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.

Successful completion of the KIOS 2024 Expedition

The Korea Institute of Ocean Science and Technology (KIOST) recently completed the KIOS 2024 expedition, marking a significant achievement in Indian Ocean research. This expedition was part of the KIOS (KIOST Indian Ocean Study) program, a joint research project with NOAA, USA, endorsed by the International Indian Ocean Expedition 2 (IIOE2-EP51: Korea-US Joint Observation Study of the Indian Ocean), led by Dr. Dong-Jin Kang, PI, KIOST, and funded by the Ministry of Oceans and Fisheries, Republic of Korea.

The expedition, which took place from May 25th to June 21st, 2024, aboard the KIOST research vessel ISABU, covered a meridional transect from 65°E and 20°S to 1°S, departing from Port Louis, Mauritius, and concluding in Malé, Maldives. A key focus of this expedition was the Seychelles-Chagos Thermocline Ridge (SCTR), a crucial area in the tropical Indian Ocean known for its open ocean upwelling, which plays a significant role in global climate patterns. The primary objective of this expedition was to explore the physical, biogeochemical, and ecological characteristics of the SCTR. During the expedition, a comprehensive range of oceanographic studies and sample collections were conducted. Extensive observations and analyses were carried out during this cruise, including CTD profiling from the surface to the bottom, high-resolution nitrate observations using ISUS, measurements of dissolved oxygen, nutrients and dissolved inorganic carbon, sampling for primary productivity, particulate and dissolved organic carbon, nitrogen isotopes of nitrate and dissolved noble gases. Zooplankton samples were also collected using a multi-net system, and the deployment of an underwater glider further bolstered the data collection efforts. NOAA's Pacific Marine Environmental Laboratory (PMEL) staff also participated in the RAMA moored buoy operations. During the cruise, three RAMA moored buoys were re-deployed at 12°S-65°E, 8°S-65°E, and 4°S-65°E, and ten drifters from NOAA's Atlantic Oceanographic and Meteorological Laboratory (AOML) and eight ARGO profiling CTD floats from NOAA PMEL were also deployed.

Figure-1: Group photo of the participants on R/V Isabu

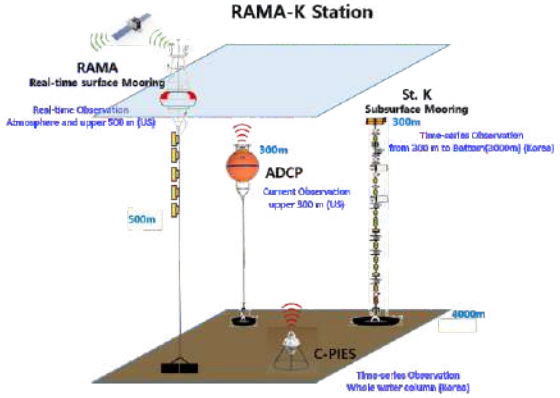

Figure-2: Schematic diagram of RAMA-K

A notable highlight of the expedition was the establishment of the "RAMA-K station" around 8°S, 65°E. The construction of RAMA-K, which began with the 65°E shift of the RAMA buoy last year, was completed during this cruise with the successful relocation of station K to 8°S-65°E. This super observation site is now equipped with the RAMA buoy operated by NOAA, which covers atmosphere and upper 500m depth, the station K subsurface mooring system which covers from 300m to the bottom, operated by Koren scientists , alongside subsurface ADCP (NOAA), and C-PIES (Korea), marking thus the beginning of the the world's first observation system from the atmosphere all the way to the depths of 4,000 m in the Indian Ocean.

[Report Courtesy: Sujin Kang and Dong-Jin Kang, Korea Institute of Ocean Science & Technology, Busan, Korea; E-mail: sjkang@kiost.ac.kr]

Enhancing Knowledge of the Arabian Sea Marine Environment through Science and Advanced Training (EKAMSAT): Scientific field campaign in the eastern Arabian Sea during the summer of 2024

