VI Convection – Permitting Climate Modeling Workshop

Effects of climate change on drought events on the Salar de Atacama

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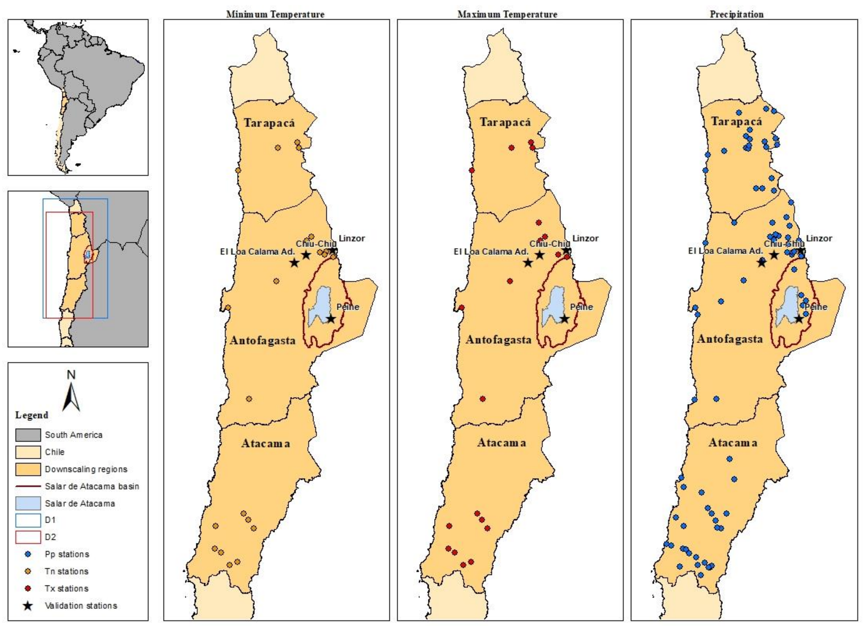
1. BACKGROUND



D2: M1, M2 & M8

The **basin of the Salar de Atacama** is located in the Antofagasta region, its approximate area is 15,620 km^2 equivalent to 12% of the region and its **climate** is **marginal high-desert**. The anual mean temperature and precipitation rate in the Salar de Atacama basin are **14°C and 160 mm/year**, respectively (Valdivielso *et al*., 2022).

The bottom of the basin is occupied by the **Salar de Atacama (SA),** considered as the **driest region in the world.** It has an approximate area of 3,000 km^2 (Salas *et al*., 2010) and its average altitude is 2,300 m.a.s.l (Valdivielso *et al*., 2022).

Climate projections predict an increase in the frequency of extreme drought events, since they are related to the increase in temperature and decreases in precipitation. **Meteorological drough** is the basis that leads to agricultural and hydrological drough, and focuses on the **deviation of local water balance from normal conditions**. Drough inhibits vegetation growth, reduces large-scale agricultural production and affects ecosystem health (Cao *et al*., 2022).

2. MATERIAL AND METHODS

A. Climate proyection

Predictand: Observed daily precipitation (pp), minimum (tn) and maximum temperature (tx) for the period of study 1980 – 2020 (CR2). 3 filters were applied (≥15 years, outliers, >50% NA).

Predictor: Daily data from reanalysis 1 NCEP- NCAR for the 1980 – 2020 period and 13 GCM for RCP4.5 and RCP8.5 scenarios. A bias adjustment correction was applied to every predictor variable for each GCM using the reanalysis. 20 predictors were analyzed (10 for temperature[1] and 10 for precipitation[2]).

Downscaling: A statistical downscaling with analog method was applied under a perfect prognosis approach. The model was trained with reanalysis and observed data using a cross-validation technique to select the best predictor (bias, correlation, K-S test and RMSE; Araya-Osses *et al.*, 2020).

Climate Change Signal (CCS): Difference between the projection and historical data. Pp was estimated in percentage.

