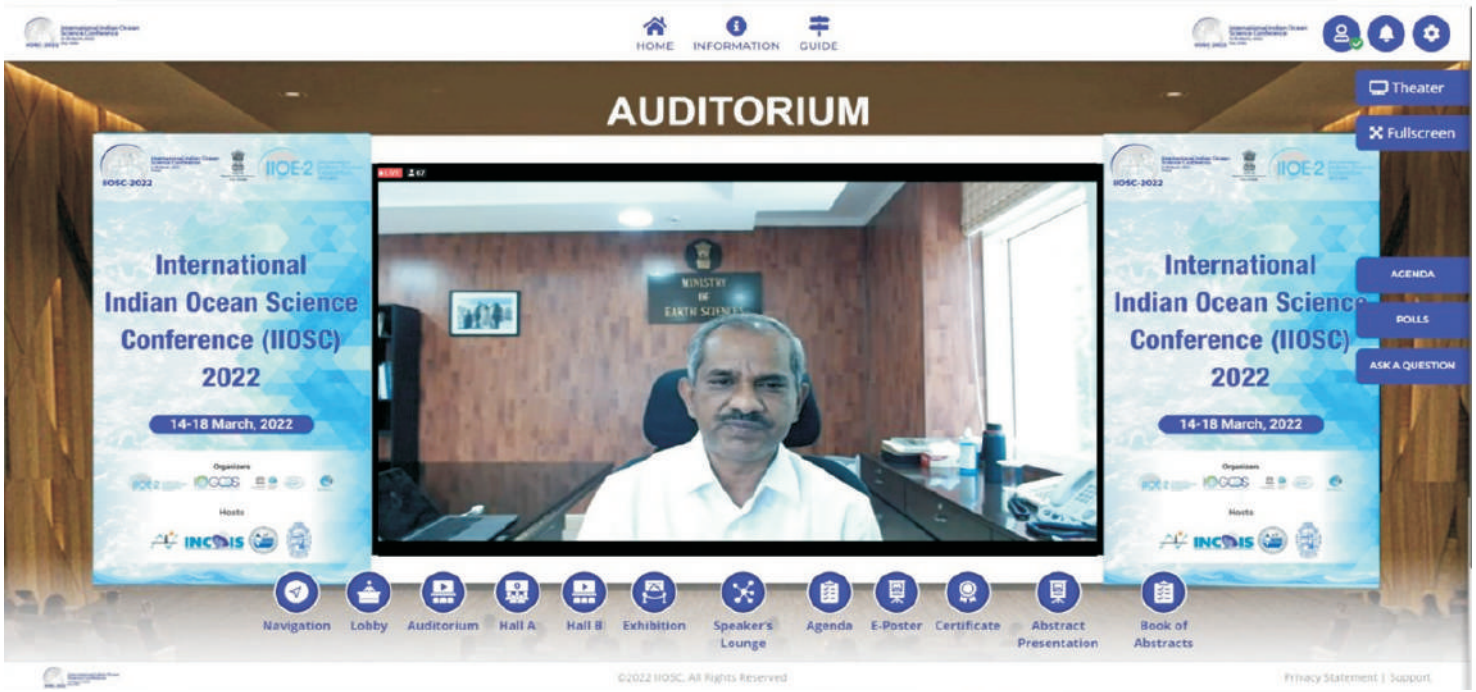
Inaugural address by Dr. Jitendra Singh, Minister of State (Independent Charge) of the Ministry of Earth Sciences, Minister of State (Independent Charge) of Science & Technology and Minister of State in the Prime Minister's Office.