The Arabian Sea plays a vital role in shaping climatic patterns in the Indian Ocean region on various spatiotemporal scales. Recognizing the growing scientific importance of the Arabian Sea, a joint research initiative was formulated between India and the United States of America, titled "Enhancing Knowledge of the Arabian Sea Marine Environment through Science and Advanced Training" (EKAMSAT) to collect fine-scale oceanographic and atmospheric measurements, focusing on surface mixed layer/interior ocean, and marine atmospheric boundary layer processes for the evaluation of various small scale process-representations representations in numerical models. As part of this programme, INCOIS conducted a three-week-long scientific cruise in the Arabian Sea from June 26 to July 15, 2024, onboard the Ministry of Earth Sciences research vessel Sagar Nidhi (SN191) from Mangalore to Tuticorin. A highlight of this expedition was a 12-day time series of fine-scale oceanographic and near-surface meteorological data using advanced tools like the vertical microstructure profiler (VMP), radiometer, near-surface meteorological measurements using a state-of-the-art upgraded automatic weather station onboard, eddy covariance flux system, lowered acoustic Doppler current profiler (L-ADCP), ocean glider and upper air-observation using radiosonde at 12.6°N, 73.0°E on the eastern Arabian Sea, during wet and dry phases of monsoon rainfall. These efforts aim to improve the representation of oceanic and atmospheric processes in numerical models. In addition, water samples were collected for various biogeochemical parameters, and primary productivity and photosynthesis irradiance experiments were conducted onboard.

