Abstract

Present study primarily focuses on the investigation of Indian Summer Monsoon (ISM) and its spatio-temporal variability through seasonal scale simulation (SCS) using Regional Climate Model (RCM). A popular RCM of recent times viz., RegCM version 4 (RegCM4) is employed in the entire thesis. In addition to different analytic procedures, the model skill is also evaluated using statistical techniques. First, the model was customized through sensitivity studies on cumulus convection (CCS) and land surface (LSM) parameterizations based on SCS of ISM for three consecutive years: 2007, 2008, 2009. Two different model versions viz., RegCM4.1 and RegCM4.4.5 with five CCSs namely, MIT, KUO, GRELL, GO ML and GL MO and three LSMs such as BATS, CLM (version 3.5) and CLM (version 4.5) are considered in this study. Results from different combinations of CCSs and LSMs are analyzed and verified with observation/reanalysis datasets. Better performing schemes based on the initial analysis of simulations using RegCM4.1 with BATS, CLM3.5 and five CCSs, are further compared with RegCM4.4.5 with CLM4.5. Analysis of the results indicate that RegCM4.4.5 in combination with CLM4.5 and GO ML scheme exhibits better skill in simulating spatial distribution and magnitude of different synoptic features during ISM. Afterwards, variability of ISMR at interannual (IAV) and intraseasonal (ISV) time scales are based on 32 years (1982- 2013) SCS of customized RegCM4. Different facets of IAV (seasonal/monthly climatology, excess/deficit year identification, leading modes etc.) and ISV (daily climatology, active/break spell classification, intraseasonal oscillations etc.) are investigated and verified with the high resolution rainfall observation data from India Meteorological Department (IMD). Furthermore, model skill is not only evaluated over all India level but also over different homogeneous regions. Based on the above analysis, it is reported that even though the model shows good skill in simulating different broad scale features associated with IAV and ISV, large deviation is noticed in their temporal variation. Spatial distributions of the climatological features of various parameters at different temporal scale viz., daily, monthly, seasonal etc. are nicely captured by the model but it fails to accurately predict different epochs of rainfall such as active/break spell at sub-seasonal scale and thereby hampers variability at interannual scale also. An attempt has also been made to evaluate the impact of soil moisture (SM) initialization towards SCS of ISM. Numerical simulations are conducted using customized RegCM4, initialized with satellite derived and high resolution SM data from European Space Agency-Climate Change Initiative (ESA-CCI) by replacing its default SM data during two selected years viz., 2002 (deficit) and 2011 (normal). The analysis suggests that the model simulation got enhanced to an extent while initialized with SM both in seasonal and monthly scale. Especially, unusual model bias diminishes and thereby justifies the better skill. However, still the model lacks in simulating the various epochs of ISM accurately and hence influences its ability to predict the temporal variation. Based on the results, the present study advocates that the use of high resolution RegCM4 model, within its limitations, can be useful for the understanding and prediction of ISM rainfall variability.

Keywords: Indian Summer Monsoon, Regional Climate Modeling, Interannual Variability, Intraseasonal Variability, Satellite derived soil moisture, Seasonal Climatology of Monsoon Rainfall.