STATISTICAL DOWNSCALING OF CLIMATE SCENARIOS OVER AREQUIPA-PERU

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Introduction

Arequipa is a region located in southwestern Peru which has a complex topography and a great variety of climates, this is the reason this region provides many important resources for the country. Is expected that water demand in this area will increase in the coming decades and is necessary to study the water availability in this region under climate change conditions. The main target of this research is to develop and analyze downscaled future climate projections of precipitation and temperature over this region, using statistical downscaling methods.

Methodology

Daily precipitation/maximum/minimum temperature data for a set of 60 stations were used and, moreover, data from ERA-Interim Reanalysis and three general circulation models: **CESM1-CAM5, HadGEM2-ES** and **MPI-ESM-LR**. Additionally, it was used precipitation data simulated over South America by **SMHI's RCA4 CORDEX** regional climate model forced by the MOHC's HadGEM2-ES earth system, in order to compare it with our statically downscaled results. An **empirical quantile mapping** method was applied to adjust bias for this CORDEX data, using gridded precipitation data PISCO v2.0 as observed data.

The statistical models are based on **analog method** for precipitation and **multiple linear regression** for maximum/minimum temperature. Under the perfect-prog approach, **ten geographical domains** and a set of **33 predictors groups** were explored. Predictors and optimal domains were selected under the principle that they should have a significant and physically interpretable association with the predictands, in addition to the necessary statistical support. The validation of the statistical methods was done using a **k-fold cross validation** in the period of **1981-2005.** The period of scenarios developed is **2016-2065**

Predictor variable	Level
2T, SLP Z, T, Q, U ,V	Surface 1000, 850, 700, 500, 250 (hPa)

Table 1.Potential predictors available for ERA-INTERIM and the three CMIP5 models.

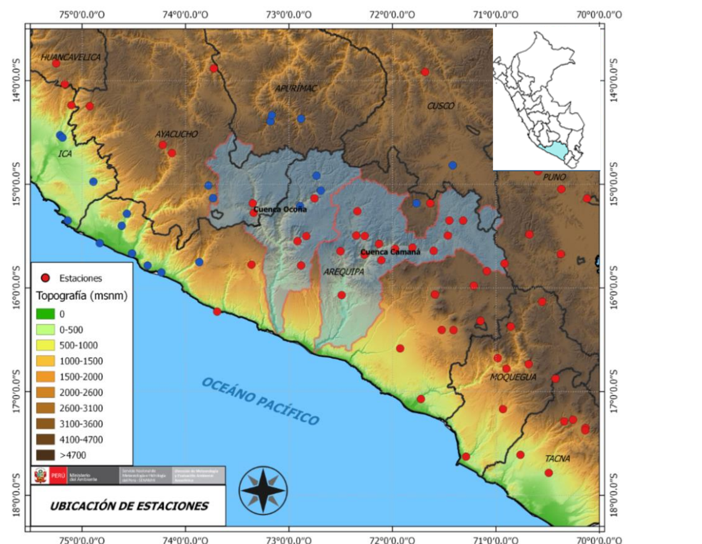


Figure 1. Localization of Study Area and stations used.

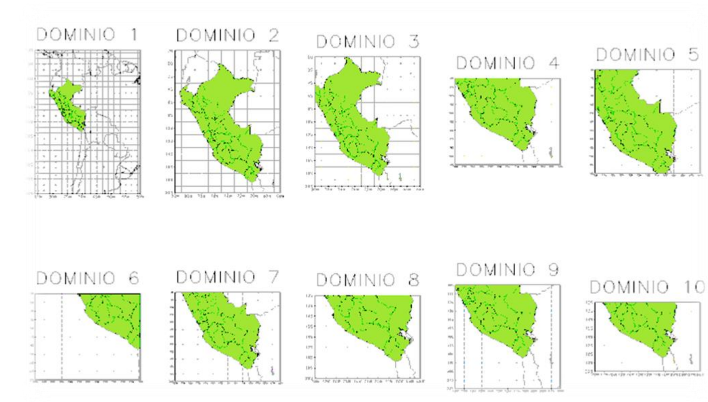


Figure 2. Domains of predictors selected.

Results

The downscaled scenario shows a significant increase of the mean precipitation by about 20-300mm under RCP 4.5 and RCP 8.5 scenario. The most pronounced changes correspond to downscaled RCP 8.5 projection (figure 8). The main increase of precipitation amounts occurs in zones between 2000-4000 masl. In case of higher regions (>4000 masl), the statistical downscaling provides decreasing in the range of 1-40 mm. Similar results of signal were found using CORDEX scenarios in this region (figure 5), with positive changes in medium-high zones and negatives in higher zones. However, the principal difference is in regions near to the sea where we can observe negative changes, whereas the statistical downscaling shows positive precipitation changes. On the other hand, downscaled scenario shows increase for maximum/minimum temperature, specially in higher zones.

