SEA SURFACE TEMPERATURE RESPONSE TO TROPICAL CYCLONES IN THE TROPICAL WESTERN NORTH PACIFIC

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Background

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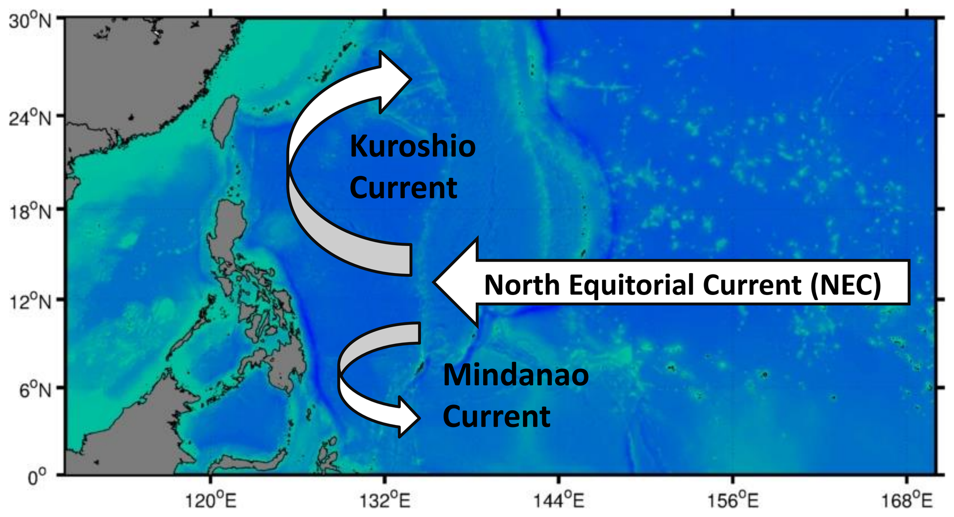
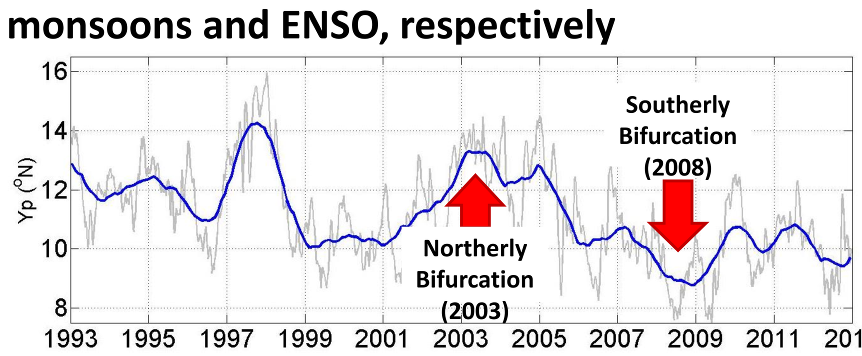
- **North Equatorial Current (NEC)** bifurcates into the **Kuroshio Current** to the north and **Mindanao Current** to the south.



- **Displacement** and **intensity** of NEC bifurcation varies **seasonally** and **interannually** driven by local monsoons and ENSO, respectively



NEC Latitude Bifurcation displacement derived from SSHA Anomaly (Yp) from 1993 to 2012

