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Tropical circulations and changes of the hydrological cycle during the Holocene and Eemian from climate model simulations

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We performed simulations of the early Holocene (9.5K) and the Eemian warm period (126K) with the Kiel Climate Model (KCM). Our model results show an intensification of the SH winter (boreal summer) Hadley cell and a northward extension of its rising branch (ITCZ) for both the early Holocene and Eemian. The strengthening of the Hadley circulation dominates over the tropical Atlantic and, especially, over the tropical Pacific sectors due to an enhanced meridional SST gradient between southern and northern Tropics. Our model results also show that the rising branch of the Walker circulation is shifted towards the Indian Ocean during the early Holocene and Eemian in response to increased zonal SST gradient across the Indo-Pacific Ocean.

The orbitally-induced increase of the cross-equatorial insolation gradient in the tropical Pacific leads to a strengthening (weakening) of the wind speed and evaporative cooling over the southern (northern) tropical Pacific, which reinforces the initial radiatively-forced meridional SST gradient change. The increased cross-equatorial insolation gradient in combination with strong wind-evaporation-SST feedback and changing surface humidity are important mechanisms to intensify the Hadley circulation in response to orbital forcing.

Another important goal of our study is to analyze a possible difference between Holocene and Eemian monsoon intensity in terms of magnitudes as well as of regional and seasonal pattern of precipitation over Africa, India and Asia using model simulation with more realistic external forcing.