2nd International Indian Ocean Expedition 2015-2025

# Newsletter

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

**Volume-5, Issue-4**

**April, 2021**

*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.*

## Fourth meeting of the Steering Committee of IIOE-2

The fourth meeting of the Steering Committee of the IIOE-2 was organised virtually from the 12-15 of April, 2021 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 Marie-Alexandrine Sicre (SCOR) and Satheesh Shenoi (INCOIS), co-chairs of the Steering Committee of the IIOE-2 with Vladimir Ryabinin (IOC). Marie-Alexandrine (France) succeeded former co-chair Peter Burkill (UK) who stepped down in October 2020. Over 70 participants representing more than 45 organisations from 14 countries attended the three-day meeting.


*Figure-1:* Snapshot of some of the active cameras during the IIOE-2 SC4

A full agenda and links to the background documents including the presentations can be found at: https://iioe-2.incois.gov.in/IIOE-2/SC4_agenda.jsp

Reports on national activities were delivered on the first day by the chairs or representatives of IIOE-2 National Committees. The progress reports of the three Working Groups, WG1 (Science and Research), WG2 (Data and Information Management) and WG-3 (Operational Coordination) presented by the respective Co-Chairs or representatives highlighted 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, as well as one of the Co-Chairs of IIOE-2 provided an update on the UN Decade of Ocean Science for Sustainable development and feedbacks on IIOE-2 endorsement request.

During Day 2 and 3 of the meeting, the progress reports in respect of the six science themes were delivered by the respective chairs/co-chairs. This was followed by presentations from invited projects, the Early Career Scientists Network, and results of the GEOTRACES project in the Indian Ocean.

An open Science Symposium was held on Day 4, with six long (15 minute) talks and seven flash (5 minute) talks on a diversity of topics including features of the Southern Bay of Bengal, Indian Ocean fisheries and variability, biological oceanography in upwelling regions, ocean circulation, climate change and extreme events in the Indian Ocean, among others.

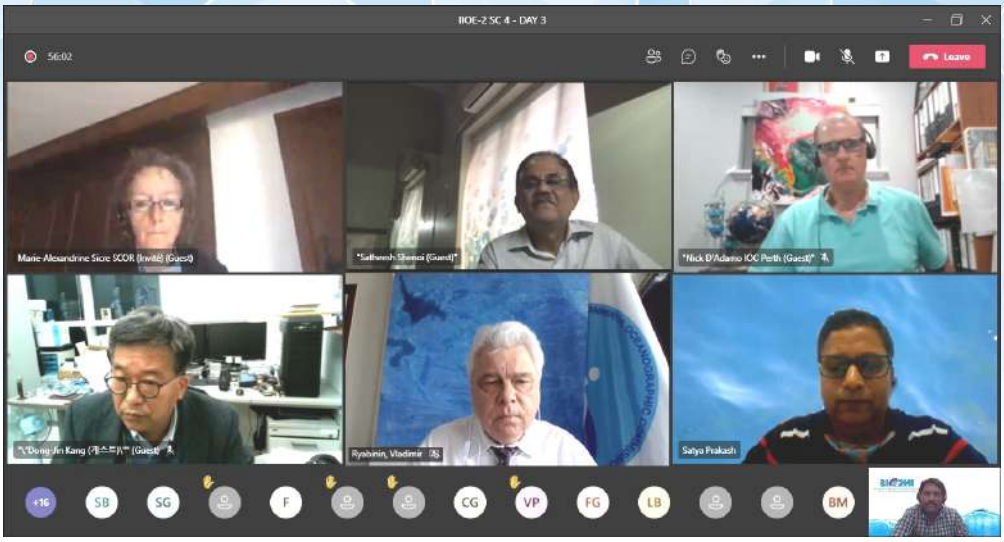



*Figure-2:* IIOE-2 co-chairs Marie Alexandrine Sicre (SCOR), Satheesh Shenoi (INCOIS), Vladimir Ryabinin (UNESCO-IOC) with members of the IIOE-2 Secretariat, Nick D'Adamo (UNESCO IOC Perth Programme Office) and Satya Prakash (INCOIS), and Dong-Jin Kang (KIOST, Korea).

