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Analyzing the double ITCZ phenomenon with ECHAM6 in aqua-planet mode

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The double-ITCZ phenomenon is studied using aqua-planet experiments. Sea-surface temperatures are specified following the QOBS formulation of the aqua-planet inter-comparison project and are characterized by latitudinal and hemispheric symmetry. Depending on choice of convection scheme simulations with ECHAM6 produce either a double ITCZ located about 10 degree or a single ITCZ located at the equator. Deep convection is shown to be organized through a feedback loop which consists of two parts: (i) a wind-evaporation feedback, which controls the moist static energy profile in the planetary boundary layer; and (ii) a thermodynamic regulation working through the regulation of the thermal stability and humidity in the troposphere as a whole. By prescribing the windspeed input to the surface evaporation scheme the ITCZ placement becomes relatively independent of ones choice of convection scheme, which suggests that this feedback loop is crucial to the determination of the placement of the ITCZ, and that subtle differences between convection schemes may be amplified through dynamic feedbacks. In our experiments we find that a crucial difference among the convection schemes we test is in the representation of organized entrainment by deep convection. High entrainment rates render the convection more sensitive to free troposphere humidity and favor more organized patches of convection and a single ITCZ.