THE INFLUENCE OF GLOBAL WARMING ON TROPICAL CYCLONE CHARACTERISTICS AND THEIR IMPACTS IN THE PHILIPPINES

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ABSTRACT

Tropical cyclones (TCs) are among the Philippines' deadliest and most damaging natural hazards, owing to high winds, heavy rain, and storm surge. Most climate models project a decrease in the frequency of TCs in the future due to global warming and climate change (CC), but a rise in the number of intense TCs as well as an increase in TC-associated rainfall globally and in the Western North Pacific (WNP) Basin. In the Philippines, estimates are broadly in line with global studies of TCs and CC, which predict a drop in TC frequency but a rise in the frequency of strong TCs and an increase in TC-related rainfall. These changes could result in further harm in the future. As a result, a greater knowledge of how TCs might change in the future, particularly the most devastating events, is critical. This study aims to analyze how the characteristics and potential impacts of the most damaging TC events in the Philippines might change under future climate conditions using a high-resolution limited area model and the pseudo-global warming technique.

The characteristics and damage potential of three of the most damaging TC events in the Philippines (Haiyan, Mangkhut, and Bopha) under future climate conditions were studied. Using downscaling and the pseudo global warming technique, we looked at how the TCs' track, speed, intensity, size, rainfall, and damage potential would change. Climate change deltas were derived from the latest Coupled Model Intercomparison Project Phase Six (CMIP6) Global Climate Models, and simulations were run using the Weather Research and Forecasting model. Simulating the three TCs under future warming scenarios results in minimal changes in the track, except when just surface variable perturbations are used, which results in northward shifts in the track, owing to the weakening of the Western North Pacific Sub-tropical High. We also found that, relative to the current climate conditions, future warming leads to more intense TCs (lower central pressure and higher maximum peak winds), particularly for Haiyan and Mangkhut, as well as more intense TC-associated rainfall for all TC cases, with varied magnitudes of change depending on the TC case. The differences in size and translation speed are small. Simulations without convective parameterization reveal similar changes in the projected TC intensity response's sign (increase), but differing signals of change in terms of size and speed (increase / decrease).

The findings also show that in the future, the more intense TC cases – Haiyan and Mangkhut – could cause considerably more damage. The increase in the cyclone damage potential ranges from ~1% to up to 37% in the far future under the SSP5-8.5 scenario, primarily due to the increase in maximum winds. TCs of such intensity and damage potential in the future will have serious implications with the increasing exposure and vulnerability in the Philippines to climate change risks.

Keywords: Tropical Cyclones, Philippines, Global Warming, Climate Change, Pseudo-Global Warming Technique, Cyclone Damage Potential