What is the effect of the topography of Luzon, Philippines on the characteristics and precipitation of Tropical Cyclones?

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WRF Modeling of Tropical Cyclones (TC)

Simulated 8 TCs making landfall in Luzon

Weather Research and Forecasting (WRF) model

- ERA5
- Two (2) nested domains: 10x10km, 5x5km (Figure 1)
- Initialised 96 hours before TC landfall, ended at 24 hours after landfall.

Topography sensitivity experiments (Figure 2)

- Control
- Reduced (0.5x Cordillera Mountain Range, or CMR)
- Enhanced (2.0x CMR)

Figure 1 . WRF domain configuration of two domains, with the outer domain at 10km resolution and the inner domain at 5km.

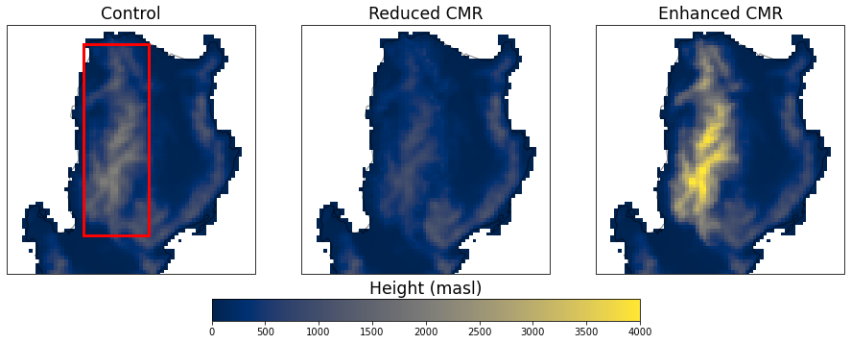


Figure 2. The topography of (a) the Control case, (b) the Reduced case (0.5x CMR), and (c) the Enhanced case (2.0x CMR) . The red box in (a) encloses the general region of CMR.

Results: 24 hour accumulated precipitation difference between Enhanced and Control

