How well do climate model perform for southern Brazil?

Maria Fernanda R. Pereima[1], Pablo B. Amorim[1], Tássia M. Brighenti[1], Regina R. Rodrigues[2], Pedro Luiz B. Chaffe[1]
[1]Department of Sanitary and Environmental Engineering, Federal University of Santa Catarina, Florianopolis, Brazil (mfernandapereima@hotmail.com)
[2]Department of Oceanography, Federal University of Santa Catarina, Florianopolis, Brazil

Laboratory of Hydrology – LabHidro (www.labhidro.ufsc.br)

Motivation

The aim of this study is to evaluate the performance of CMIP5 climate model to simulate precipitation in southern Brazil and when model pos-processing such as bias correction should be applied.

Being a transitional zone between tropical and extratropical climates, southern Brazil (Figure 1) has shown to be rather sensitive to climate change and related expansion of the tropics in the Southern Hemisphere.

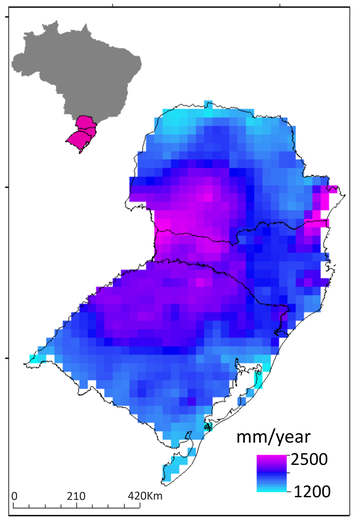

Figure 1. Study area

Methods

Simulations were evaluated in three categories of aspect related to: the distribution of precipitation (marginal aspects), the annual cycle (temporal aspects), and spatial patterns (Table 1).

Marginal aspects	Temporal aspects
Annual rainfall	Markham seasonality index
Annual variance	Autocorrelation
Skewness	Time of annual maxima
98th Percentile	Dry spell average and maximum lengths
Dry Day Fraction	Wet spell average and maximum lengths
Wet Day Fraction	

Table 1. Performance measures

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 by Xavier et al. (2015) obtained from ground stations.

Results

Climate models perform better in simulating the characteristics of the marginal distribution then the temporal aspect of precipitation in southern Brazil. Most performance metrics of the temporal aspect of precipitation show a positive bias, that is, models simulate higher values than the observed ones (Table 2).

Percentual bias			
Marginal aspects		Temporal aspects	
Annual mean	-12%	Markham seasonality index	464%
Variance	-57%	Autocorrelation	102%
Skewness	-58%	Time of the annual maxima	-25%
98th Percentile	-26%	Dry spell average	54%
Dry day fraction	-21%	Dry spell maxima	42%
Wet day fraction	37%	Wet spell average	162%
		Wet spell maxima	142%

Table 2. Performance measures: Results

Models have more difficulty in simulating extremes such as the 98th percentile than simulating annual rainfall (Figure 2).

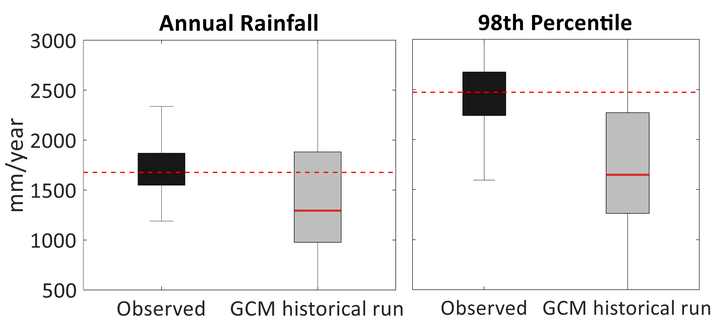

Figure 2. Annual and extreme precipitation

Models do not properly represent the seasonal cycle (Figure 3) and the Markham's seasonality index is up to four times the observed.

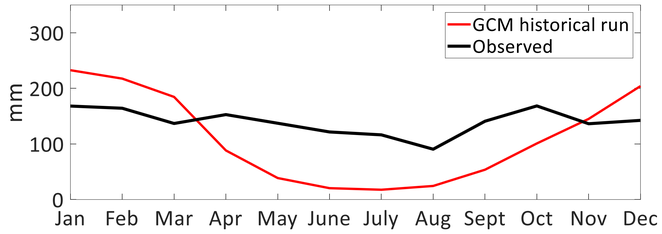

Figure 3. Seasonal cycle

Spatial pattern of annual rainfall is not captured by models in the historical period.

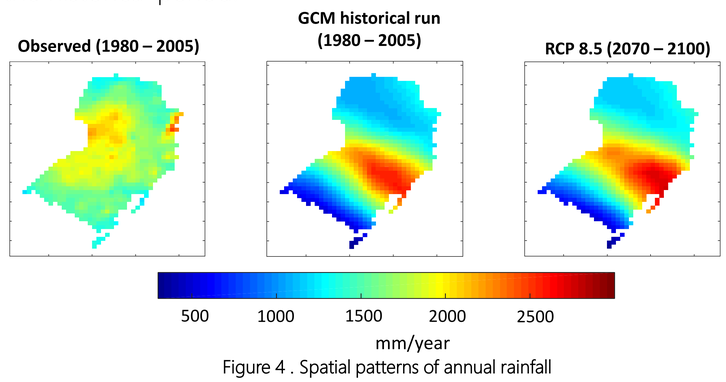

Figure 4 . Spatial patterns of annual rainfall

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 (Figure 4).

Conclusions

Given the poor performance in the area, the use of simulations for 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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