

Projected regional-scale changes in environmental stability for summertime convective rain in Tokyo under global warming

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Understanding and forecasting of summertime afternoon precipitation due to rapidly developing cumulonimbus clouds without any significant synoptic-scale influences are important to prevent and mitigate the induced disasters. Future changes in the behavior of such precipitation events have recently gained scientific and societal interests. This study investigates the environmental stability for afternoon precipitation that develops under synoptically undisturbed conditions in summer by using the outputs of 20-km-mesh, super-high-resolution atmospheric general circulation model (GCM) simulations for a present, a near-future, and a future climate under global warming with the Intergovernmental Panel on Climate Change A1B emission scenario. The Kanto Plain was chosen as the analysis area. After verifying the usefulness of the GCM present-climate outputs with observations and gridded mesoscale analyses, we examine the future changes in the environmental stability for the afternoon precipitation by conducting statistical analyses. In the future climates, temperature lapse rate decreased in the lower troposphere, while water vapor mixing ratio increased throughout the deep troposphere. The changes in the temperature and moisture profiles resulted in the increase in both precipitable water vapor and convective available potential energy. These projected changes will be enhanced with the future period. Furthermore, the statistical analyses for the differences of the stability parameters between no-rain and rain days under the synoptically undisturbed condition in each simulated climate period indicated that the representations of the stability parameters that distinguish no-rain and rain events are basically unchanged between the present and the future climates. This result suggests that the environmental characteristics favorable for afternoon precipitation in the synoptically undisturbed environments will not change under global warming.

Keywords: convective rain, global warming, regional climate, Tokyo, environmental stability