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Do Models and Observations Disagree on the Rainfall Response to Global Warming?

B. Liepert and M. Previdi

Lamont-Doherty Earth Observatory of Columbia University, Palisades New York USA (liepert@ldeo.columbia.edu)

Climate models and observations indicate that the total amount of water vapor in the atmosphere increases at approximately the rate of 7% per degree Kelvin which is about the temperature dependence of the water vapor saturation pressure as given by the Clausius-Clapeyron (C-C) equation for a global mean surface temperature of 288 K. Climate models, however, suggest that precipitation increases at a much slower rate of about 1 to 3% K^{-1} of global warming. In a recent paper Wentz et al. (2007) showed that satellite derived global mean precipitation has increased by 13.2 $\pm$ 4.8 mm/aper decade or 1.4 $\pm$ 0.5 % per decade over the period July 1987 through August 2006. Over the same time period Earth's surface warmed by 0.2 K per decade, indicating a rate of precipitation increase of 7% per degree K, which is close to the C-C rate. A possible explanation for the discrepancy is internal climate variability, which implies that the 20-year time period might be too short. Another explanation is the possibility that the climate models have in common a compensating error in characterizing the radiative balance for the troposphere and Earth's surface. Here we investigate the muted precipitation response to global warming by analyzing output from eight fully coupled atmosphere-ocean climate models covering the entire length of the satellite data. Firstly, we investigate the representativeness of the 20-year satellite time period for covering the expected interdecadal variability. Secondly, we investigate the radiative forcing uncertainties as possibility explanation. We analyze one model's specific response to various individual forcings during the satellite time period and the 20^{th} century. And thirdly we introduce an alternative concept of "hydrological sensitivity" that has the potential to thermodynamically constrain the dependence of P on anthro-

pogenic forcings.