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Global monsoon, El Niño, and their interannual linkage simulated by MIROC5 and the CMIP3 CGCMs

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The capability of coupled global climate models (CGCMs) in simulating the prime examples of the forced response (global monsoon) and internal feedback process (El Niño)is investigated. In Particular, due to the low level of assessment of the interannual monsoon variability from a global viewpoint, emphases are placed on the fidelity of the year-to-year variability of global monsoon precipitation that is coordinated by the interannual tropical SST swing. The outcomes of the latest version of Model for Interdisciplinary Research on Climate (MIROC5) with advanced physical schemes are compared with its ancestors having higher and lower resolution than MIROC5 (MIROC3hi and MIROC3med, respectively) and with twenty CGCMs participating in the third phase of the Coupled Model Intercomparison Project (CMIP3). Thirty years of observational records (1979-2008) and the Twentieth-Century Coupled Climate Model simulations (1970-1999) are analyzed using a set of diagnostic metrics and the maximum covariance analysis (MCA).
The climatological annual mean and cycles of precipitation and 850-hPa winds, the key components to demarcate global monsoon domain, are reproduced better in MIROC5 than in MIROC3s. As a consequence, MIROC5 considerably outperforms MIROC3s and is generally superior to the CMIP3 CGCMs in replicating the intensity and domain of global monsoon precipitation and circulations. These results highlight the importance of the improved physical parameterization in a model. Analyses on the monthly Niño 3 index suggest that the amplitude and periodicity of El Niño are simulated better in MIROC5 than in MIROC3s. Yet the reality of nonlinear ENSO dynamics measured indirectly by the asymmetricity is unsatisfactory in the MIROC family as well as in the majority of the CMIP3 models. The MCA shows observational evidences indicating that a significant fraction of the interannual global monsoon rainfall variability is associated with the tropical SST forcing of El Niño. The multi-model results reveal that such coupling is robust across the current CGCMs. More importantly, the fidelity of the global monsoon precipitation significantly relies on the realism of the tropical SST. Comparison among the MIROC models suggests that improved El Niño is likely attributable to the more realistic Bjerknes feedback loop, which results from the intensified convective activity over the equatorial central Pacific.