# Impact of strong ENSO on regional tropical cyclone activity in a high-resolution climate model

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Tropical cyclones (TCs) are one of the deadliest natural disasters causing intense damage to human life and property. The El Niño Southern Oscillation (ENSO) phenomenon has been shown to exhibit considerable influence on TCs in the North Pacific and North Atlantic Oceans through changes in the thermodynamic factors and large-scale circulation. Climate change studies suggest that ENSO may undergo significant changes in the next century with an increase in extreme El Niño and La Niña events in response to increased greenhouse gas concentrations. Thus, it is important to examine the response of regional TCs to changes in the state of the tropical Pacific Ocean either caused by climate change or other factors.

Further, evaluation of the ability of current generation coupled climate models in simulating these changes in the ENSO-TC relation to the changes in the strength of ENSO in different ocean basins could advance our ability to predict the variations in TCs using these models. This study is in line with NOAA's mission, which involves understanding and modeling of the physical dynamics of high impact events (such as tropical cyclones) and the effect of climate change on such events.

We make use of long simulations from GFDL FLOR model (which has relatively high-resolution in the atmosphere) and a flux-adjusted version of FLOR (FLOR-FA) as a tool to investigate the sensitivity of TC activity to the strength of ENSO events and associated mechanisms. The key findings from this paper are,

1. We show that TCs exhibit a non-linear response to the strength of ENSO in the tropical eastern North Pacific (ENP) but a quasi-linear response in the tropical west North Pacific (WNP) and tropical North Atlantic. Specifically, stronger El Niño result in disproportionate inhibition of TCs in the east North Pacific and North Atlantic, and lead to an eastward shift in the location of TCs in the southeast of the west North Pacific. However, the character of the response of TCs in the Pacific is insensitive to the amplitude of La Niña events (Fig. 1).

2. The eastward shift of TCs in the southeast of the WNP in response to a strong El Niño is due to an eastward shift of the convection and of the associated environmental conditions favorable for TCs (Fig. 2).

3. The inhibition of TC activity in the ENP and Atlantic during El Niño is attributed to the increase in the number of days with strong vertical wind shear during stronger El Niño events (Fig. 2).

These results are further substantiated with coupled model experiment.

