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Riverine Flooding and Landfalling Tropical Cyclones over China

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Riverine flooding associated with landfalling tropical cyclones (TCs) in the Western North Pacific basin is responsible for some of the most severe socioeconomic losses in East Asian countries. However, little is known about the spatial and temporal patterns of TC flooding and its synoptic controls, which constrain predictive understandings of flood risk in this highly populated region. In this study, we investigate hydrology, hydrometeorology, and hydroclimatology of riverine flooding over China induced by landfalling tropical cyclones, based on empirical analysis of dense networks of stream gauging and rainfall stations as well as downscaling simulations using the Weather Research and Forecasting (WRF) model driven by 20th Century Reanalysis fields. The most extreme floods in central and northeastern China are associated with TCs despite infrequent TC visits in these regions. Inter-annual variations in TC flooding demonstrate a mixture of climate controls tied to surface temperature anomalies in central tropical Pacific, western North Pacific and north Atlantic. We implement numerical modelling analysis of typhoon Nina (1975), typhoon Andy (1982) and typhoon Herb (1996) to further shed light on key hydro-meteorological features of landfalling TCs that are responsible for severe flooding over China. We highlight the important role of interactions of storm circulations with mid-latitude synoptic systems (e.g., upper-level trough) and complex terrains in producing extreme rain rates and flooding. Analytical framework developed in this study aims to explore utilization of hydro-meteorological approach in flood-control engineering designs by providing details on the key elements of flood-producing storms. We also highlight potential challenges of developing predictive tools of TC flood risk in east Asian countries.