

Future Enhancement of Heavy Rainfall Events Associated with a Typhoon in the Midlatitude Regions

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In August 2016, eastern Hokkaido in northern Japan had unusual typhoon landfalls (TY1607, TY1609 and T1611, Fig. 1) and experienced heavy rainfall events that caused severe disasters. To understand the impact of global warming on typhoon-related rainfall in such midlatitude regions, numerical experiments on one of the typhoons in August 2016, Typhoon Chanthu (TY1607), were conducted by using a high-resolution three-dimensional atmosphere–ocean coupled regional model in current and pseudo-global warming (PGW) climates. The model used in the study is a high-resolution three-dimensional atmosphere–ocean coupled regional model composed of the Cloud Resolving Storm Simulator version 3.4.1 (CReSS; Tsuboki and Sakakibara 2002) for the atmospheric part and the Non-Hydrostatic Ocean model for the Earth Simulator (NHOES; Aiki et al. 2006, 2011) for the oceanic part. The coupled model is referred to as CReSS–NHOES (Aiki et al. 2015). The horizontal domain of the coupled model spans 132°E–155°E and 25°N–50°N (Fig. 1), and is discretized with a grid spacing of 0.04° by 0.04°. The PGW simulations were conducted by the same procedure as in Kanada et al. (2017). The amount, intensity, and duration of rainfall in eastern Hokkaido associated with the typhoon increased in the warming climate. Due to the reduction of baroclinicity which led to a weakening of the jet streak along Japan, the PGW typhoon traveled northward with relatively slower translation speed and resulted in a delay in the landfalls for 6 h. Furthermore, large amounts of near-surface water vapor $> 22 \text{ g kg}^{-1}$ from the southern sea increased the convective instability around eastern Hokkaido and caused tall and intense updrafts. As a result, significant predecessor rainfall events with intense rainfall developed about 24 h before the typhoon landfall. Increased near-surface water vapor in the warming climate also enhanced rainfall associated with the typhoon passage over a widespread area. These results suggest that attention should be paid to future enhancement of heavy rainfall events in the midlatitude regions under global warming.

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