Impact of Different Ocean Conditions Present in the Bay of Bengal on Coupled TC Intensity Prediction

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1. Introduction

Experiments are performed to study the impact of oceanic conditions over the Bay of Bengal on TC intensity predictions. Idealized experiments are performed using an experimental version of the HWRF coupled TC prediction system coupled to the Hybrid Coordinate Ocean Model (HYCOM). The atmospheric model is initialized by an idealized vortex with background conditions highly favorable for intensification.

Climatological experiments are performed to document the sensitivity of predicted maximum storm intensity to climatological mean ocean conditions representative of three different subregions of the Bay of Bengal during both the pre- and post-monsoon seasons. Maximum intensity is compared to both SST and enthalpy flux averaged beneath the inner core region of the storms.

Extreme condition experiments are also performed that are representative of unusually cold (cold eddy) and warm (warm eddy) conditions to document the resulting large impact on storm intensity

2. Design of Climatological Experiments

- Experimental HWRF model
  - Operational atmospheric model
  - Coupled to HYCOM ocean model
- Initialization
  - Uniform background atmospheric sounding with embedded idealized vortex
    - Highly favorable for intensification
  - Uniform ocean over entire Bay of Bengal with initial T, S profiles representative of average conditions over the entire bay plus three sub-regions, for both pre- and post-monsoon seasons (8 experiments)
    - Three sub-regions: north, central, and south bay
  - All storms initialized at the same central bay location
- All storms follow similar tracks, drifting to the NW at ~1.5 m/s
- Figure 1 illustrates the experimental domains and initial T, S profiles

