

# Climatic Modulation of the Euphotic Zone in the Arabian Sea: Multi-Sensor Satellite Evidence from 1998–2023



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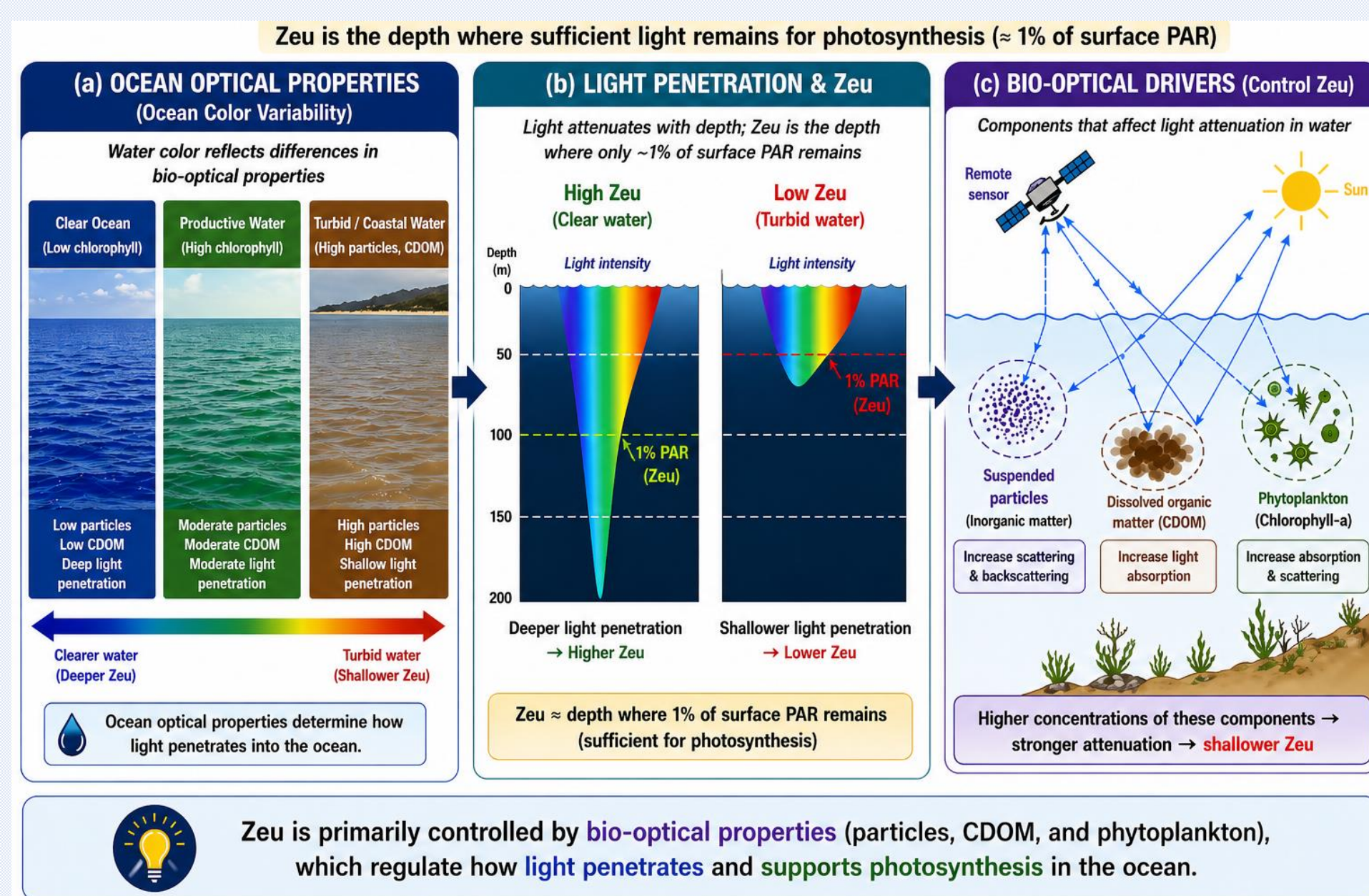
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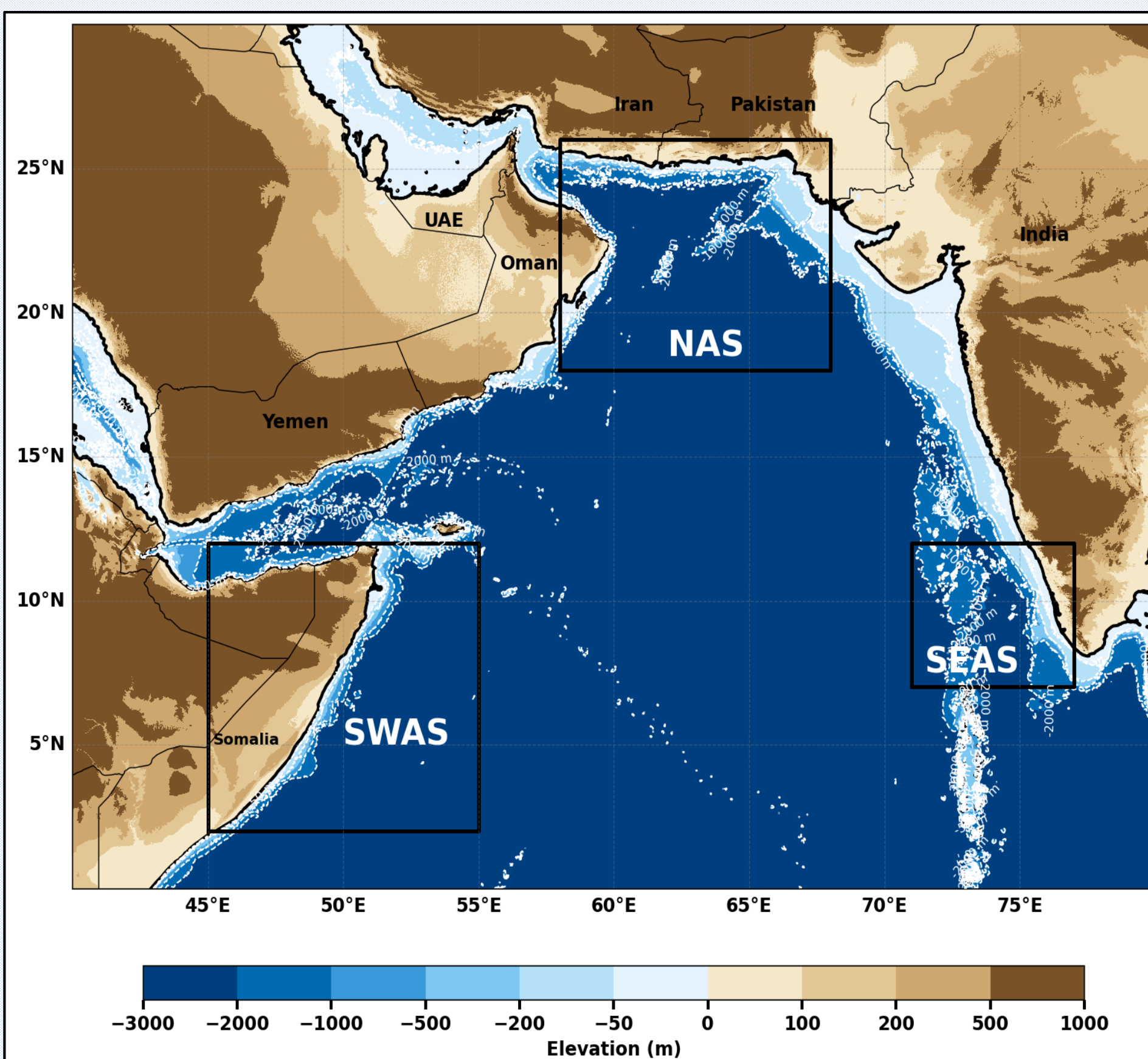
Scan for Abstract