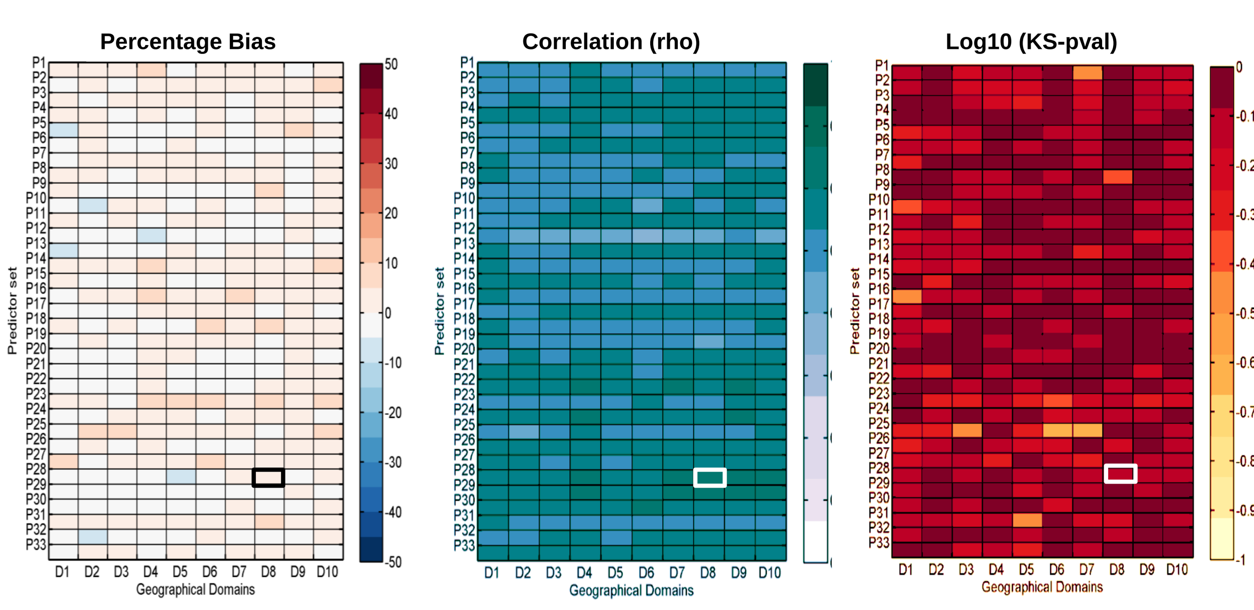


Figure 6. Performance of different predictors sets and geographical domains in terms of bias (left), correlation (middle) and Kolmogorov Smirnov test (right)

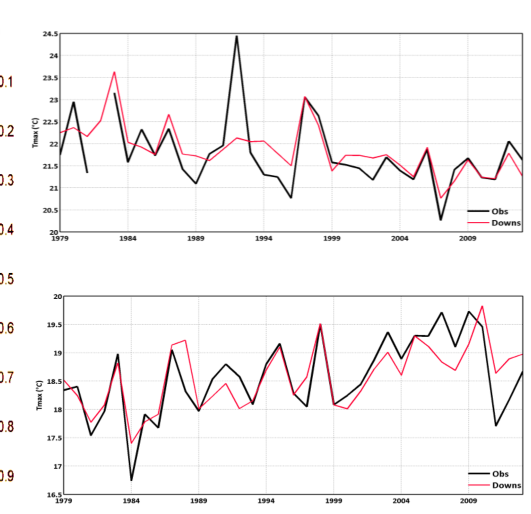


Figure 7. Inter-annual observed and downscaled time-series for one station for maximum (top) and minimum (bottom) temperature

