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Intercomparison of precipitation-based extremes indices over Japan simulated by 60km and 20km-mesh AGCMs and 5km-mesh RCM

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Under the framework of KAKUSHIN Program, numerical experiments with 20km-mesh and 60km-mesh atmospheric global climate models (AGCMs) are conducted to project climate changes. In addition, to study future changes of weather extremes such as heavy precipitation over the Japanese Island, numerical experiments with a 5km-mesh regional climate model (RCM), nested within the 20km-mesh AGCM, are also conducted. In this study, precipitation-based extremes indices over the Japanese Islands are calculated from present-day climate simulations by 20 and 60km-mesh AGCMs and 5km-mesh RCM, and they are compared using Taylor's skill score (Taylor, 2001).

The AGCMs used in this study are MRI-AGCM3.2H (TL319L64) and MRI-AGCM3.2S (TL959L64) developed at the Meteorological Research Institute (MRI) and the Japan Meteorological Agency (JMA) (Mizuta et al. 2011, in preparation). The AMIP-type present-day climate simulations are conducted for 25 years (1979-2003), using HadISST1 (Rayner et al. 2003) dataset as bottom boundary conditions. The Yoshimura cumulus convection scheme (Yukimoto et al. 2010), modified from the Tiedtke scheme (Tiedtle, 1989) and the Arakawa-Schubert scheme (Arakawa and Schubert, 1974), is employed in the control simulation. In addition to the control simulation, three initial-value ensemble and two multi-scheme ensemble experiments are also performed using MRI-AGCM3.2H. In the latter two experiments, the Arakawa-Schubert scheme and the Kain-Fritsch scheme (Kain and Fritsch, 1990) are used instead of the Yoshimura scheme.

The 5km-mesh RCM used in this study is a non-hydrostatic model (hereafter, abbreviated to NHM5,Nakano et al. 2011 in preparation) improved from JMA-NHM (Saito et al. 2007). Initial and lateral boundary conditions are given from simulation results of MRI-AGCM3.2S. To reduce the inconsistency in synoptic-scale atmospheric conditions between NHM5 and MRI-AGCM3.2S, the spectral nudging is applied for large-scale wave components (wavelength > 1000 km) of horizontal momentums and potential temperature above a 7-km height. The model domain covers an area of 3345x2970 square kilometers. The model has 50 vertical levels at variable intervals from 40 m (near the surface) to 886 m (top of the domain). The model top is located at a height of 21.8 km. NHM5 is continuously integrated from 00 UTC 17 May to 00 UTC 1 November for each year of 1979-2003 in MRI-AGCM3.2S simulations.

Precipitation-related indices of total precipitation amount for five months (Pav), maximum number of consecutive dry/wet days (CDD/CWD), total number of dry days (DD), simple daily intensity index (SDII), and maximum five-day precipitation amount (R5d) are calculated from daily precipitation data of all experiments during June-October. These indices are compared with those calculated from Japanese area special version of Asian Precipitation-Highly Resolved Observational Data Integration Towards the Evaluation of Water Resources (APHRO_JP; Kamiguchi et al. 2010) dataset.

The peak intensities [total amounts] of precipitation projected by coarser-mesh models are weaker [less] than those from observations. In addition, AGCM simulations show much more wet days in many areas. NHM5 has the best skill scores in all indices. The scores of MRI-AGCM3.2S for CDD [DD and CWD] are comparable with [lower than] those of MRI-AGCM3.2H, while the scores of MRI-AGCM3.2S for Pav, SDII and R5d are higher than those of MRI-AGCM3.2H. The scores in initial value ensemble experiments are comparable with those in the control experiment except for CWD. Among multi-scheme ensemble experiments, the scores of the experiment with the Kain-Fritsch scheme are the highest for R5d, SDII, Pav, and CWD. The differences of large-scale atmospheric fields and thermodynamic vertical profiles among the above-mentioned experiments, which could control the characteristics of precipitation, will be also shown on the poster.