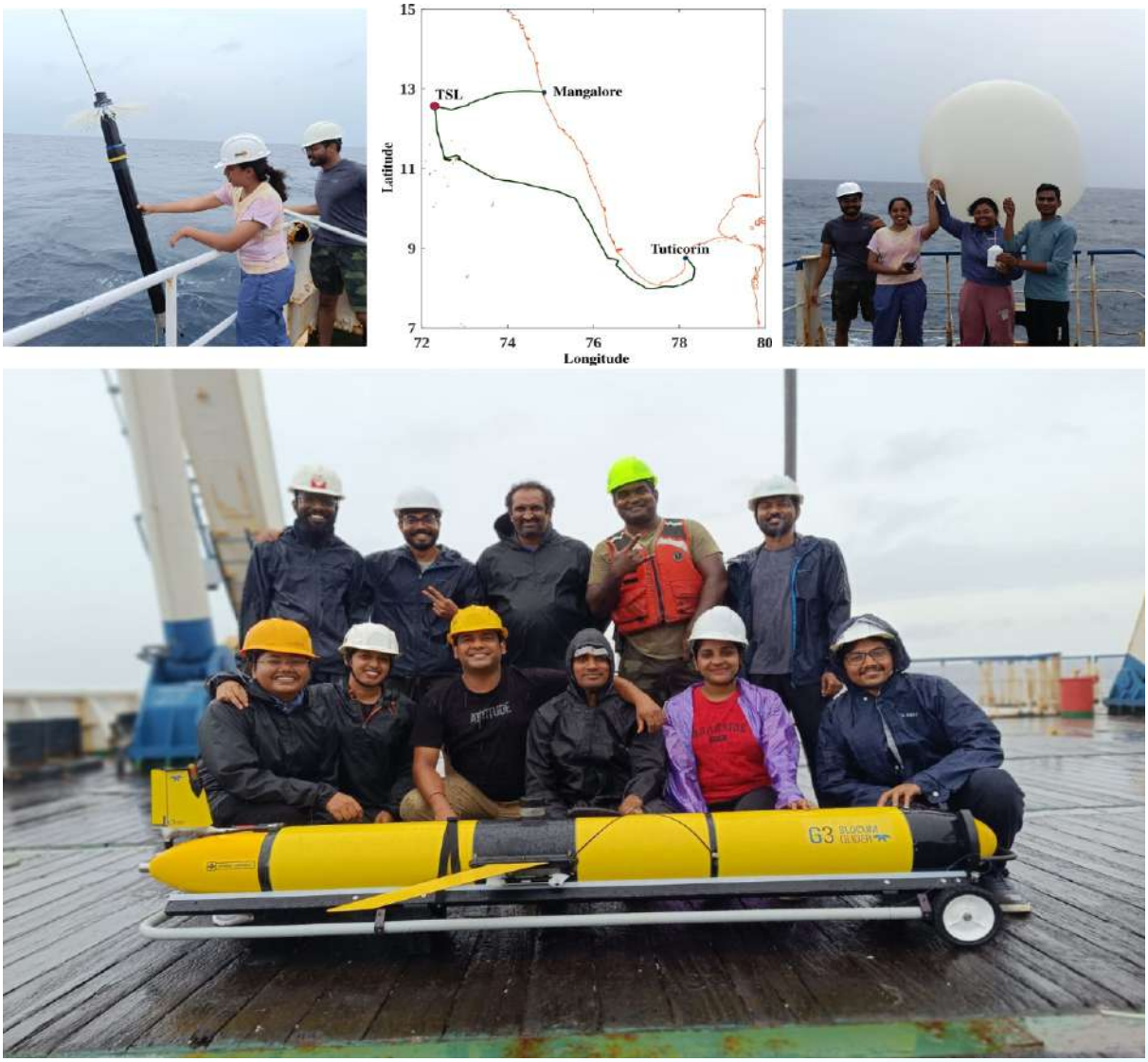

Figure-1: Track and observational activities during the SN191 Cruise

[Report Courtesy: Dr. Girishkumar M. S., Indian National Centre for Ocean Information Services (INCOIS), Ministry of Earth Sciences (MoES), Hyderabad, Telangana, India; E-mail: girish@incois.gov.in]

A review of air-sea exchange of reactive trace gases over the northern Indian Ocean

Reactive trace gases are essential components of chemistry-climate interactions in Earth's atmosphere. These gases are emitted from both natural and anthropogenic sources over terrestrial and marine regions. Air-sea exchange is the dominant process controlling the distribution of several important trace gases over remote marine regions. The production and air-sea exchange of trace gases are controlled by physical conditions at both sides of the interface and ocean biogeochemistry. The northern Indian Ocean (NIO) experiences strong seasonal monsoon winds and intense tropical cyclones. Consisting of the Arabian Sea and Bay of Bengal, it is one the most biologically productive regimes of world ocean and home to intense oxygen minimum zone (OMZ) of the Arabian Sea with low dissolved oxygen concentrations (< 5 µM). Thus, the NIO offers a unique system to investigate the air-sea exchange processes of reactive trace gases. So far, most of the studies of air-sea exchange of trace gases have focused on the Atlantic and Pacific Oceans, while studies over the northern Indian Ocean have been very limited and mainly for greenhouse gases such as CH_4, CO_2 and N_2O. Although much progress has been made in recent years, studies of air-sea exchange of reactive trace gases such as non-methane hydrocarbon (NMHCs), oxygen-, sulfur- and halogen- containing hydrocarbons remain scarce. In our recent review paper, we have addressed the current understanding of air-sea exchange processes and fluxes of reactive trace gases, including NMHCs, dimethyl sulfide (DMS), oxygenated volatile organic compounds (OVOCs), and halocarbons in the northern Indian Ocean. We have discussed the importance of the northern Indian Ocean apropos the production and exchange of reactive trace gases, the knowledge gaps and the future scientific scope as well as the need for a multidisciplinary study of oceanic reactive trace gas cycling and their impact on regional atmospheric chemistry.

