

Title	Assessment of typhoon hazards under global warming: Case studies on severe typhoons with downscaling experiments(abstract)
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Citation	(2015)
Issue Date	2015-10
URL	http://hdl.handle.net/2433/218197
Right	
Type	Others
Textversion	author

Assessment of Typhoon Hazards under Global Warming: Case Studies on Severe Typhoons with Downscaling Experiments

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The assessment of the impacts by severe typhoons under global warming is a challenging and important task for the prevention and mitigation of natural disasters in the future climate. In the present study, we assess typhoon hazards under global warming by investigating the changes in the intensity of typhoons in the future climate conditions. For this purpose, we use the Weather Research and Forecasting (WRF) model to perform downscaling numerical experiments at regional scales. The numerical experiments are intended to simulate the existing severe typhoons in the past and to project the behaviors of the same typhoons but under assumed global warming. The Japanese long-term reanalysis dataset, JRA-55, is used as the initial and boundary conditions for the WRF model to perform simulations for the past typhoons. The assumed warming climate conditions are created with the use of the pseudo-global warming technique (Sato et al. 2007), which uses the climate-change deficits between the future and the present climate. The climate-change deficits are obtained from the present and the future climate simulations by the MRI's AGCM (Mizuta et al. 2014). Two severe typhoons are examined here: one is Typhoon Vera in September 1959, so called Isewan Typhoon, and the other is Typhoon Songda in September 2004. The analysis area is the central part of Japan for the former case, while it is the Hokkaido area, the norther part of Japan, for the latter case. Both typhoons occurred in September, and therefore, the climate deficit data are based on the monthly means of September in the present and the future climate simulations. In addition to the control AGCM future simulation, we examine 3 AGCM simulations with different SST patterns (Mizuta et al. 2014). By adding the warming deficits from the AGCM simulations with the control SST and the other SST category patterns, we find that the intensity of the simulated typhoons unanimously increases at their mature stages under the future climate conditions. For Typhoon Vera, the increased intensity of the typhoon affects more severely to the central part of Japan. In contrast, despite the increased intensity of Typhoon Songda under global warming, the severity of the resulting hazards in the Hokkaido area is decreased. The reason for this different behavior will be discussed.