Comparison of statistical downscaling in climate change models to simulate climate elements in Northwest Iran

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Extended abstract

Introduction

Linking global climate models with local scale as a micro climatic process is of great importance. Recently, many attempts have been made by researchers to develop dynamics and statistical downscaling methods for expressing climate change at a local and regional scale. Two general techniques are used for downscaling of the output of General Circulation Models (GCM). The primary solution is application of statistical methods in which the output of a statistical model (MOS) and a planned approach to weather short-term numerical prediction is presented. The second is regional climate model (RCM), that same is limited GCM model in a subnet of the network global model and by dynamic method using climatic conditions temporal changes according to GCM model. Both methods play an important role in determination of the potential effects of climate change caused by increased greenhouse gas emissions. Much work is done to use this method for downscaling of the global model output in different areas in which the performance of the model is assessed and uncertainty analysis has been done on these methods or were compared by other statistical methods.

Materials and methods

In this study, three approaches to statistical downscaling methods are provided. The first approach uses random generation of climate models based on time series and fourier series delivers. LARS-WG statistical model is one of the ways to build this approach. In this model, the empirical distribution of daily series of dry and wet precipitation and solar radiation is desirable. The minimum and maximum daily temperatures are the daily stochastic process with mean and standard deviations. Seasonal cycles by means of finite fourier series have the order 3

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and model residuals (model errors) is approximated by a normal distribution.

The second approach is regression model or transfer function that is used to examine the relationship between atmospheric parameters and synoptic factors (predictor variables) to have a vision of the future (Instant predictor variable) for a transfer function. One of the applications that combine these two approaches is based on statistical downscaling model (SDSM). The meteorological station data are required as input and output in seven steps of GCM model are downscaled on the basis of daily data in the area.

The third downscaling model is Artificial Neural Network (ANN). This model is a non-linear regression type in which a relationship is developed between a few selected large-scale atmospheric predictors and basin scale meteorological predictors. In developing that relationship a time lagged recurrent network is used in which the inputs are supplied through tap delay line and the network is trained using a variation of backpropagation algorithm. A slightly different approach is application of the predictors for the case of neural network downscaling.

To compare the data generated by the models and observation values, we employed two non-parametric tests of MANN-Whitney. For the observed values and the model values, we have also used Spearman correlation. The basic correlation analysis is based on linear correlation coefficient of the two variables. One of the important indicators that can be used for performance evaluation model, index model mean square error (LARS-WG) is defined as follows:

$$RMSE = \sqrt{\frac{\sum_{i=1}^{N}(O_i - E_i)^2}{N}}$$

The North West area of Iran, including the provinces of East Azerbaijan and West Azerbaijan, Ardabil, Zanjan and a part of Kurdistan in the geographical coordinates ˚49 '30 ˚44 '07 and the ˚36 '00 to ˚39 '50 North. To study the effects of climate change in the region, we used statistical models for a minimum period of 1961-1990. In addition to the complete statistical period, synoptic meteorological stations of old climate data confirmed the country's Meteorological Agency to help some regional stations for multi-year statistical vacuum.

Results and discussion

The results indicated that according to the MANN-Whitney test the performance of three models for minimum temperature in the study area are close together. Spearman correlation test results for minimum temperature show that the number of correlation, in all stations for LARS-WG model is less than the other two. This demonstrates low performance of LARS-WG model in this respect. The average number of months with significant correlation for ANN model with seven months of the year represented that the best performance was among the three models. SDSM model with a four-month correlation table is in the middle. In terms of LARS-WG index for the minimum temperature, LARS-WG and ANN models have average values close together. This shows the error of sum of squares closer to the two models. LARS-WG values are less than the SDSM model and this shows the SDSM model is less accurate than the other two models.

According to our evaluation, according to MANN-Whitney test of the model generated

values it can be stated that the difference between the observed and tested model values, for minimum and maximum temperatures in three models have not different performance. But the results were somewhat different in different stations. Correlation data for SDSM and ANN models for maximum high temperature and minimum temperature for solidarity in SDSM model is less than ANN model. However, because the same structure prediction methods and large-scale use of such an outcome was not unexpected.

MANN-Whitney test for precipitation results show that significant differences between the observed and modeled data for ANN is much more than the other two. This reflects the low performance of this model. SDSM and LARS-WG models have similar good performance in this regard. The Spearman correlation test indicated that all three models have a low correlation. This represents that the three models are low in this respect in the study area. According to the LARS-WG, the SDSM model is better than the other two models in average performance.

Keywords: ANN, climate change model, downscaling, LARS-WG, SDSM.