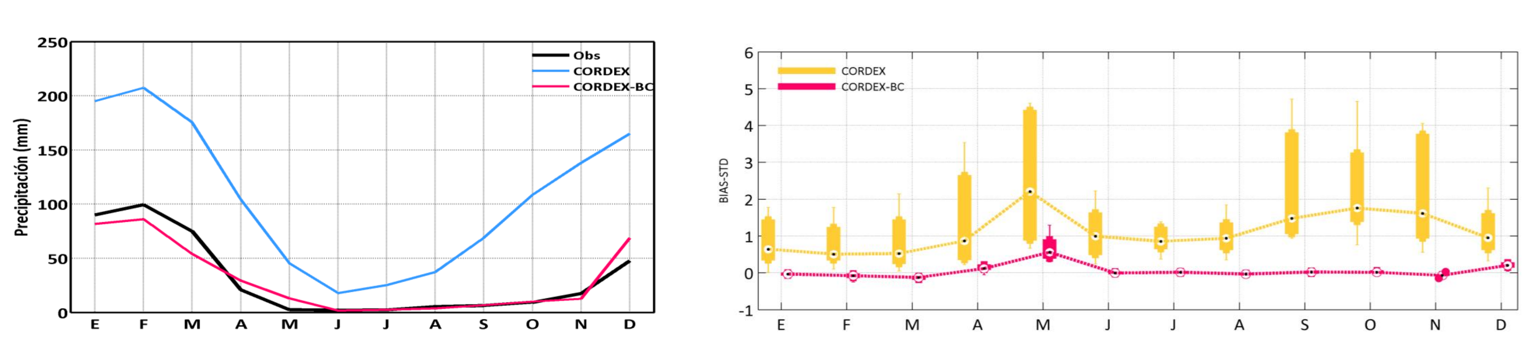
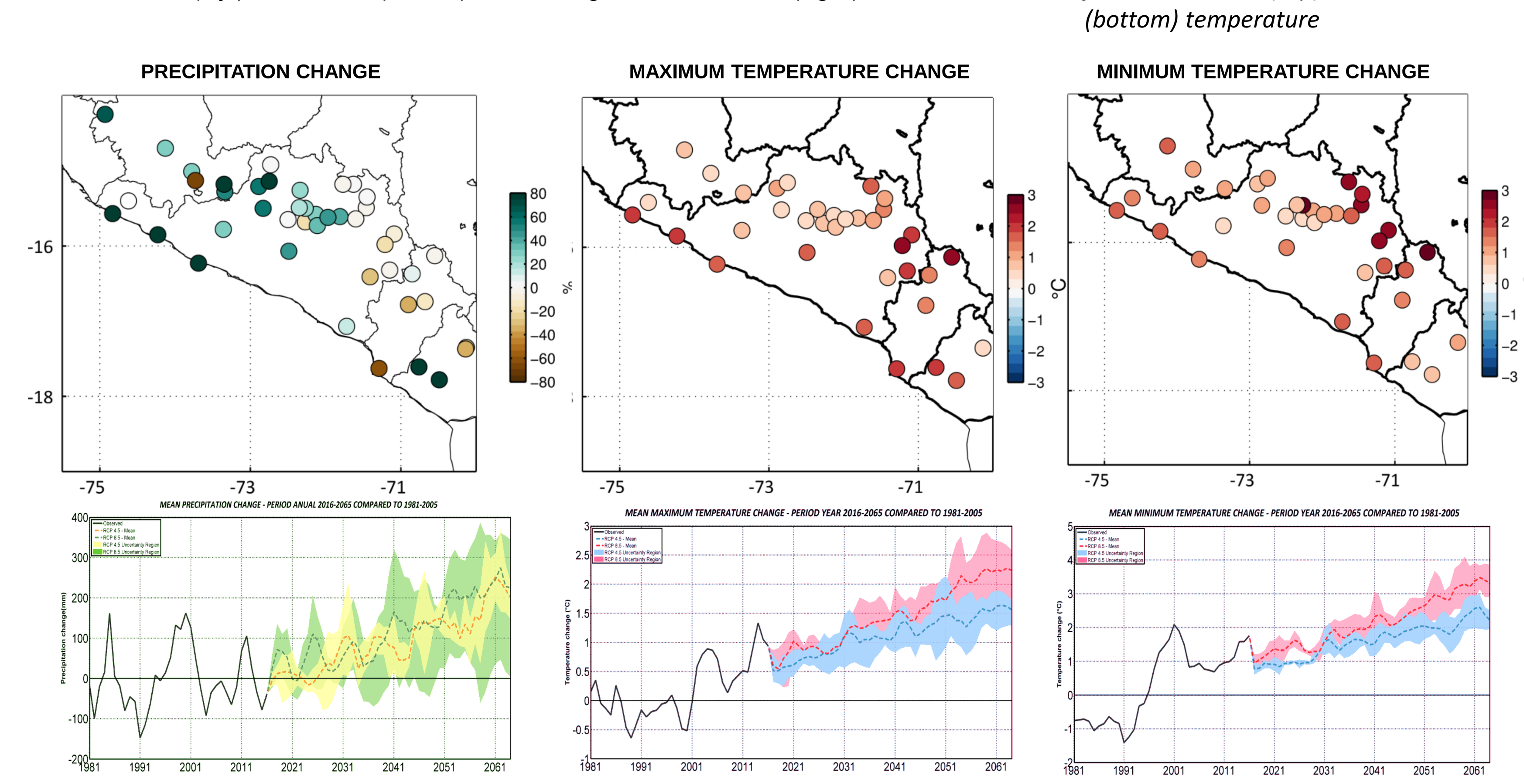


