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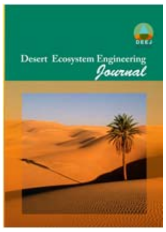

Reducing Uncertainty in Average Temperature Projections of Global Climate Models in Dry Regions

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Extended Abstract

Introduction: The increased use of fossil fuels has resulted in the production of pollutants and the release of greenhouse gases, leading to a global rise in temperature and climate change. On the other hand, climate change significantly influences temperature, precipitation, humidity, and cloud cover in local and regional variations. Therefore, considering the varying trends of climate change across different regions, it is crucially important to investigate the long-term trends of key climate parameters, including temperature and precipitation.

Global Climate Models (GCMs) are reliable tools for simulating the global climate response to greenhouse gas concentrations. Performing based on greenhouse gas emission scenarios, the models can project the data of future climate variables such as precipitation and temperature for the entire Earth in three dimensions. On the other hand, the temperature is expected to rise in different parts of the world by varying degrees, although the exact amount is uncertain. In this regard, climate change not only raises temperature but also affects the hydrological cycle by accelerating ocean surface evaporation.

It is important to acknowledge the uncertainty of GCM outputs in investigations, as its ignorance may reduce the reliability of the results. It should be noted that the raw data obtained from GCMs may not adequately resolve this problem and can diminish the precision of the results. Bias-correction methods have become increasingly common in climate change impact studies over the past decade, ranging from simple averaging methods to complex ones. Therefore, this study sought to investigate the efficiency of LS, NBC, and SDSM bias-correction methods and the combination of SDSM and LS models in reducing the uncertainty of CanESM2 temperature predictions in dry areas.

Material and methods: covering an area of approximately 74,650 square kilometers, Yazd province is located in the center of Iran between 29 degrees 48 minutes to 33 degrees 30 minutes north latitude and 52 degrees 45 minutes to 56 degrees 30 minutes east longitude, being characterized by the most unfavorable natural factors that dominate Iran's central plateau.

This study used three groups of data: 1) daily temperature data collected from Yazd synoptic station from 1966 to 2020, provided by the National Meteorological Organization; 2) Atmospheric statistics obtained from the National Center for Environmental Prediction and the National Center for Atmospheric Research (NCEP/NCAR) for the same period; 3) CanESM2 general circulation model of temperature simulations used for the periods of 1966-2005 and 2006-2045, based on the RCP8.5 emission scenario. The study applied three bias-correction methods, including LS, NBC, and SDSM, and performed LS on the outputs of the SDSM model to correct the temperature outputs of the CanESM2 model under the RCP8.5 emission scenario. To assess the

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efficiency of the methods used, the outputs of each bias-correction method were compared with observational data during the 2006-2020 period.

Results: The results revealed a consistent sinusoidal trend in the daily and monthly temperature data. The highest and lowest monthly average temperature rates were found to have been typically recorded in July and January, respectively. Moreover, the average annual temperature indicated an increasing trend from 1966 to 2005, which was found to have continued from 2006 to 2020, but with fewer variations. On the other hand, the results of the CanESM2 temperature simulations based on the RCP8.5 emission scenario suggested that the variations followed a pattern relatively similar to that of the observations. The average annual temperature simulated by the model for both the past (1966-2005) and future (2006-2045) showed a significant increasing trend. However, observational data for the 1966-2005 period indicated a slower increasing trend than the simulated values during the same period. As predicted, compared to the raw model values, the bias-corrected values obtained via the LS method better matched the actual data found for the evaluation period (2006-2020). As for the NBC application, the results suggested that the method improved the accuracy of future average temperature projections of CanESM2. It was also found that SDSM and LS offered relatively acceptable accuracy in terms of SDSM outputs. The results also revealed that the temperature data corrected by all four methods, including LS, SDSM, NBC, and the combination of LS and SDSM agreed well with observational data collected from the synoptic station, whose coefficients of determination were found to be 0.948, 0.968, 0.969, and 0.969, respectively. Moreover, the non-parametric Kendall test revealed a significant increasing trend in the average annual air temperature for both past and future periods in the study area.

Discussion and conclusion: the comparison of the coefficients of determination of the average monthly temperature rates corrected by the above-mentioned methods and the ones found for the observational data during the evaluation period indicated that all four bias-correction methods performed acceptably in the study area. It is worth noting that the LS method showed a slightly poorer performance than the other error correction methods. Based on the results of this study, it can be concluded that since the efficiency of methods used for reducing the uncertainty of temperature outputs in dry areas was relatively acceptable, it seems that investigating suitable methods for reducing the uncertainty of precipitation outputs in dry areas would be of greater importance.

Keywords: Arid Regions, Bias-Correction, Climate Change, Mean Temperature, NBC, Uncertainty.