## 1. INTRODUCTION

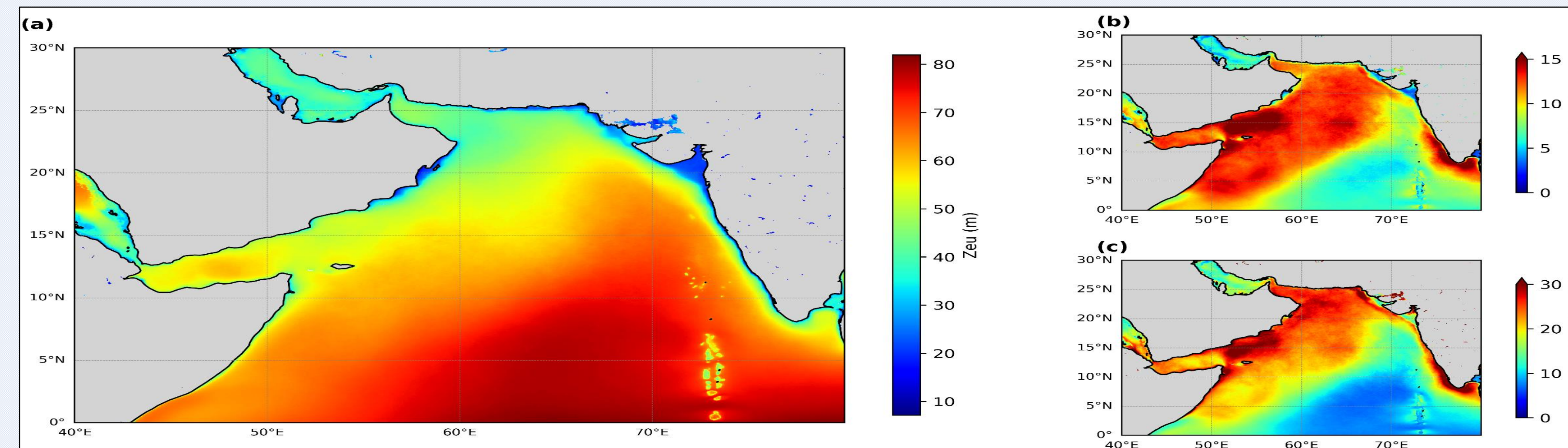


- The uppermost layer of the ocean, is characterized by the presence of most of the visible light, which is available for photosynthesis. It extends from the surface to a depth of 200 m.
- Long-term basin-wide assessment of Zeu variability (1998-2023) and its climatic controls remain limited
- The study investigates the trends, seasonal cycle and climatic linkages of Zeu using multi-sensor satellite data.

