2nd International Indian Ocean Expedition 2015-2025

IIOE-2

Newsletter

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

Volume-4, Issue-8
August, 2020

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.

Decoding spice patterns in the Bay of Bengal

The Bay of Bengal harbors a rich tapestry of patterns in its temperature and salinity field that can be used to study its dynamics. Freshwater from abundant rains and rivers, cooled and subducted, intermingles with very salty and warm seawater brought by currents from the neighboring Arabian Sea, creating strong temperature-salinity contrasts in the upper 200 m. Like patterns of paint that record the movements of a brush over canvas, thermohaline patterns record the turbulence of flows that stir the ocean's water. During the ASIRI-OMM and MISOBOB expeditions from 2013 to 2018, along a combined 4800 km of ship tracks, we recorded patterns in "spice", a natural passive tracer formed by anomalies of salinity that are density-compensated by equivalent anomalies of temperature (Figure-1A). An analysis of horizontal variance statistics of this tracer (Figure-1B), on scales ranging from the sub-mesoscale (~ 1 km) to the mesoscale (~ 100 km), supports the expected variance spectrum from surface quasi-geostrophic theory and frontogenesis at all but the largest scales and the deepest layers sampled. A relative deficit in spice variance at scales of 1–10 km raises the possibility that sub-mesoscale turbulence affects not only the surface mixed layer, but also the stratified layers in the thermocline, which lies right beneath. A visualization of high-resolution sections offers further clues in the form of multiple, parallel, thin layers of alternating spice anomalies (Figure-1C). We propose two new formation mechanisms for these thermohaline patterns: twisting by sub-mesoscale sheared eddies, and interleaving by high-vertical-wavenumber near-inertial waves (Figure-1D). Both can create thermohaline layering and interleaving with much longer-and-thinner aspect ratios than tracer patterns produced by mesoscale stirring. The short time scale for the production of such interleaving layers with thin vertical scales (greater cross-isopycnal surface area), suggests that these mechanisms can potentially enhance horizontal mixing by shear dispersion. Understanding the mixing processes in the Bay of Bengal is a prerequisite to accurately model its stratification, surface boundary layers, and ultimately air-sea fluxes during the monsoons.

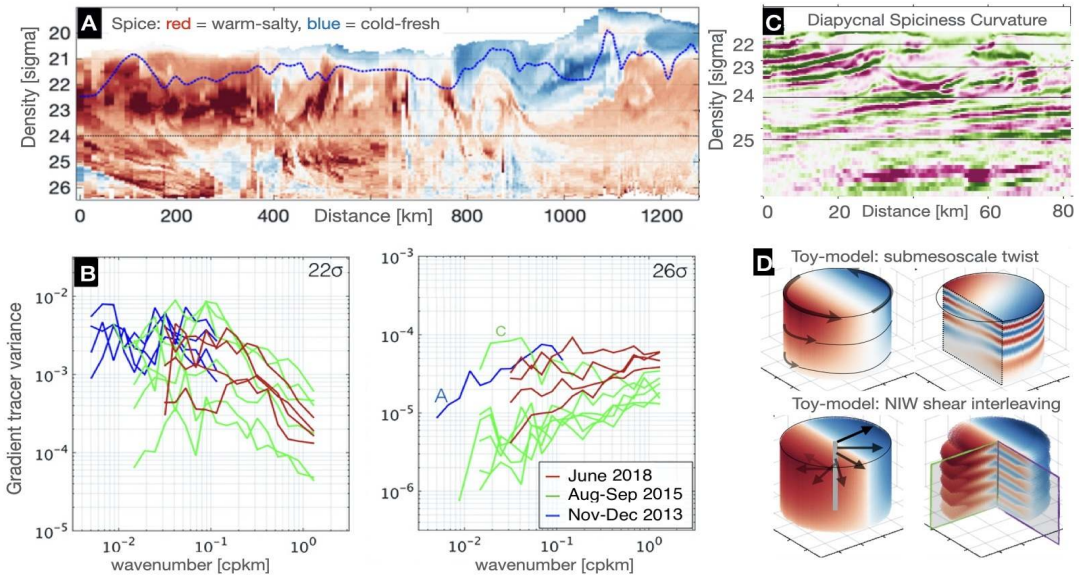


Figure-1 (A): Thermohaline "spice" section across the Bay of Bengal in 2013. (B): Gradient tracer variance spectra of thermohaline anomalies along surfaces of constant density, sigma = 22 and 26, showing depth- and scale-dependent slopes. (C): Section of diapycnal spiciness curvature, showing multiple thin layers crossing isopycnals. (D) Two toy-models of processes that could create multiple thin spice layers.

