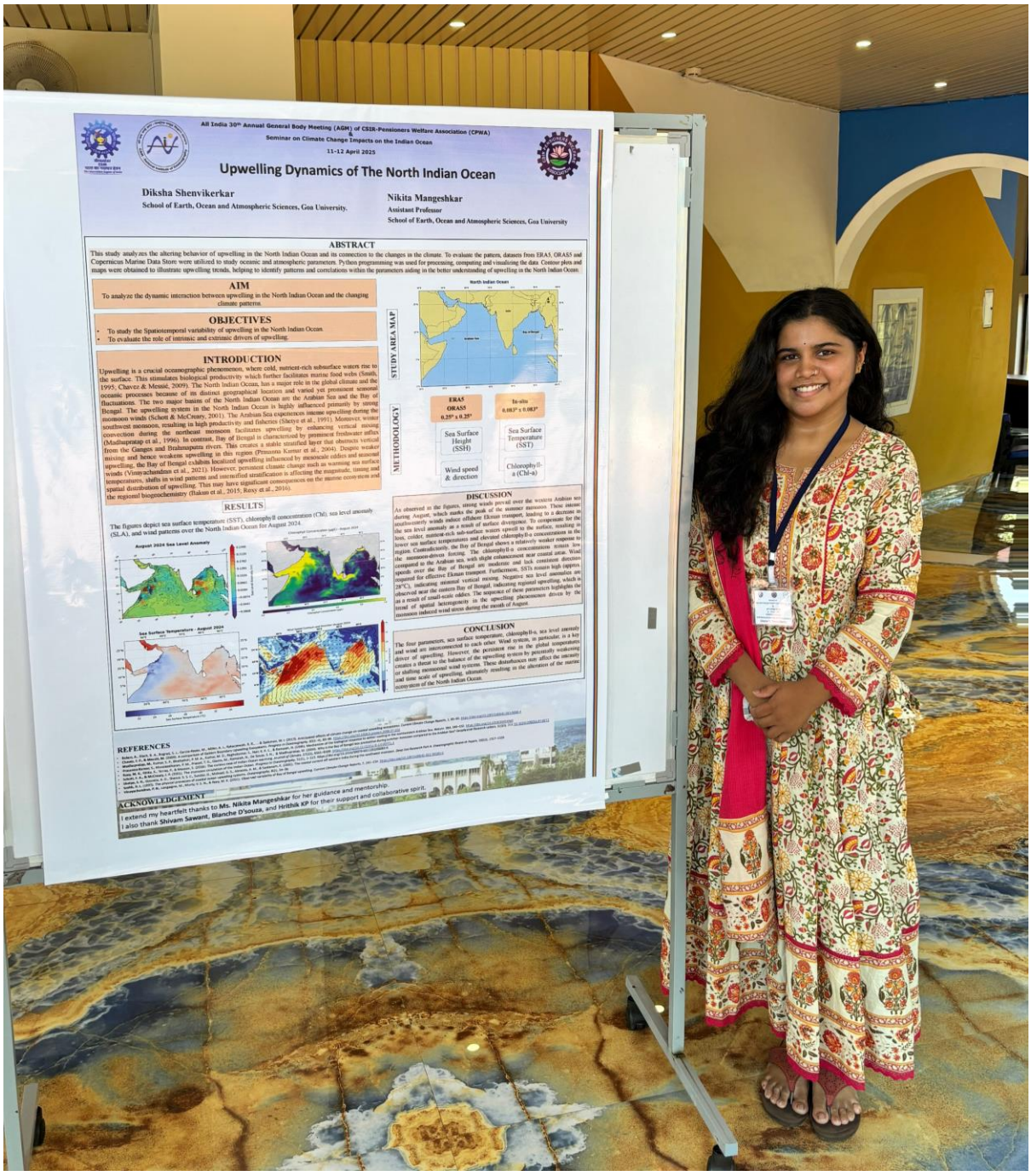
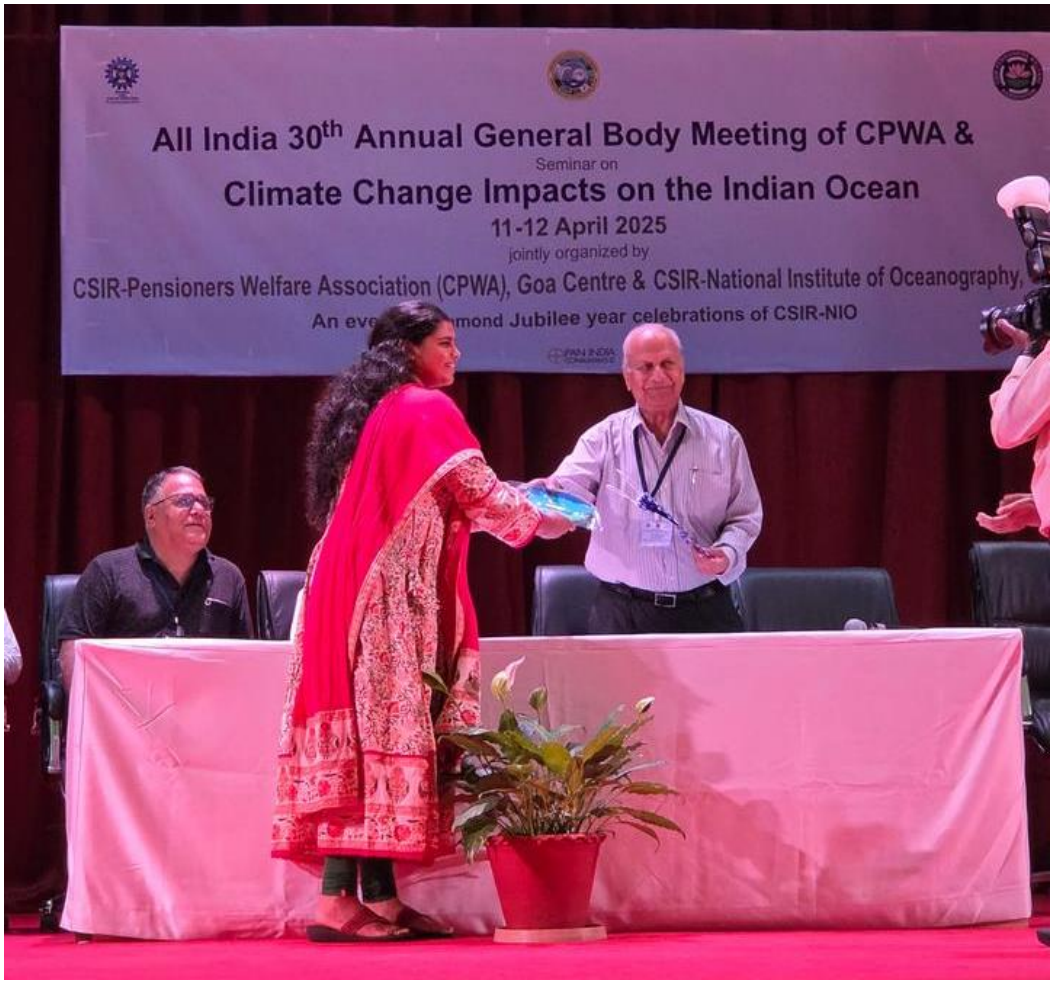
Ms. Diksha Shenvikerker, a student of MSc Part II, Marine Science, School of Earth, Ocean and Atmospheric Sciences, has received the Best Poster Award at the 'All India 30 Annual General Body Meeting (AGM) of CSIR-Pensioners Welfare Association (CPWA)'; for the Seminar on Climate Change impacts on the Indian Ocean, held from 11-12th April 2025, organized by CPWA and CSIR-NIO at NIO, Dona Paula Goa.