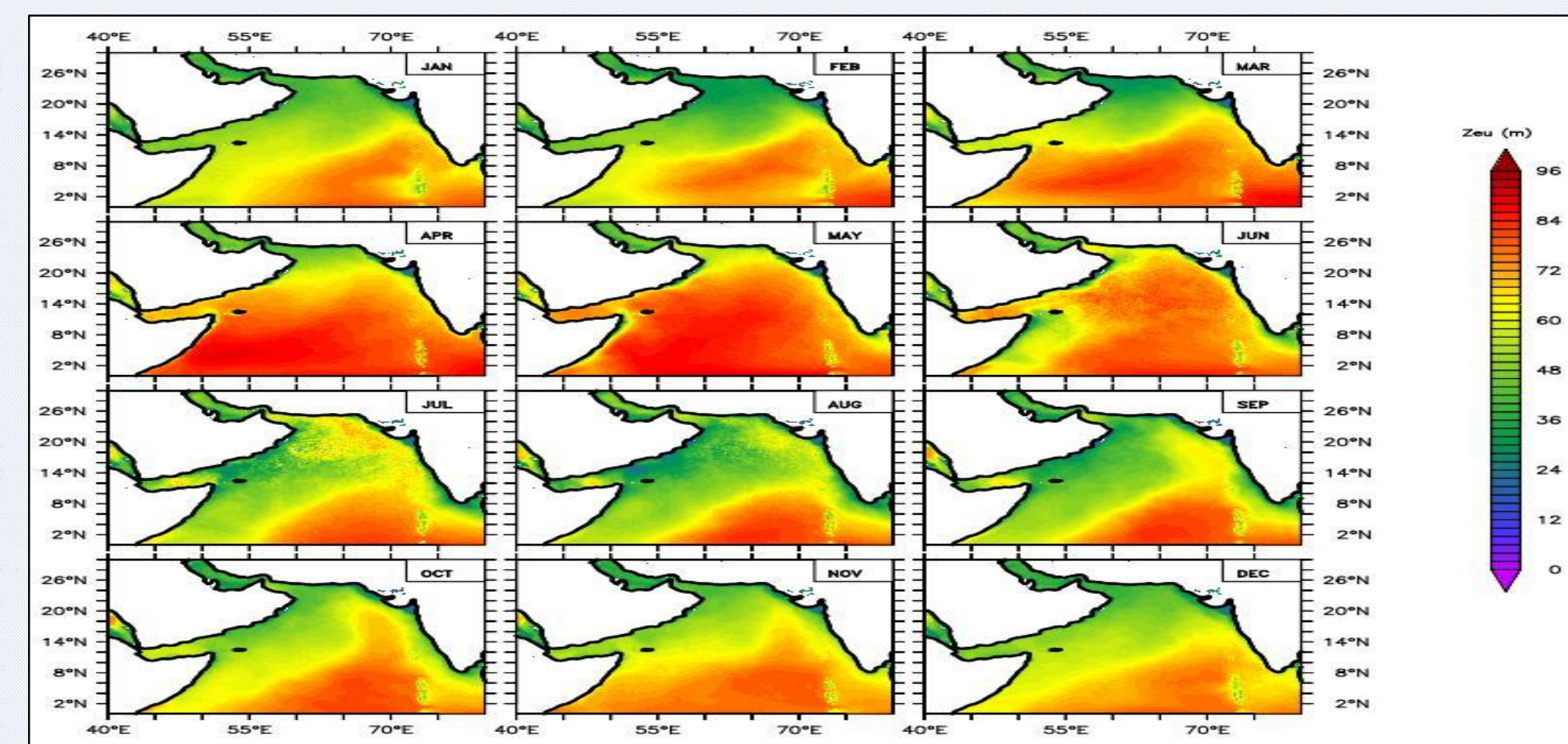
## 2. STUDY AREA