The conference was inaugurated by Dr Jitendra Singh Minister of State (Independent Charge) of the Ministry of Earth Sciences, who delivered his inaugural address through a recorded message. The other dignitaries present during the inaugural session were Dr M. Ravichandran, Secretary to the Government of India for Ministry of Earth Sciences (MoES), Dr. Vladimir Ryabinin, IOC Executive Secretary & Co-Chair, IIOE-2, Dr. Marie Alexandrine Sicre, President, Scientific Committee on Ocean Research (SCOR) and Co-chair of IIOE-2 Steering Committee, Dr. T. Srinivasa Kumar, Director, INCOIS & Chair, IOGOOS and Prof. Sunil Kumar Singh, Director, CSIR-NIO. The inaugural session also witnessed a keynote talk by Dr. M. Ravichandran on "India's Deep Ocean Mission" and by Dr. Vladimir Ryabinin on "The United Nation Decade of Ocean Science for Sustainable Development, 2021-2030". The complete coverage of the inaugural session is available at

https://youtu.be/_k5-hI3SEm0

Dr. Vladimir Ryabinin, IOC Executive Secretary & Co-Chair, IIOE-2 giving the keynote address

The conference was witnessed by 400+ registered participants, representing 20 countries. There was a total of 179 oral and 98 poster presentations on Indian Ocean research across 14 themes (https://iiosc2020.incois.gov.in/). The scientific presentations discussed at this conference provided a road map to address such challenging issues climate change, sustainability of living and non-living resources, marine pollution, etc. and helped in providing new insights on the Indian Ocean. In addition, there were five plenary sessions on Monsoon and climate variability, Blue economy and sustainable development, Biogeochemistry and Ecology, Ocean value chain: Observations to services, and Contribution to United Nations Decade of Ocean Science for Sustainable Development, during which eminent scientists in these fields delivered keynote talks.



Dr. M. Ravichandran, Secretary to the Government of India for Ministry of Earth Sciences (MoES) giving his key note talk.

An unique activity during the IIOSC-2022 was a moderated panel discussion on the final day where the keynote speakers of each of the five plenary sessions presented the Challenges and Outcome of United Nation Decade of Ocean Science for Sustainable Development within their plenary theme.

