ROLE OF OCEAN PARAMETERS IN MODULATING TROPICAL CYCLONE INTENSITY AND STRUCTURE

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Introduction

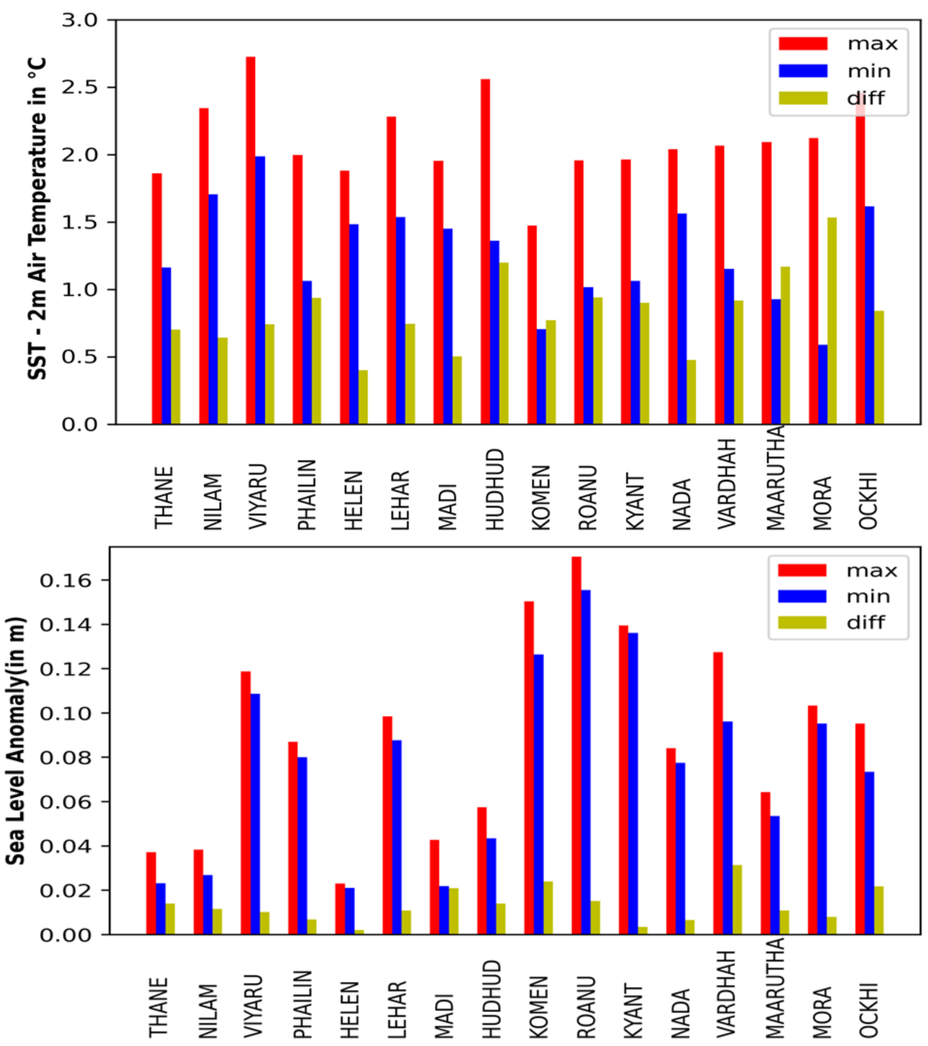
Bay of Bengal exhibits distinct cyclone characteristics, inflicting severe impact particularly along the east coast of India. With the frequency of cyclones on the rise, understanding oceanic parameters during cyclogenesis has paramount significance. This study investigate cyclone structure and discretizes it into 4 regions corresponding to its strength and intensity. This is done employing fractal dimensions to estimate sectorial intensity of the cyclone. We analyze the characteristics of the underlying ocean corresponding to each sector. Key parameters including Sea Level Anomalies (SLA), Sea Surface Temperature (SST) variations, Wind Speed, and Net Heat Flux (NHF), are considered for this aiming to unravel the intricate relationship between the ocean and cyclone structure. The study thereby aims in advancing our predictive capabilities and disaster management strategies.

