The effect of extratropical warming amplification on the future tropical precipitation

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The Arctic warms much more than the rest of the world under relatively uniform radiative forcing. Recent observations verify this characteristics of global warming. On the other hand, previous studies based on paleo-proxy data and paleo- and idealized numerical experiments have indicated that asymmetric warming between the two hemispheres can impact on the distribution of tropical precipitation. It was suggested diagnostically that the Arctic warming amplification may become responsible for a part of the future precipitation change in the tropics. In the current study, we have conducted several sensitivity experiments that isolate the effect of remote warming on the tropical precipitation using an atmospheric general circulation model with a mixture of prescribed and predicted mixed-layer sea surface conditions, depending of the region.

In a standard equilibrium experiment of doubling of atmospheric CO_2 concentration (2xCO2), the Northern Hemisphere mid-high latitude (40-90ºN) warms by about 7ºC and precipitation change occurs mostly in the tropical Pacific (20ºS-20ºN). In the zonal average, the increase in precipitation is larger in the North than the South by about 0.5 mm/day and the peak latitude of precipitation shifted northward by about 1º. Sensitivity experiments were designed to amplify or suppress the Northern Hemisphere mid-high latitude warming to different levels and to allow for the tropics to respond freely to those perturbations. The perturbations of the mid-high latitude warming range from -5ºC to +7ºC from the standard 2xCO2 experiment, and precipitation change range from -160% to +160% relative to the difference between 2xCO2 and control experiments. The peak latitude of precipitation shifted northward from -1.5º to +2.5º, and it was verified that most of the change is contributed by the change in the Hadley circulation, rather than the change in the moisture amount in the atmosphere. Energetic analysis will be presented.