Evaluation of the land surface schemes impact in the simulated climate over the Andes Mountain

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Introduction

Regional Climate Models have shown a large sensitivity of the atmospheric circulation to surface-atmosphere interactions, owing to the fact that there is a large and diverse ecosystem exchanging mass, momentum and heat with the atmosphere.

One of the major uncertainties in the climate simulations in the parameterization used to simulate the physics processes at the land-atmosphere interface. A poor representation of this interaction may affect climate variables such as near-surface temperature and precipitation.

The need to consider comprehensive data set is important in the Andean regions since rainfall tends to decrease with altitude, but the windward or leeward exposure of the stations to the dominant moist wind makes difficult to find a simple relation-ship between rainfall and altitude. Over the Andes Mountain, we compared the performance of two surface parameterizations, the Community Land Model (CLM version 4.5) and BATS (Biosphere-Atmosphere Transfer Scheme) coupled to RegCM4 .6 and RegCM4 .7.

Data and Methods

For the period 2005-2009, the simulated (RegCM4 .6 and RegCM4 .7) climatology of the temperature and precipitation fields were compared with the CRU data (Climate Research Unit) (Fig3) and 88 meteorological stations over Peru-Bolivia regions (Fig. 1). Station data were used to obtain the gridded climatology using Thiessen, Inverse Distance Weighted, Kriging and multiple linear regression methods.

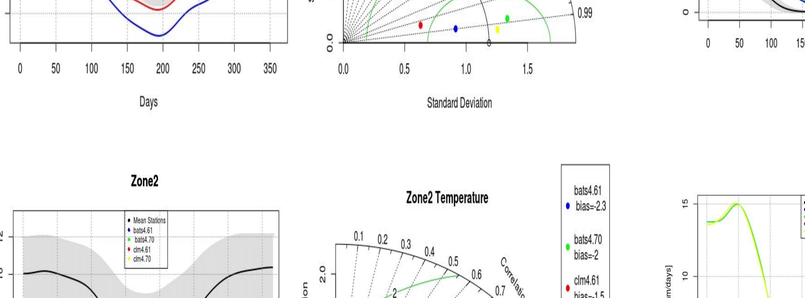


Figure 1. Red and Sky-blue lines define the region of interest for our analysis. Red circles, stations with only temperature data and Sky-blue circles represent stations with only precipitation.

Results

RegBATS4.6 rainfall amounts are closer to the observations than RegCLM4.6 and RegCLM4.7 (It is wetter in general) over most of the Andes Mountains and also produces small bias for air temperature. Over Andes Mountains, the amplitudes of annual cycle of precipitation are higher in RegBATS4.7 and RegCLM4.7 than in RegBATS4.6 and RegCLM4.7. This indicates that Regbats4.7 larger amounts of water vapor to the atmosphere resulting in higher precipitation rates and large wet bias. RegBATS4.6 is closer to the observations than RegCLM6.1, presenting smaller wet and warm biases in three zones of the meteorological stations located in the Bolivian-Peruvian Andes (**Fig. 2**)