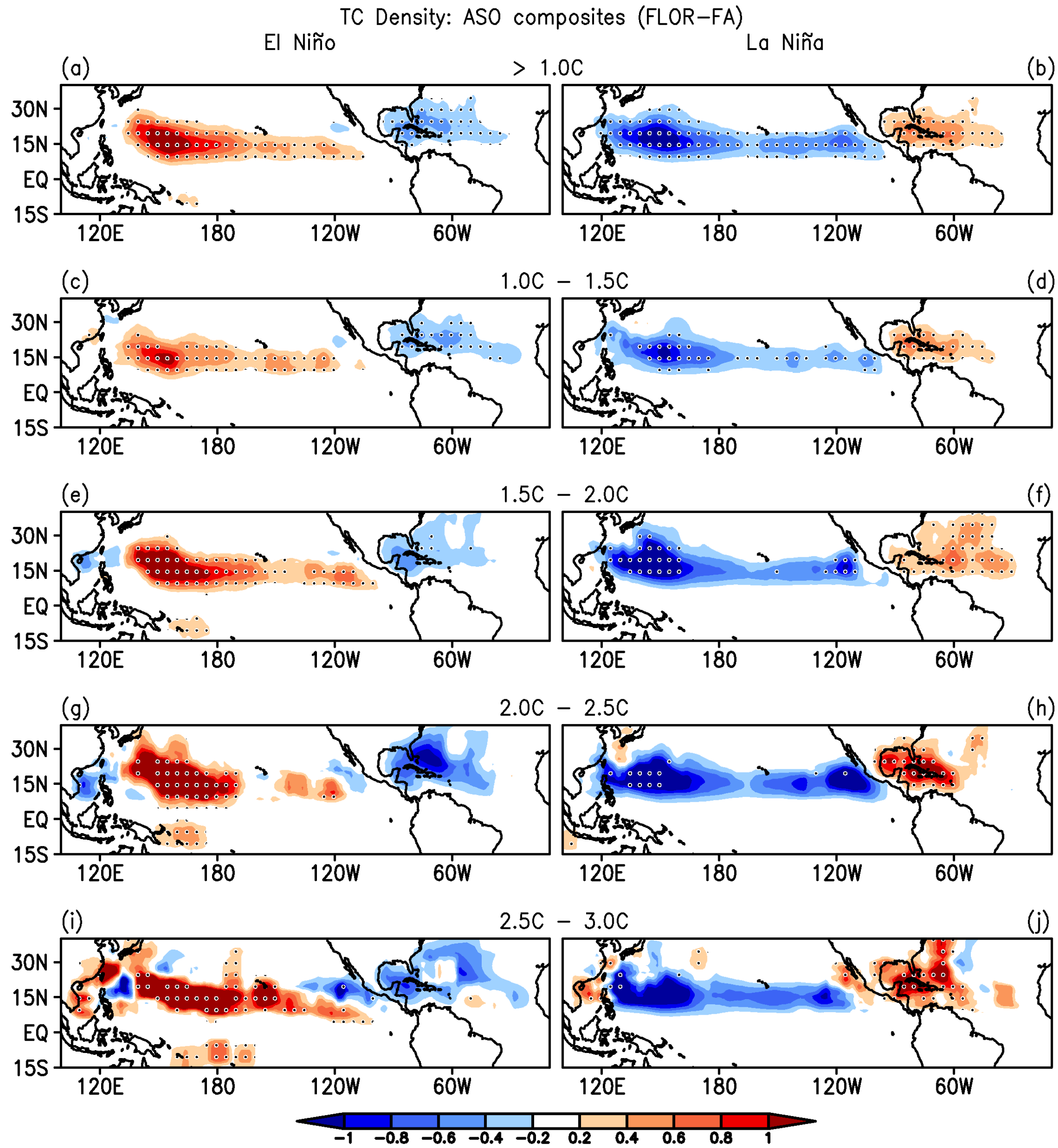


Figure 1: ASO composites of TC density for FLOR-FA based on Niño3.4 (a) greater than 1°C (c) between 1.0°C to 1.5°C (e) between 1.5°C to 2.0°C (g) between 2.0°C to 2.5°C (i) between 2.5°C to 3.0°C and (k) between 3.0°C to 3.5°C for El Niño. La Niña composites are based on Niño3.4 (b) less than −1.0°C (d) between −1.0°C to −1.5°C (f) between −1.5°C to −2.0°C (h) between −2.0°C to −2.5°C (j) between −2.5°C to −3.0°C and (l) between −3.0°C to −3.5°C. The number of years over which composites are based is noted in Table 2. The dotted regions indicate 5% significance level.

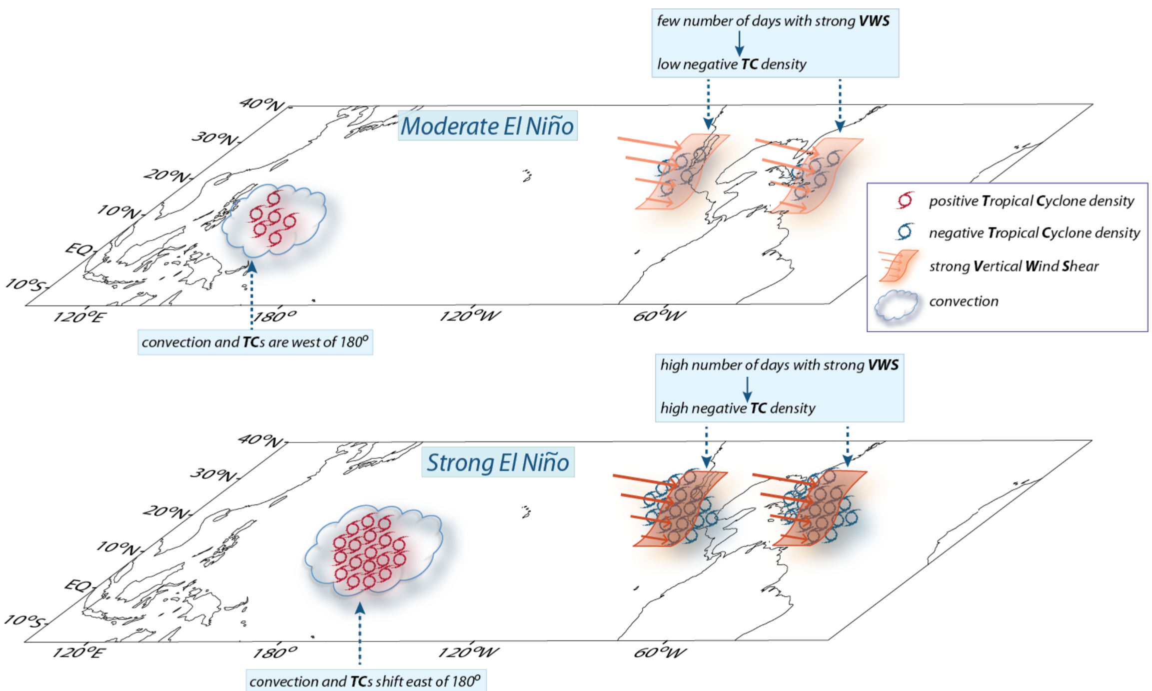


Figure 2: Schematic showing the effect of strong and moderate El Niño on TC activity.