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What controls changes in global precipitation?

Graeme L Stephens
Department of Atmospheric Sciences, Colorado State University, Ft Collins, CO 80523

Results from a number of recent studies on precipitation trends apparently support the general notion that precipitation increases should match the water vapor increases that have been observed over the past 20 years. However, the projections of precipitation change are a factor of 3-4 times smaller than this water vapor change. This paper will provide an explanation for why the rate of increase of precipitation cannot keep pace with the increase of water vapor. Using results from the 1% increase in carbon dioxide until doubled (1pctto2x) scenario of global climate models (GCMs) included in the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment report (AR4), the factors that govern this precipitation change will be demonstrated. It will be shown that increased emission of infrared radiation due to this increased water vapor is the primary factor that determines this reduced global precipitation sensitivity to warming. Other factors that affect this quantity include cloud-radiation feedbacks associated with changes in the vertical distribution of clouds and it will be shown how this feedback is negative in all models. A positive effect due to changes in sensible heating largely compensates for the negative cloud feedback. This apparent contradiction between these observational studies and the results presented in this study that define the robust constraints on global precipitation merely highlights the inconsistencies in the global data sources themselves and, coupled with the difficulties that arise from calculating decadal-scale trends with data that span a relatively short time period, serves as reminder that trends in these data should be treated cautiously.