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Sensitivity of the hydrologic cycle to cloud changes in warm climates

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Climates of the deep past have posed the longstanding challenge to understand which mechanisms maintained very warm climates. Warm climates have been hard to simulate without very high CO_2 concentrations compared to estimates from proxy data. Large climate sensitivity implies a route to warm temperatures without very high concentrations of CO_2. In at least one model cloud feedbacks play a central role in increasing climate sensitivity with temperature. However, it is hard to evaluate cloud feedbacks using proxies. On the other hand, there are proxies that provide information about the hydrologic cycle for example through estimating aridity and isotope analysis of leaf wax. Cloud feedbacks could influence the hydrologic cycle through a change in the shortwave radiative flux at the surface that causes a change in latent heat flux and thereby a change in precipitation. We study the impact of clouds in a general circulation model for a broad range of temperatures. One set of simulations with variable clouds is compared to a set of simulations where clouds are represented by a climatology. Our aim to provide a constraint for cloud feedbacks based on hydrology proves elusive. Precipitation change with temperature is very similar regardless of cloud treatment and there is no saturation effect in precipitation as seen in idealized models. However, there is a large change in shortwave absorption by atmospheric water vapor. Our results indicate that the hydrologic cycle is not sensitive to cloud representation in Eocene-like climates but correct representation of shortwave absorption is essential.