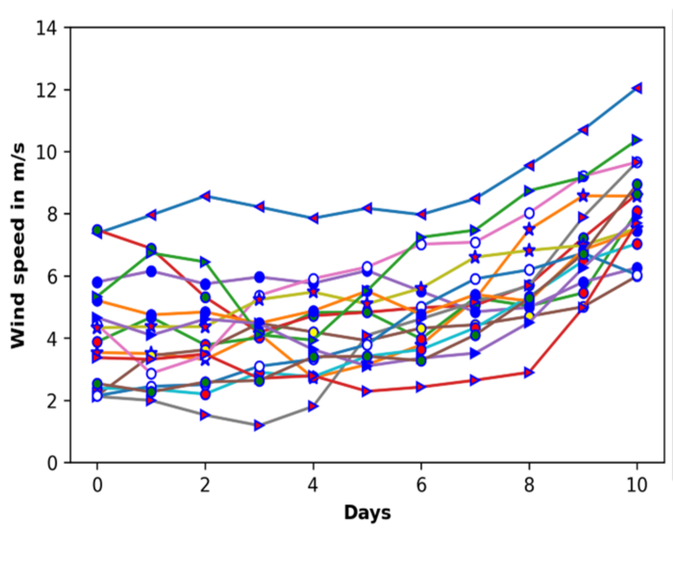
Data

- Cyclone best track data from IMD.
- INSAT-3DR Rainfall estimates
- Sea Level Anomaly (SLA), Sea Surface Temperature (SST), Air Temperature at 2m height (T_air) and wind speed is taken from ERA-5 6 Hourly Reanalysis data.
- Net Heat Flux (NHF) is obtained from J-OFURO3 v 1.1 provided by APDRC.

Methodology

- Initially we considered a 10°x10° box around the location of cyclogenesis for several cyclone cases (2011-2017) and analyzed the ocean parameters including SLA, SST−T_air, wind speed, and NHF datasets in that zone.
- This exercise provides an overview of thresholds of various ocean parameters during the cyclogenesis over Bay of Bengal .
- Based on cyclone centre location, INSAT-3DR rainfall data is used to determine asymmetry of the cyclone using box imposition technique and Fractal dimension such that a cyclone is divided into 4 sectors
- For each sector we also analyse met-ocean parameters SLA, SST and air temperature to look for any correlation with the asymmetry observed in the cyclone.





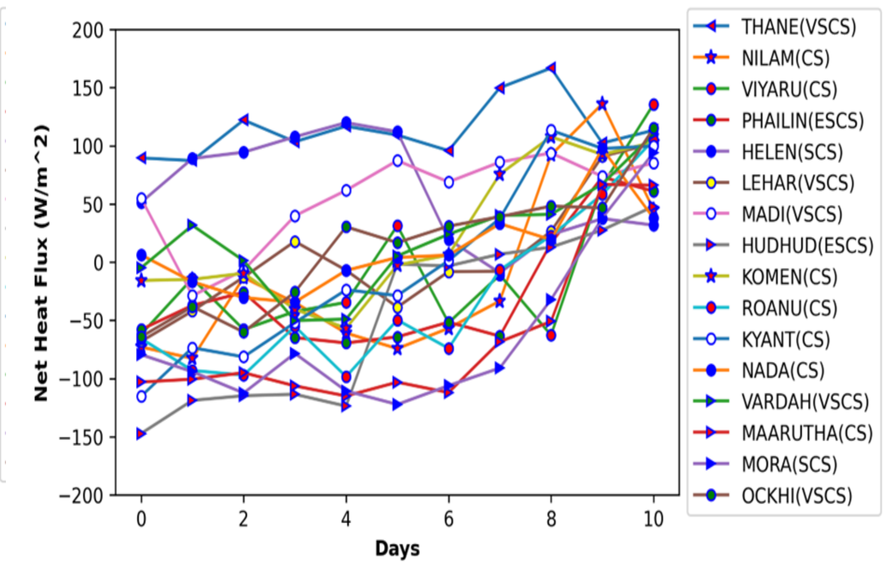
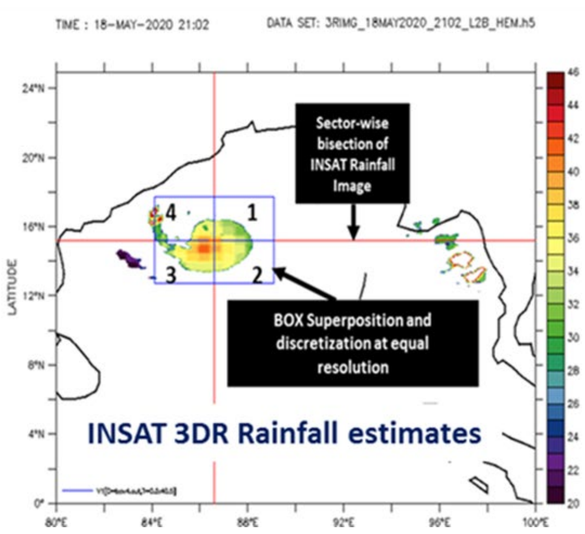
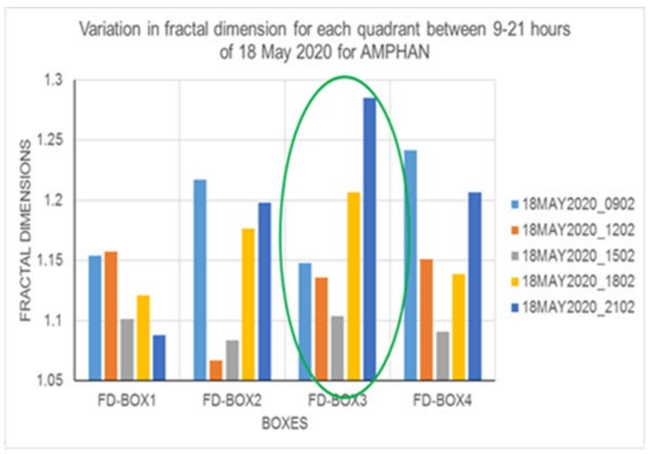