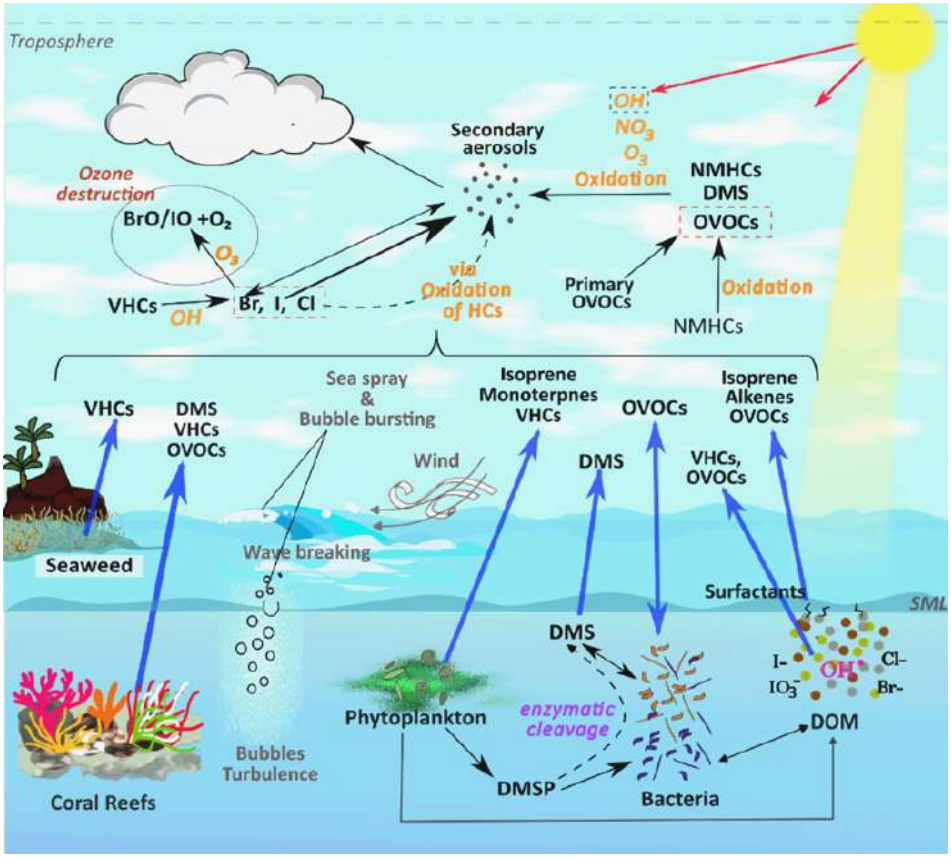

*Figure: Schematic representation of sources (production), air-sea exchange and tropospheric chemistry of reactive trace gases. The blue arrows indicate air-sea exchange, the red arrows indicate photochemical process, and the dashed arrows indicates indirect production processes. *DMS-Dimethyl Sulphide; OVOC-Oxygenated Volatile Organic Compounds; VHC-Volatile Halocarbons; HC-Hydrocarbons; NMHC-Non-Methane Hydrocarbon; SML-Surface Microlayer; DOM-Dissolved Organic Matter; DMSP- Dimethylsulfoniopropionate.*

Citation: Gupta, M., Tripathi, N., Malik, T. G., & Sahu, L. K. (2024). A review on air–sea exchange of reactive trace gases over the northern Indian Ocean. Journal of Earth System Science, 133(2), 77.

https://doi.org/10.1007/s12040-024-02268-5

[Report Courtesy: Mansi Gupta, Senior Research Fellow, Physical Research Laboratory, Ahmedabad, India; E-mail: mansigupta@prl.res.in]

Variability and environmental control on phytoplankton size classes in Port Blair Bay

Phytoplankton plays a crucial role in marine ecosystems as the base of the marine food web. Different sizes of phytoplankton (pico, nano, micro) influence the function of pelagic food webs significantly. Phytoplankton size shapes the existence of the type of food web in the marine ecosystem. Conversely, the sustenance of phytoplankton size depends upon their ambient nutrient concentrations. Thus, a study has been conducted by a group of scientists from the National Institute of Oceanography, the Indian National Centre for Ocean Information Services, and the National Institute of Ocean Technology in Port Blair Bay, South Andaman Island, to explore the relationship between size-fractionated phytoplankton biomass and corresponding environmental conditions (Figure-1a). Port Blair Bay exhibits open ocean characteristics due to the direct connection with the waters of Bay of Bengal and fuelled by nutrients from a small catchment area. The study focused on understanding the variability of ambient environmental conditions and their impact on the variability of different phytoplankton size classes during the winter and spring seasons 2020-2021 based on the seasonal field observation data at seven locations covering the inner and outer Bay.

