# Intensification of sub-daily and daily rainfall extremes from densely distributed records for Japan

*Megumi Watanabe[1], Sayaka Yoshikawa[1], Shinjiro Kanae[1]

1. Tokyo Institute of Technology

Rainfall intensity is projected to increase in most regions under warmer climates, and the increase in heavy rainfall will be larger than that in the mean rainfall. The increase in rainfall intensity caused by global warming was often predicted by studies with climate models. There is an argument that climate models tend to underestimate the observed changes in heavy rainfall intensity. Meanwhile, it has been suggested that, to first order, the intensification of heavy rainfall in a warmer climate could follow the Clausius-Clapeyron (CC) relationship which states that warmer air has a higher water vapor holding capacity. According to the C-C relationship a rainfall intensities are estimated to increase by ~7% per degree warming. However, observed evidence that detects CC-related changes both in daily and sub-daily (e.g., hourly) rainfall extremes between two periods (namely the past and the present) is limited. A comprehensive result derived from observed data confirmed that the intensification rate of daily precipitation is close to the rate of CC in Europe, but their analysis was done for daily precipitation only and limited observation data over a large region was used. Another recently published analysis for Australia shows on average a CC-like response for daily extremes and a super-CC (double to triple CC) response for hourly extremes which is also suggested in temperature-rainfall scaling. Nevertheless, large regional variability in their results derived from sparsely distributed observations from the tropics to mid-latitude calls for an analysis of densely-distributed observations in a single climatic zone. In this study, we try to analyze whether the CC relationship, or super-CC, can be applied to the intensification of both daily and sub-daily rainfall extremes over Japan. We also try to show the sensitivity of the estimated intensification of rainfall extremes caused by setting of the past and present period, referenced stations. We used rainfall data at more than 700 stations with less than 1% missing data for the entire area of Japan. We divided whole observation period into the past and present period. We then defined extreme precipitation criteria in the previous period at each individual observation point and counted the number of the event of extreme precipitation. Finally, we calculated the intensification rate of rainfall extremes from the past to present period. In the results, we show that the intensification rate of sub-daily extremes is higher than that of daily extremes. However, the magnitude of intensification rate greatly differs depending on referenced period, the number of stations and rate of increase in temperature.

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