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A Bayesian Approach for GCMs Selection and Ensemble Projections under the latest Emission Scenarios

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Background: The tremendous development in computational technology makes it easy to run Global Climate/Circulation Models, however, due to different parameterization schemes, variation in boundary layers and different resolutions, relying on the output from a single model may give deceptive results. Appropriate Selection of GCMs becomes even trickier when the study area has abrupt spatial variability in climate.

Methodology: Posterior inclusion probability is used as model selection parameter under the Bayesian model averaging approach to select the best Global Climate/Circulation Model(s) among a number of competing models over a given study area. To minimize the gap between observed and simulated data, statistical bias correction has been implemented which preserves the climate change signals in future. Bayesian Model averaging is used to produce ensemble climate projections using the outputs from thirteen Global Circulation Models. In Bayesian model averaging, each model is assigned a weight equal to the posterior probability of being included in a regression model. Ensemble projection will increase the confidence as compared to single model's projections because it considers the uncertainty inherent in the models. Further, a comparison is made between baseline and future climate projections under RCP45 and RCP85 for maximum and minimum temperature and precipitation.

Results: The best models among thirteen Global climate models have varying importance for maximum, minimum temperature and precipitation, however, they share some common models with regard to the top five. In addition, different prior choices have influence on the selection of GCMs, which is different under each variable, but for maximum temperature there is no distinctive prior's influence for the top five models. The ensemble projections and their 90% prediction intervals almost covered the observed data. The ensemble projections have higher correlation with observed data and reproduced the variability of observed data more closely than that of individual models' output. Further, comparison of future projections using Bayesian model averaging shows that there are more changes under the RCP85, however, the projections under the RCP45 have more variability as compared to that under the RCP85

Conclusion: Prior to simulating the climatology, it is important to do a preliminary study and uncertainty analysis to choose a representative climate model for specific locations based on their climatic conditions. Ensemble projections have closer agreement with observed data compared to that of individual models' output.

Keywords: Global Circulation Model, Ensemble Projections, Uncertainty Analysis, Posterior Inclusion Probability, Bayesian Model Averaging, Northern Pakistan.