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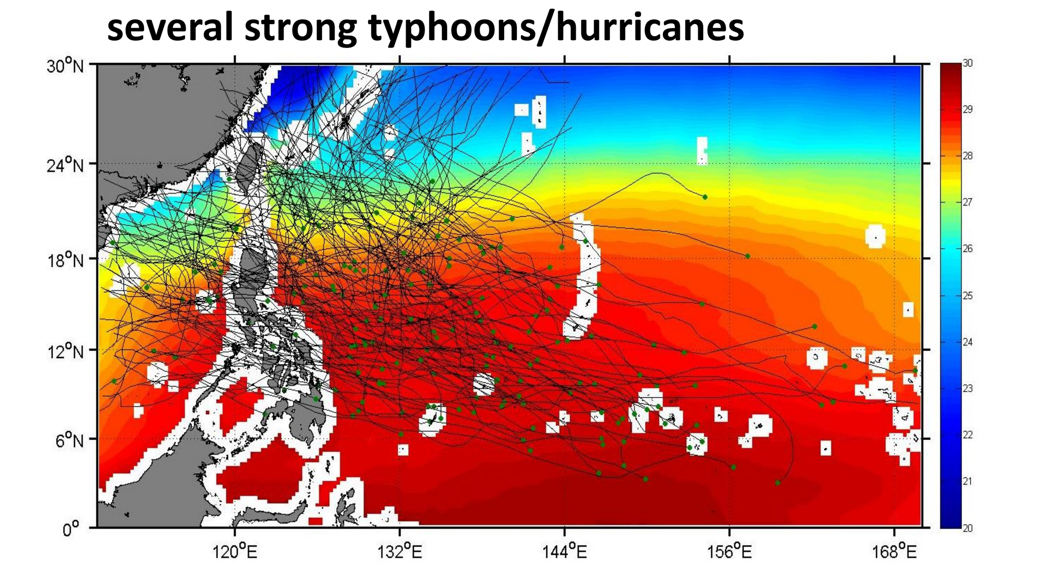
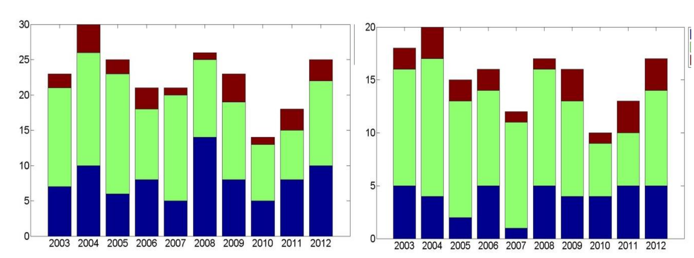
- The area east of the Philippines in the Tropical Western North Pacific serves as an entry point to at least **15 tropical cyclones (TC) every year** including several strong typhoons/hurricanes



Regional map showing the tracks of tropical cyclones during the period 2003–2012, with green circles indicating where they are formed. The background color is the satellite-derived mean SST (℃) from 2003 to 2012.



Number of occurrences of Tropical cyclones affecting (Left) Western North Pacific (Right) Philippine Area of Responsibility (Blue- Tropical Storms; Green- Cat 1-4; Red- Cat 5)

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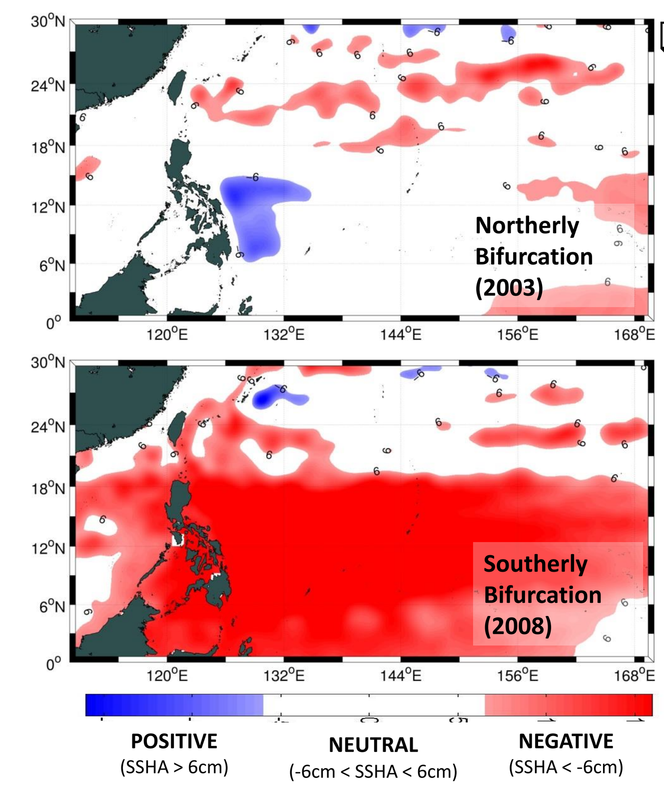
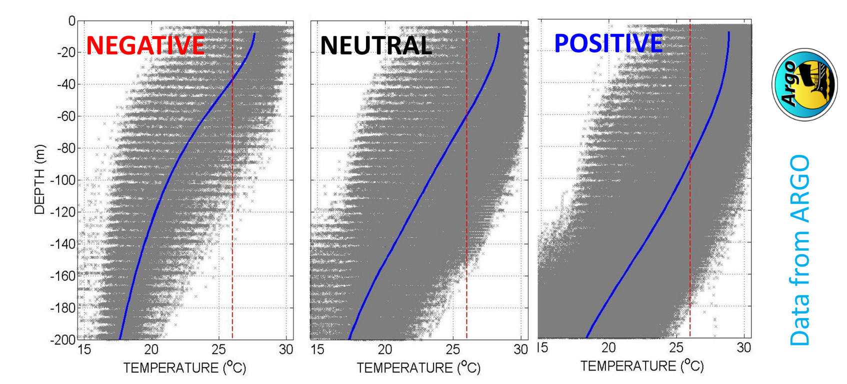


