

Application of bias correction Artificial Intelligence techniques on various CMIP6 SST teleconnections

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Abstract: In recent decades, Brazil has experienced increasing impacts from extreme weather events associated with climate change. Previous studies have demonstrated robust links between large-scale teleconnection indices and synoptic-scale phenomena that trigger extreme events across the country. Among global teleconnections, those associated with sea surface temperature (SST) exhibit stronger correlations with synoptic indices, highlighting the oceans' role in modulating these events. Although climate model projections have limited horizontal resolution to directly represent regional extremes, they perform consistently in simulating large-scale features such as SST variability and associated teleconnection patterns. Therefore, SST-based teleconnection indices offer a promising approach for inferring potential changes in event frequency and intensity. A key requirement for such applications is the identification and correction of SST biases in climate model simulations, as these biases can distort the representation of extreme conditions. This study proposes a methodology to identify and correct biases in SST-based teleconnection indices derived from CMIP6 Earth System Models, incorporating Artificial Intelligence techniques to assess bias structure and non-linearity. Six models were selected considering the historical experiment and the SSP2-4.5 and SSP5-8.5 scenarios. To construct a consistent observational reference, three SST datasets were combined: NOAA OISST V2 dataset (1981–2014; 0.25°), Hadley Centre Sea Ice and SST dataset (1870–2014; 1°), and NOAA Extended Reconstructed SST v5 dataset (1854–2014; 2°). The merged observational series prioritizes spatial resolution while maintaining long-term coverage. Bias identification is conducted by comparing teleconnection indices derived from observations and historical simulations. Linear regression-based bias correction is used as a baseline approach, while Quantile Mapping is applied to indices with non-linear bias structures. Additionally, the Extreme Gradient Boosting algorithm is explored to capture potential non-linear patterns in SST bias structures. The resulting bias-corrected indices provide a more consistent basis for assessing future changes in extreme events in Brazil.

Keywords: Sea Surface Temperature; Linear regression; Quantile Mapping; extreme events; SSP projections; XGBoost

