



Temperature and precipitation in the context of the annual cycle over Asia: Model evaluation and future change

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The Asian monsoon is characterized by a strong annual cycle with rainy summer and dry winter. Nevertheless, most of monsoon studies have focused on the seasonal-mean of temperature and precipitation. The present study aims to evaluate the 27 coupled models participating in phase 5 of the Coupled Model Intercomparison Project (CMIP5) for projection of the time evolution and the intensity of Asian monsoon on the basis of the annual cycle of temperature and precipitation. Moreover, future changes of onset, retreat, and intensity of monsoon are analyzed. Four models for good seasonal-mean (GSM) and good harmonic (GH) groups are selected based on the seasonal-mean and annual cycle of temperature and precipitation, respectively. It is noteworthy that the highest PCCs of onset, retreat, and duration between the reanalysis data and model outputs demonstrate that GH models' MME predicts time evolution of monsoon most precisely, with PCC values of 0.80, 0.52, and 0.63, respectively. To predict future changes of the monsoon, the representative concentration pathway 4.5 (RCP 4.5) experiments for the period of 2073-2099 are compared with historical simulations for the period of 1979-2005 from CMIP5 using GH models' MME. The Asian monsoon domain is expanded by 22.6% in the future projection. The onset date in the future is advanced over most parts of Asian monsoon region. the duration of summer Asian monsoon in the future projection will be lengthened by up to 2 pentads over the Asia monsoon region, as a result of advanced onset. The Asian monsoon intensity becomes stronger with the passage of time. This study has important implication for assessment of CMIP5 models in terms of the prediction of time evolution and intensity of Asian monsoon based on the annual cycle of temperature and precipitation.