- Variability of the **NEC bifurcation latitude** may alter the source waters of the Kuroshio and modify the intensity of **oceanic features** and the **temperature field** and consequently, the **strength of the typhoons** and **upper ocean response.**

Mean Profiles for different Oceanic Features derived from ARGO Float Data (red line indicating the location of the D26, the depth of 26℃ isotherms)



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- Thermal response to tropical cyclones based on **local minima** and **recovery period** is necessary to **understand its role to TC intensification** and to estimate **associated thermal fluxes** due to the passage of TCs along the tropical Western North Pacific Region.

Interaction of the Tropical Cyclones and the Ocean with associated SST Response and role intensification depending on background thermal structure.

Objective

- To determine the **SST response** for **different oceanic features** and its association with the **migration of the NEC bifurcation latitude**.

Data and Methods

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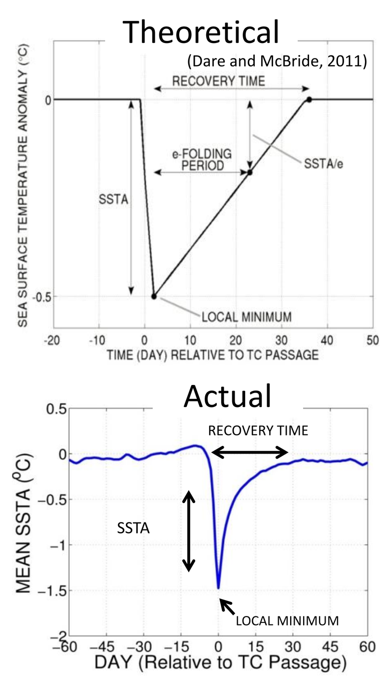
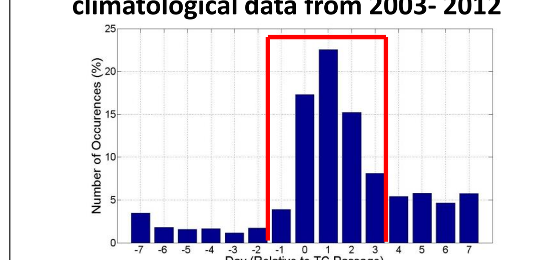


Observation Data

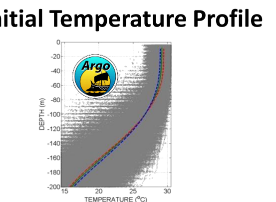
Typhoon Tracks → Daily SST Data (TMI-AMSRE) → Compute for SSTA based on daily climatological data from 2003- 2012