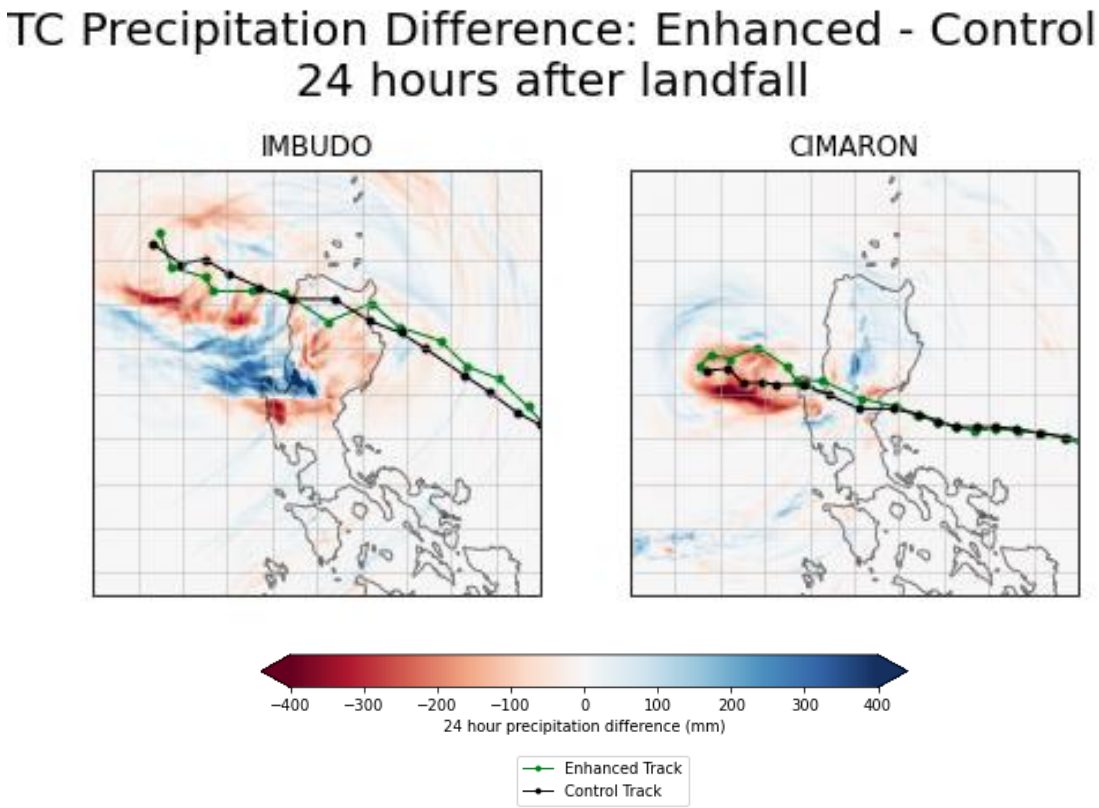


Figure 3. The difference in accumulated 24 hour precipitation starting from landfall between the Enhanced and Control simulations for the 2 representative TCs: IMBUDO (north tracking) and CIMARON (south tracking). TC tracks are plotted every 3-hours for Control (black) and Enhanced (green).

Results: Difference in TC intensity and mean precipitation over CMR every 3 hours.

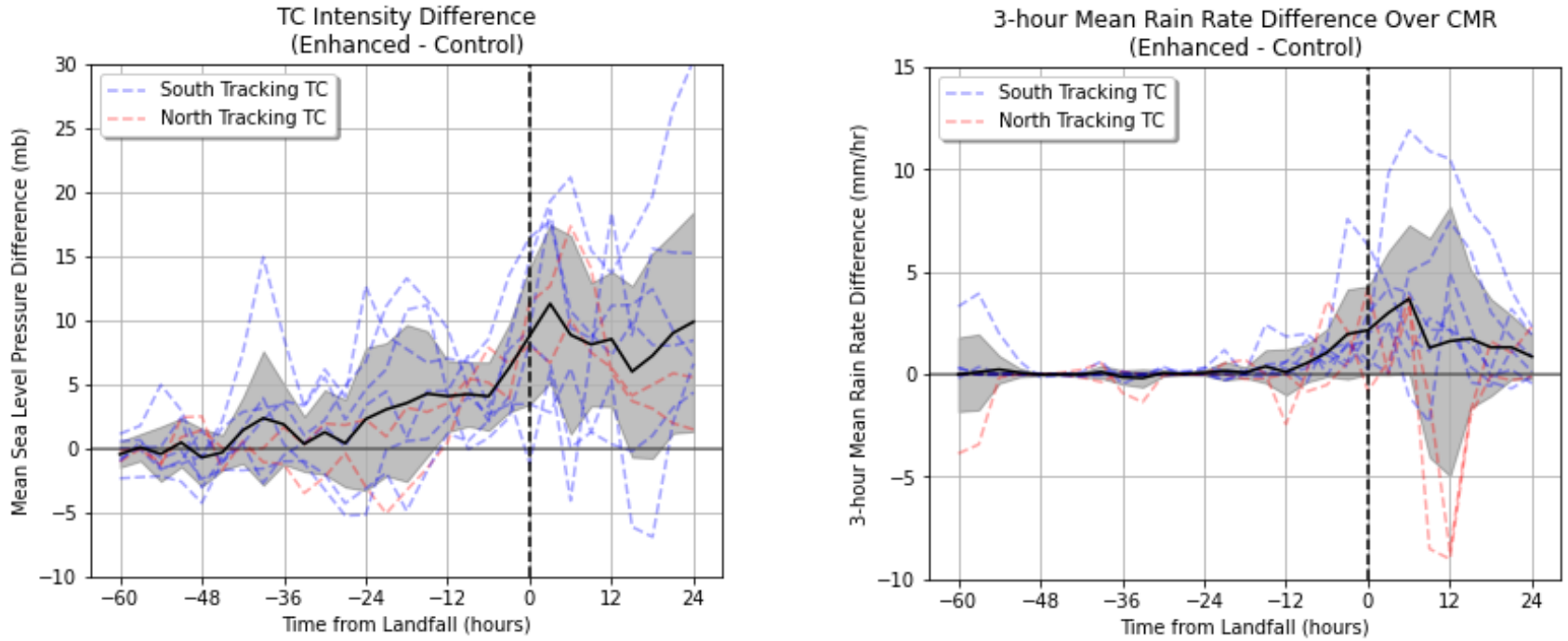
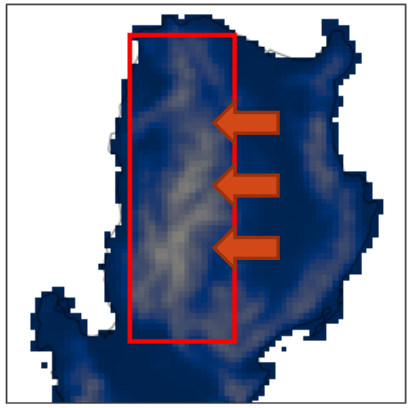


