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Master of Science in Meteorology

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Combined Influences of PDO, ENSO, and QBO on tropical cyclone activity in the Western North Pacific

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ABSTRACT

COMBINED INFLUENCES OF PDO, ENSO, AND QBO ON TROPICAL CYCLONE ACTIVITY IN THE WESTERN NORTH PACIFIC

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Tropical cyclone (TC) frequency, genesis location, tracks, and accumulated cyclone energy trends and variability in the western North Pacific (WNP) were investigated during combined phases of Pacific Decadal Oscillation (PDO), El Niño-Southern Oscillation (ENSO), and Quasi-Biennial Oscillation (QBO) from 1980-2014. TC meteorological characteristics and prevailing indices of the modes of climate variability were also subjected to Principal Component Analysis (PCA) to find out the main variance determinant. Further investigation of the dynamical and/thermodynamic TC factors was conducted to explain the influence of the determinants of the main PCs to the variance. Total TC frequency was highest when moderate ENSO intensities were in-phase with PDO and coincided with E-QBO but normalized frequency was highest when moderate ENSO events were out of phase with PDO, with E-QBO (W-QBO) coinciding with La Niña (El Niño). Genesis location shift observed between the cold and warm ENSO phases was also noticed across the phase combinations of the climate modes. There were more straight-moving and recurving-south TCs in almost all phase combinations. Total ACE was highest when moderate and very strong intensities of El Niño coincided with with E-QBO and W-QBO, respectively, and warm PDO while there was no clear pattern in the mean ACE across all phase combinations. The primary mode of TC variability in the WNP represents almost 40% of the variance for all the storms that formed during the different PDO-ENSO-QBO phase combinations. It showed that cold (warm) ENSO and PDO events resulted to TC genesis in the western (eastern) part of the WNP at higher (lower) latitudes closer (farther) to the landmass which led to lower (higher) ACE. While vertical wind shear was weaker during W-QBO, regardless of coinciding PDO and ENSO phases, it did not necessarily translate to higher TC frequency: only during very strong El Niño while more TCs formed in the moderate ENSO intensities during E-QBO. Tropical convection is meanwhile enhanced in JAS during W-QBO (E-QBO)

when warm (cold) ENSO and PDO are in-phase. Despite the enhanced convection in JAS during E-QBO (W-QBO), more TCs formed when very strong El Niño (moderate La Niña) coincided with W-QBO (E-QBO). Although there is significant influence exerted individually by ENSO, these results show that the different phase combinations of the three climate modes modulate environmental conditions in the WNP that lead to varying effects on TC activity. The findings of this study can be incorporated in long-term and seasonal TC forecasts to better improve disaster risk reduction management. Finally, there is a need for further investigation of interplay of the climate modes to better understand their combined influences on TC activity in the WNP.