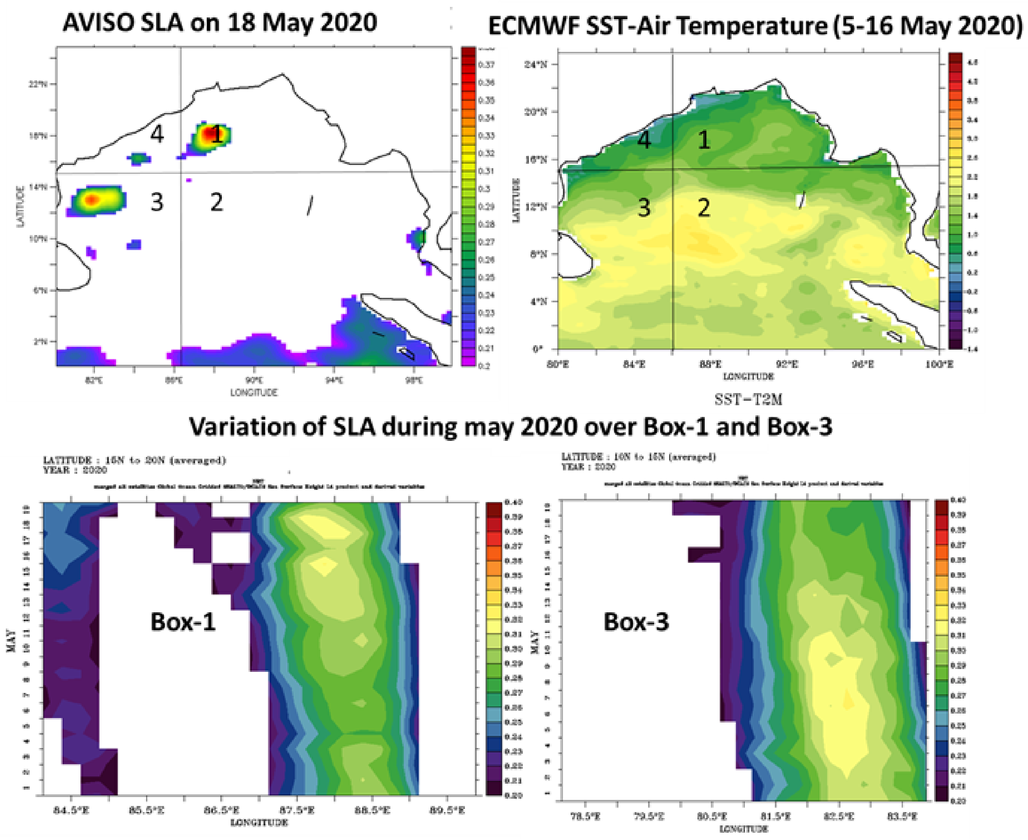
Figure -1 Time series of average SST-T air. SLA, Wind speed and Net heat flux for Cyclones (2011-2017)

Hence SST-Air temp ≥ 1°C and SLA ≥ 2cm and a very lower wind speed prior to cyclone is a common observation.

Now for each cyclone, based on its centre location, we divide the underlying ocean into 4 sectors and identify the sector with most potential. This is done using FRACTAL DIMENSION. Once the sector is identified we look for ocean parameters that can possibly impact cyclone structure. Typical example of AMPHAN is given below.







- **Amphan rainfall shows sector 3 as most strong sector.**
- **However, SLA on the day of consideration (18 May 2020) indicated that both sector 1 and 3 are equally strong.**
- **However, analysis of time series of SLA for full month of May over sector 1 and 3 show Sector -3 was warmer from much longer period as compared to sector -1 or 2.**

CONCLUSION

- Depressions and cyclones in the Bay of Bengal exhibit consistent patterns in SLA, indicating significant vertical ocean surface displacements (0.5 - 3 cm) prior to the event.
- NHF plays a crucial role during cyclogenesis, with positive values aiding cyclone growth and intensification, showcasing its significance. The air sea temperature gradient also has a role to play.
- A calm wind is always a boon for air sea interaction and cyclogenesis.
- Oceans plays a crucial role in modulation of cyclone structure.
- However, we need to consider several days of ocean state prior to cyclogenesis in order to understand its role completely.

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