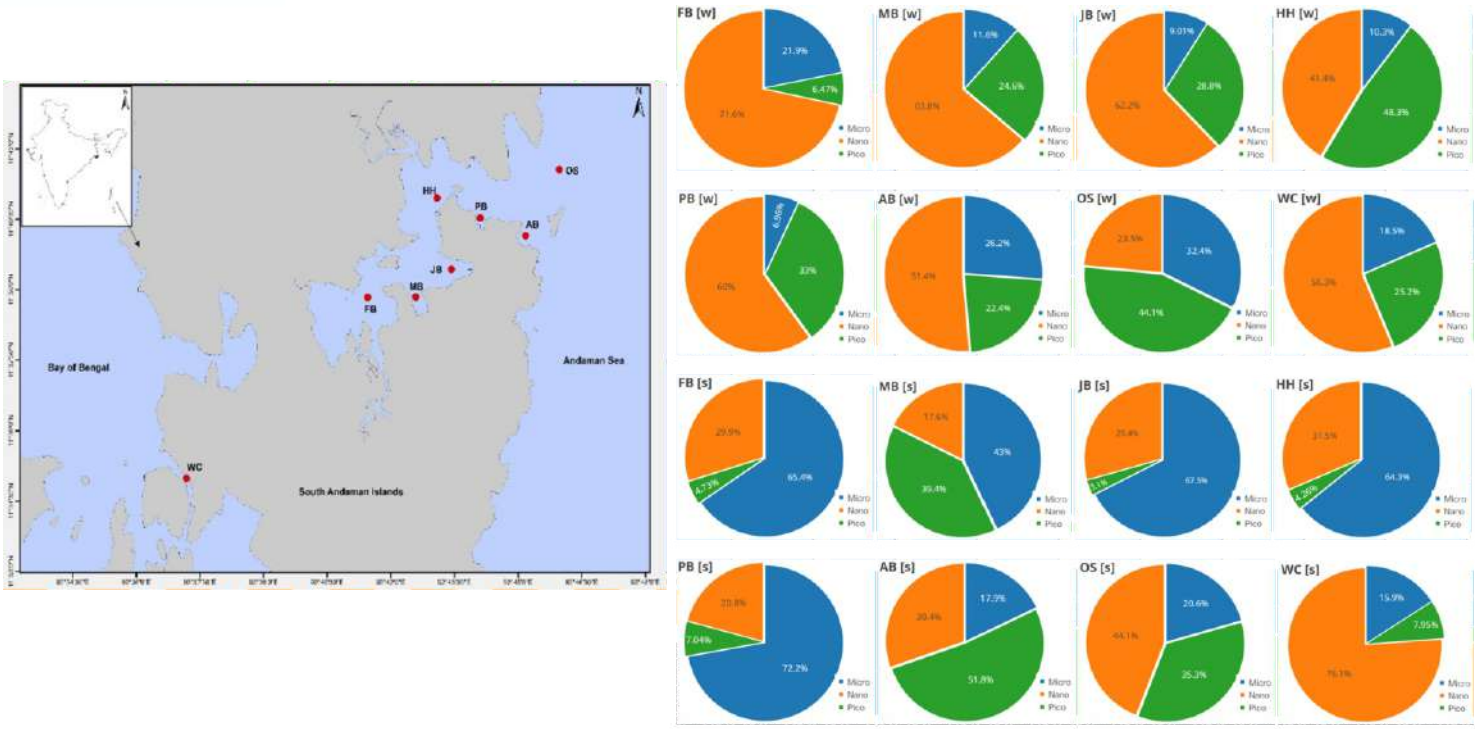

Figure-1: Figure representing (a) Map showing the sampling locations (red dots) in the inner and outer Port Blair Bay (b) Seasonal (w: winter and s: spring) variability of size-fractionated phytoplankton biomass (chlorophyll) represented as pico, nano, and micro in the inner and outer Port Blair Bay

The study provided the first of its kind information on the size-fractionated phytoplankton biomass (chlorophyll) from the Bay. The investigation revealed a significant seasonal difference in the distribution of phytoplankton communities in the inner and outer bay with the dominance of nano phytoplankton during the winter season. In contrast during the spring season, the inner bay and outer bay were found to be dominated by microphytoplankton and picophytoplankton, respectively. Among the size groups, microphytoplankton exhibited a significant seasonal variation as compared to the other two phytoplankton groups (Fig. 1b). The dominant micro-phytoplankton during the winter season were Leptocylindrus minimus, Eucampia zodiacus and Nitzschia seriata while Chaetoceros mostly dominated in the spring season.

The findings delved into the role of ambient nutrient concentrations as a key determinant of dominance and succession of phytoplankton groups in different seasons. Interesting observations were reported explaining the high nutrient and low chlorophyll condition during the winter season and low nutrient-high chlorophyll concentrations during the spring season. The possible factors behind high nutrient and low chlorophyll conditions may be related to the late response of phytoplankton groups to the sudden nutrient elevations and high grazing pressure during the winter season (Fig. 2). On the contrary, the low nutrient-high chlorophyll concentration may be due to the complete nutrient utilization by phytoplankton and also the low grazing pressure during the spring season. This study recommends further long-term observations to understand the seasonality and intra-annual phytoplankton size classes dynamics in such marine ecosystems.