Figure 3: Left: Comparisson between mean anual cycle of precipitation of station (black), Cordex (blue) and bias-adjusted Cordex (red) data. Right: Standarized bias of Cordex (yellow) and bias-adjusted Cordex data (red)



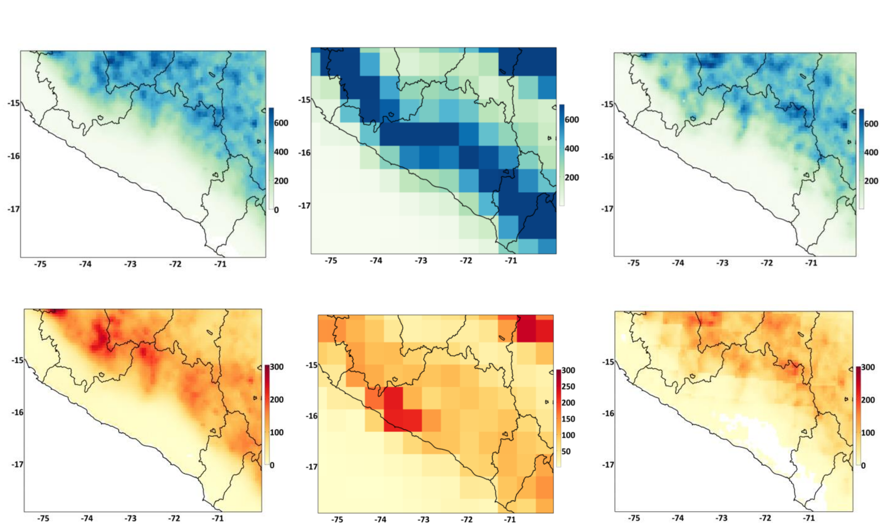


Figure 4. Top: Mean JFM precipitation using PISCO (left), Cordex (middle) and Bias-adjusted Cordex (right). Bottom: The same as top but with standard deviation.

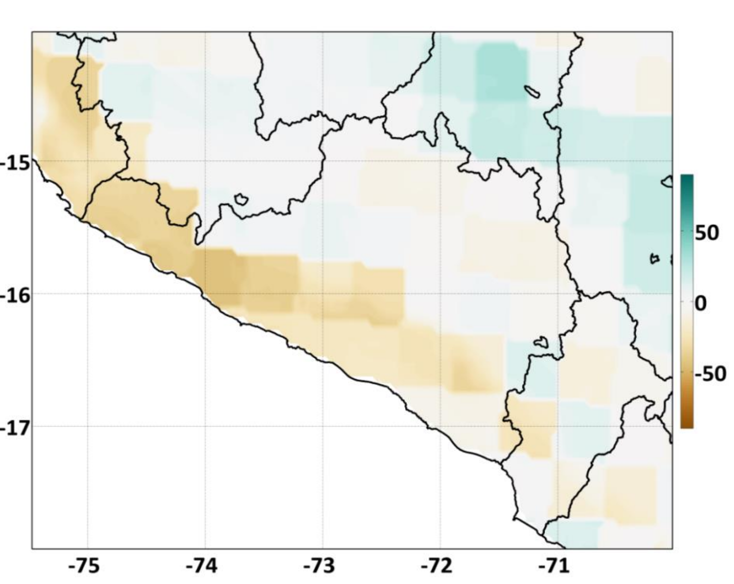


Figure 5. Precipitation change (%) for the period 2036-2065 (with respect to 1981-2005) using bias-adjusted Cordex

Figure 8. Top: Changes in precipitation (left), maximum temperature (middle) and minimum temperature (right) for the period 2036-2065 (with respect to 1981-2005) Bottom: Absolute projections averaged over stations above 3000 masl precipitation (left), maximum temperature (middle) and minimum temperature (right) .

Conclusions

- Results of bias-adjusted CORDEX shows there is a mean increasing for annual precipitation between 0 and 20 (%) in medium-high zones and in coastal regions the change range is from 0% to 30%.
- According to the statistical downscaling, the changes of precipitation for the period 2045-2065 are stronger in RCP 8.5 scenarios than 4.5 scenarios. These changes are stronger in middle basin, whereas, in higher zones (>4000 masl) there is a signal of drecreasing for precipitation.
- For the period 2045-2065, results shows increasing of maximum and minimum temperature, with respect to 1981-2005, specially in higher zones. These temperature changes are in the range of 1-3°C for maximum temperature and 1-4° for minimum temperature.

Bibliography

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