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ITCZ-MIP: Understanding ITCZ width and its impacts on climate and circulation

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The intertropical convergence zone (ITCZ) is a band of intense rainfall near the equator that dominates tropical climate. Recent work has demonstrated that most climate models predict a narrowing of the ITCZ under global warming and this narrowing may act as a control on global precipitation (Byrne et al., 2018). Observations suggest that a narrowing of the ITCZ has already occurred (Wodzicki and Rapp, 2016). However, a firm theoretical understanding of what sets ITCZ width is still lacking and an understanding of how ITCZ width influences circulation and climate elsewhere is only beginning to be developed (e.g. Watt-Meyer and Frierson, 2019). Theoretical advances to date have been tested in an idealized gray-radiation model and across comprehensive coupled atmosphere-ocean models. We have begun an effort to systematically test theories of ITCZ width at an intermediate level of complexity: in aquaplanets with full radiation schemes but no seasonal cycle. Our approach is to use a slab ocean boundary condition to ensure energy conservation but at the same time constrain global mean surface temperatures to be similar across a small set of models. By imposing idealized q-flux profiles of heating in the deep tropics and cooling elsewhere, we vary ITCZ width. We also perform instantaneous CO_2 quadrupling experiments to test the response to greenhouse gas forcing. Results from the protocol development and proof of concept phase of the effort, including simulations from three climate models, show changes in ITCZ width of up to 40% that are roughly linear in forcing. In these experiments, ITCZ width has substantial effects on global climate and circulation, including the strength of the ITCZ, global-mean temperature, and the Hadley cell.