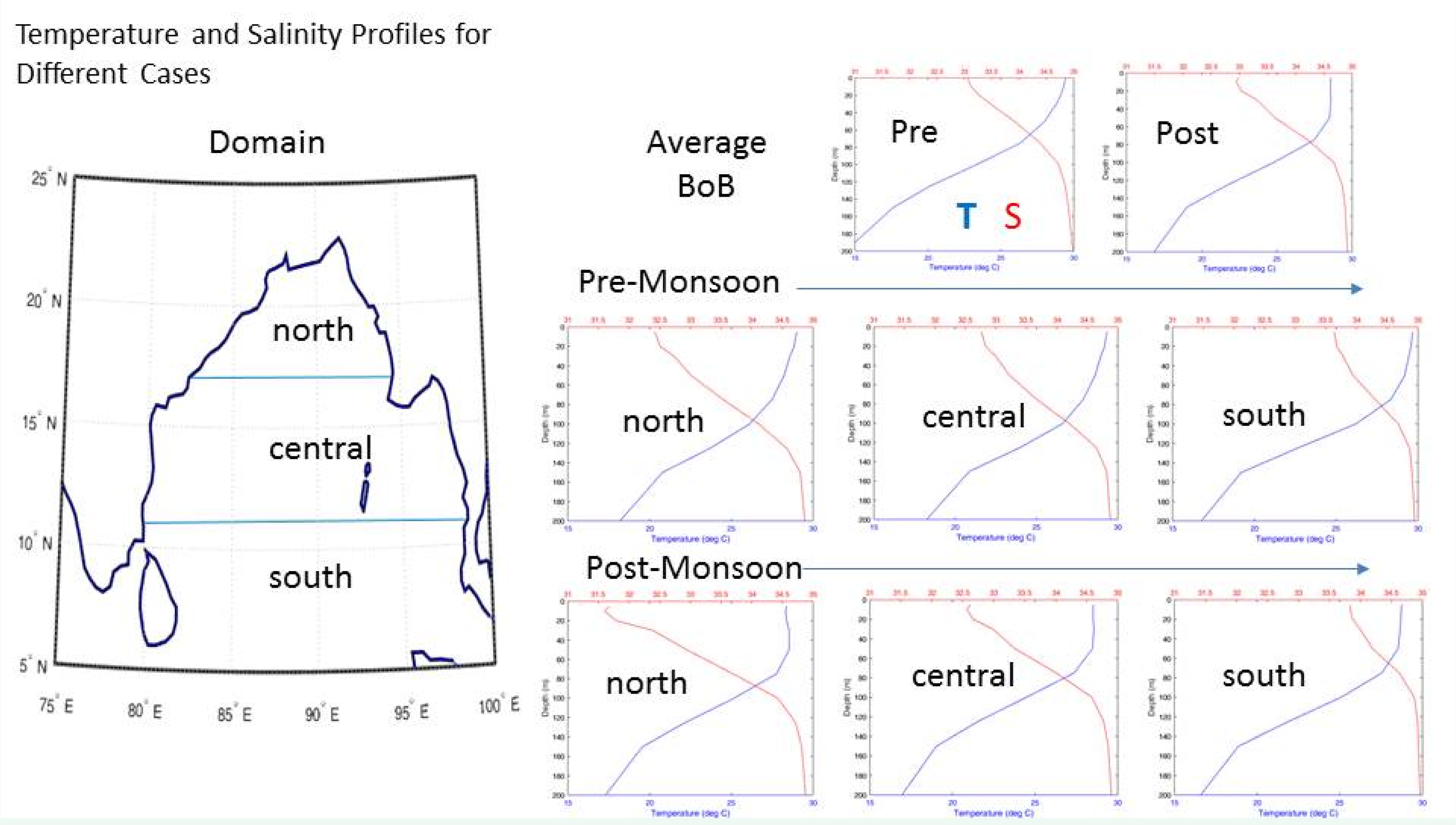

Figure 1. Bay of Bengal, showing the three sub-regions (left) and the initial T, S profiles for all eight experiments (right).

3. Intensity Evolution in Climatological Experiments

- Figures 2 and 3 illustrate intensity evolution for the eight experiments.

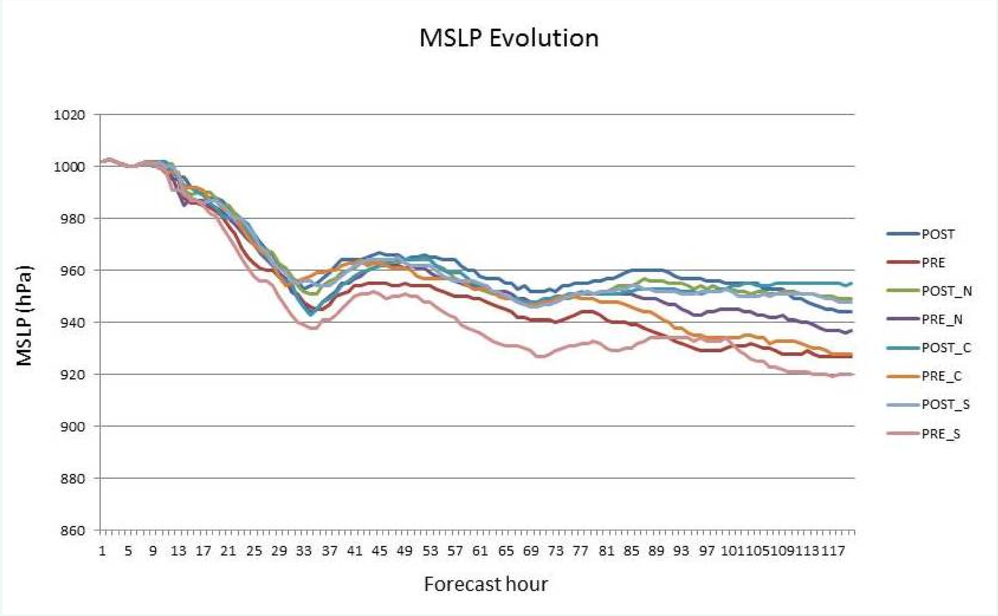

Figure 2. Evolution of minimum central pressure in the eight experiments.