## The world's largest zone of coastal hypoxia-anoxia over the west coast of India is not anthropogenically driven

The growing number of oxygen-deficient coastal zones around the world and their impacts on marine life have always been controversial issues as the development of oxygen deficiency is largely attributed to anthropogenic activities which can be mitigated by human actions. The west coast of India (eastern Arabian Sea) houses the world's largest seasonal coastal hypoxic-anoxic zone and despite several studies addressing its biogeochemical effects, the exact mechanism(s), i.e. natural vs terrestrial and/or their combination, behind its formation is still debated. Using the new coherent datasets collected from estuaries to coastal to offshore regions of India's west coast during early, peak and late summer monsoon (SM) as part of the project Marine Ecosystem Dynamics of eastern Arabian Sea (MEDAS) led by the Centre for Marine Living Resources and Ecology, Kochi, India for the first time, that in contrast to the prevailing understanding, the world's largest coastal hypoxic-anoxic zone along the west coast of India is not driven by the anthropogenic inputs but formed naturaly through upwelling of deoxygenated waters during the summer monsoon.

Our studies indicate that the coastal oxygen deficiency during the SM upwelling gradually intensified from hypoxic during early SM to suboxic/anoxic ($\leq 5\ \mu M$) by late SM, with the latter confined to the central shelf between 11° and 18°N, which is equivalent to almost half of the western Indian shelf. This anoxic central zone is located away from receiving significant anthropogenic inputs unlike in the south (Kochi) and north (Mumbai), where the two largest coastal cities receive substantial allochthonous inputs, yet remain during entire SM. The two-fold lower concentrations of nutrients in the estuaries of central region during SM, where coastal anoxia is confined, compared to those in the northern and southern regions indicate that the increased anthropogenic activities have not impaired these coastal waters. Coastal hypoxia in the south remain unchanged compared to the conditions five decades ago and the monsoonal estuaries of India act as heavy sink zones and export only < 10% of anthropogenic nutrients to the coastal seas. The stable isotopic composition of particulate organic matter showed confinement of significant anthropogenic signals only to few pockets of nearshore regions and the paleoceanographic records did not show significant impact of anthropogenically derived eutrophication, indicating that this coastal deoxygenation is not a human induced effect.

The study found that the extent of coastal deoxygenation follows the corresponding spatio-temporal changes in the distribution of dissolved oxygen concentrations in the offshore oxygen minimum zone (OMZ). The Arabian Sea has a perennial OMZ with its southern boundary at 12°N and its core OMZ, represented by 0.2 ml L-1 ($\sim 9\ \mu M$) dissolved oxygen, has a northern boundary at 18°N. The formation of cyclonic eddies in the south and central regions respectively during peak and late phases of SM thus leads to a shift in the upliftment of oxycline from outside the core OMZ to within core OMZ during the progression of SM.

Accordingly, the development of seasonal anoxia over the central west coast of India (11°-18°N) is caused by the upwelling of suboxic waters sourced from the core OMZ, while those of the south and north are from hypoxic waters ( ~ 20 $\mu$M) outside the core OMZ. The formation of weak or no coastal anoxia during IOD and ENSO years further supports the hypothesis of it being driven naturally. The upwelling driven coastal biogeochemistry further intensifies this oxygen deficiency. The intense anoxia over the central shelf declines the abundance of zooplankton and herbivorous fishes. Therefore, the lower grazing loss of upwelling driven phytoplankton results in higher decomposition of sinking organic flux and intensifies the oxygen depletion over the central shelf.

Though the upwelling driven coastal anoxia is confined to 11-18°N, the anoxic volume is less-spread north of 15°N due to the thick pycnocline, governed by the equatorward spread of Arabian Sea high saline waters (ASHSW). The fact that the interaction of ASHSW with upwelling influences the spatio-temporal variation of oxycline depth is a significant finding, as larger the anoxic volume greater the reduction in habitat for higher pelagic organisms, which in turn, alters the trophic food-web dynamics. The fish mortalities due to such situations have been often occurring over the central anoxic coast as well as in the sharp hypoxic-anoxic boarder zones.

Nevertheless, considering the natural origin of the world's largest zone of coastal hypoxia-anoxia over the west coast of India it is likely that not all the coastal anoxic systems around the world are anthropogenically dead zones.