Temperature

Precipitation

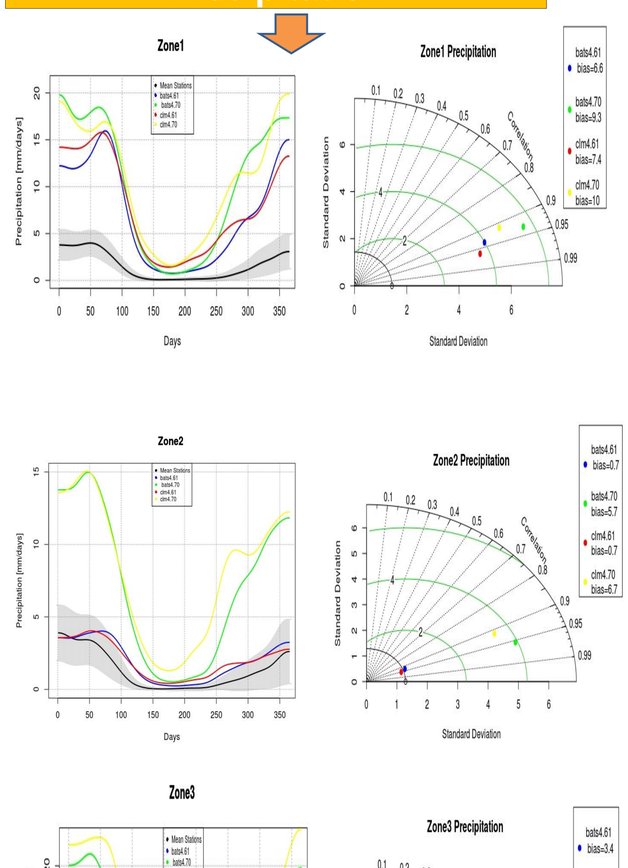
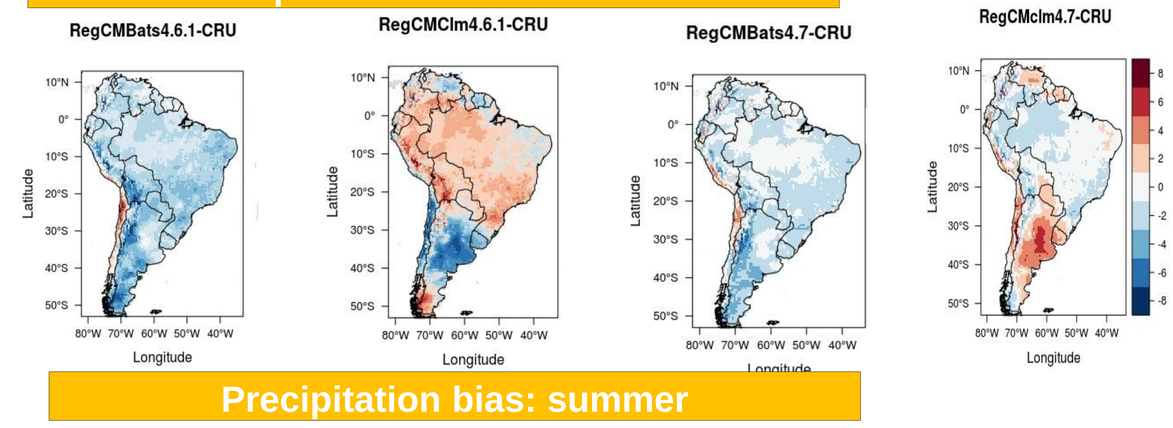


Figure 2. Mean annual cycle and Taylor diagram computed by zones 1, 2 and 3, mean stations (Black line), RegBats4.6(Blue line),Regclm4.6 (red line), RegBats4.7(green line), Regclm4.7 (yellow line) for temperature (°C) and precipitation(mm/day)

Temperature bias: summer



Precipitation bias: summer

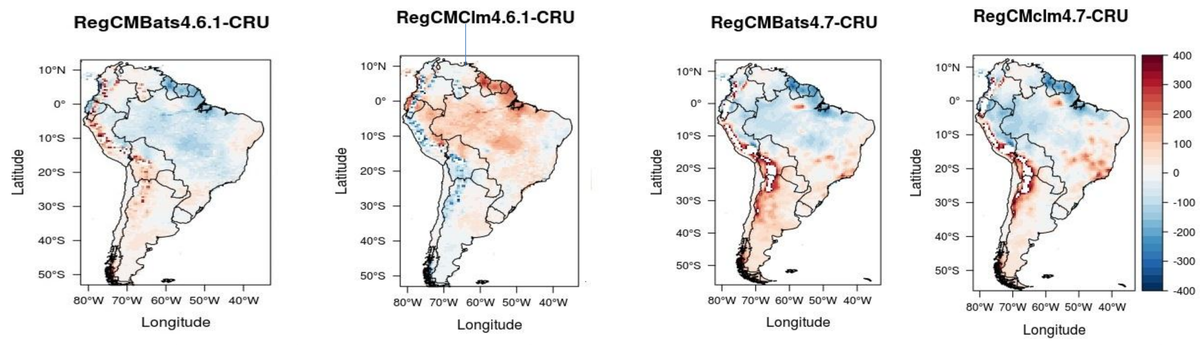


Figure 3. Difference between the simulations RegCMBats4.6, RegCMBats4.7, RegCMclm4.6, RegCMclm4.7 and the observed CRU air temperature (°C) and rainfall (mm/day) for summer average in the period 2005-2009.

What kind of interpolation is the best for the Andean region?

There are many methods of interpolation, but very few that include the altitude. For this reason, we compared four interpolation methods. The multiple regression is the method that considers altitude.

Thiessen	Inverse Distance Weighted	Kriging	Multiple regression
$P = \frac{\sum_{i=0}^{n} P_i * A_i}{\sum_{i=0}^{n} A_i}$	$Zp = \frac{\sum_{i=0}^{n} (\frac{Z_i}{di^p})}{\sum_{i=0}^{n} (\frac{1}{di^p})}$	$z(s_o) = \sum_{i=0}^{n} (\lambda_i) * Z(Si)$	$Y_i = \beta_0 + \beta_1 x_{i1} + \beta_2 x_{22} + \cdots$