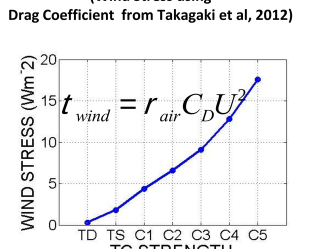
- Local Minimum, Induced Maximum SSTA
- Recovery Time

Numerical Experiments

Initial Temperature Profile



Input Momentum Fluxes (Wind Stress using Drag Coefficient from Takagaki et al, 2012)



NUMERICAL EXPERIMENTS

Global Ocean Turbulence Model (GOTM) (Umlauf, 2005)

Turbulence Equation (Cheng et al, 2002)

Shortwave Radiation (200 W·m⁻²)

- Post Storm Temperature Response
  - SSTA Local Minimum
  - Temperature Profiles

Results and Discussion

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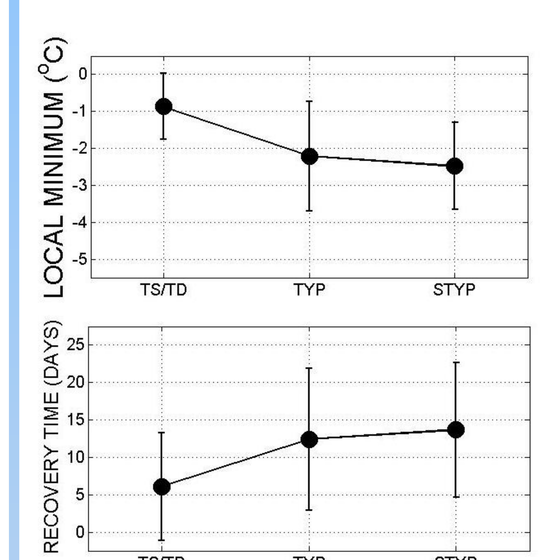
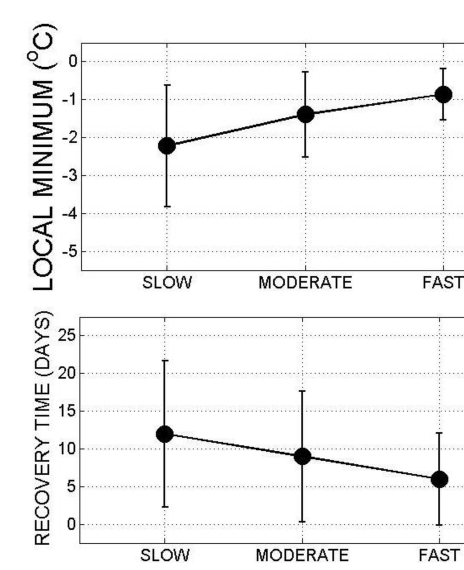


← TC Strength *(based on Saffir-Simpson Hurricane Scale)*

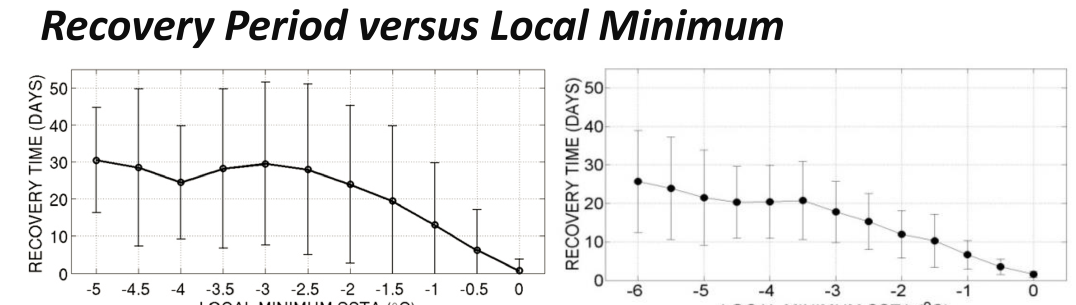
SST Response based on Local Minimum (top) and Recovery Period (bottom) on different TC Strength; TS/TD – Tropical Storms and Depression; TYP – Category 1 to 3; STYP – Category 4 to 5

