

Why this study?

Lightning is an important indicator of deep convection, mixed-phase cloud processes, and severe weather potential. The North Indian Ocean (NIO) shows strong regional contrasts between the Arabian Sea and the Bay of Bengal, where recent warming and changes in cyclone activity may influence oceanic thunderstorms differently. This study examines changes in total and cyclone-associated lightning over these two basins during 2002–2023 using TRMM-LIS/ISS-LIS observations, ERA5 thermodynamic fields, MODIS cloud properties, and IMD cyclone best-track data. The objective is to identify whether recent climate variability has produced contrasting changes in electrified convection over the Arabian Sea and Bay of Bengal.

Key Points

- ❖ Arabian Sea lightning shows localized enhancement.
- ❖ Bay of Bengal changes are weaker or mostly reduced.
- ❖ Cyclones and mixed-phase ice processes support stronger AS electrified convection.

Data and Methodology

Lightning: TRMM-LIS and ISS-LIS total lightning data during 2002–2023.

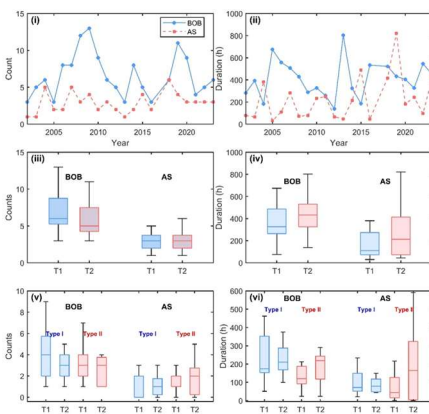
Cyclones: IMD/RSMC best-track data for cyclone position, intensity, and duration.

Environment: ERA5 SST, CAPE, IWC, and LWC.

Cloud properties: MODIS cloud-top temperature, liquid effective radius, and ice effective radius.

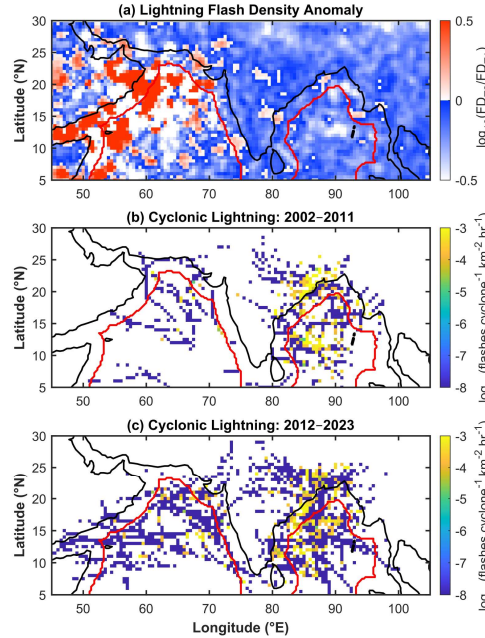
Method: Lightning flash density was compared between T1: 2002–2011 and T2: 2012–2023 over the Arabian Sea and Bay of Bengal. Cyclone-associated lightning was identified within ± 1 h and 5° radius of cyclone centers. Thermodynamic and cloud anomalies were analyzed to interpret changes in electrified convection.

Changes in Cyclone Frequency and Duration

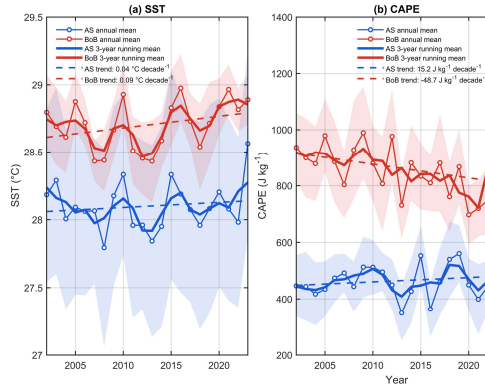


Results

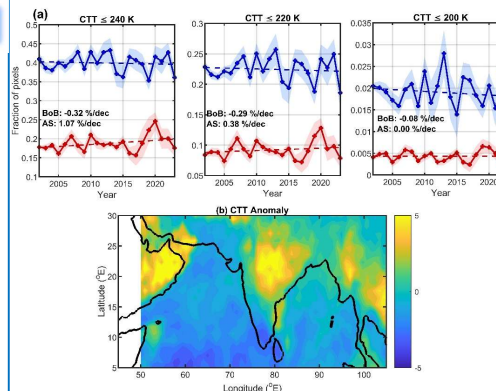
Changes in the total and cyclone lightning activity



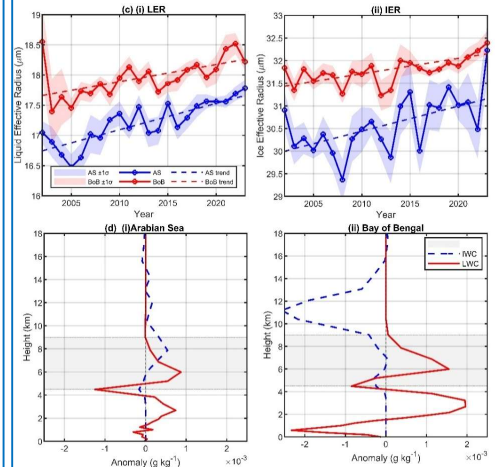
Thermodynamic Changes over the NIO



Changes in Deep Convection and Cloud Microphysics



Changes Cloud Microphysics



Summary

- Lightning changes over the North Indian Ocean are basin-dependent, with localized enhancement over the Arabian Sea and weaker/reduced changes over the Bay of Bengal.
- Cyclone-associated lightning expanded more over the Arabian Sea, indicating stronger offshore electrified convection during recent years.
- CAPE, colder cloud tops, and enhanced mixed-phase ice support stronger convective development over the Arabian Sea.
- The results highlight an emerging AS–BoB contrast, important for cyclone electrification, offshore hazards, and regional climate variability.

Acknowledgments

Authors express their gratitude to Director, IITM for his support for this study.

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