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# Development of incremental dynamical downscaling and analysis system for regional scale climate change projections

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Regional scale climate change projections play an important role in assessments of influences of global warming and include statistical (SD) and dynamical downscaling (DD) approaches. One of DD methods is developed basing on the pseudo-global-warming (PGW) method developed by Kimura and Kitoh (2007) in this study. In general, DD uses regional climate model (RCM) with lateral boundary data. In PGW method, the climatological mean difference estimated by GCMs are added to the objective analysis data (ANAL), and the data are used as the lateral boundary data in the future climate simulations. The ANAL is also used as the lateral boundary conditions of the present climate simulation. One of merits of the PGW method is that influences of biases of GCMs in RCM simulations are reduced. However, the PGW method does not treat climate changes in relative humidity, year-to-year variation, and short-term disturbances. The developing new downscaling method is named as the incremental dynamical downscaling and analysis system (InDDAS). The InDDAS treat climate changes in relative humidity and year-to-year variations.

On the other hand, uncertainties of climate change projections estimated by many GCMs are large and are not negligible. Thus, stochastic regional scale climate change projections are expected for assessments of influences of global warming. Many RCM runs must be performed to make stochastic information. However, the computational costs are huge because grid size of RCM runs should be small to resolve heavy rainfall phenomena. Therefore, the number of runs to make stochastic information must be reduced. In InDDAS, climatological differences added to ANAL become statistically pre-analyzed information. The climatological differences of many GCMs are divided into mean climatological difference (MD) and departures from MD. The departures are analyzed by principal component analysis, and positive and negative perturbations (positive and negative standard deviations multiplied by departure patterns (eigenvectors)) with multi modes are added to MD. Consequently, the most likely future states are calculated with climatological difference of MD. For example, future states in cases that temperature increase is large and small are calculated with MD plus positive and negative perturbations of the first mode.