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How well does climate model perform for southern Brazil?

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Southern Brazil is in a transitional zone between tropical and extratropical climates. The rainfall regime in such transitional zones can be rather sensitive to climate change and related expansion of the tropics in the Southern Hemisphere. It is expected that rainfall will increase up to 30% over this area in the next decades. It is important, however, to investigate if the mechanisms that generate rainfall are simulated correctly in the models to know when downscaling and bias correction methods should be applied. The objective of this study is to evaluate the performance of the CMIP5 climate models in terms of precipitation in southern Brazil. This study addresses fundamental aspects of model evaluation and aims to give guidance on the proper use of climate model outputs for southern Brazil. We use 41 historical climate simulations and 22 RCP8.5 future climate simulations for the periods of 1980-2005 and 2070-2100, respectively. We compare the historical simulations with an interpolated product database obtained from ground stations. To evaluate the model performance regarding its marginal distribution, we use the following metrics: annual rainfall, variance, skewness, dry day fraction, wet day fraction, high percentiles and similarity of distributions (trough Kolmogorov-Smirnov test). There is a negative bias in all of them except for wet day fraction. All metrics of temporal aspects such as Markham's seasonality index, autocorrelation, time of the annual maxima, dry spell average and maximum lengths, wet spell average and maximum lengths show a positive bias, apart from the time of annual maxima. Overall, annual rainfall is expected to increase in southern Brazil. Spatial patterns of annual rainfall are similar in the RCP 8.5 future pathways to the ones found in the historical period, with wetter areas expanding toward the north. However, the spatial pattern of observed rainfall is not captured by climate models. They simulate smaller volumes of precipitation in the southern border. A similar pattern was found in extreme precipitation, with bias almost twice as large than the one found in annual rainfall. Furthermore, the models do not properly represent the seasonal cycle, the Markham's seasonality index reached four times the observed in some areas. Given the poor performance in the area, the use of future simulations in impact studies should be done carefully once the direct use of climate model precipitation in hydrological studies could result in misleading conclusions.

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