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Assessment of dynamical downscaling in Japan

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The responses of the climate system to increases in carbon dioxide concentrations and to changes in land use/land cover and the subsequent impacts of climatic variability on humans and natural ecosystems are of fundamental concern. Because regional responses of surface hydrological and biogeochemical changes are particularly complex, it is necessary to add spatial resolution to accurately assess critical interactions within the regional climate system for climate change impacts assessments. We quantified the confidence and uncertainties of Type II dynamical downscaling where the lateral and bottom boundary conditions were obtained from Japanese 25-year ReAnalysis (JRA-25) and assessed the value (skill) added by the downscaling to a climate simulation in Japan. We conducted the sensitivity study of domain size and nudging scheme using a regional climate model (NIED-RAMS). The Meteorological Research Institute Nonhydrostatic Model (MRI-NHM) and the University of Tsukuba Weather Research and Forecasting Model (T-WRF) were also used for the comparison. Two key variables for impact studies, surface air temperature and precipitation, were investigated using the Japanese high-resolution surface observation, Automated Meteorological Data Acquisition System (AMeDAS) on 78 river basins. RAMS shows the cool and low pressure biases. In the period (JJA) when the control of lateral boundary condition is relatively weak, the RCM solution in the interior of the domain was much deteriorated in the larger domain. In the larger domain, spectral nudging reduced the mean biases. However, in other seasons when the influence of synoptic scale disturbances is strong, spectral nudging had insignificant impacts. Except for the 2mT in JJA, dynamical downscaling could add value to the forcing data beyond what is achieved by interpolating global reanalysis. Wave model bias was reduced by using multi-model forcing. The multi-model ensemble approach promises to increase the credibility of impact studies.