Abstract

[Research Title]

Communications on Future Changes of Extreme Weather with Reduced Uncertainty Based on Physical Understandings

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[Abstract]

In order to ensure a safe and sustainable society under the climate change, it is necessary to optimize adaptation measures based on quantitative global warming impact assessment information. In particular, there is a great concern about the vulnerability of society to extreme weather events. The IPCC AR6 reports increases of extreme heat waves and heavy rainfalls in many parts of the world, but their physical understanding is insufficient. Recently, Japan also has been plagued by frequent widespread floods and severe heat waves.

Projections of future changes simulated by most recent ensemble of climate models, CMIP6, are still subject to large uncertainties. Moreover, there raised an issue of “hot models”: some of the CMIP6 models are suspiciously too sensitive to the GHG increase (Tokarska et al. 2020), so that future projections should be performed with ensembles excluding “hot models” (Hausfather et al. 2022, Shiogama et al. 2022).

In this project, JPMEERF20222002, we aim to provide information about future changes of extreme phenomena with reduced uncertainty based on physical understandings, to climate change impact assessment research.

To this end, we study mechanisms of extreme weather occurrences under the influence of both local and remote climate and their changes. We use satellite and other observational data, global reanalysis data, CMIP6 historical and scenario runs, and high-resolution climate model ensemble d4PDF data, to analyze uncertainties of future projections of extreme weather, with physical rationality. We also develop methods to reduce such uncertainties and utilize the information in a hydrological model research, and convey information to impact assessment research group S-18.

Results are obtained for following subjects, and their reliability evaluated with accumulated observations. The results are utilized to narrow down the range of projections, and conveyed to the impact assessment group. (1) Dependence of future projections of local heavy rainfalls on reproducibility of global-scale SST and jet-streams. (2) Land-Ocean differences on relationship between heavy rainfalls and environments and their reproducibility in CMIP6 models. (3) A downscaling bias correction method developed and applied to the CMIP6 data, and implemented to a hydrological model. (4) Remote influence patterns and changes in storm track activity associated with the global warming that bring extreme weather to Japan. (5) Systemizing mechanisms how changes in temperature and large-scale circulation from upper troposphere to stratosphere affect precipitation and extreme events in East Asia. (6) Mechanisms determining climate patters, their fluctuations, and long-term changes observed and reanalyzed since the 1980s. (7) The impact of removing the “hot models” from the ensemble to reduce the projection uncertainty of global-scale phenomena; on reducing the uncertainty of various climate variables and extreme event indices around Japan and the Asia-Pacific region.

[References]

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