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Shifting the ITCZ with longwave and shortwave cloud-radiative effects

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The so called double-ITCZ bias, the too pronounced occurrence of two distinct ITCZs on both sides of the equator, is a long-standing problem in climate simulations. Different mechanisms that can contribute to the emergence of two ITCZs have been suggested, but a coherent theory is still lacking. In this study we investigate for the first time how the shortwave and longwave cloud-radiative effects (CRE) alter the ITCZ position. We use a developmental version of the new GFDL atmosphere model to perform simulations on an idealized aqua-planet with an idealized sea-surface temperature distribution in which we turn off the longwave CRE and the shortwave CRE individually and simultaneously. We find that longwave and shortwave CRE have an opposite effect, with the longwave CRE pulling the ITCZ towards the equator and the shortwave CRE pushing it away from the equator. The mechanism by which the CRE affects the ITCZ position involves changes in the meridional heating gradient by the CREs. The altered heating gradients change the strength of the atmospheric overturning circulation and thereby affect the zonal-mean meridional advection of low-level moist static energy. This change in zonal-mean meridional advection then alters the distribution of low-level moist static energy and thereby the distribution of convection and precipitation.