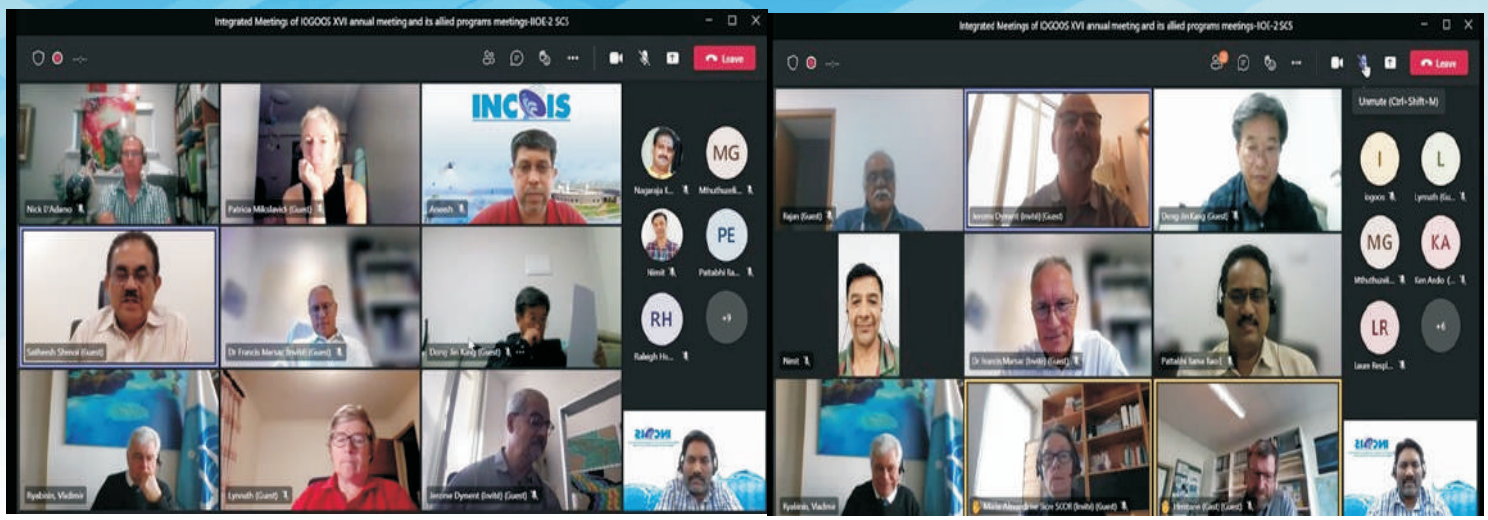
Inaugural session of IIOSC-2022

Fifth meeting of the Steering Committee of IIOE-2

The fifth meeting of the Steering Committee of the IIOE-2 was organised virtually from the 21-25 of March, 2022 by the IIOE-2 Joint Project Office (JPO) through its respective nodes at the Indian National Center for Ocean Information Services (INCOIS), Hyderabad, and UNESCO IOC Perth Programme Office. The meeting was chaired by Vladimir Ryabinin (IOC), Marie-Alexandrine Sicre (SCOR) and Satheesh Shenoi (IOGOOS). Over 30 participants representing 10 countries attended the two-day meeting. A full agenda and links to the background documents including the presentations can be found at:

https://iioe-2.incois.gov.in/IIOE-2/SC5_agenda.jsp

The reports on national activities were delivered on the first day by the representatives of IIOE-2 National Committees from India, Australia, Germany, France and Republic of Korea. The progress reports of the IIOE-2 Working Groups on Science and Research (WG-1), Data and Information Management (WG-2) and Operational Coordination (WG-3) were also presented by the respective Co Chairs highlighting the important achievements in regard to the publications, data management and related operational aspects. Dr. Vladimir Ryabinin, Executive Secretary of the IOC of UNESCO and Assistant Director-General of UNESCO and co-chair of IIOE-2 provided an update on the UN Decade of Ocean Science for Sustainable development and feedbacks on IIOE-2 endorsement request. In addition, the progress reports in respect of the six science themes were delivered by the respective co-chairs followed by presentation by the representative of the IIOE-2 Early Career Scientists Network.The IIOE-2 JPO also endorsed three projects entitled [IIOE2-EP46] Bluefin Larvae in Oligotrophic Ocean Foodwebs: Investigation of Nutrients to Zooplankton, [IIOE2-EP47] Quantifying vertical and lateral ocean transport due to submesoscale fronts and eddies and [IIOE2-EP48] Valuing the Gascoyne Marine Park submitted by Dr. Michael Landry, Nicole Jones and John Keesing respectively.



Snapshot of some of the active cameras of participants during the IIOE-2 SC5

Front and Skeleton Features based Methods for Tracking Salinity Propagation in the Ocean

The Bay of Bengal (BoB) fosters several monsoon depressions and cyclones, playing a crucial role in the Asian summer and winter monsoons. The capacity of the bay to remain warm and energize such weather systems is attributed to its strong vertical stratification sustained by the large freshwater input into the bay. River runoff and rainfall into the northern bay in contrast to the high salinity water intrusion in the south creates a strong north–south salinity gradient.

We have developed visual analysis techniques and algorithms to trace the path of the high salinity core (HSC) entering the BoB from the Arabian Sea. The key challenge in tracking the HSC is that its boundaries are not well defined. Due to the various ocean dynamics processes such as advection by ocean currents, mixing and diffusion, the HSC can be considered as a continuously evolving mass of salinity that undergoes irregular and unpredictable shape transformations as it moves across BoB.

In this paper, we introduce two approaches to represent the HSC and its characteristics, and describe methods to track the movement and evolution of the HSC. The HSC in the southern Bay of Bengal is located between a depth range of 50–150m, mostly below the intense summer monsoon current (SMC). The SMC weakens considerably after it crosses the latitude of about 11°N, shedding several eddies on its path. The path of the HSC into the northern Bay of Bengal has not yet been documented in detail, which can be mostly attributed to the lack of an appropriate tool or method for analysis and visual representation.

We introduce two feature definitions that represent the movement and shape of the HSC, and algorithms to track their evolution over time. The two new feature representations, fronts and skeletons, are based on geometric and topological analysis of the HSC. The method is validated via comparison with well-established observations on the flow of the HSC in the BoB, including its entry from the Arabian Sea and its movement near Sri Lanka. Further, the visual analysis and tracking framework enable new detailed observations on forking behavior near the centre of the BoB and subsequent northward movement of the HSC. The tools that we have developed offer new perspectives on the propagation of high salinity water and its mixing with the ambient low salinity waters.

