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Relationship between future changes in summertime precipitation and topography in the Japanese islands

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This study investigated future changes in summertime precipitation over the Japanese islands and their relations to the topography by analyzing data from 20-km resolution regional climate model downscalings of MIROC3.2-hires 20C3M and SRES A1B scenario data. To obtain the geographical distributions of simulated daily precipitation amounts in Japan during the periods of 1981-2000 (hereafter "recent climate") and 2081-2100 ("future climate"), we analyzed results of long-term numerical simulations performed by three RCMs: Non-Hydrostatic Regional Climate Model (NHRCM; Saito et al., 2006; Ishizaki and Takayabu, 2009), Regional Atmospheric Modeling System V 4.3 (Pielke et al., 1992) modified by National Research Institute for Earth Science and Disaster Prevention (NRAMS; Dairaku et al., 2008), and Weather Research and Forecasting model (Skamarock et al., 2008) V 3.1.1 modified by University of Tsukuba (T-WRF; Kusaka et al., 2012). Each simulation was carried out with a 20-km horizontal grid resolution, as part of the Japanese research project of Multi-Model Ensembles and Downscaling Methods for Assessment of Climate Change Impact (S-5-3; e.g., Ishizaki et al., 2012). Results of the analyses indicate that future increases in June-July-August mean daily precipitation amounts are noticeable in the west and south sides (windward sides) of the mountainous regions, especially in Western Japan where heavy rainfall is frequently observed in the recent climate. The large precipitation increases are likely to occur not only in high altitude areas but also at low altitudes. The model grid points where the future increases in JJA mean daily precipitation exceed 3 mm and 5 mm are shown in Figure 1 (a figure shown in this abstract) after dividing the topographical heights at every grid points into several elevation zones at an interval of 300 m. In the west and south sides of the mountainous regions, the precipitation increases of more than 3 mm day-1 can be seen not only in high altitude areas but also at low altitudes below 300 m above mean sea level (AMSL) (Figures 1a-c). Note that the precipitation increases exceeding 5 mm day-1 are widely distributed at the low altitude areas in the western part of Kyushu (Figures 1d-f). In those areas, the occurrence frequencies of precipitation amounts greater than 100 mm day-1 would also increase under the future climate scenario (A1B). One of the main causes of these precipitation changes appears to be the intensification of southwesterly moist air flows in the lower troposphere, which is likely to be associated with future increases in the north-south atmospheric pressure gradient, especially at latitudes south of 35 degrees north. The intensified southwesterly moist air flows that impinge on the western and southern slopes of the mountains can generate stronger upslope flows and well-developed clouds, leading to the increased precipitation. In contrast, the future changes of the simulated precipitation amounts in the lee sides of the mountainous regions, such as the Tokyo metropolitan area would be comparatively small.

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Keywords: Future changes in summertime precipitation, Topography, Regional climate modeling, Multi-model, Dynamical downscaling, Dynamical mechanism of future precipitation changes

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