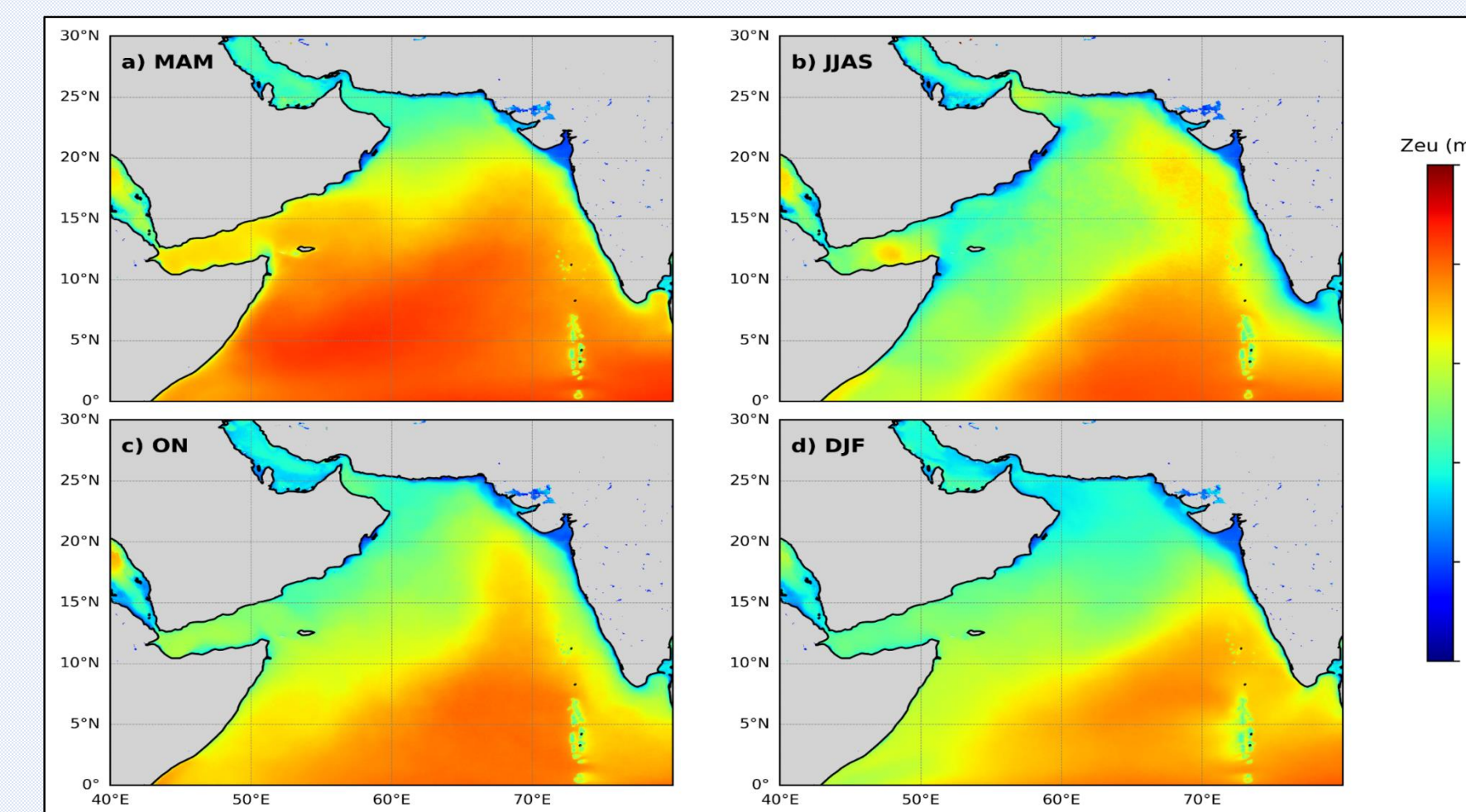
## 3. MEAN STATE & VARIABILITY OF Zeu (1998 - 2023)



