Geophysical Research Abstracts
Vol. 19, EGU2017-18778, 2017
EGU General Assembly 2017

Seasonal cycle of precipitation over major river basins in South and Southeast Asia: A review of the CMIP5 climate models data for present climate and future climate projections

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We review the skill of thirty coupled climate models participating in the Coupled Model Intercomparison Project Phase 5 (CMIP5) in terms of reproducing properties of the seasonal cycle of precipitation over the major river basins of South and Southeast Asia (Indus, Ganges, Brahmaputra and Mekong) for the historical period (1961–2000). We also present how these models represent the impact of climate change by the end of century (2061–2100) under the extreme scenario RCP8.5. First, we assess the models' ability to reproduce the observed timings of the monsoon onset and the rate of rapid fractional accumulation (RFA) slope — a measure of seasonality within the active monsoon period. Secondly, we apply a threshold-independent seasonality index (SI) — a multiplicative measure of precipitation (P) and extent of its concentration relative to uniform distribution (relative entropy — RE). We apply SI distinctly over the monsoonal precipitation regime (MPR), westerly precipitation regime (WPR) and annual precipitation. For the present climate, neither any single model nor the multi-model mean performs best in all chosen metrics. Models show overall a modest skill in suggesting right timings of the monsoon onset while the RFA slope is generally underestimated. One third of the models fail to capture the monsoon signal over the Indus basin. Mostly, the estimates for SI during WPR are higher than observed for all basins. When looking at MPR, the models typically simulate an SI higher (lower) than observed for the Ganges and Brahmaputra (Indus and Mekong) basins, following the pattern of overestimation (underestimation) of precipitation. Most of the models are biased negative (positive) for RE estimates over the Brahmaputra and Mekong (Indus and Ganges) basins, implying the extent of precipitation concentration for MPR and number of dry days within WPR lower (higher) than observed for these basins. Such skill of the CMIP5 models in representing the present-day monsoonal hydroclimatology poses some caveats on their ability to represent correctly the climate change signal. Nevertheless, considering the majority-model agreement as a measure of robustness for the qualitative scale projected future changes, we find a slightly delayed onset, and a general increase in the RFA slope and in the extent of precipitation concentration (RE) for MPR. Overall, a modest inter-model agreement suggests an increase in the seasonality of MPR and a less intermittent WPR for all basins and for most of the study domain. The SI-based indicator of change in the monsoonal domain suggests its extension westward over northwest India and Pakistan and northward over China. These findings have serious implications for the food and water security of the region in the future.

Reference
Ul Hasson, S., Pascale, S., Lucarini, V., & Böhner, J. (2016). Seasonal cycle of precipitation over major river basins in South and Southeast Asia: A review of the CMIP5 climate models data for present climate and future climate projections. Atmospheric Research, 180, 42-63. doi:10.1016/j.atmosres.2016.05.008