Evaluation of cloud and precipitation bias of East Asia Summer Monsoon using Climate Model Short-Range Hindcasts

Hsi-Yen Ma (Lawrence Livermore National Laboratory)

Wei-Ting Chen (Department of Atmospheric Sciences, National Taiwan University)

Chien-Ming Wu (Department of Atmospheric Sciences, National Taiwan University)

Wei-Hua Hsu (Department of Atmospheric Sciences, National Taiwan University)

Shaocheng Xie (Lawrence Livermore National Laboratory)

Abstract

This study evaluates precipitation and clouds of East Asia Summer Monsoon (EASM) in the Community Atmosphere Model version 5 (CAM5) with a multi-year (1998-2012) hindcast experiment and an AMIP simulation of the same period. Simulating the EASM has long been a grand challenge for global climate models (GCMs) because the monsoon system involves multi-scale interactions between moist convection and the large-scale state. It is difficult to better disentangle the bias contribution from the model physics or dynamics in the long-term climate simulations (AMIP or CMIP). This suite of multi-year hindcasts, initialized from the ERA-Interim reanalysis, allow for evaluating the simulated monsoon system given a well-constrained large-scale state at the exact period surrounding the abrupt onset each year over the South China Sea (SCS), a key precursor of the overall EASM onset. With this experiment, one can better attribute model biases to fast physical processes, such as precipitation and clouds.

Based on the low-level wind SCS onset index, results from the Day 2 (24 to 48 hours) and Day 3 (48 to 72 hours) simulations between years 1998 and 2012 are composited for the two pentads before or after the onset date, and is evaluated against observations. During the pre-onset period, CAM5 simulates excess convective precipitation over SCS and the western Pacific, where the convection is mostly suppressed by subsidence of the subtropical high ridge in the observations. Comparisons between the CFMIP Observation Simulator Package (COSP) output from the hindcast and the climatology of MODIS retrievals show an underestimation in cloud fraction and overestimation of cloud top height over these regions. Such bias indicates that deep and shallow convection is not accurately represented under the suppressed large-scale conditions. The bias in cloud fields is consistent with the bias of overestimated outgoing longwave radiation. The post-onset precipitation in the hindcast shows different genres of bias. The location of coastal precipitation hotspots over south China and west of Philippine is not accurately captured. The Mei-Yu front south of Japan is also weaker and shift northward in the hindcast. Further analysis on the regional water budget and diabatic processes, and their relationship to the precipitation bias will be discussed during the presentation.