Spatio-temporal and Sensitivity Analysis for Tropical Cyclone Maintenance and Intensification within the Philippine Archipelago

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ABSTRACT

A tropical cyclone (TC) is a synoptic-scale weather phenomenon characterized by a quasi-axisymmetric flow about a low-pressure center. The decrease in central pressure results from the constant uplifting of moisture from the warm ocean surface where TCs form. From a combination of several environmental factors, a tropical cyclone can move into land and lose connection to the ocean surface. The loss of moisture source accompanied by the increased surface friction inland causes a disruption of both the TC convection and circulation, leading to the eventual dissipation of the system. Contrary to this theory however were several studies in the early 2000s which show several TCs were able to maintain strength and even reintensify inland. A global spatio-temporal analysis by Andersen and Shepherd in 2013 showed that TC Maintenance and Intensification (TCMI) occurred at different parts of the world 16 times from 1979 to 2008. Their analysis and various succeeding studies however focus only on continental TCs and TCs moving into archipelagos such as the Philippines in the Pacific Ocean or the Carribean islands in the Atlantic were not included. With the location of the Philippines squarely in the typhoon belt in the Pacific basin, the country is at high risk from direct TC impacts. Hence, a more accurate prediction of TC intensity over the country that can account for TCMI would prove beneficial for TC forecasting and risk assessment.

In this study, I perform a similar spatio-temporal analysis for TCMI occurrence for the Philippine archipelago using TC track, wind, and pressure data from the International Best Track Archive for Climate Stewardship (IBTrACS) and reanalysis data from the 5th generation European Center for Medium-range Weather Forecast Reanalysis (ERA5). I aim to isolate TCs that traverse the country and maintain or intensify within the archipelago.

Knowing which TCs underwent TCMIs, an assessment of TC pre-landfall and post-landfall characteristics would be performed to correlate any likelihood of TCMI occurrences. Furthermore, using reanalysis data, environment variables pre-landfall such as latent and sensible heat fluxes and preceding precipitation would be accounted for to determine favorable conditions for TCMI in the country. In addition, I will be performing a sensitivity analysis of TCMI on surface characteristics for Luzon and Visayas using the Weather Research and Forecast (WRF) model. The variables for consideration are the land cover type in Luzon and the presence of inland seas within Visayas. As such, the appropriate modifications to the geographic file for the WRF simulations will be performed.