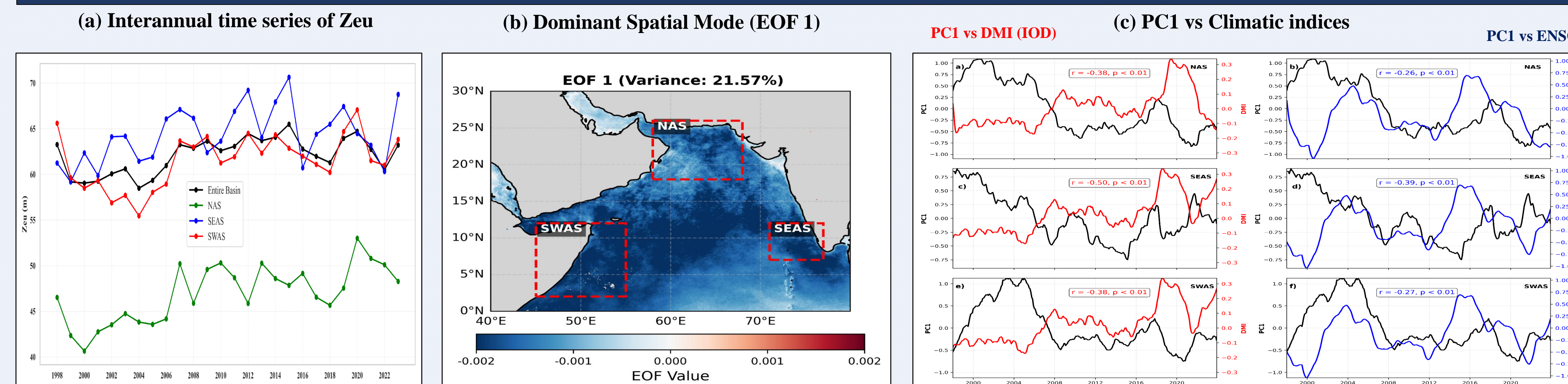
## 4. MONTHLY CLIMATOLOGY OF Zeu



## 5. SEASONAL VARIABILITY



## 6. INTERANNUAL VARIABILITY, MODES & CLIMATIC LINKAGES

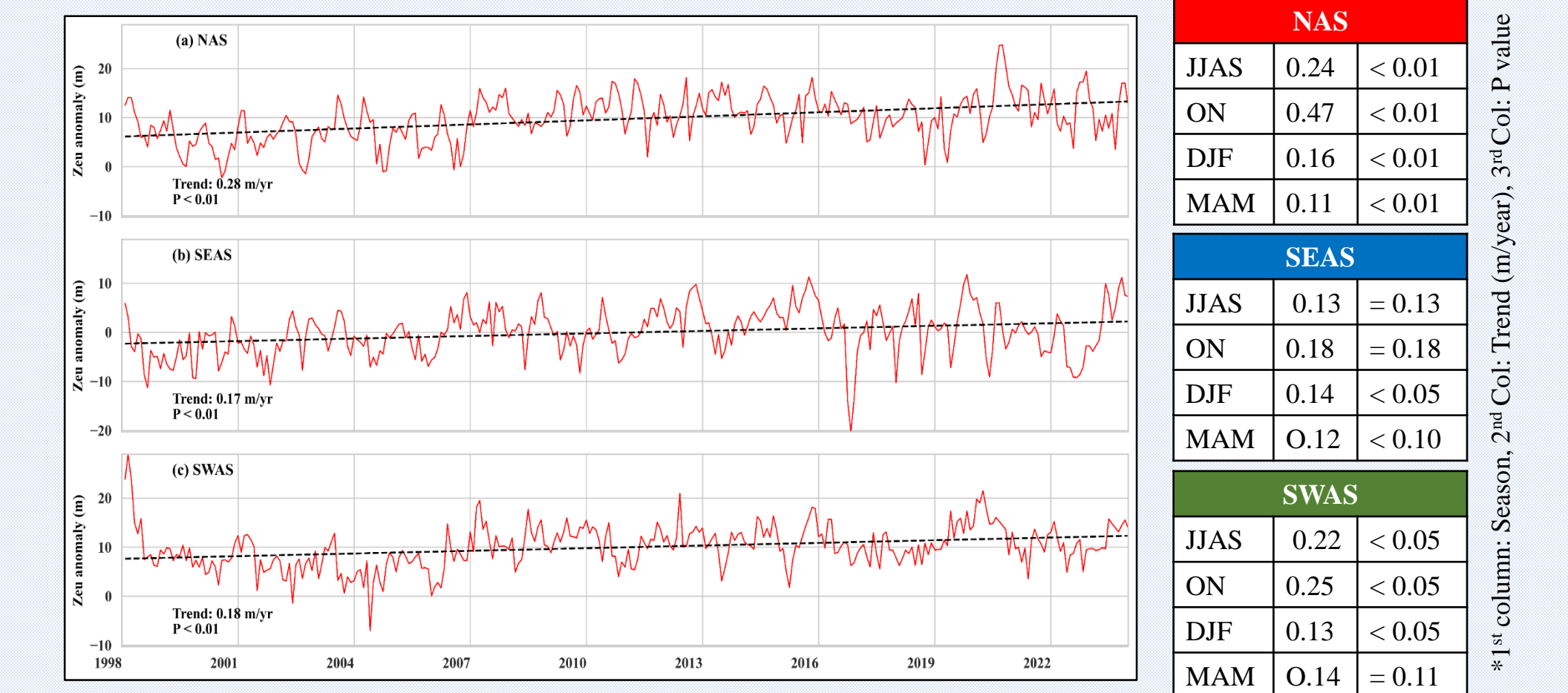


- Basin-wide Zeu: 58–66 m
- SEAS: Highest Zeu (59–71 m) → Clearer waters
- NAS: Lowest Zeu (40–53 m) → More turbid conditions
- SWAS: Comparable to basin mean (55–67 m)

