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Prediction and Projection of Tropical Cyclone Activity over the Western North Pacific Using CMIP5 Near-Term Experiments

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In line with the experimental design for near-term climate prediction toward the 5th Assessment Report of the Intergovernmental Panel on Climate Change, we performed ensembles of initialized decadal hindcast and near-future (NF) projection using three versions of the coupled atmosphere-ocean model MIROC. In this study, interannual and multiyear predictability of tropical cyclone (TC) activity in the western North Pacific (WNP) is explored, using the initialized hindcasts. In addition, global warming impacts on WNP TC activity in the NF are also examined using the NF projection up to 2035.

The hindcasts show that year-to-year variation of TC number reasonably captures the observation. Interannual variability for TC genesis and occurrence frequency (TGF and TOF) associated with ElNino Southern Oscillation (ENSO) is found to be predictable mainly through better prediction of sea surface temperature (SST) and lower-tropospheric large-scale vorticity anomalies. These results indicate that models are able to reproduce the major basic mechanisms that link TC genesis with large-scale circulation. On the multiyear timescale, skillful prediction of TC number is likely difficult at least in our hindcasts, but three-year-mean states of hindcast started in 1998 reasonably capture observed major characteristics of TC activity associated with the Pacific climate shift during the late 1990s through the initialization.

Projected NF (2016-2035) change in WNP TC genesis number shows significant reduction (approximately 14%) especially over the western WNP even in the NF when the global warming is not so prominent compared with the end of this century. The reduction is likely due to the suppression of large-scale lower-tropospheric vorticity and relative humidity, and enhancement of vertical wind shear. The projected SST exhibits a more pronounced warming over the eastern tropical Pacific and accompanies weakening of Walker circulation via redistribution of tropical convection activity, which appears to be responsible for the change in large-scale fields in WNP.

Keywords: Tropical Cyclone, Predictability