

A Process Driven Downscaling Technique to Improve Confidence in Climate Projections

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November 23, 2022

Abstract

Statistical downscaling plays an important role in reducing the uncertainty in regional-scale climate change studies. A major assumption of all statistical downscaling studies is the stationarity in the relationship identified from the historical observations. This assumption is difficult to validate since the future is truly unknown. The proposed methodology tries to overcome the limitations of this assumption by considering global physics that drive the regional climate to select the predictors to develop the statistical relationship. Since the statistical model is developed with climatic processes as a background, it can be said with higher confidence that the modelled relation would remain sound for the future as well. The proposed methodology is divided into two stages. In the first stage, a Relevance Vector Machine model is developed using historical observed global predictors that are identified to have teleconnections with the regional climate predictand. The spatial downscaling of this regional predictand has been done on a monthly scale. The bias associated with the downscaled predictand is removed by separating the anomalies from the prediction and adding that to the historical mean of the observed data. This monthly series is further disaggregated into daily series using a weather generator. The non-stationarity in the climate projections is accommodated in the weather generator and more regional features of the climate is integrated into the predictand in this stage. The proposed methodology is validated by downscaling rainfall over a river basin in India and its performance is analysed. The downscaled data is seen to reproduce characteristics of daily rainfall like consecutive wet days, the number of rainy days, wet spell duration, and dry spell duration with a bias of less than 10%.

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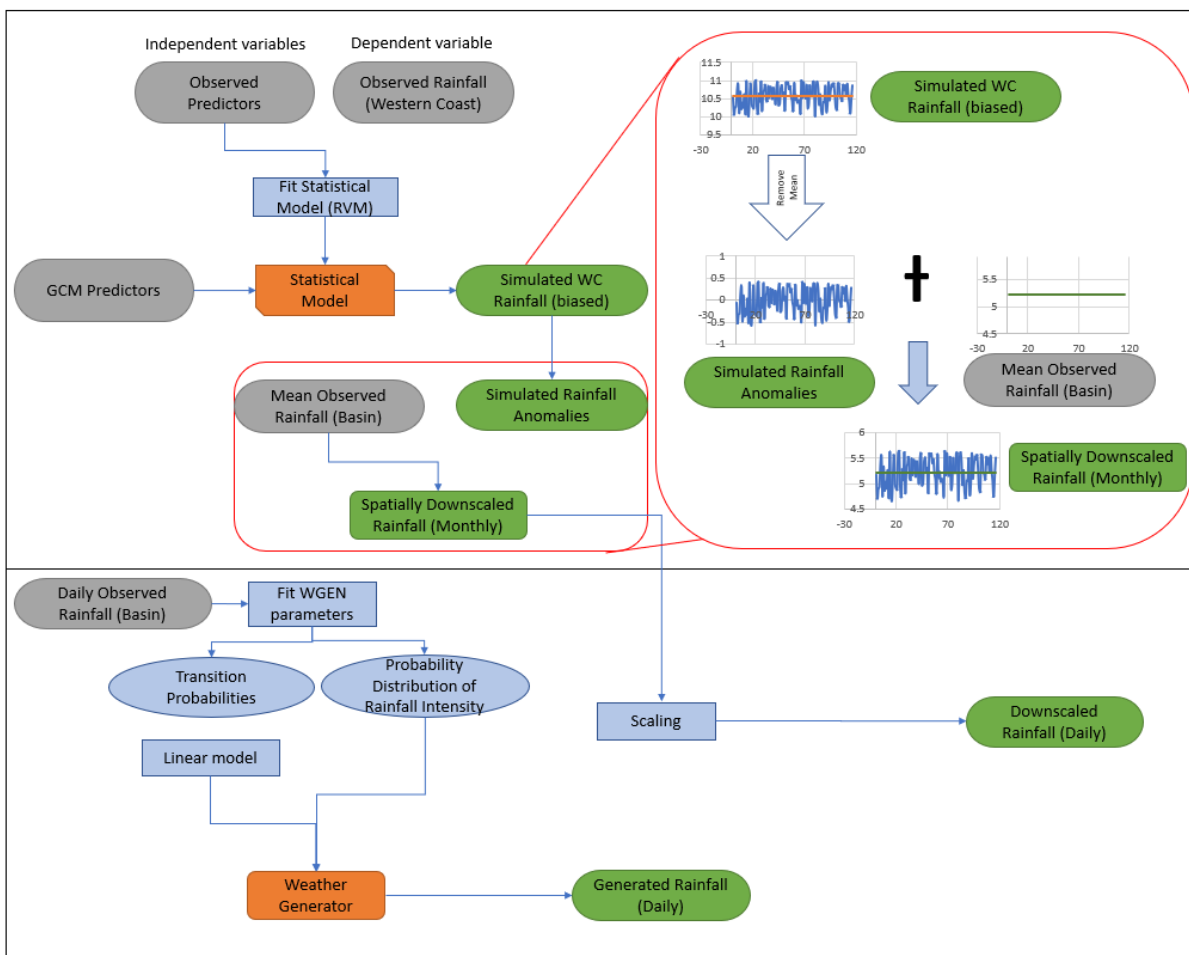
MOTIVATION

