Improvement of future climate projection technology using downscaling of large ensemble GCMs and evaluation of its regional applicability

a) Downscaling

The government of Japan updated the standard rainfall for river management based on climate projection data with a 5-km resolution. The ICHARM research team examined whether this 5-km downscaled data can be applied to small watersheds of 100 km^2 or less. Results from downscaling JRA3Q reanalysis data to reproduce typhoon-related torrential rainfall indicate that differences between 1-km and 5-km model resolutions are relatively small in the Kannagawa and Yunishigawa watersheds in the upper Tone River basin. In contrast, model resolution dependence is relatively large in the upper Abukuma River basin and the Yagisawa Dam catchment during the same typhoon event. A similar trend in resolution dependence is seen in the Hakone catchment during a Baiu-frontal rainfall event and the upper Kumagawa basin during a linear-precipitation-zone event. These results suggest that special caution is needed when applying 5-km climate projection data to small watersheds.

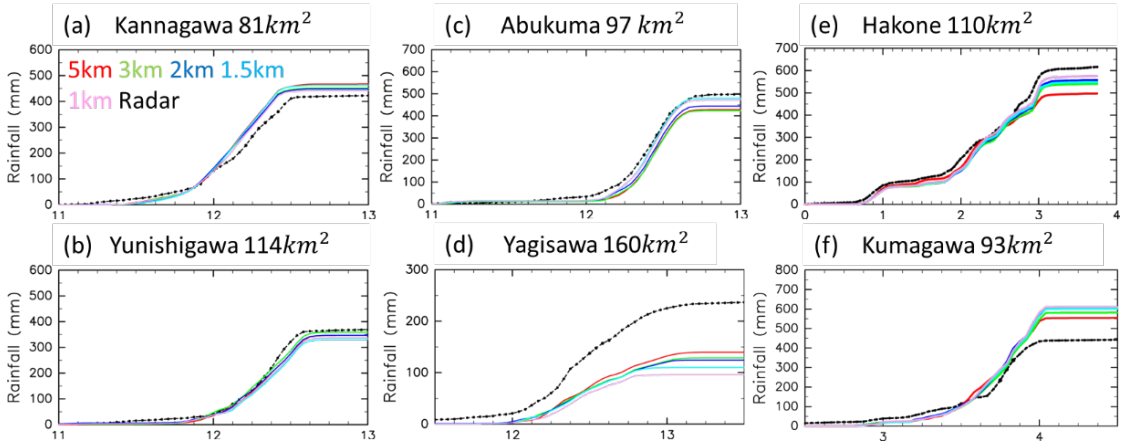


Figure 1 Catchment-average rainfall accumulation with different regional model resolutions. Line colors indicate model resolutions of 5 km (red), 3 km (green), 2 km (blue), 1.5 km (sky blue), and 1 km (pink). The black dotted line shows observed rainfall from Analyzed Rainfall provided by the Japan Meteorological Agency. The horizontal axis shows the number of days. Panels (a)-(f) indicate the target catchments and their respective areas.

a) DAD analysis

In the Depth-Area-Duration (DAD) analysis, the team assessed how climate change affects probable maximum precipitation (PMP) using 5-km hourly rainfall data from the d4PDF ensemble dataset. PMP was estimated through the DAD analysis under historical, +2K, and +4K warming scenarios for southeastern and northwestern Kyushu, Japan. The PMP estimation followed five steps: aggregating rainfall data (2–72 hours), selecting annual maximum rainfall, deriving depth-area curves via the Flexible Element Method (FEM), enveloping maximum curves across 720 events, and calculating PMP and change factors. Change factors were computed for durations of 1–72 hours and rain areas of 100, 1000, 10000 km².

Figure 2 shows 24-hour PMP change factors, with results indicating that PMP increases up to 1.22 (+2 K)

and 1.37 (+4 K) in northwestern Kyushu, and up to 1.13 (+2 K) and 1.26 (+4 K) in southeastern Kyushu. PMP increases with warming, especially under the +4 K scenario, across all rain areas. These findings support updating PMP estimates to improve flood risk management and infrastructure resilience. The study was submitted to *Hydrological Research Letters*.

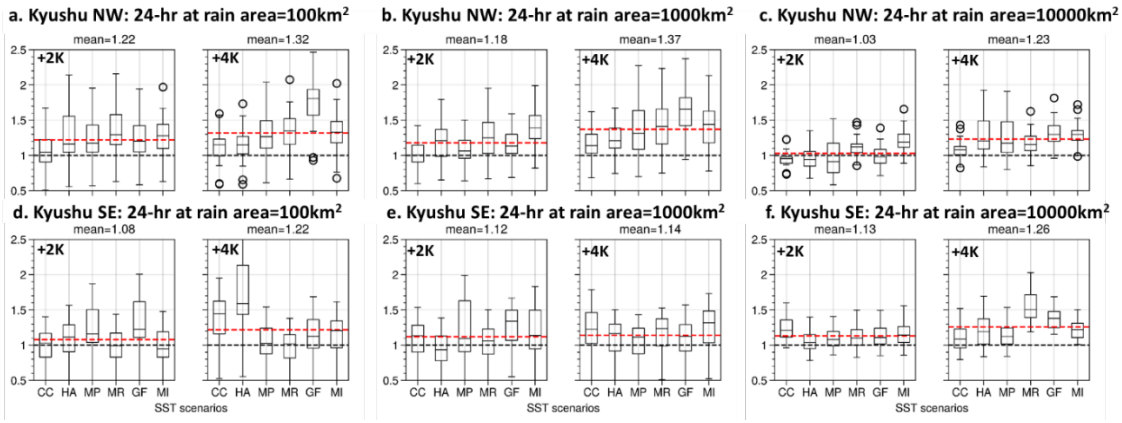


Figure 2 PMP change factors for 24-hour rainfall for multiple rain areas (a:100 km^2, b:1000 km^2, and c:10000 km^2) under the +2 K and +4 K SST warming scenarios for southeastern Kyushu (Kyushu SE) and northwestern Kyushu (Kyushu NW)