Figure 4. 3-hourly time series plots of the difference in (a) TC intensity and (b) TC rain rate between Enhanced and Control. TC intensity was taken from the mean sea level pressure at the centre of the TC, while 3-hour mean rain rate was taken from the average rain rate within the boxed region in Figure 1a.

Results: Precipitation compared to TC Winds and Mountain Slope

Compared Rain Rate with product of incoming easterly TC winds (u_w) and CMR slope (h/dx).

- Every 3 hours, between 24 hours before and 24 hours after landfall
- For all 3 CMR heights



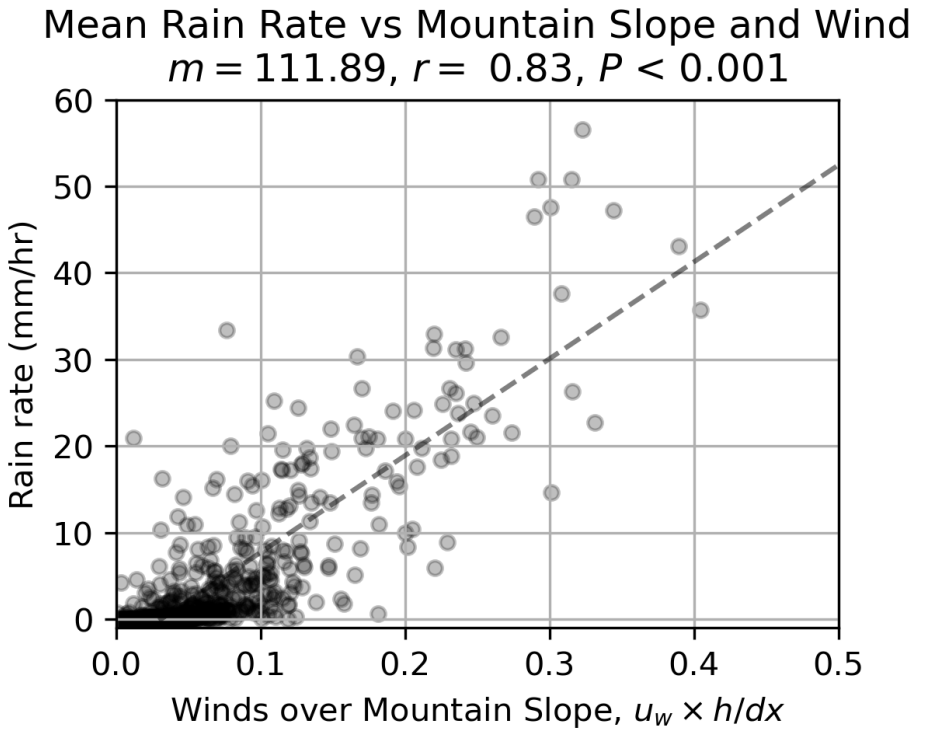


Figure 5. TC rain rate compared to the product of TC winds and mountain slope. For each TC for Control, Reduced, and Enhanced, values for rain rate, slope, and wind speed were taken in the eastern region of CMR from 24 hours before landfall until 24 hours after landfall for every 3-hours. The dashed line shows the least-squares regression slope for each relationship. The Pearson correlation coefficient (r) and p value (p) are listed above each plot.

Summary

Numerical experiments of eight Tropical Cyclones (TC) making landfall over Luzon, Philippines show that as the height of Cordillera Mountain Range (CMR) increases, precipitation over mountain range increases for most TC simulations.

However, taller CMR heights also weaken TCs after they make landfall.

For the eastern regions of CMR, precipitation along the mountain range increases for steeper mountain slopes and stronger perpendicular TC winds.

Preliminary findings show that sign and extent of precipitation change depends on whether a TC tracks north or south of Luzon.

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