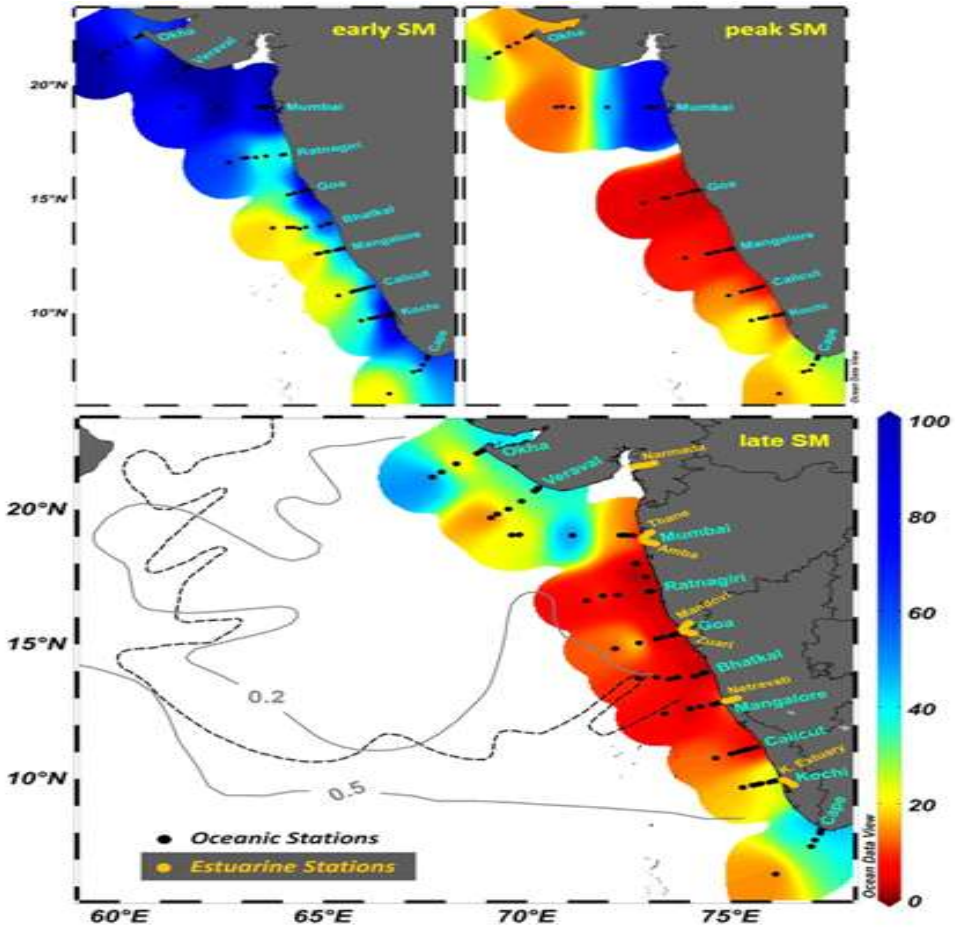



*Figure-1:* Study area and station locations overlaid on bottom oxygen ($\mu$M) during all three phases of SM. The dashed black line represents the boundary of OMZ/denitrification, and solid grey lines of 0.2 and 0.5 ml L-1 ( ~ 9 and 22 $\mu$M) represent oxygen distribution at 200m.

*Citation: G.V.M. Gupta et al. 2021. Environ. Res. Lett., 16, 054009, https://doi.org/10.1088/1748-9326/abe9eb.*

*[Report Courtesy: G.V.M. Gupta, Centre for Marine Living Resources and Ecology (CMLRE), MoES, Kochi, India E-mail: gvmgupta@cmlre.gov.in]*

## Uncertainty in palaeosalinity records in the northern Indian Ocean

Palaeosalinity is estimated from the oxygen isotopic composition of foraminiferal shells ($\delta^{18}O_F$). $\delta^{18}O_F$ depends on palaeo in-situ temperature and the oxygen isotopic composition of seawater ($\delta^{18}O_{sw}$), which in turn depends on various processes, such as evaporation, precipitation, advection, and freshwater fluxes. $\delta^{18}O_{sw}$ and salinity covary linearly, as they both increase with increases in evaporation and decrease with higher rainfall and continental runoff. Palaeosalinity is calculated assuming a constant relationship between $\delta^{18}O_{sw}$ and salinity. However, evaporative and freshwater fluxes exhibit spatiotemporal variability (Fig. 1) and thus, can change the slope and intercept of the $\delta^{18}O$ salinity relationship. Hence, the use of a constant $\delta^{18}O_{sw}$-salinity relationship may produce errors in palaeosalinity. We revisit palaeosalinity estimates and provide a reassessment of errors arising from these calculations based on recently reported $\delta^{18}O_{sw}$-salinity relationships in the northern Indian Ocean. Our calculations point to errors in palaeosalinity that can be as large as 55% - significant enough to change our understanding of past ocean circulation and palaeomonsoon. These results have important implications for