- Statistical Downscaling; Primary assumption - Statistical relation between predictor (Large Scale Variables) and predictand (Rainfall or temperature) remains same in the future **Cannot validate because of Unknown future**
- Statistical models using predictor variables that drive the predictand will provide better performance (Liu et al., 2019)

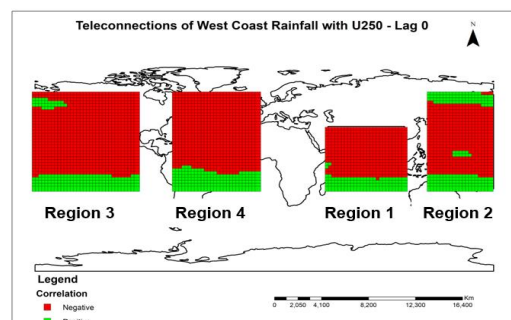
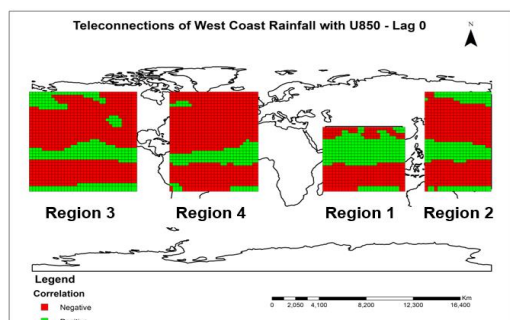
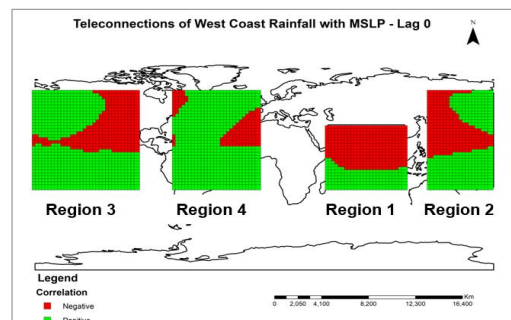
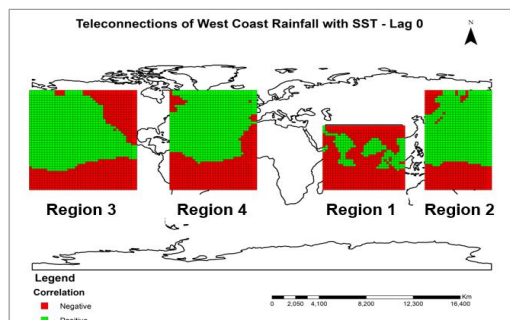
Liu, Yonghe, Jinming Feng, Yuehong Shao, and JianLin Li. "Identify optimal predictors of statistical downscaling of summer daily precipitation in China from three-dimensional large-scale variables." Atmospheric research 224 (2019): 99-113.



METHODOLOGY



Combine spatial downscaling using Relevance Vector Machine with temporal downscaling using Weather Generator



Statistic – Daily downscaled	Observed	Downscaled
Mean	5.69	6.47
Variance	139.47	209.87
Skewness	3.60	3.81
98th Percentile rainfall	44.30	54.97
P98th percentile of wet series	54.58	75.25
Frequency of below 15 mm rainfall	0.87	0.85
Frequency of Above 15 mm rainfall	0.05	0.06
Precipitation Concentration Index	17.84	16.64

Setting Up the RVM Model

RVM Model Performance	Calibration (1981-2018)	Validation (1949-1980)
NSE	0.75	0.68
Correlation Coefficient	0.86	0.82
RMSE	113.87	136.91

- Methodology validated at Bharathapuzha catchment for the GCM: **BNU-ESM**
- Physical relations modelled using RVM
- Occurrence characteristics of rainfall events added in weather generator

THANK YOU

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