Citation: Jaeger, G.S., J. MacKinnon, A. Lucas, E. Shroyer, J. Nash, A. Tandon, J. Farrar, and A. Mahadevan, How spice is stirred in the Bay of Bengal. J. Phys. Oceanogr., doi: https://doi.org/10.1175/JPO-D-19-0077.1

Jaeger, G.S., A. Lucas, A. Mahadevan,Formation of interleaving layers in the Bay of Bengal. Deep Sea Research II,doi: https://doi.org/10.1016/j.dsr2.2019.104717

[Report Courtesy: Gualtiero Jaeger, E-mail: gvsj@alumni.mit.edu]

Anomalous surface chlorophyll blooms in the southeastern Arabian Sea during the extreme negative Indian Ocean Dipole of 2016

Biological productivity in the Indian Ocean is highly sensitive to the Indian Ocean Dipole (IOD). During positive IOD (pIOD), Ekman pumping and mixed layer entrainment trigger anomalous chlorophyll blooms in the eastern equatorial Indian Ocean and the Bay of Bengal. Previous studies have focussed on this impact of pIOD on the biological productivity of the Indian Ocean. However, the impact of negative IOD (nIOD) has been little explored, mainly due to the weaker anomalies in chlorophyll and the lesser frequency of strong nIOD events. In 2016, the Indian Ocean witnessed an extreme nIOD, whose strength was comparable to the strong 1998 nIOD. During this period, the southeastern Arabian Sea (SEAS) exhibited unusually high surface chlorophyll, which was the highest ever observed in the region in the past two decades.

The SEAS is one among the biological hotspots of the North Indian Ocean, contributing significantly to the country's fisheries production. The SEAS exhibits high surface chlorophyll triggered by coastal upwelling off the Kerala coast, which peaks during the peak phase of the summer monsoon and decays by late summer (Figure-1a-d). In 2016, this seasonal cycle was disrupted due to the unusual intensification of surface chlorophyll by late summer and Fall (Figure-1e-h). Mean chlorophyll in the SEAS exceeded 1.0 mg m^{-3} in September, a two-fold increase compared to previous years (Figure-2a). Strong negative correlation (- 0.6) of chlorophyll anomaly in the SEAS with the dipole mode index (DMI) indicates the impact of teleconnections favouring enhanced biological productivity in the region during nIOD (Figure-2b).

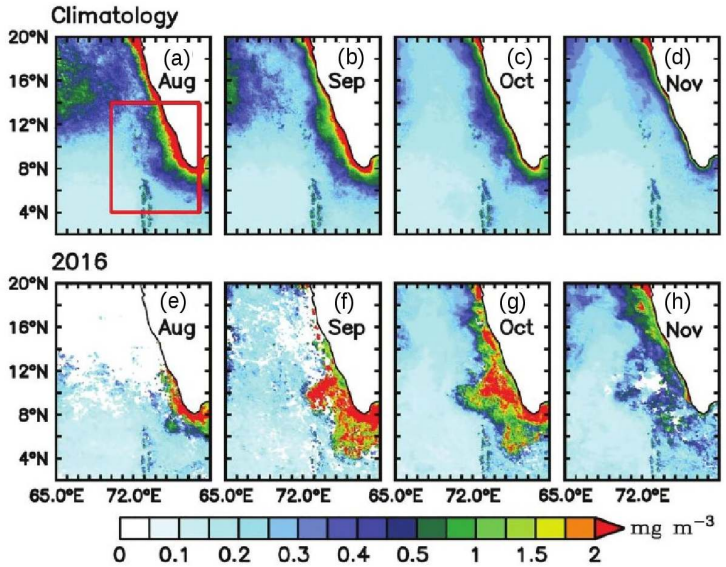


Figure-1: Spatial distribution of chlorophyll in the southeastern Arabian Sea (SEAS) for August–November from climatology (a–d) and during 2016 (e–h) from OC-CCI ocean color data product.

