29th Conference on Climate Variability and Change, Poster Session 2: Climate Variability and Change #485

Regional Climate Modeling of the Changes in Environmental Stability and Heavy Rainfall under Global Warming

Tetsuya Takemi*

Disaster Prevention Research Institute, Kyoto University, Uji, Kyoto, Japan

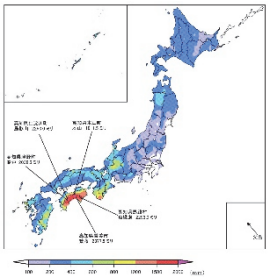
*Contact: takemi@storm.dpri.Kyoto-u.ac.jp

Introduction

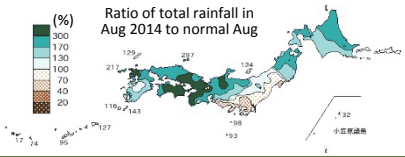
Heavy rainfall by deep convection depends on environmental stability conditions such as temperature lapse rate and moisture content. From the previous studies and the past IPCC assessment reports, it has been understood that the occurrence of extreme rainfall events will increase in projected future climates under global warming. Downscaling experiments with regional climate models enable to diagnose the effects of climate change on the development and evolution of specific extreme convective events through a pseudo-global warming assumption in which incremental amounts from the historical to a future climate are added to the analysis field of a past event. In this study, we investigated the effects of global warming on the changes in the relationship between environmental stability and heavy rainfall by conducting pseudo-global warming experiments for the heavy rainfall period in August 2014 in Japan.

Heavy rainfall in August 2014 in Japan

Total rainfall in August 2014



Landslide in Hiroshima

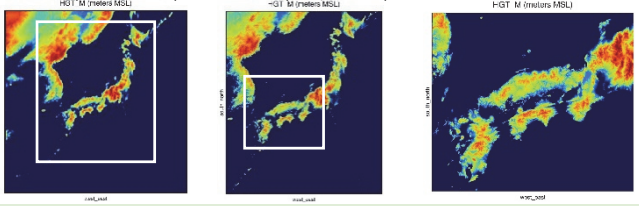


Model settings

Numerical model Weather Research and Forecasting (WRF)/ARW
Domain nesting three domains at 9 km/3 km/1 km grid spacings
Analysis field Japanese 55-year Reanalysis (JRA-55)
Simulation period 00 UTC 30 July 2014 – 00 UTC 1 Sep 2014

Computational Domain

Domain 1 (9 km, 301x301) | Domain 2 (9 km, 601x703) | Domain 3 (9 km, 865 x 766)



Pseudo-global warming (PGW) experiment

Global warming (GW) increment =
(Future climate: 2075-2099) – (Present climate: 1979-2003)
Obtained from MRI-AGCM3.2 (Mizuta et al. 2012)

Added variables sea surface temperature (SST)*, air temperature
* SST: 4 patters (Mizuta et al. 2014) → 4 future runs with AGCM

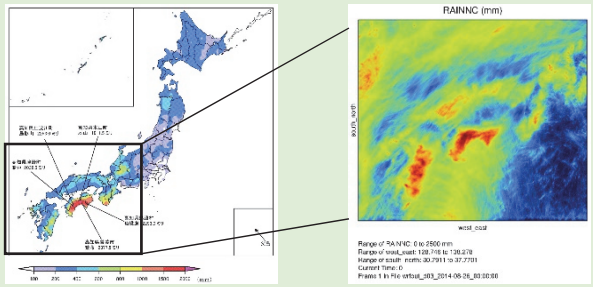
PGW climate state = (JRA-55 analysis field) + (GW increment)

Experiments
Present climate experiment: CNTL
PGW experiments: PGW0 (control SST), PGW1, PGW2, PGW3 (ensemble SSTs)

Results

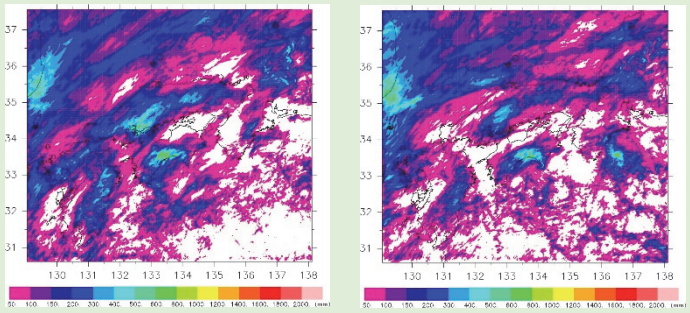
Validation: Total rainfall in August 2014

Observation | Simulation (CNTL)



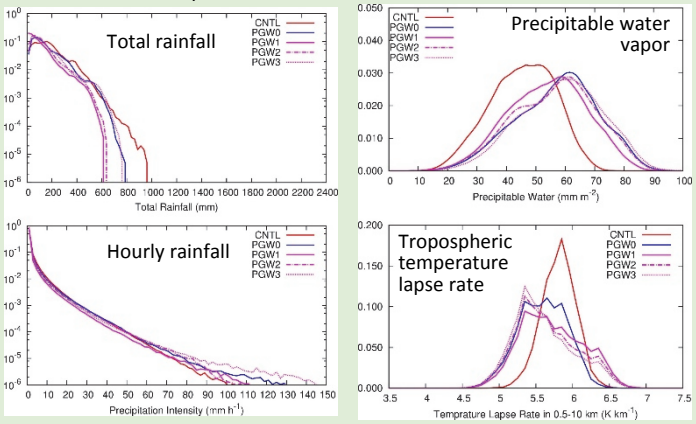
Accumulated rainfall from 11 Aug to 1 September

2014 condition (CNTL) | PGW climate (PGW0)



Frequency distribution of rainfall and environmental conditions

Total vs hourly rainfall | Environmental conditions



Summary

From pseudo-global warming experiments for a month-long heavy rainfall event due to the activity of stationary front, it was found:

- Total rainfall may not increase under global warming;
- The frequency of strong hourly rain will increase under global warming.

Acknowledgments This work was supported by the SOUSEI program of Ministry of Education (MEXT), Japan.

See reference: Takemi, T., Y. Okada, R. Ito, H. Ishikawa, E. Nakakita, 2016: Assessing the impacts of global warming on meteorological hazards and risks in Japan: Philosophy and achievements of the SOUSEI program. *Hydrological Research Letters*, **10**, 119-125, doi: 10.3178/hrl.10.119.