Ms. Diksha, presented her paper entitled 'Upwelling Dynamics of The North Indian Ocean' and was guided by Mrs. Nikita Mangeshkar, Assistant Professor, Marine Science, SEOAS, Goa University.

Congratulations Ms. Diksha!




All India 30th Annual General Body Meeting of CPWA &
Seminar on
Climate Change Impacts on the Indian Ocean
11-12 April 2025
jointly organized by
CSIR-Pensioners Welfare Association (CPWA), Goa Centre & CSIR-National Institute of Oceanography,

All India 30th Annual General Body Meeting (AGM) of CSIR-Pensioners Welfare Association (CPWA)
&
Seminar on Climate Change Impacts on the Indian Ocean
11-12 April 2025

Upwelling Dynamics of The North Indian Ocean

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ABSTRACT

This study analyzes the altering behavior of upwelling in the North Indian Ocean and its connection to the changes in the climate. To evaluate the pattern, datasets from ERA5, ORAS5 and Copernicus Marine Data Store were utilized to study oceanic and atmospheric parameters. Python programming was used for processing, computing and visualizing the data. Contour plots and maps were obtained to illustrate upwelling trends, helping to identify patterns and correlations within the parameters aiding in the better understanding of upwelling in the North Indian Ocean.

AIM

To analyze the dynamic interaction between upwelling in the North Indian Ocean and the changing climate patterns.