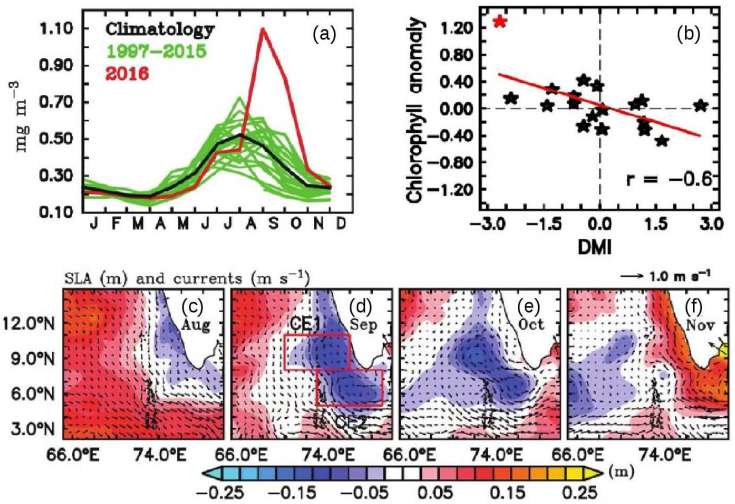


Figure-2:(a) Annual cycle of mean chlorophyll in the SEAS (red box in Fig. 1a) for 1997–2015 (green), 2016 (red), and climatology (black). (b) Relation between chlorophyll anomaly in the SEAS and DMI during September, for 1997–2016. Red star indicates year 2016. (c-f) Sea level anomalies (SLA; m) and surface currents (m s-1; vectors) in the SEAS for August–November, 2016. Boxes in panel (d) represent the regions of cold-core eddies, CE1, and CE2.

Circulation and sea level anomalies (SLA) in the SEAS reveal that the observed chlorophyll anomaly was triggered by two strong cold-core eddies, along the periphery of the coastal upwelling zone (Fig. 2c-f). The SEAS generally exhibit strong Ekman suction during nIOD, favouring thermocline shoaling. This favourable dynamical background, along with eddy formation led to anomalous shoaling of thermocline in the SEAS during 2016. This suggests enhanced vertical supply of subsurface nutrients and chlorophyll to the surface layers, triggering the anomalous blooms. It is interesting to note that eddy formation occured when the thermocline was already shallow due to coastal upwelling during the peak monsoon phase. This preconditioning was favourable for efficient vertical transport of subsurface nutrients and chlorophyll.

Eddy formation is attributed to local and remote forcings in association with the nIOD. Local Ekman suction favoured upwelling in the SEAS; however, Ekman velocities were not always consistent with the thermocline variability, indicating the influence of forcings originating from remote locations. Westward propagation of negative SLA indicate the presence of upwelling Rossby waves. Observational evidence suggests that these upwelling Rossby waves were forced by strong upwelling around Sri Lanka and the southern tip of India, in association with the nIOD-related wind anomalies, and the resultant propagation of upwelling Kelvin waves along the west coast of India.

The study signifies the unprecedented impacts of extreme climatic events on the chlorophyll distribution of the Indian Ocean. The climatic and economic significance of Indian Ocean productivity demands the need for a better understanding of biophysical interactions associated with climatic events.

Citation: V. Thushara and P. N. Vinayachandran (2020), Unprecedented Surface Chlorophyll Blooms in the Southeastern Arabian Sea During an Extreme Negative Indian Ocean Dipole, Geophysical Research Letters, 47 (13), doi: https://doi.org/10.1029/2019GL085026

[Report Courtesy: V. Thushara and P. N. Vinayachandran, Indian Institute of Science, Bangalore, India. E-mail: thushara@iisc.ac.in]

The Indian Ocean Bubble, Issue No.13 is now available online

Web Link: https://iioe-2.incois.gov.in/IIOE-2/pdfviewer_pub.jsp?docname=IIOE-2-DOC_OM_191.pdf

Call for Contributions

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 November, 2020**

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

Free Online Course- OceanScience in Action: Addressing Marine Ecosystems and Food Security in the Western Indian Ocean

A new free Massive Open Online Course (MOOC) starts this October. OceanScience in Action: Addressing Marine Ecosystems and Food Security in the Western Indian Ocean will introduce learners to innovative marine technologies and their applications used to tackle the challenges of the sustainable management of marine ecosystems.

The course has been developed by the National Oceanography Centre (UK) in partnership with Western Indian Ocean institutions as an output from the SOLSTICE-WIO project, a four-year collaborative project funded by the UK Global Challenges Research Fund (GCRF). Launched in October 2017, the project brings together advances in marine technologies, local knowledge and research expertise, to address challenges facing the Western Indian Ocean region in a cost-effective way via state-of-the-art technology transfer, collaborative environmental and socio-economic research and hands-on training.

In this four-week course, featuring over 30 video lectures including footage of fieldwork, numerical ocean model animations and visualisations of the Remote Sensing data, learners will explore how new technologies can form the basis for environmental research and monitoring programs to deliver decision support for marine policy development and resource management. Using case studies based in the Western Indian Ocean, learners will see how marine science could be applied to the sustainable management of local marine ecosystems, and how this may contribute to global efforts to meet the UN Sustainable Development Goals.

The course is available via Future Learn https://www.futurelearn.com/ and starts 1 October. Registration opens 1 September, search 'National Oceanography Centre' on Future Learn to register for a place. Although the course is free to all participants, a paid upgrade is offered by the platform to receive unlimited access to the course materials and a certificate of completion upon successful completion of the test at the end of the course.

