The Double-ITCZ Problem in IPCC AR4 Coupled GCMs: Symptoms, Physical Mechanisms, and Possible Ways to Alleviate

Jia-Lin Lin
NOAA ESRL/CIORES Climate Diagnostics Center, Boulder, CO

1. Introduction
The double-ITCZ problem is one of the major tropical biases in coupled general circulation models (GCMs). It has been persisting in the last several generations of coupled GCMs (e.g., Mechoso et al. 1995; Latif et al. 2001; Davey et al. 2002; Meekel et al. 2005). Previous GCM sensitivity experiments suggested that the problem is mainly caused by the AGCM rather than the OGCM (e.g., Schneider 2002), and increasing the AGCM resolution or modifying AGCM convection scheme can alleviate to some extent the problem (e.g., Mechoso 2006; Zhang and Wang 2006). However, as pointed out by Mechoso (2006), “a synthetic view of the double-ITCZ problem is still elusive”.

2. Symptoms of the double-ITCZ problem in 22 IPCC AR4 coupled GCMs
About half of the models have significant double-ITCZ problem, which is characterized by cold SST bias over much of the tropical oceans, excessive tropical precipitation, overly strong trade winds, excessive latent heat flux, and insufficient shortwave flux.

3. Physical mechanisms of the double-ITCZ problem: Three ocean-atmosphere feedbacks
Neelin and Dijkstra (1995) showed that any excessive positive feedback (or insufficient negative feedback) tends to shift the whole system westward, leading to a double-ITCZ pattern. However, few previous studies have evaluated quantitatively the feedback parameters in GCMs.

4. Quantitative evaluation of ocean-atmosphere feedback parameters in AGCMs
(1) Bjerknes feedback parameter: Overly strong in several models, which is caused by insufficient boundary layer mechanical damping.

5. Summary of the double-ITCZ problem: Symptoms, physical mechanisms, and possible ways to alleviate

6. Future works
(1) Apply the analysis to NCEP CFS/GFS and NASA GEOS5 models;
(2) Apply the analysis to OGCMs to assess the feedback parameters.

REFERENCES
Acknowledgments: This work benefits from discussions with Chris Bretherton, Brian Mapes, Ed Schneider, Max Suarez, Julio Bacmeister and Winston Chao.