OBJECTIVES

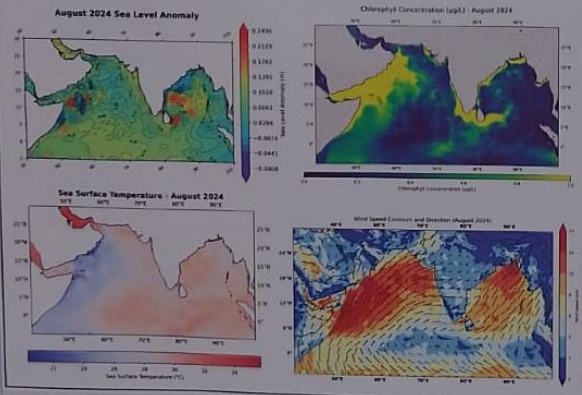
- To study the Spatiotemporal variability of upwelling in the North Indian Ocean.
- To evaluate the role of intrinsic and extrinsic drivers of upwelling.

INTRODUCTION

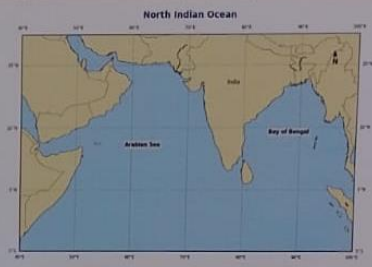
Upwelling is a crucial oceanographic phenomenon, where cold, nutrient-rich subsurface waters rise to the surface. This stimulates biological productivity which further facilitates marine food webs (Smith, 1995; Chavez & Messié, 2009). The North Indian Ocean, has a major role in the global climate and the oceanic processes because of its distinct geographical location and varied yet prominent seasonal fluctuations. The two major basins of the North Indian Ocean are the Arabian Sea and the Bay of Bengal. The upwelling system in the North Indian Ocean is highly influenced primarily by strong monsoon winds (Schott & McCreary, 2001). The Arabian Sea experiences intense upwelling during the southwest monsoon, resulting in high productivity and fisheries (Shetye et al., 1991). Moreover, winter convection during the northeast monsoon facilitates upwelling by enhancing vertical mixing (Madhupratap et al., 1996). In contrast, Bay of Bengal is characterized by prominent freshwater influx from the Ganges and Brahmaputra rivers. This creates a stable stratified layer that obstructs vertical mixing and hence weakens upwelling in this region (Prasanna Kumar et al., 2004). Despite weaker upwelling, the Bay of Bengal exhibits localized upwelling influenced by mesoscale eddies and seasonal winds (Vinayachandran et al., 2021). However, persistent climate change such as warming sea surface temperatures, shifts in wind patterns and intensified stratification is affecting the magnitude, timing and spatial distribution of upwelling. This may have significant consequences on the marine ecosystem and the regional biogeochemistry (Bakun et al., 2015; Roxy et al., 2016).

RESULTS

The figures depict sea surface temperature (SST), chlorophyll concentration (Chl), sea level anomaly (SLA), and wind patterns over the North Indian Ocean for August 2024.



STUDY AREA MAP



METHODOLOGY

ERA5 ORAS5 0.25° x 0.25°	In-situ 0.083° x 0.083°
Sea Surface Height (SSH)	Sea Surface Temperature (SST)
Wind speed & direction	Chlorophyll-a (Chl-a)

DISCUSSION

As observed in the figures, strong winds prevail over the western Arabian sea during August, which marks the peak of the summer monsoon. These intense southwesterly winds induce offshore Ekman transport, leading to a decrease in the sea level anomaly as a result of surface divergence. To compensate for the loss, colder, nutrient-rich sub-surface waters upwell to the surface, resulting in lower sea surface temperatures and elevated chlorophyll-a concentrations in the region. Contradictorily, the Bay of Bengal shows a relatively weaker response to the monsoon-driven forcing. The chlorophyll-a concentrations remain low compared to the Arabian sea, with slight enhancement near coastal areas. Wind speeds over the Bay of Bengal are moderate and lack consistent direction required for effective Ekman transport. Furthermore, SSTs remain high (approx. 28°C), indicating minimal vertical mixing. Negative sea level anomalies are observed near the eastern Bay of Bengal, indicating regional upwelling, which is as a result of small-scale eddies. The sequence of these parameters highlights the trend of spatial heterogeneity in the upwelling phenomenon driven by the monsoon induced wind stress during the month of August.

CONCLUSION

The four parameters, sea surface temperature, chlorophyll-a, sea level anomaly and wind are interconnected to each other. Wind system, in particular, is a key driver of upwelling. However, the persistent rise in the global temperatures creates a threat to the balance of the upwelling system by potentially weakening or shifting monsoonal wind systems. These disturbances may affect the intensity and time scale of upwelling, ultimately resulting in the alteration of the marine ecosystem of the North Indian Ocean.

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