Geophysical Research Abstracts
Vol. 15, EGU2013-3859, 2013
EGU General Assembly 2013

Dependency of precipitation scaling pattern on emission scenarios in RCPs

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Pattern scaling is an efficient way to generate projections of regional climate change for a wide range of emission scenarios. This approach assumes that the spatial changes per 1 K increase in global mean surface air temperature (SAT) (scaling pattern) are common between emission scenarios. We validated the assumption of precipitation scaling pattern (SP) focusing on the scenario dependency (SD) of aerosols SP among representative concentration pathways. Overall, the SD of aerosols SPs induced an SD of surface shortwave radiation (SSR) SP. The SD of SSR SP over ocean tends to induce an SD of evaporation SP. The SD of evaporation SP led to an SD of precipitation SP over the site and the downstream regions. Contrariwise, when an SD of aerosols SPs occurred over land, the SD of SSR SP induced not only an SD of evaporation SP but also an SD of surface longwave radiation and sensible heat SPs. Consequently, the SD of evaporation SP was smaller over land than over ocean, and the SD of precipitation SP does not tend to be significant. In addition to the SD of aerosols scaling patterns, the SD of the southern annular mode and polar amplification caused some of the SD of precipitation SP. Projections of precipitation are important inputs to assessments of the impacts of climate change and related adaptation research. Scientists who study these topics need to pay attention to the scenario dependence of the scaling pattern of precipitation if the scenario dependences are important for their research.

Because the differences of the global mean SAT changes between RCP8.5 and RCP4.5 are smaller than those between RCP8.5 and RCP2.6, the scenario dependences of the scaling patterns of anthropogenic aerosols and of Hadley circulation and SAM between RCP8.5 and RCP4.5 were less than those between RCP8.5 and RCP2.6. As a result, the scenario dependence of precipitation tended to be less between RCP8.5 and RCP4.5 than between RCP8.5 and RCP2.6 overall. Thus, when pattern scaling is applied to an emission scenario, it is better to remove the scenario dependence by using the RCP that projects global mean SAT changes similar to those projected by the emission scenario.

In this study, we analyzed the results of only one global climate mode. Thus, the dependencies of precipitation SP among global climate models are required in future work.