A limited number of free upgrades are available to learners from WIO-based universities and organisations involved in conservation and management of marine resources. The first 200 learners to sign up via https://www.solstice-wio.org/outputs/solstice-mooc/upgrade will receive a free course upgrade.WIO universities or large organisations who wish to promote this course to their students or members of staff can apply for a promotional material pack (brochures) and the full course content on memory sticksby emailing: solsticeMOOC@noc.ac.uk

[Report Courtesy: Sofia Alexiou, National Oceanography Centre, European Way, Southampton. E-mail: sofia.alexiou@noc.ac.uk]

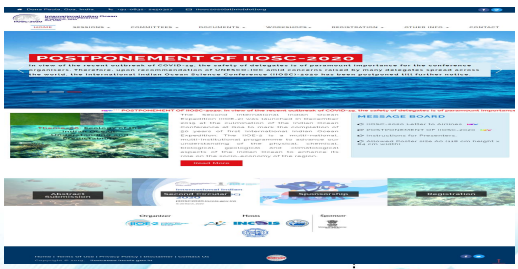
POSTPONEMENT of International Indian Ocean Science Conference (IIOSC)-2020

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)



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

IOGOOS GLOBAL OCEAN OBSERVING SYSTEM FOR INDIAN OCEAN

UNESCO United Nations Educational, Scientific and Cultural Organization

Intergovernmental Oceanographic Commission

International Council for Science SCOR Scientific Committee on Oceanic Research

POSTPONEMENT of the 15th Pan Ocean Remote Sensing Conference (PORSEC-2020) and Capacity Building Tutorial to year 2021

It is with regret that we announce that the 15th Pan Ocean Remote Sensing Conference (PORSEC2020) and capacity building tutorial, scheduled for 15-22 September 2020, have unfortunately been postponed to 2021 over Coronavirus (COVID-19) concerns. We continue to monitor the situation and will decide and announce the new dates sometime around September of this year, or when the situation becomes normal again.

In the meantime, we are continuing accepting new abstracts and registrations, which will remain open until 15 September 2020. The Committee has decided to publish the first volume of abstract proceedings (with ISBN) by December 2020, prior to the conference. At that time we will also consider the preparation of and call for papers for a first volume of a Special Issue of the International Journal of Remote Sensing (IJRS), prior to the conference. We will send out the details to all participants once we have made the decision.

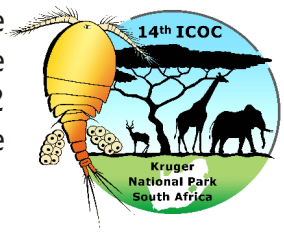
The Committee has arrived at this decision after realizing our capacity to keep an audience sufficiently "distanced" and considering the current uncertainty around gatherings and people's justifiable precautions regarding their own health.

Our sincere apologies for any inconvenience that the postponement may have caused. We wish to thank all speakers, sponsors, exhibitors and participants for their continued support of the event, and we look forward to seeing you at the new date that we will announce.

[Report Courtesy: Nurul Hazrina Idris, Chair of PORSEC2020 LOC, Universiti Teknologi Malaysia, Skudai, Johor, MALAYSIA. E-mail: nurulhazrina@utm.my]

POSTPONEMENT of 14th International Conference on Copepoda (ICOC 2020) to 2021

Due to the COVID-19 virus, the ICOC 2020 and pre-conference workshop scheduled to take place in June 2020, have been postponed by one year. The new dates will be 31 May – 4 June 2021 for the preconference workshop at the University of Limpopo in Polokwane, and 6 – 12 June for the conference in Skukuza, Kruger Park, South Africa. The conference will still be referred to as the ICOC2020 and not the ICOC2021.



Unfortunately, increase in prices and costs can be expected, with an increase in the accommodation costs and probably also in the registration fees. These can only be calculated at a later date. The registration website will stay open for new participants to register and book, while the list of people who already registered will be saved, together with all the payments already received, and transferred to the bookings for June 2021.

Abstract submissions for the ICOC 2020 in June 2021 have re-opened. Please go to https://app.oxfordabstracts.com/dashboard/events/1160 where you can decide whether you want to keep your abstract as submitted for June 2020 or whether you want to change it for June 2021. Note that there is no deadline yet, and this will be determined at a later stage, probably 30 December 2020.

Visit https://www.abevents.co.za/web_icoc2020/ for further details.

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 41 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 August 2020 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 August, 2020 is available at:

https://mailchi.mp/clivar.org/clivar-august-2020-bulletin

Call for Contributions

Informal articles/short notes of general interest to the IIOE-2 community are invited for the next (September-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 September, 2020**

The Indian Ocean Bubble 2

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