

*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.*

Introducing

## EC Buzz!

### Early Careers make a splash into the Ocean Decade with EC Workshop during IIOSC-2022

The Early Career Scientists' Network (ECSN) emerged from the IIOE-2 symposium at Goa in 2015. Since then ECSN members have been contributing significantly to various IIOE-2 activities and meetings. A dedicated workshop by and for EC was envisaged during the IIOSC-2020 which was hosted in the form of a virtual IIOSC-2022 during 14-16 March, 2022. This ECSN workshop was co-chaired by Michelle Fernandes, Fehmi Dilmahmood and Nimit Kumar, with the latter also serving as technical coordinator. Meanwhile, the UN Decade of Ocean Science had also kicked off, adding an exciting new dimension to the relevance of this network and the EC workshop hosted by us. The IIOE-2 ECSN is arguably the oldest and the only basin-focused multidisciplinary EC network globally. The workshop report that follows, envisages to continue in fostering EC networks to cater to regional needs.

On Day-1 of the IIOE-2 ECSN organized workshop, the session was chaired by Dr. Michelle Fernandes. Upon invite, Dr. Arvind Singh (then Chairperson, ECSN, Core-Committee) provided an overview of the network since the 2015 IIOE-2 Goa workshop. He detailed the activities undertaken and achievements so far. After that, the moderator of the session, Dr. Danielle Su (Secretary, ECSN-CC) who also acted as the election officer, announced the outcome of the online elections held for the formation of the new core committee. The new committee members then introduced themselves to and connected with the audience. The session was concluded with closing remarks and vote of thanks by Dr. Riaan Cedras.

On Day-2, the session was chaired by the new ECSN Chair Dr. Fehmi Dilmahmood and moderated by Dr. Nimit Kumar. As per the agenda, all the former and committee members as well as the other EC participants discussed the future scope of activities under this network including writing group-thematic white papers, capacity building and collaborations. Dr. Subhadeep volunteered as the lead Editor for the newsletter. Dr. Daneeja Marwan concluded the session with summary remarks and vote of thanks.

Day-3 was dedicated to invited talks from other EC networks. The session was convened and chaired by Dr. Nimit Kumar and moderated by Dr. Aditi Modi. At the outset, the chair noted that this is probably the most unique network catering to the EC of a single ocean. He also highlighted that the motivation of the session is that to provide a platform to introduce IO-EC to other networks active in the IO-region. After the Chairperson's introductory remarks, the first talk was by Dr. Lilian Anne Krug who presented about NANO (NF-POGO Alumni Network for Oceans). This was followed by presentation on PORSEC (Pan-Ocean Remote Sensing Conference) capacity building by Dr. Nimit Kumar.

Next was the WIO-ECSN (Western IO-ECSN) activities by Ms. Alessia Dinoi, who provided a pre-recorded video but was present online for interaction. The last presentation of the session was by Mr. Raphael Roman on UN Ocean Decade ECOPs (EC Ocean Professionals), who also provided a pre-recorded video and the network was represented by Ms Evgeniia Kostianaia. After enthusiastic discussions, the session was concluded by Dr. Michelle Fernandes summarising all three days' proceedings. On behalf of the other founders of the network, she assured that they are available for guidance to the new CC as mentors and to the advisory committee for smooth functioning. The EC echoed the feeling for regular interaction and meeting moving forward.



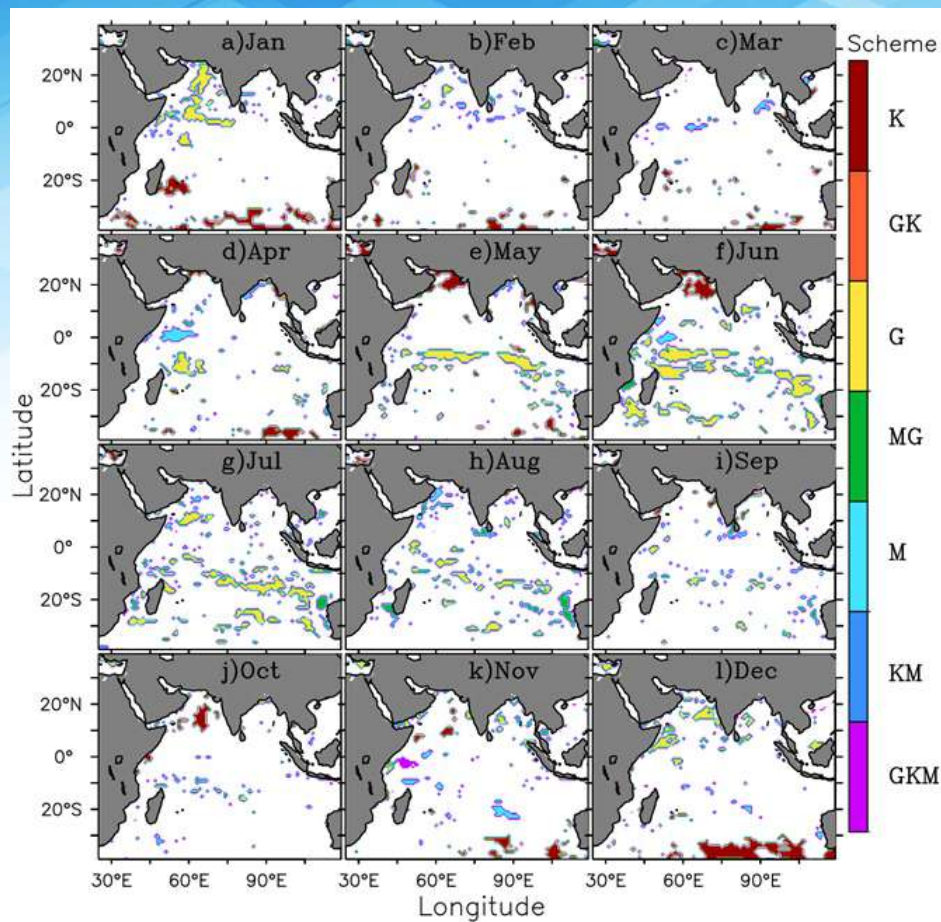
Photo: A glimpse of the Day-3 session of EC workshop (Courtesy: Lilian Anne Krug).

