# Responses of Global and East Asian Monsoon to Specified Historical SST Forcing in AGCM Simulations

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Multi-model sets of atmospheric simulations forced by historical sea surface temperature (SST) for the period of 1950-1999 are studied to understand the mechanisms of monsoon variability at interdecadal and interannual time scales. Major findings regarding both the strength and weakness of this kind of AGCM simulations are reviewed:

1) Examinations of long-term change in global land monsoon rainfall using rain-gauge precipitation datasets suggest an overall weakening of the global land monsoon precipitation, primarily due to weakening of the summer monsoon rainfall in the Northern Hemisphere. When forced by historical SST covering the same period, an ensemble simulation with an AGCM successfully reproduced the weakening tendency of global land monsoon precipitation. This decreasing tendency was mainly caused by the warming trend over the central-eastern Pacific and the western tropical Indian Ocean. However, the reproduced signal in East Asia monsoon rainfall is low, partly due to the neglect of air-sea feedback in the SST-specified simulation (*Zhou et al. 2008, Journal of Climate*).

2) The prominent feature of East Asian summer monsoon variability during the period of 1950-1999 exhibits a weakening tendency. The authors analyzed the ensemble runs of two different AGCMs forced separately by observed tropical and global SSTs. The results show that the specified SST forcing, primarily from the tropics, including both the Pacific and the Indian Ocean, induced most of the observed circulation changes associated with the weakening of the EASM since the 1970s. The recent warming over tropical oceans, especially those associated with the tropical interdecadal variability centered over the central and eastern Pacific, has played a major role in the weakening of the EASM. However, despite the reasonable simulations of the observed circulation changes, the two AGCMs failed to reproduce the relatively small-scale rainfall change patterns over East China, suggesting that a realistic simulation of the EASM rain-belt and its decadal change remains a challenge to current state-of-the-art global climate models (*Li et al. 2010, Climate Dynamics*).

3) To know how well the AGCMs capture the leading modes of the interannual variability of Asian-Australian Monsoon, we evaluated the performances of 11 AGCMs that participated in the AMIP II, which were forced by historical SST covering the period 1979-1999, and their multi-model ensemble (MME) simulation

of the interannual variability of Asian-Australian Monsoon (AAM). We explored to what extent these models can reproduce two observed major modes of AAM rainfall for the period 1979-1999, which account for about 38% of the total interannual variances. The results show that the MME SST-forced simulation of the seasonal rainfall anomalies reproduces the first two leading modes of variability with a skill that is comparable to NCEP-2 in terms of the spatial patterns and the corresponding temporal variations, as well as their relationships with ENSO evolution. The skill of AMIP simulation is seasonally dependent. The DJF (JJA) has the highest (lowest) skill. Over the extra-tropical western North Pacific and South China Sea, where ocean-atmosphere coupling may be critical for modeling the monsoon rainfall, the MME fails to demonstrate any skill in JJA, while the reanalysis has higher skills. The MME has deficiencies in simulating the seasonal phase of two anti-cyclones associated with the first mode, which are not in phase with ENSO forcing in observation, but strictly match that of Nino3.4 SST in MME. While the success of MME in capturing essential features of the first mode suggests the dominance of remote El Nino forcing in producing the predictable portion of AAM rainfall variability, the deficiency in capturing the seasonal phase implies the importance of local air-sea coupling effects (*Zhou et al. 2009, Journal of Climate*).

**References**

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