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Sensitivity of the hydrological cycle to climatic changes

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Characteristics of the atmospheric hydrological cycle including precipitable water, relative humidity, precipitation and residence time of atmospheric moisture from different climate forcing simulations are analyzed. Therefore, simulations of the coupled atmosphere-ocean general circulation model KCM (Kiel Climate Model) forced by variations of orbital parameters (corresponding to the Eemian, 126-115 kyr BP, and Holocene, 9.5 kyr BP - preindustrial) and increasing concentration of greenhouse gases (SRES-A1B scenario, 1850-2100) have been used. Paleo-climate simulations with the KCM are compared to the reconstructions of the lake level for the mid-Holocene (6 kyr BP). The model simulates an increase (decrease) of summer (winter) cross-equatorial flux of water vapor into the Northern Hemisphere for the early Holocene and Eemian with respect to present. It leads to 30% and 50% increase in annual cross-equatorial water flux into the Northern Hemisphere for the 9 kyr and 126 kyr BP, respectively. As a result of the stronger seasonal variations of cross-equatorial water transport, the hemispheric-mean atmospheric moisture in Northern Hemisphere increases with surface temperature at a higher (lower) rate during summer (winter) relative to that obtained in SRES-A1B scenario experiment. The model simulation with SRES-A1B scenario predicts an increase in the global mean residence time of atmospheric moisture at a rate of about 5% per Kelvin of surface warming in the 21st century, corresponding to an increase from 9 to 11 days in 2100.