[Report Courtesy: Dr. Nimit Kumar, Founder-Mentor, IIOE-2 ECSN; Exec. Sec., Membership, Edu. & Outreach, PORSEC  
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## Performance of mixing schemes in simulation of upper ocean properties in the tropical Indian Ocean in the HYbrid Coordinate Ocean Model (HYCOM)

The upper ocean plays a vital role in determining ocean-atmosphere interactions on synoptic to interannual timescales. Due to inadequate understanding of the upper ocean mixing processes and horizontal and vertical resolution limitations, ocean vertical mixing is often parameterized in Ocean General Circulation Models (OGCMs). Several mixing schemes are used for this purpose. It is crucial to evaluate their performance in simulating the upper ocean properties in an OGCM. INCOIS uses the HYbrid Coordinate Ocean Model (HYCOM) for several of its oceanographic services. Recently INCOIS scientists evaluated the performance of K-Profile Parameterization (KPP), Goddard Institute of Space Sciences (GISS), and Mellor-Yamada (MY) in the tropical Indian Ocean in HYCOM. The study showed that the simulated SST by the free model is generally warmer by 1–2 °C than the observations and that there is little difference in SST between simulations by these different mixing schemes except in specific locations. The simulated MLD, irrespective of the mixing scheme's choice, is generally deeper than observations in the tropical Indian Ocean. However, this MLD bias varies with time and location depending on the mixing scheme choice. None of the mixing schemes consistently simulated the MLD with minimal error at all locations and times in the tropical Indian Ocean. The scientists at INCOIS designed a novel spatio-temporal map (Fig. 1) to show the best performing scheme to guide further studies using the model. Differences between the schemes regarding the amount of cross-equatorial heat transport and the estimated thermal eddy diffusivity, especially in the eastern Indian Ocean, are estimated. A heat budget analysis signifies the importance of the vertical diffusive heat flux and points to the role of positive short wave flux bias in determining the warm SST bias. Possible causes of the MLD biases in the simulations are investigated, and the bias is not due to wind stress forcing errors. In addition, the wind stress-MLD relationship in the model is found to be stronger for these schemes than the observations. The sensitivity of the KPP simulated MLD to the critical bulk Richardson number (Ribc) is explored and shown that changing the value of Ribc from the often-used 0.25 to 0.15 can marginally improve MLD simulation. Results of this study can be expected to contribute to improving the ocean forecasts issued using the model.



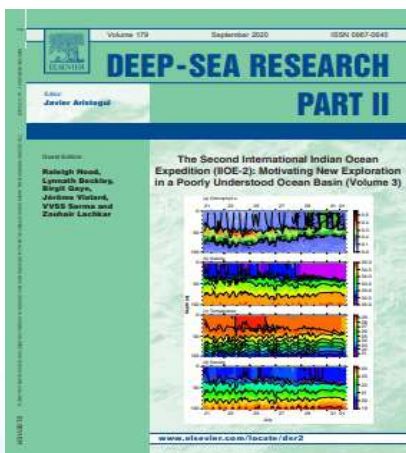


**Fig. 1:** Spatiotemporal evolution of the performance of different mixing schemes in simulating the MLD in the tropical Indian Ocean, showing the best scheme(s) simulating the MLD with minimal error compared to the observation in each calendar month indicated on the corresponding subpanel. All possible combinations of three mixing schemes are shown on the color bar, with K, G, and M, indicating KPP, GISS and MY schemes, respectively. For instance, KM indicates the areas where KPP and Mellor-Yamada simulate the MLD equally well with minimal errors. As an example, KPP simulates the MLD best among the three schemes in the northern Arabian Sea in June (Fig. 1f).