Major contributions of this paper include

- Introduction of feature definitions of the HSC based on the notion of fronts and skeletons.
- A parallel algorithm for extracting fronts.
- Algorithms to track front-based and skeleton-based features.
- An interactive visual analysis tool for analyzing HSC propagation in the BoB.
- New documentation on salinity propagation in the BoB based on the above method.

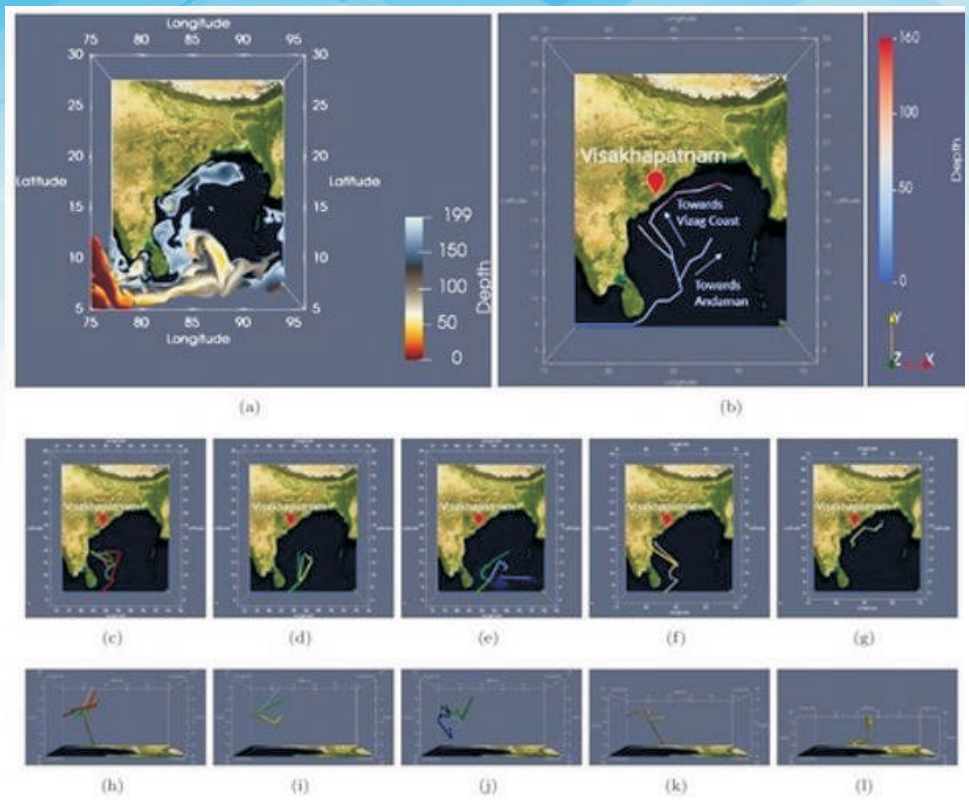


Figure 1: (a) Volume rendering of salinity; (b) Representative tracks that depict movement of the IISC skeleton. Tracks are computed against a user specific query consisting of points near south of BoB, Visakhapatnam coast and Andaman coast; Different tracks extracted from the track graph Tg1, grouped together based on their source and destination made in the graph. (c,d,e,f,g) top view, (h,i,j,k,l) corresponding side view from east.

Citation: Upkar Singh, T.M. Dhipu, P. N. Vinayachandran and Vijay Natarajan. Front and skeleton features based methods for tracking salinity propagation in the ocean. Computers & Geosciences, 159, 2022, 104993:1-9.

[Report Courtesy: Dr.P.N.Vinayachandran, IISC, Bangalore, India, Email:vinay@iisc.ac.in]

Double diffusion in the Arabian Sea during winter and spring

Measurements of the microstructure of temperature and shear in winter and spring 2019 reveal the relative importance of double diffusion and shear-driven mixing processes in the thermocline region of (upper 400 m) of the Eastern Arabian Sea (EAS). It was found that the shear-driven mixing rates are weak in the thermocline region of EAS with a mean value of diapycnal diffusivity (K_ρ) around 5.4×10^{-6} m^2 s^{-1}. The mixing in the region was dominated by strong double diffusion, with 70% of the water column favouring salt fingering and ~ 2-3% favouring diffusive convection. Moreover, the frequent occurrence of well-defined thermohaline staircases in the EAS further confirms the occurrence of double-diffusive instability here. The measurements indicate that the Radko and Smith (2012) salt fingering scheme and the Kelley (1984) diffusive convection schemes are the best double diffusion parameterizations for the ocean general circulation models with vertical heat diffusivity (K_T). The weighted sum of heat flux associated with salt finger and diffusive convection estimated using flux laws shows a net downward heat flux of magnitude ~-2.5 Wm^{-2}.

