Geophysical Research Abstracts
Vol. 12, EGU2010-5674-1, 2010
EGU General Assembly 2010

Improving Monsoon Simulations in a Coupled Atmosphere-Ocean GCM

C. Roberto Mechoso (1), Hsi-Yen Ma (1), Heng Xiao (1), Chien-Ming Wu (1), Yongkang Xue (1,2), Jui-Lin Li (3), and Fernando De Sales (2)

(1) UCLA, Department of Atmospheric and Oceanic Sciences, University of California Los Angeles, Los Angeles, CA, United States (mechoso@atmos.ucla.edu), (2) UCLA, Geography Department, University of California Los Angeles, Los Angeles, CA, United States (yxue@geog.ucla.edu), (3) Jet Propulsion Laboratory, NASA/Caltech, Pasadena, CA, United States (juilin.f.li@jpl.nasa.gov)

The present paper demonstrates that the sensitivity of the warm season (Dec-Feb) climate to land surface processes is crucial to the successful simulation of the monsoon systems by an atmospheric general circulation model (AGCM) both uncoupled (i.e., with prescribed sea surface temperature, SST) or coupled to an oceanic GCM (OGCM). We use the UCLA AGCM with either a simple land scheme that specifies soil moisture availability or with the Simplified Simple Biosphere Model (SSiB), which allows for consideration of soil and vegetation biophysical process. The AGCM is either coupled or uncoupled to the MIT OGCM. The best simulation is consistently obtained in the configurations with SSiB.

To illustrate the reasons for improvement due to a better representation of land surface processes, we focus on the South American monsoon system. In this case, improvement is not confined to the "hot spot" in Amazonia but extends to the heat low region in subtropical South America (Chaco Low). In particular, the regions along the lee of the Andes (South American low-level jet), Amazonia, and Chaco Low are better simulated. It is argued that the more successful depiction of the Chaco Low, which is controlled by local effects of land surface processes, decisively contributes to the improved model performance in the low-level flows over central South America and moisture transport from the Amazon basin to high latitudes. The better representation of the atmospheric column static stability and large-scale moisture convergence in tropical South America contribute to more realistic precipitation over the core monsoon region. The overall success in the simulation of SAMS is, therefore, due to a combination of both local and non-local processes. This finding is supported by idealized AGCM experiments, in which the representation of surface processes is downgraded in selected model domains.

The improvements are even more dramatic in the coupled atmosphere-ocean GCM performance as systematic errors in the tropics that plague such models are reduced with SSiB. The simulated annual mean precipitation and SST are improved. The excessive westward extension of the equatorial cold tongue is reduced and the South Pacific Convergence Zone (SPCZ) is better positioned. In the tropical Pacific, the annual harmonic in the seasonal cycle of SST shows better phase and amplitude, and the frequency and amplitude of the interannual variability in SST are more realistic. It is shown that these results are consistent with the expected effects of more realistic diabatic heating over the continents on the subtropical highs and trade wind distributions, but with significant effects of atmosphere-ocean interactions.