ABSTRACT

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SGER: Hydrological Cycles in the Tropics

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The PIs will analyze and compare with available observations, the late 19th - 20th century simulations carried out by the National Center for Atmospheric Research (NCAR) Community Climate System Model (CCSM3), Goddard Institute for Space Studies (GISS) ModelE and the Geophysical Fluid Dynamics Laboratory (GFDL) coupled General Circulation Models (GCM)s. The goal is to document and understand the changes in the hydrological cycle of the atmosphere in the tropics simulated by the three coupled models.

The first aspect of the proposed work is on the trends and variability of precipitation and atmospheric temperature over the tropical land and oceans. In the second half of the 20th century, while the trends in surface-air temperature over the tropical land and oceans are all upward, the trend in precipitation over the land is opposite to that over the oceans. Precipitation over the tropical land has been decreasing in the past 50 years. Following their work, we will analyze the trends and variability of tropical precipitation, surface-air temperature, sea-surface temperature, soil moisture, 200-hPa geopotential height and large-scale overturning circulation simulated by the GCMs for the entire 140-year simulations. Observations in the past 50 years or so will be utilized to validate the GCM simulations. Discrepancies between GCM simulations and observations will be identified and the causes will be explored. The second aspect is on the warm rain processes over the tropical ocean. From analysis of satellite observations, Lau and Wu (2003) found that there is a substantial increase in precipitation efficiency (ratio of precipitation to cloud liquid water) of light warm rain as sea surface temperatures (SST)s increases, but precipitation efficiency of heavy rain associated with deep convection is not sensitive to SST changes. Following their work, we will analyze cloudiness, precipitation, and water vapor residence time (ratio of water vapor to precipitation) to document the recycling of water vapor, warm and cold rainfall efficiency, and their dependence on SSTs simulated by the three coupled models. Results from the 140-year simulations of the three models will be inter-compared to discern the commonality and discrepancy among the models. Recent observations, especially those from the satellite era will be used to validate and comprehend the GCM results.

Broader Impacts: If successful, this research will have a positive impact on the quality of future climate and water resources information provided to environmental managers, policy-makers and societal activities.

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