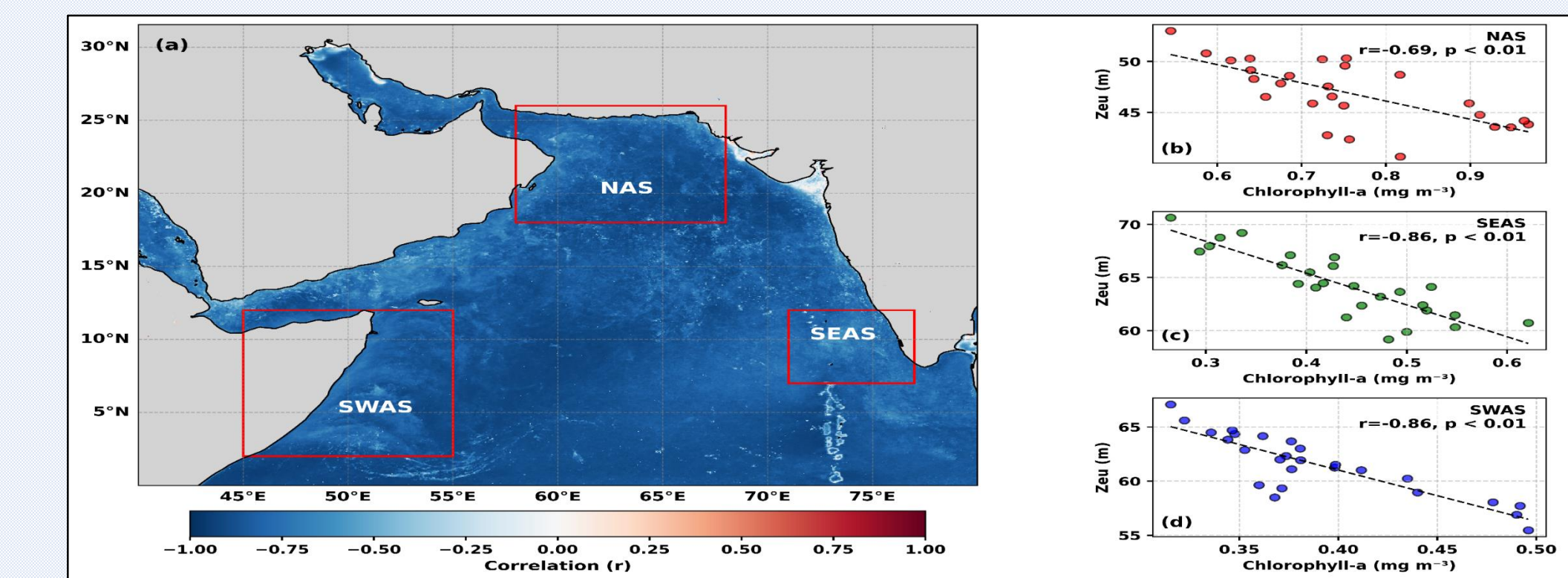
- EOF1 captures interannual variability (21.57% basin variance)
- Negative spatial loadings across basin → (+PC1 = shallower Zeu | -PC1 = deeper Zeu / clearer waters)
- SEAS most climate-sensitive region

- NAS: Weak direct correlation, but significant lagged response (10 / 8 months) indicating delayed IOD influence.
- SEAS: Strongest negative correlation showing IOD as the dominant driver of Zeu variability.
- SWAS: Significant negative relationship, confirming basin-wide IOD control on Zeu.
- Positive IOD/ENSO → Deeper Zeu basin-wide

## 7. LONG TERM TREND



## 8. CHLOROPHYLL – Zeu RELATIONSHIP



## 9. KEY TAKEAWAYS

- First comprehensive quantification of Zeu variability in the Arabian Sea across seasonal, interannual, and long-term timescales using multi-sensor satellite data.
- Zeu shows an overall increasing trend, indicating enhanced water clarity across the Arabian Sea basin.
- Zeu is strongly inversely related to chl-a, highlighting the dominant role of bio-optical processes.
- Interannual variability in the NAS, SEAS, and SWAS is primarily driven by the IOD, followed by the ENSO.
- Regional contrasts are evident: the NAS during the ON season demonstrates the highest positive trend in Zeu.

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