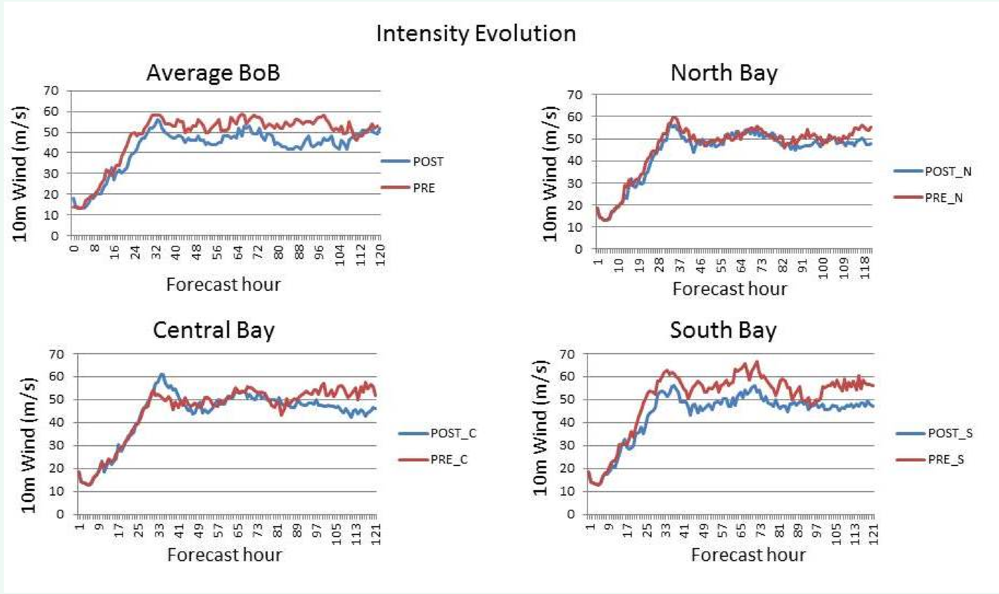

Figure 3. Evolution of maximum wind speed in the eight experiments.

4. Ocean Coupling Impact on Maximum Intensity

- Figure 4 presents minimum central pressure along with SST and enthalpy flux averaged over the inner-core region, all temporally averaged over forecast hours 36-84
- Scatter plots in Figure 5 show tighter relationship between minimum central pressure vs. enthalpy flux than vs. SST.