B. Projections of drought

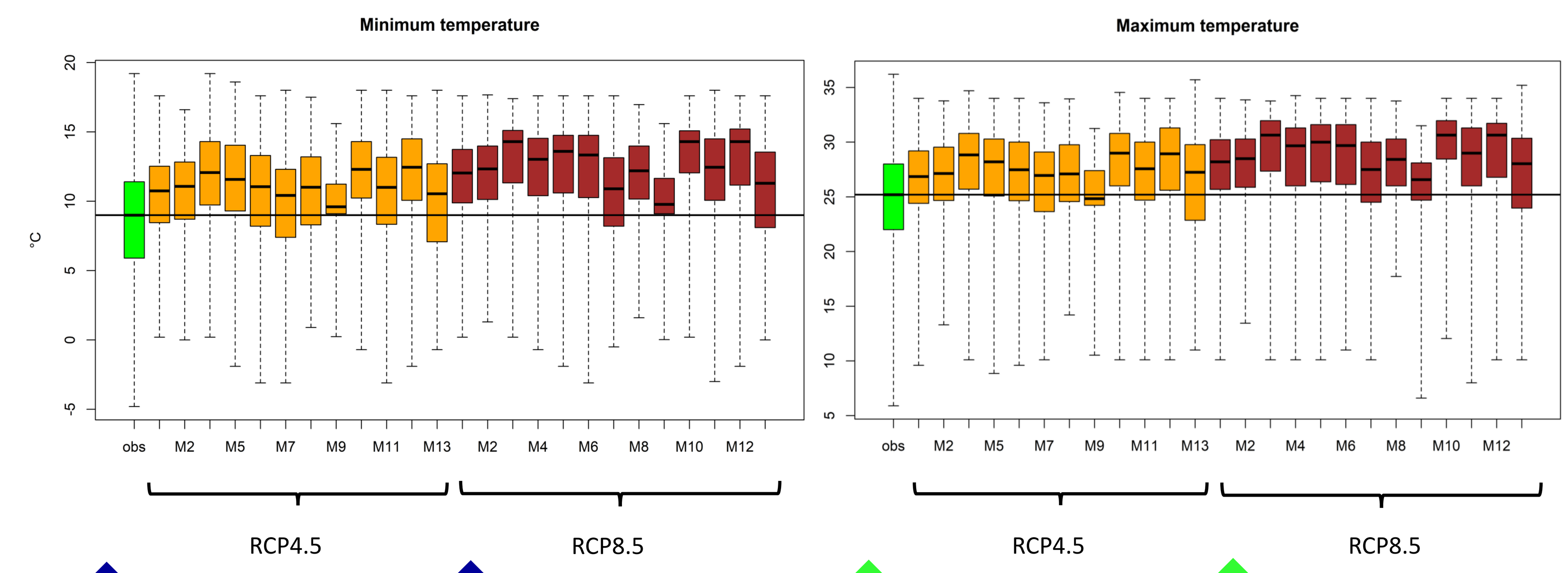
Potential Evapotranspiration (PET): Hargreaves and Samani equation was used since it has been given good results in arid and semiarid zones (Ocampo & Rivas, 2011; Vásquez-Méndez *et al*., 2011). The future trend was evaluated with Mann-Kendall test.

Standardized Precipitation Index (SPI): SPI is one of the most used index in drought studies since it only require pp data. It was calculated to 6 and 12 month. The future trend, frequency and intensity was estimated to the present and future. The future trend was evaluated with Mann Kendall test. (Mohammed *et al*., 2022).

[1]Selected Predictor T: Tas, T700, Z250, Z500; [2]Selected Predictor pp: Tas, Q700, Z500

3. RESULTS

Reported results from Peine station (most representative of SA).

