

Causes and Interrelationships Between Errors in Climate Models: The Double ITCZ Bias

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The 'Double Intertropical Convergence Zone (ITCZ) Bias' has been a persistent feature of climate models in which simulated mean precipitation appears south of the equator in the East Pacific, when, in reality, this region is relatively dry. We present a number of sensitivity experiments with a coupled climate model in which we modify aspects of the hemispheric surface and atmospheric energy budgets with the aim of affecting the cross-equatorial energy and moisture transports and mean precipitation. In contrast to previous studies that have focused on atmosphere-only experiments, we find more complex relationships between hemispheric energy budgets and the double ITCZ bias in the coupled system. Ocean heat transport seems to play an important role. A linear relationship between precipitation, SSTs and surface flux highlights the role of coupled processes.

We also examine the relationship between the Double ITCZ Bias and the simulation of the El Niño Southern Oscillation (ENSO) in the CMIP5 models. The mean-climate bias is strongly related to biases in the strength of the damping of SST anomalies by surface turbulent fluxes during ENSO events. The surface flux feedback errors are traced to errors in the surface winds, linked to low-level convergence and mean precipitation biases. Although mean climate biases are smaller in the atmosphere-only AMIP simulations, ENSO surface flux feedback biases in those simulations are similar to those found in the associated coupled model. This indicates a major role for the atmosphere model in setting coupled-model errors in both mean climate and variability.

We propose that interrelationships between errors and biases in models may be used to prioritize efforts in model improvement and raise the possibility of solving multiple and persistent model biases simultaneously.