TC Translation Speed → *or forward speed of the TC*

SST Response based on Local Minimum (top) and Recovery Period (bottom) on different TC Translation Speed; 0 to 4 m/s – Slow; 4 to 8 m/s – Moderate; and Fast - > 8 m/s



Recovery Period versus Local Minimum



Relationship of SST Cooling based on Local Minimum with Recovery Period based on (left) Global dataset (1981-2008) (Dare and McBride, 2011) and this study (right) Tropical Western North Pacific (2003-2012)

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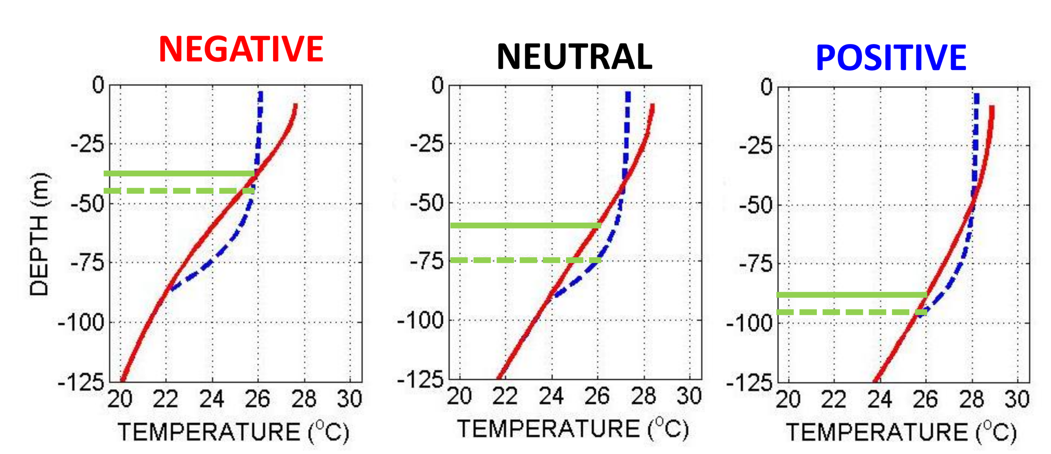
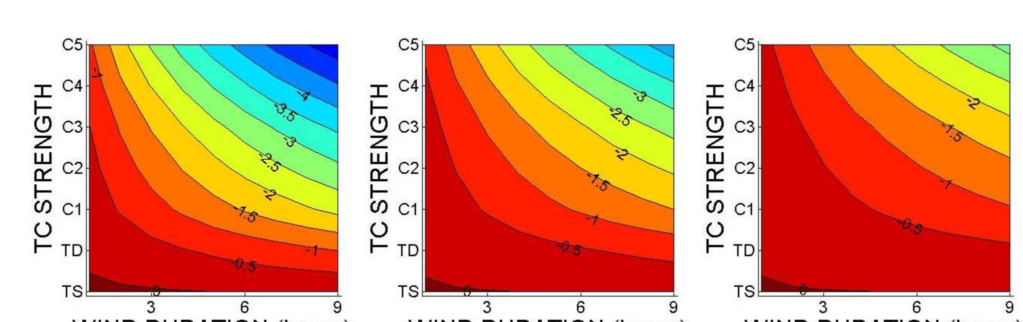
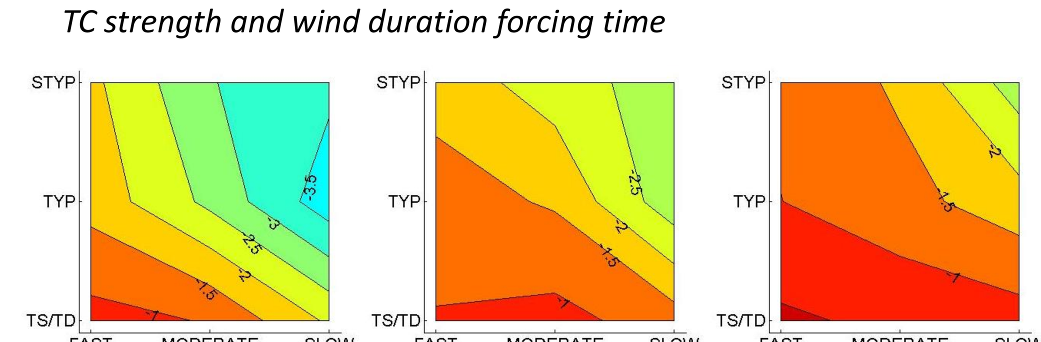
Temperature Response with Different Oceanic Features