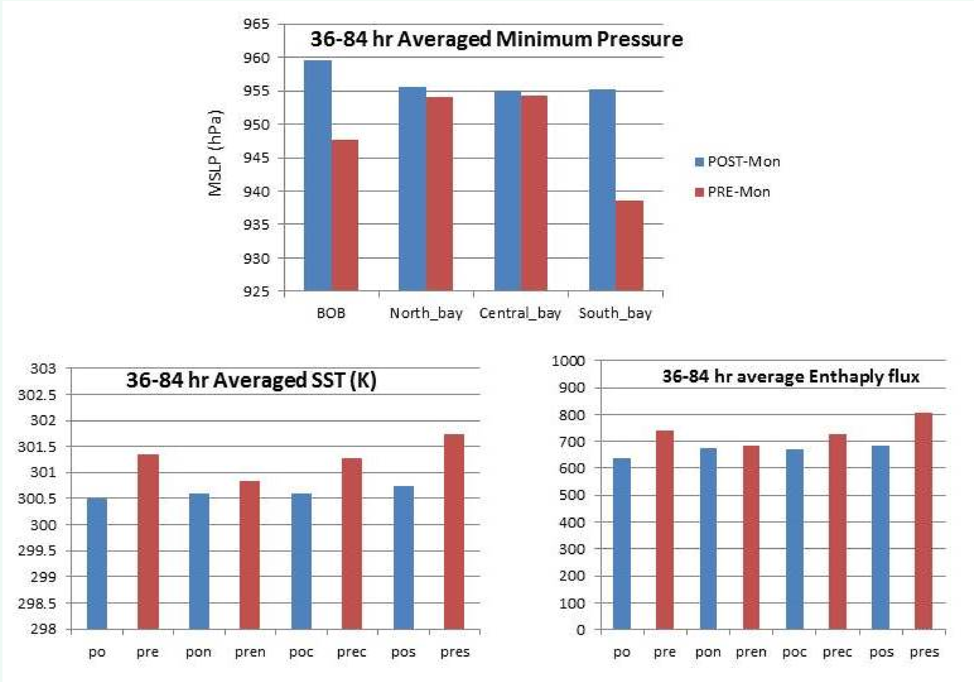

Figure 4. Minimum central pressure (top), SST averaged over inner core region (bottom left), and enthalpy flux averaged over inner core region (bottom right) for the eight experiments. All values are temporal averages over forecast hours 36-84.

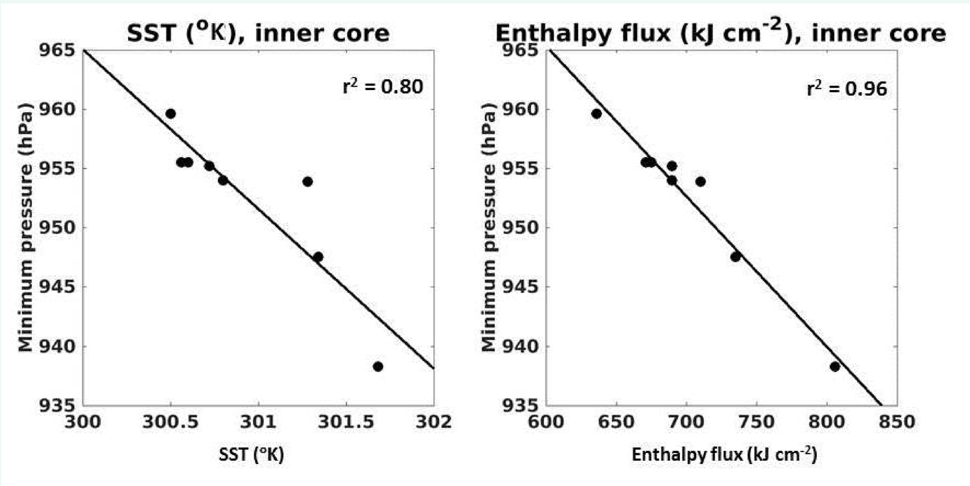

Figure 5. Scatter plots relating minimum central pressure to SST (left) and enthalpy flux (right) for the eight experiments.

5. Extreme Condition Experiments

- Experimental setup
  - Fixed salinity profile
  - Two temperature profiles representative of ocean conditions present in cold-core cyclones and warm-core anticyclones
- As expected, extreme ocean conditions exert a much larger impact on predicted intensity than the regional climatological differences