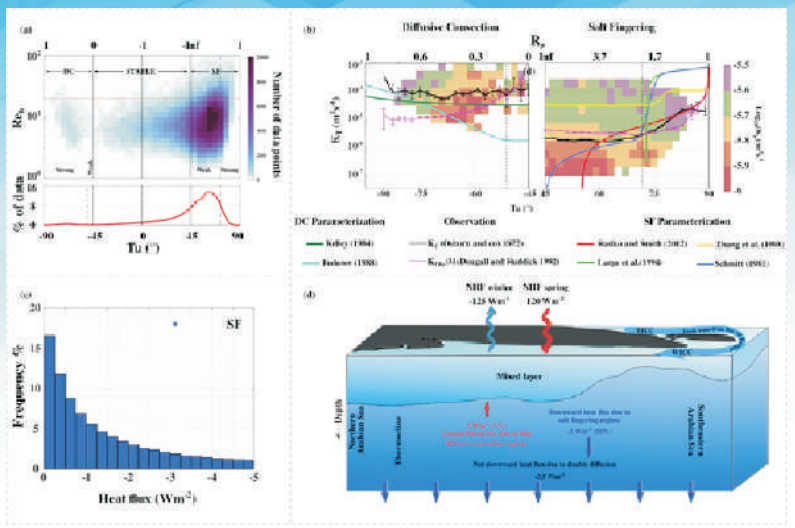


Figure: (a) Distribution of data as a function of Turner angle (Tu; x-axis; every 5°) and log(Re_b; Buoyancy Reynolds number) (y-axis; 25 bins between 10^0 and 10^2) in the eastern Arabian Sea during winter and spring. (b) Comparison of vertical heat diffusivity (K_T; $m^2 s^{-1}$) calculated from observed thermal variance dissipation rates (□) (Osborn and Cox 1972) and different parameterizations used in OGCMs for diffusive convection and salt fingering. (c) Frequency distribution (%) of heat flux (Wm^{-2}) estimated using flux law in the salt finger regimes in the EAS during winter 2019 and spring 2019. (d) The schematic diagram explains the vertical heat flux associated with the salt finger and diffusive convection in the thermocline in the EAS during winter and spring.

Citation: Ashin, K., Girishkumar, M.S., Joseph, J., D'asaro, E., Sureshkumar, N., Sherin, V. R., Murali, B., Thangaprakash, V. P., Pattabhi Ram Rao, E., & Shenoi, S. (2022). Double diffusion in the Arabian Sea during winter and spring, Journal of Physical Oceanography (published online ahead of print in 2022).

https://journals.ametsoc.org/view/journals/phoc/aop/JPO-D-21-0186.1/JPO-D-21-0186.1.xml.

[Report Courtesy: Dr. Girishkumar M. S. Ocean Observation Network Division, INCOIS, Hyderabad, India, Email:girish@incois.gov.in]

Are you interested in Mesopelagic Respiration? Mentoring Program Opportunity from the SCOR WG161 (ReMO)

The Scientific Committee on Oceanic Research (SCOR) working group 161 [WG 161- Respiration in the Mesopelagic or ReMO] announces a capacity-building program to foster exchange of expertise and to establish international collaborations in the area of respiration in the mesopelagic ocean for early-career scientists. The mentoring program aims to enable participants to develop an original research project linked to mesopelagic microbial respiration, using either observations, experimentation, or modeling approaches. The program will further facilitate participants to start up new collaborations and strengthen their network in the field of mesopelagic respiration globally. The duration of the mentoring program will be limited to a maximum of 3 years until the end of the WG.