SST profile before and after passage of Category 3 typhoon with a moderate Translation Speed (Wind Forcing = 3 hours) at different background profiles (red line are pre typhoon profile; blue broken line are post typhoon profiles; green lines are the location of D26)



SSTA response (local minimum) from numerical experiments by varying TC strength and wind duration forcing time



SSTA response (local minimum) from observation data from varying TC strength and translation speed

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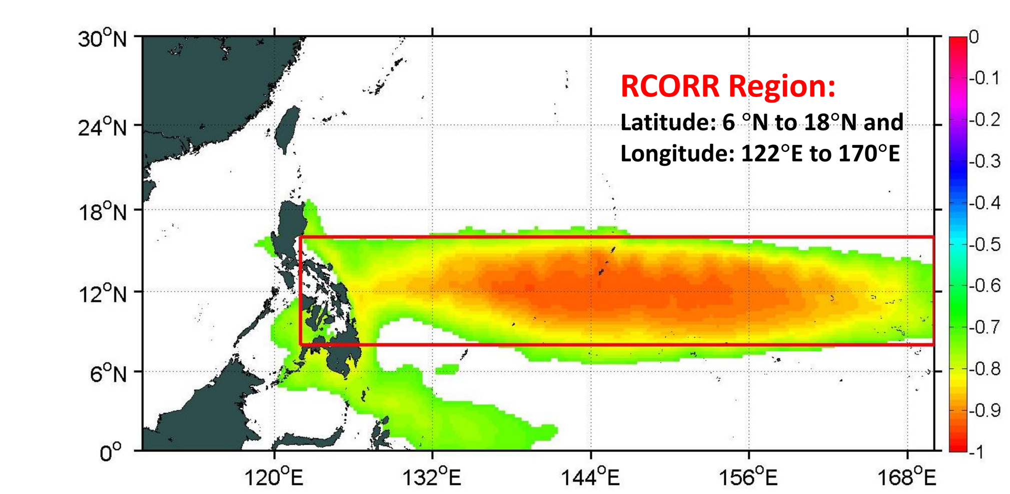
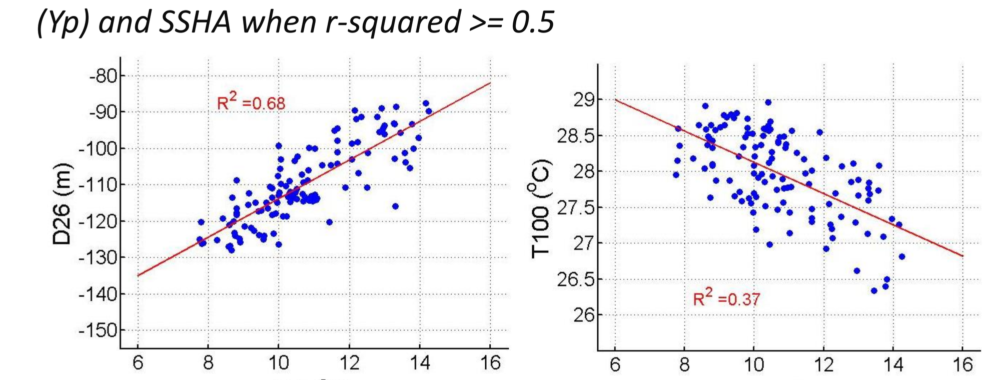
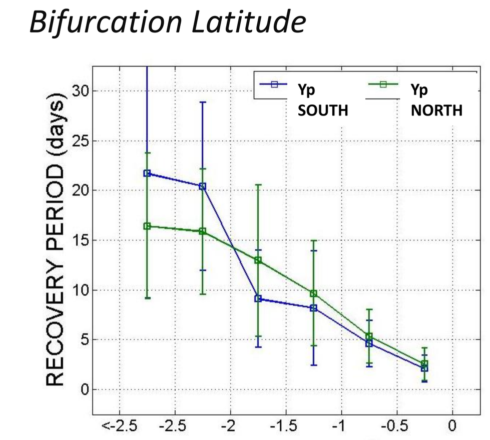
Temperature Response with NEC Bifurcation Latitude