Citation: Pottapinjala V, Joseph S (2022) Evaluation of mixing schemes in the HYbrid Coordinate Ocean Model (HYCOM) in the tropical Indian Ocean. *Ocean Dynamics*. <https://doi.org/10.1007/s10236-022-01510-2>

[Report courtesy: Vijay Pottapinjala and Sudheer Joseph, Indian National Centre for Information Services, Hyderabad, India; Email: vijay.p@incois.gov.in or sjo@incois.gov.in]

## 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 ([rhoo@umces.edu](mailto:rhoo@umces.edu)).



## Obituary Shri. Lankalapalli Veera Gangadhara Rao (1941-2022)



With deep sadness and sorrow, we report the demise of Shri L V G Rao. Shri L.V.G. Rao passed away peacefully on 3 April 2022.

Shri Lankapalli V. Gangadhara Rao – popularly known as LVG Rao was born on 24<sup>th</sup> April 1941. He completed his early education in Andhra Pradesh and completed his M.Sc (Tech.). in Meteorology and Oceanography from Andhra University in 1963. He joined Council of Scientific and Industrial Research (CSIR) on 26<sup>th</sup> October 1968 and superannuated as Scientist-G in 2001.



Shri Rao started his research career in 1964 at CSIR –National Institute of Oceanography as one of the first Junior Research Fellows of IIOE (International Indian Expedition) from its directorate at Hauz Khas, New Delhi. Following which, Shri LVG Rao participated in several cruises onboard INS Kristna organized as part of IIOE. At IIOE and during the later stages of his career he concentrated on understanding the upper ocean processes, mainly through observations. His initial publications were on the variability of thermal structures of Bay of Bengal and the Andaman Sea.

Shri Rao also played a critical role in the understanding of Indian monsoon when he was given the responsibility to plan, execute and coordinate various Monsoon Experiments (MONEX), conducted in the Arabian Sea, the Monsoon Trough Boundary Layer Experiment (MONTBLEX) and the Bay of Bengal Monsoon Experiment (BOBMEX). LVG Rao also successfully coordinated the Indo-French collaborative programme, Indian Ocean Experiment (INDOEX) in 1996-99 and the internationally coordinated World Ocean Circulation Experiment (WOCE) during 1990-2002. Both programmes were observation intensive, and he led some of the cruises onboard Indian research vessels.

Shri Rao was modern in scientific thinking and ahead of his time as he jumped to apply the satellite-based observations for oceanographic applications. He pioneered Satellite Oceanography at NIO and his persistent efforts fructified in launching and executing a large project in Satellite Remote Sensing with the funding from UNDP and Government of India. Through the UNDP funded project, he enabled the training of about 15 early career Scientists at NIO in different aspects of Satellite Remote Sensing at expert centers/universities in the world. He also led the project on “Sea Truth Validation”, a collaborative project with SAC-ISRO.

During the latter part of his career, in 1997-2001, Shi Rao coordinated, led and executed a major project on “Ocean Observing System (OOS)” which included the regular measurements of upper ocean thermal structure along designated shipping routes using XBT probes, measurement of surface temperature, atmospheric pressure and wind speed & direction using satellite tracked drifting buoys, surface weather parameters and SST using merchant and research vessels and long-term time series measurements of ocean currents in the equatorial Indian Ocean using moored instruments. This project turned out to be a major contributor to IndOOS (Indian Ocean Observing System) established jointly by IOGOOS and IORP of CLIVAR with the support of IOC/UNESCO.

Shri Rao participated in many cruises onboard ORV Gaveshani, ORV Sagar Kanya and other research ships including the US and USSR research vessels. He was the Chief Scientist of ORV Sagar Kanya on her maiden scientific cruise in the Indian Ocean (Mormugao-Mombasa). In addition, Shri Rao participated in many national and international seminars and symposia.

With his able leadership, simplicity, dedication and the mastery of maintaining excellent person-to-person interactions with colleagues at all levels, Shri Rao earned the respect of everyone. He nurtured/guided the careers of many physical oceanographers in India who grew to the leadership levels at NIO and other institutions. He always knew how to make his colleagues and acquaintances feel special.

Shri LVG Rao is survived by his wife, a daughter and two sons.

The IIOE-2 JPO pray to the Almighty to grant eternal peace to the departed soul and strength to the family to bear this irreparable loss.



2nd International  
Indian Ocean  
Expedition  
2015-2025





## 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](https://iioe-2.incois.gov.in/IIOE-2/Endorsed_Projects.jsp)

## CLIVAR April 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 April, 2022 is available at:

<https://mailchi.mp/clivar.org/clivar-april-2022-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, 2022**



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