Mentors will be members of the SCOR WG 161, whose research expertise is available on the SCOR WG webpage. They will provide technical guidance on experiments and study design, supervision of data analysis, exchange of scientific articles, advice with writing proposals and/or manuscripts, etc. Information about capacity-building workshops, conferences, job opportunities, etc will also be provided by the mentors. Applicants can select a research project from the "list of research projects" suggested by the mentors or, alternatively, suggest their own research project based on their interests. In this latter case, the applicants should specify in the application which mentor they wish to collaborate with. Mentees will be responsible for leading all aspects of the research project, with the support of the mentors. The progress of the projects will be reviewed with monthly meetings between the mentor and the mentee.

Applicants to the scheme should be postgraduate students or postdoctoral researchers who completed their Ph.D. in the last 7 years. Applications should include a letter of motivation, including a description of the applicant's research interests and relevance to mesopelagic respiration, and a recent CV. The mentoring scheme is open to all early-career scientists involved in oceanographic work; however, applications from researchers from developing countries and from regions where there is a lack of knowledge/expertise in mesopelagic respiration will be given preference. Due to the unpredictability of the COVID-19 situation, the program will be conducted virtually. Unfortunately, there is no specific funding available for this scheme; however, we encourage the mentee/mentor partnership to apply for external funding to enable a visit to the mentor's institution. This also applies to mentees interested in participating in the training course on model and observational approaches to derive mesopelagic respiration that will be held in 2023 as part of the WG activities.

Working Group Members

For further information, please visit our webpage (https://carolrobinson62.wixsite.com/remo161), social media (Twitter @ReMO_SCOR161) or contact by email (natalia.osma@imo-chile.cl).

All applications should be sent to natalia.osma@imo-chile.cl by the 10th of April 2022

DEEP-SEA RESEARCH PART II

THE SUBMISSION PORTAL FOR VOL. 6 OF THE DEEP-SEA RESEARCH II SPECIAL ISSUE SERIES ON THE IIOE-2 IS NOW OPEN

Submission of manuscripts that describe the results of studies related to the physical, chemical, biological, and/or ecological variability and dynamics of the Indian Ocean (including higher trophic levels) is encouraged.

Submission of manuscripts from students and early career scientists is also encouraged.

If you are interested in submitting a manuscript, please contact Raleigh Hood (rhood@umces.edu).

Endorse your projects in IIOE-2

Don't miss the opportunity to network, collaborate, flesh out your research project and participate in IIOE-2 cruises!!

The endorsement of your scientific proposal or a scientific activity focusing on the Indian Ocean region is a recognition of the proposal's or activity's alignment with the mission and objectives of IIOE-2, of its potential for contributing to an increased multi-disciplinary understanding of the dynamics of the Indian Ocean, and of its contribution to the achievement of societal objectives within the Indian Ocean region. Over 48 international, multi-disciplinary scientific projects have already been endorsed to date by the IIOE-2. Yours could be the next one!

Visit https://iioe-2.incois.gov.in/IIOE-2/EndorsementForm.jsp for further details and for projects already endorsed by IIOE-2 https://iioe-2.incois.gov.in/IIOE-2/Endorsed_Projects.jsp.

CLIVAR March 2022 Bulletin is available online

The International CLIVAR Project Office distributes a monthly bulletin with announcements, funding opportunities, meeting notifications relevant to the ocean/climate science community.

The latest CLIVAR Bulletin March, 2022 is available at:
https://mailchi.mp/clivar.org/clivar-march-2022-bulletin

Call for Contributions

Informal articles/short notes of general interest to the IIOE-2 community are invited for the next (April-end) issue of the IIOE-2 Newsletter. Contributions referring IIOE-2 endorsed projects, cruises, conferences, workshops, "plain language summary" of published papers focused on the Indian Ocean etc. are welcome. Articles may be up to 500 words in length (Word files) accompanied by suitable figures, photos.(separate.jpg files).

Deadline: **25 April, 2022**

The Indian Ocean Bubble-2

Access the latest issue of Indian Ocean Bubble-2
https://iioe-2.incois.gov.in/IIOE-2/Bubble.jsp

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