

A Canonical Response in Rainfall Characteristics to Global Warming : Projections by IPCC CMIP5 Models

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Abstract

Changes in rainfall characteristics induced by global warming are examined based on probability distribution function (PDF) analysis, from outputs of 14 IPCC (Intergovernmental Panel on Climate Change), CMIP (5th Coupled Model Intercomparison Project) models under various scenarios of increased CO₂ emissions. Results show that collectively CMIP5 models project a robust and consistent global and regional rainfall response to CO₂ warming. Globally, the models show a 1-3% increase in rainfall per degree rise in temperature, with a canonical response featuring large increase (100-250 %) in frequency of occurrence of very heavy rain, a reduction (5-10%) of moderate rain, and an increase (10-15%) of light rain events. Regionally, even though details vary among models, a majority of the models (>10 out of 14) project a consistent large scale response with more heavy rain events in climatologically wet regions, most pronounced in the Pacific ITCZ and the Asian monsoon. Moderate rain events are found to decrease over extensive regions of the subtropical and extratropical oceans, but increases over the extratropical land regions, and the Southern Oceans. The spatial distribution of light rain resembles that of moderate rain, but mostly with opposite polarity. The majority of the models also show increase in the number of dry events (absence or only trace amount of rain) over subtropical and tropical land regions in both hemispheres. These results suggest that rainfall characteristics are changing and that increased extreme rainfall events and droughts occurrences are connected, as a consequent of a global adjustment of the large scale circulation to global warming.