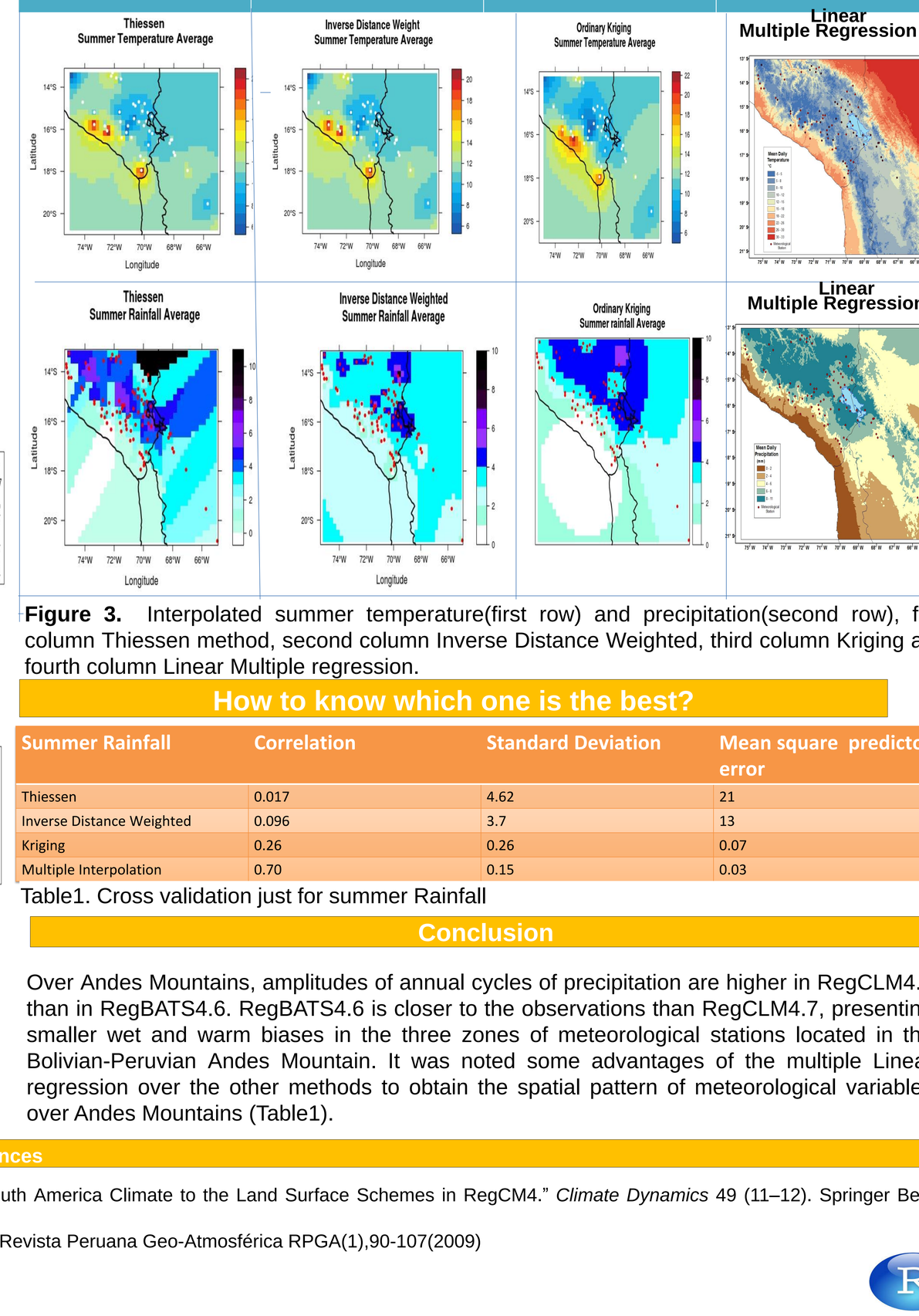


Figure 3. Interpolated summer temperature(first row) and precipitation(second row), first column Thiessen method, second column Inverse Distance Weighted, third column Kriging and fourth column Linear Multiple regression.

How to know which one is the best?

Summer Rainfall	Correlation	Standard Deviation	Mean square predictor error
Thiessen	0.017	4.62	21
Inverse Distance Weighted	0.096	3.7	13
Kriging	0.26	0.26	0.07
Multiple Interpolation	0.70	0.15	0.03

Table1. Cross validation just for summer Rainfall

Conclusion

Over Andes Mountains, amplitudes of annual cycles of precipitation are higher in RegCLM4.7 than in RegBATS4.6. RegBATS4.6 is closer to the observations than RegCLM4.7, presenting smaller wet and warm biases in the three zones of meteorological stations located in the Bolivian-Peruvian Andes Mountain. It was noted some advantages of the multiple Linear regression over the other methods to obtain the spatial pattern of meteorological variables over Andes Mountains (Table1).

References

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