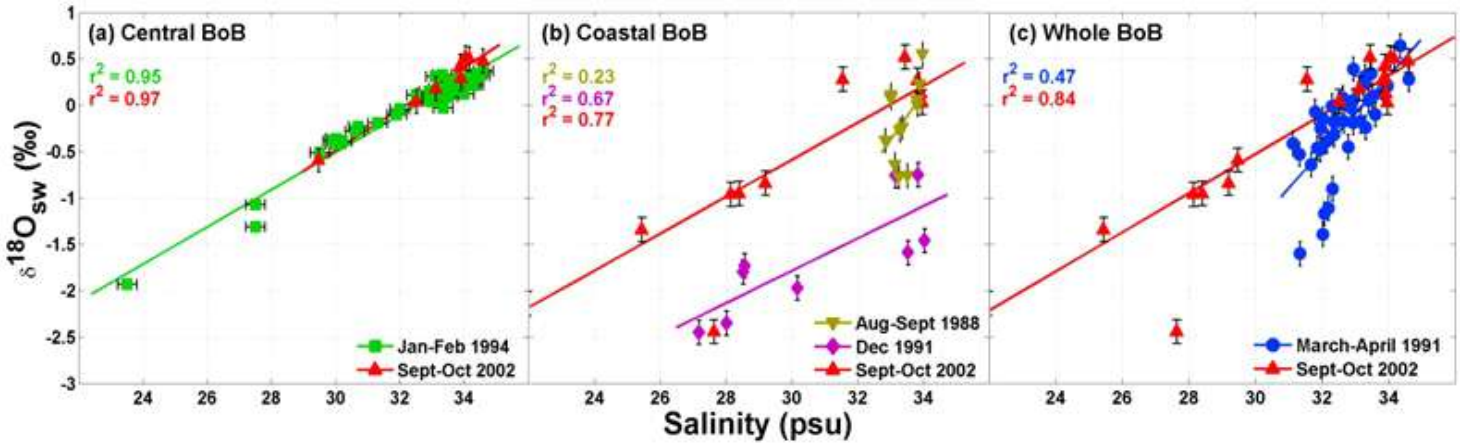
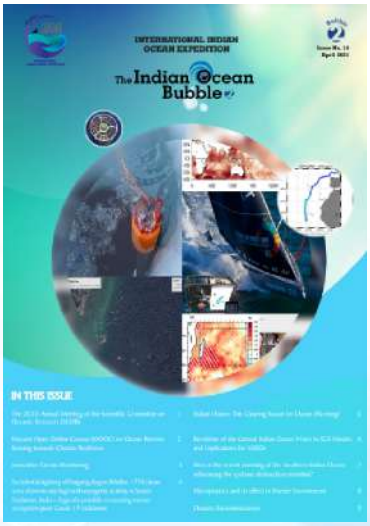



*Fig. 1. $\delta^{18}O_{sw}$-salinity weighted regression lines for (a) the central Bay of Bengal, (b) the coastal Bay of Bengal, (c) whole Bay of Bengal. All the regression lines are significant at $p < 0.05$.*

*[Reference : Mehta, S., Singh, A., &Thirumalai, K. (2021). Uncertainty in palaeosalinity estimates from foraminiferal geochemical records in the northern Indian Ocean. Palaeogeography, Palaeoclimatology, Palaeoecology, 569, 110326.]*

*[Report Courtesy: Arvind Singh, Physical Research Laboratory, Ahmedabad, India E-mail: arvinds@prl.res.in]*

## The Indian Ocean Bubble, Issue No.14 is now available online




Web Link: https://iioe-2.incois.gov.in/IIOE-2/pdfviewer_pub.jsp?docname=IIOE-2-DOC_OM_211.pdf

Informal articles are invited for the next issue. Contributions referring Indian Ocean studies, cruises, conferences, workshops, tributes to other oceanographers etc. are welcome.

Articles may be up to 1500 words in length (Word files) accompanied by suitable figures, photos (separate .jpg files)

Deadline: **30th June, 2021**

Send your contributions as usual to **iioe@incois.gov.in**

## POSTPONEMENT of International Indian Ocean Science Conference (IIOSC)-2020

In view of the recent outbreak of COVID-19, the safety of delegates is of paramount importance for the conference organisers. Therefore, upon recommendation of UNESCO-IOC amid concerns raised by many delegates spread across the world, the International Indian Ocean Science Conference (IIOSC)-2020 has been postponed till further notice.

More details on the Conference are available at the website https://iiosc2020.incois.gov.in/

### MESSAGE BOARD

- IIOSC-2020 Letter to Airlines
- Instructions for Presenters
- Allowed Poster size A0 (118 cm height x 84 cm width)


## 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 43 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 April 2021 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 April, 2021 is available at:

https://mailchi.mp/clivar.org/clivar-april-2021-bulletin

## Call for Contributions

Informal articles/short notes of general interest to the IIOE-2 community are invited for the next (May-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 May, 2021**

The Indian Ocean Bubble-2

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