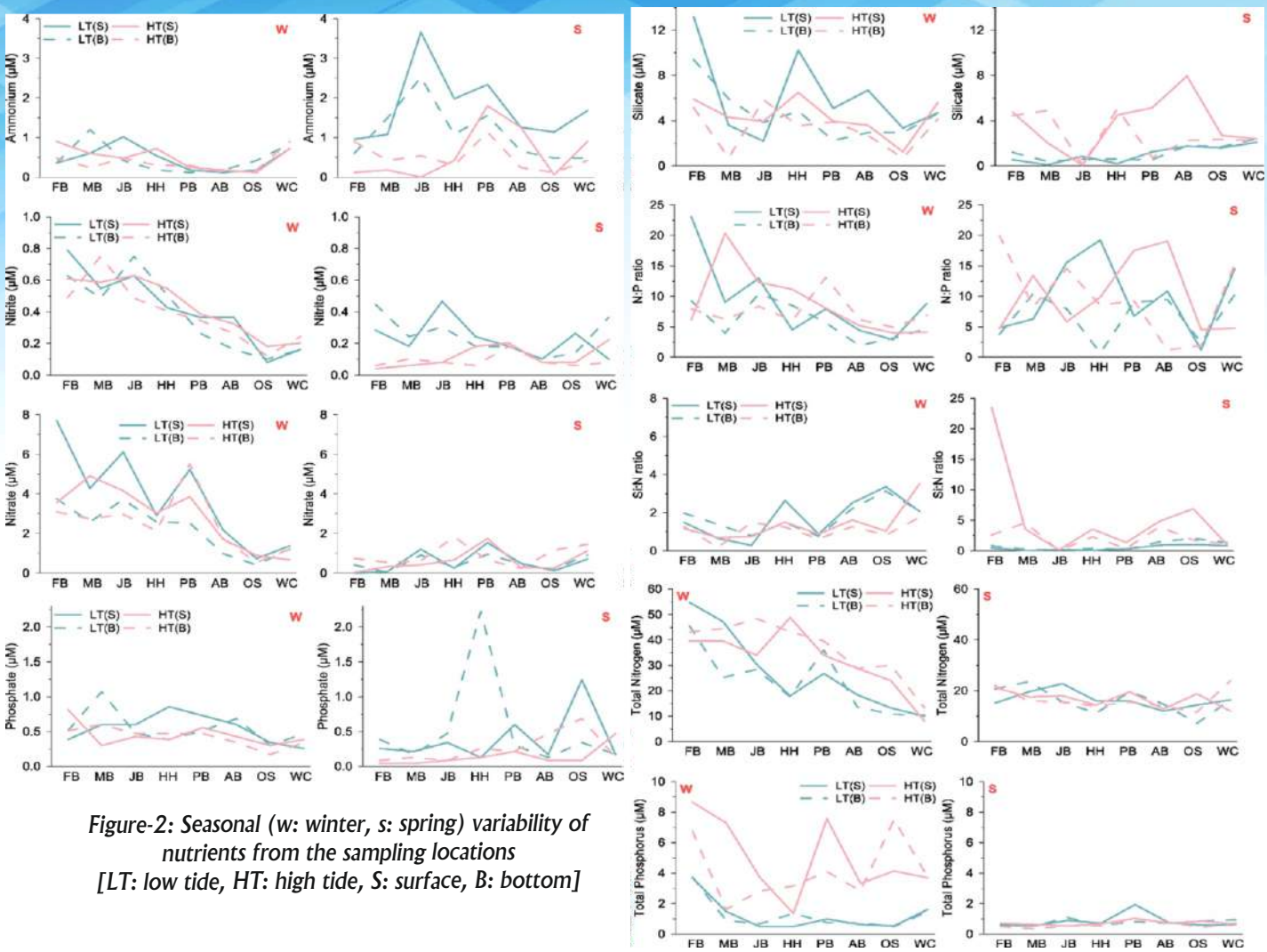

Figure-2: Seasonal (w: winter, s: spring) variability of nutrients from the sampling locations [LT: low tide, HT: high tide, S: surface, B: bottom]

Report Source: Sahu, B.K., Goswami, P., Baliarsingh, S.K., Vinithkumar, N.V., Dharani, G. (2024). Size-Fractionated Phytoplankton Biomass in Port Blair Bay, South Andaman Island: Spatial Variability and Environmental Control. Thalassas]

https://link.springer.com/article/10.1007/s41208-024-00751-w

[Report Courtesy: Susmita Raulo (s.raulo-p@incois.gov.in), Indian National Centre for Ocean Information Services, Hyderabad, India & Biraja Kumar Sahu (birajasahu@nio.org), CSIR-National Institute of Oceanography, Goa, India.]

2025 ASI & IPFC 12 Annual Meeting

DEEP-SEA RESEARCH PART II

THE SUBMISSION PORTAL FOR VOL. 7 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).

Important Dates:

Editorial Acceptance Deadline: **February 15, 2025**

For more details please visit

https://www.sciencedirect.com/journal/deep-sea-research-part-ii-topical-studies-in-oceanography/about/call-for-papers#the-2nd-international-indian-ocean-expedition-iioe-2-motivating-new-exploration-in-a-poorly-understood-basin-volume-7

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 55 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.

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, 2024**

The Indian Ocean Bubble-2

Access the latest issue of Indian Ocean Bubble-2
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