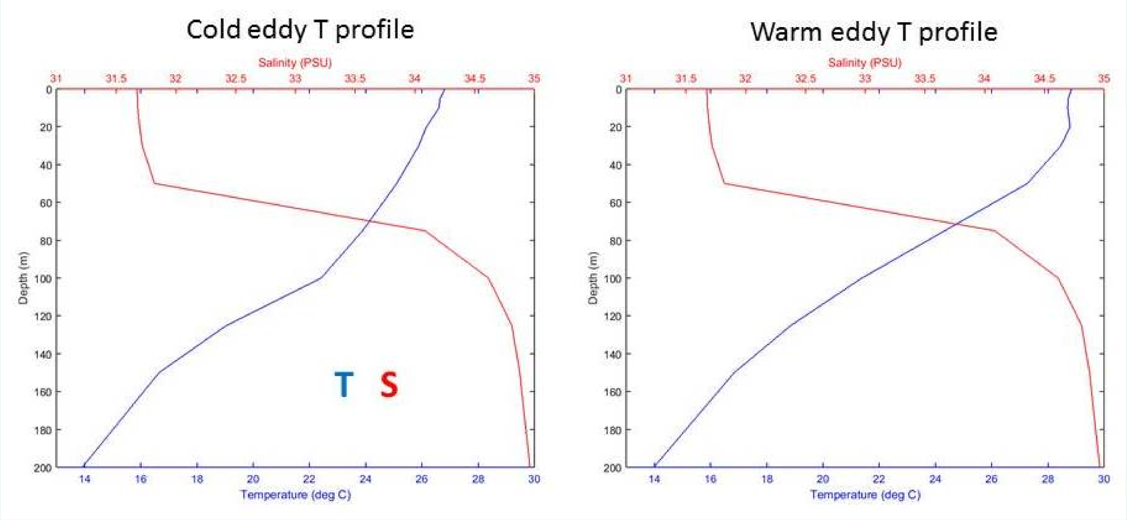

Figure 6. Initial T and S profiles for the two extreme condition experiments.

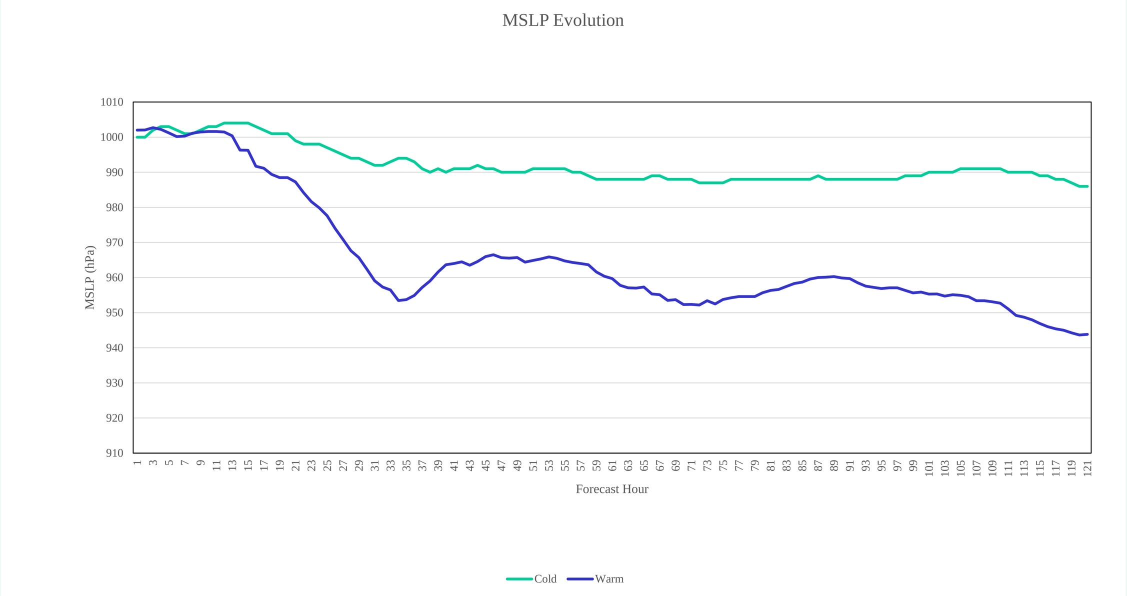

Figure 7. Evolution of minimum central pressure for the two extreme condition experiments.

6. Summary

- Climatological experiments
  - Although climatological ocean conditions are highly favorable for intensification in all eight cases, they still produce modest differences in predicted maximum intensity
  - Maximum intensity is strongly related to SST averaged over the inner core region of storms, but is more strongly related to enthalpy flux averaged over the same inner core region
    - Although based on small sample size, this result demonstrates that all physical processes that control enthalpy flux (SST, wind speed, atmospheric temperature and humidity) are important for controlling storm intensity
- Extreme condition experiments
  - Realistic ocean conditions representative of cold-core cyclones and warm-core anticyclones produce a large difference in predicted intensity (pressure difference > 30 hPa

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