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Attributing Past and Future Climate Variations with Ensemble Simulations, Data Assimilation, and Climate Predictions

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Designing a national adaptation plan for future climate change requires an estimation of the uncertainty in climate projections, which is information on the frequency of occurrence of natural disasters. However, there is only a small ensemble of climate change projection data currently available, and the reliability still not enough for assessing severe weather statistically. Through the collaboration among all themes of the SOUSEI program, which is a Japanese national research program funded by the Ministry of Education, Culture, Sport, Science, and Technology, we have done simulations in the order of 100 ensembles. This dataset is called d4PDF (database for Policy Decision making for Future climate change; Mizuta et al. 2016), which enables us to conduct a statistical analysis on probabilistic occurrences of extreme weather. The use of d4PDF is expected to help to improve the understanding of uncertainties in the past and future climate, as well as related impact studies. The projected climate change information from this dataset can also be used in the adaptation plans of stakeholders.

The d4PDF has been applied to attributing future changes in heavy snow falls (Kawase et al. 2016), historical changes in probabilities of record-breaking daily temperature and precipitation extreme events (Shiogama et al. 2016), an enhanced seasonal temperature contrast of Japan in 2000s (Imada et al. 2017), and etc.

In addition, we are currently preparing a new initializaion system for long-term climate predictions on seasonal-to-decadal time scales. Ensemble decadal predictions would be helpful for understanding future climate conditions at less than 2-degree Celsius warming relative to the pre-industrial level, which is required by the Paris agreement of COP21. Moreover, we have been conducting a climate reanalysis in a centennial scale for elongating the training period of decadal prediction models as well as for learning past climate changes. These will hopefully provide attributing studies with information on unavoidable uncertainties in models, observations, and external forcing, and with a kind of observed geophysical fields for comparison and validation.