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Evaluation of statistical corrective methods to minimize bias at different time scales in a regional climate model driven data

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ABSTRACT

The regional climate models provide sufficient information of the climate data, which can be used for simulating the impact of expected climate change on crop growth and hydrological processes. But future climate data derived from such models often suffers from bias and is not ready to use *per se* in crop growth/hydrological models, wherein reasonable and consistent meteorological daily input data is a crucial factor. The present study concerns the assessment and minimization of the bias in the PRECIS modeled data of maximum and minimum temperatures and rainfall for Ludhiana station, representing central Punjab of India. The correction functions for three corrective methods i.e. difference, modified difference and statistical bias correction at daily, monthly and annual time scales were developed and validated to minimize the bias. Amongst these, correction functions derived using modified difference method at daily time scale for rainfall and at monthly time scale for Tmax and Tmin were found to be the superseding.

Key words: Past climatic data, bias, bias correction methods, correction functions, time scale

Increasing observed temperature and rainfall over last few decades and related changes in the large-scale hydrological cycle due to anthropogenic interventions are posing an unprecedented challenge for crop production and hydrology (Parry *et al*. 2007; Bates *et al,* 2008). These challenges are likely to aggravate in future. Climate models are the main tools available for developing projections of climate change in the future. In climate change studies, general circular models (GCMs) and regional climate models (RCMs) are used to predict changing levels of CO_2, temperature and rainfall under different scenarios. The most commonly used GCMs are Hadley Centre Coupled Model version 3 (HadCM3), Commonwealth Scientific & Industrial Research Organization Mark 2 (CSIRO-Mk2) and Second version of Canadian Center for Climate Modeling and Analysis Coupled Global Climate Model (CCCMA-CGCM2). In recent years, the usage of RCMs has increased because of their improved ability to reproduce the present day climate (Xu *et al.,* 2005). Raw outputs of the climatic parameters from RCM models often suffer from systematic errors which may prevent their direct application for the analysis of the behavior of the climate system, its eventual changes and their local impacts. The errors in modeled daily rainfall and temperature may afflict the monthly or annual time trends and magnitude. Andreasson et al. (2004) pointed out that these biases are particularly pronounced for rainfall than temperature. Therefore, projected raw data must be made bias free using some corrections based on statistical corrective methods (Sharma *et al.,* 2007; Hansen *et al.,* 2006; Feddersen and Andersen, 2005). A number of statistical correction techniques from simple to advanced (Boberg *et al.,* 2007, Teutscbein and Seibert, 2010), to remove the bias in rainfall and temperature have been quoted in literature. The underlying assumptions is that the corrections methods and their parameters are valid for longer area and remain constant over time especially when moving from baseline to scenario simulations (Déqué, 2007; Hashino *et al,* 2007), but the improvements to the statistical properties of the data are limited to the specific time scale of the fluctuations and the site. Keeping this in view, the present study was undertaken with the objective to develop and validate correction functions using Statistical Bias correction (SBC) and other simple correction methods for matching the statistical parameters i.e. mean (μ), standard deviation (σ) and variance (σ^2) of the corrected modeled data with the observed.