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Regional climate change projection project with the development of incremental dynamical downscaling method

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The Research Program on Climate Change Adaptation (RECCA) has started from 2010 in Japan with a research target of adaptations to the regional scale environmental changes due to global warming. The project consists of several research teams. Our research team is developing regional climate change projection methods, and numerical experiments with the method will be performed with a target region of the Kanto district, Japan to project climate changes in precipitation. We introduce the outline of the research and the recent preliminary results. The regional scale projections of climate changes include large uncertainties. The most significant uncertainty is due to that of GCMs used as the lateral boundaries of regional climate model (RCM) experiments. The incremental dynamical downscaling (IDD) method is under development in the research team by improving the pseudo-global-warming (PGW) method (Kimura and Kitoh, 2007). The PGW method is one of the time-sliced dynamical downscaling methods for climate changes. In the present climate, an objective analysis data (ANAL) was used as the lateral boundary of RCM simulation. In the future climate, mean climatological difference estimated by GCMs are added to ANAL. This method can mostly remove the influences of biases of GCMs. In addition, it is one of advantages for the PGW and IDD methods that any climatological increments which mostly keep dynamic balances are able to treat as the climatological difference. To consider the uncertainties of GCMs, three climatological increments, the ensemble mean (EM) of GCMs, minus sigma (standard deviation of indices of mean climatological differences) from EM, and plus sigma from EM, are analyzed for the boundaries of RCM experiments. The downscaling results with the three boundary data would be able to be used for stochastic projections of regional scale climate changes. The PGW method includes some demerits that the method is not able to treat climate changes in year-to-year variations, short-term variations (disturbances), and relative humidity. The IDD method is under development to improve to treat such climate changes. Among them, a method to treat the climate changes in year-to-year variations has been theoretically developed. In the method, only the variation patterns of the ANAL are trusted. The variations of GCMs are projected to the variation patterns of ANAL. The climate changes in the variations from present to future climates of GCMs are parallel shifted to the origin of the ANAL. Next, the reliability weight for each mode of variation is defined. For the low weight mode, the climate change in the variation of GCMs is not adapted. In the present stage of the experiments, the reproducibility of RCM is evaluated. The Advanced Research WRF modeling system V3.2.1 was used to reproduce the past recent climate with ANAL as the lateral boundary. The model domains and grids have three nesting levels of 24-6-2km to focus on the Kanto district. For the 6-km grid experiment, probability distributions of hourly precipitation amounts are compared between experiments with and without KF scheme. The precipitation amount with KF showed unnaturally excessive precipitation in the medium intensity range, and the KF scheme is not recommended in the 6-km grid experiment. For 2km-grid experiment, the precipitation showed finer horizontal distribution, and that along mountain ranges was well reproduced.