Future projection of Indian summer monsoon variability under climate change scenario: Results from CMIP5/CCSM4 model simulation

Sujata K. Mandke[1,*] and Amita Prabhu[1]
[1]Indian Institute of Tropical Meteorology, Ministry of Earth Sciences, INDIA
*amin@tropmet.res.in, amitaprabhu@tropmet.res.in

1. Introduction

Considering the inherent complexities in the monsoon system and its strong sensitivity to global warming (Kitoh et al., 2013), simulations and projections of monsoon variability (Turner, 2011) have remained a challenge to the climate research community. Numerous modeling studies over last two decades have provided quantitative estimates of the monsoon variability in future (Wang et al., 2020). Nevertheless, the possible modulation of the inter-annual variability (IAV) of Indian summer monsoon rainfall (ISMR) by climate change still remains largely uncertain (IPCC, 2007). In this study, we address this issue by analyzing the simulations for the current and future projections of IAV of ISMR, using 20th century historical and 21st century projections with three Representative Concentration Pathways (RCP) scenarios by CCSM4 model from fifth Coupled Model Intercomparison Project (CMIP5; Taylor et al., 2012). CCSM4 model is selected due to its high horizontal resolution and modest ISMR climatology with respect to the observation (Prabhu and Mandke, 2019).

2. Data

Monthly mean precipitation (mm/day) data of CCSM4 model for the reference period (1861-2005; RP) of the 20th century historical and three RCP scenarios (2.6, 4.5 and 8.5), for the period (2006-2100) of the 21st century from CMIP5 (http://www-pcmdi.llnl.gov), are used.

3. Results

The IAV (bars), trend in IAV (dashed line) and decadal variability (shading) of summer monsoon precipitation averaged over India (8^0N-38^0N; 68^0E-98^0E) in historical and three RCP simulations of CCSM4 model from CMIP5 are depicted in figures 1a, 1b, 1c, and 1d respectively. A decrease in amplitude of both IAV and decadal variability in all three RCPs with respect to RP is noticed. There is consensus in IAV and decadal variability among three RCPs. The trend in the IAV is insignificant in both historical and three RCPs. The limitation of this study is the analysis of single model, which will be substantiated in future with multi-models.

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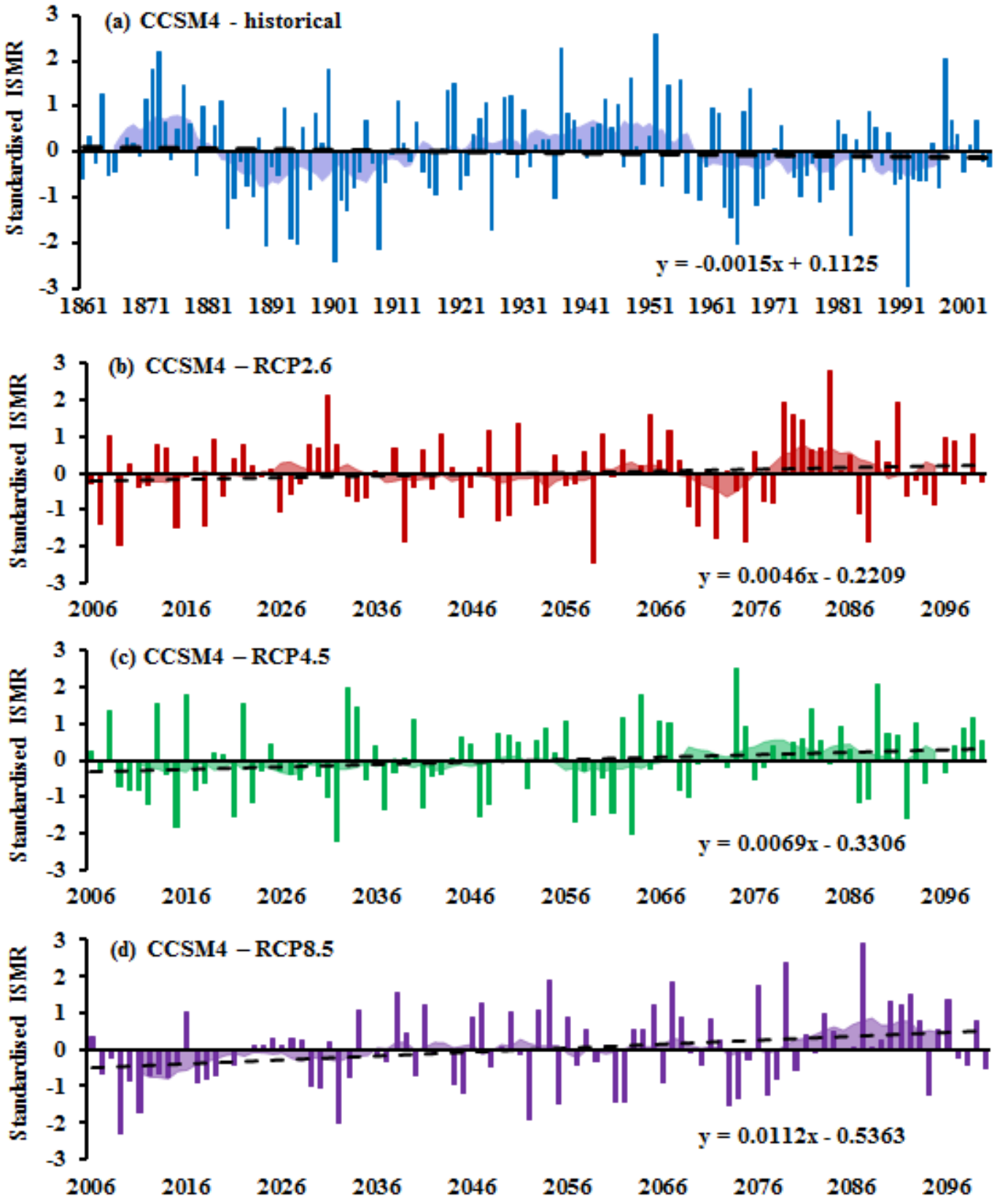

Figure 1: Inter-annual variability of precipitation over India simulated by CCSM4 model from CMIP5. Colored bars (year-to-year variations); Shading (decadal variability); Black dashed line (trend) (a) Historical run (b) RCP2.6 (c) RCP4.5 (d)RCP8.5