Spatial distribution of the correlation r of the NEC bifurcation latitude (Yp) and SSHA when r-squared >= 0.5



Thermal Characteristics along RCORR based on monthly mean D26 (left) and Depth averaged temperature up to 100 m (T100) (right) versus NEC Bifurcation Latitude



- **No significant difference** based on SSTA Response between a Northerly and Southerly Bifurcation in the RCORR Region

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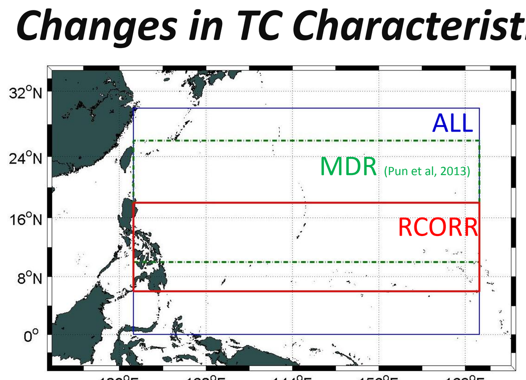
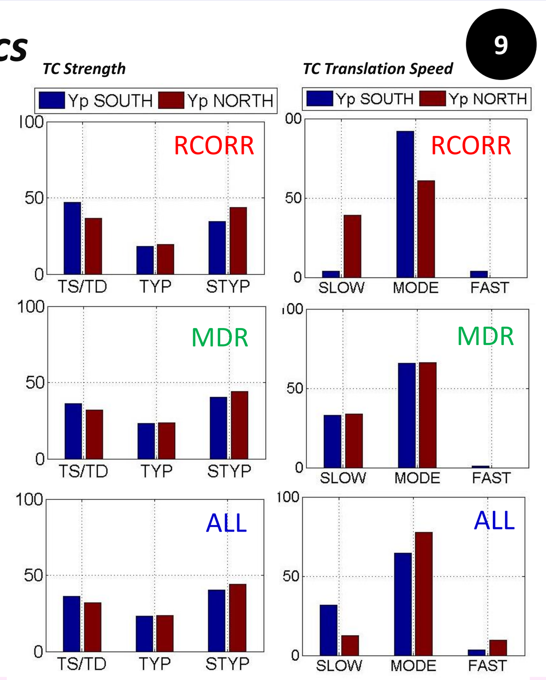
Changes in TC Characteristics





- Occurrence of more moderate moving TC during Southerly Bifurcation along RCORR

Summary and Conclusion

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Negative Features	Positive Features
Shallow D26	Deep D26
Stronger cooling Longer Recovery	Suppressed cooling Fast Recovery
SST cooling (induced local minimum) is enhanced by • Increasing TC Strength • Slower TC Translation Speed	

Southerly Bifurcation	Northerly Bifurcation
↑ Positive features ↓ Negative and Neutral Features	↓ Positive Features ↑ Negative and Neutral Features
Deep D26 Warmer T100	Shallow D26 Cooler T100
• Not significant difference on SSTA Response	
↑ Moderate moving TC	↑ Slow moving TC

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