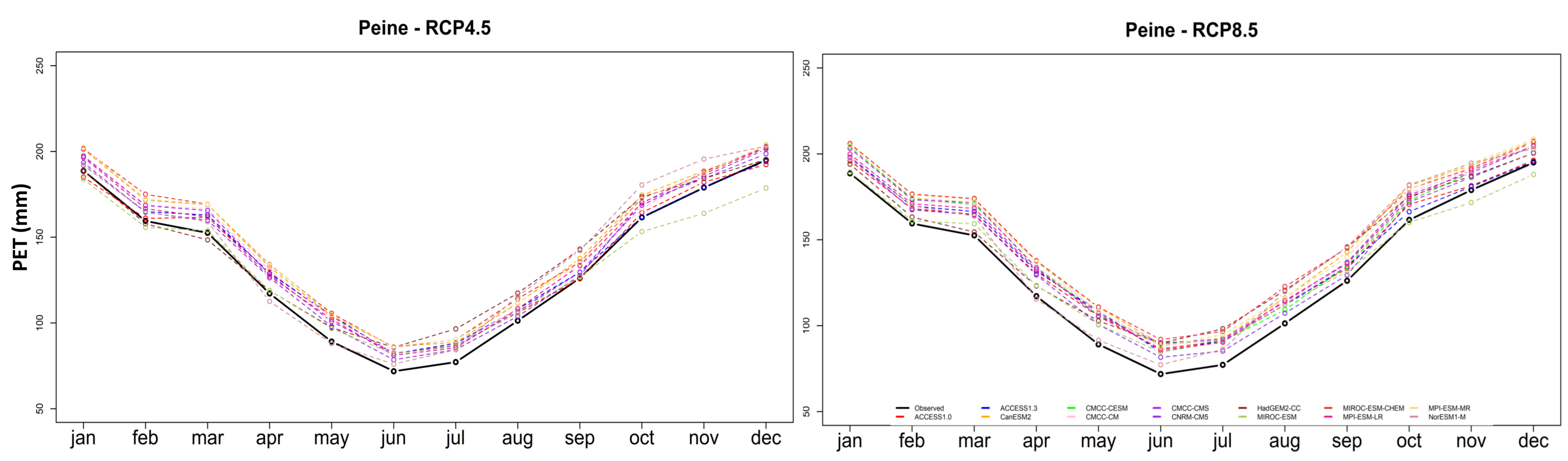


1.9°C (M7) to 3.7°C (M3)

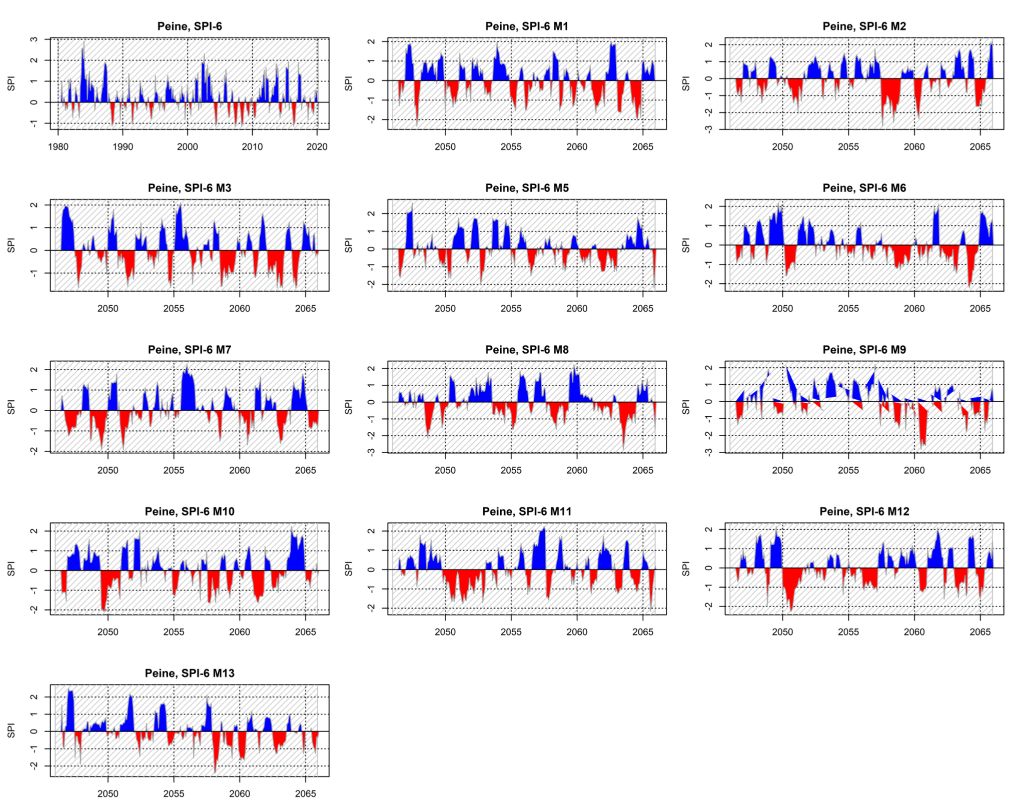
2.8°C (M9) to 5.4°C (M10)

1.1°C (M9) to 3.6°C (M3)

-0.25°C (M9) to 3.1°C (M1)



Only **M5** under **RCP8.5** presented **statistical significance at 95%** of increase

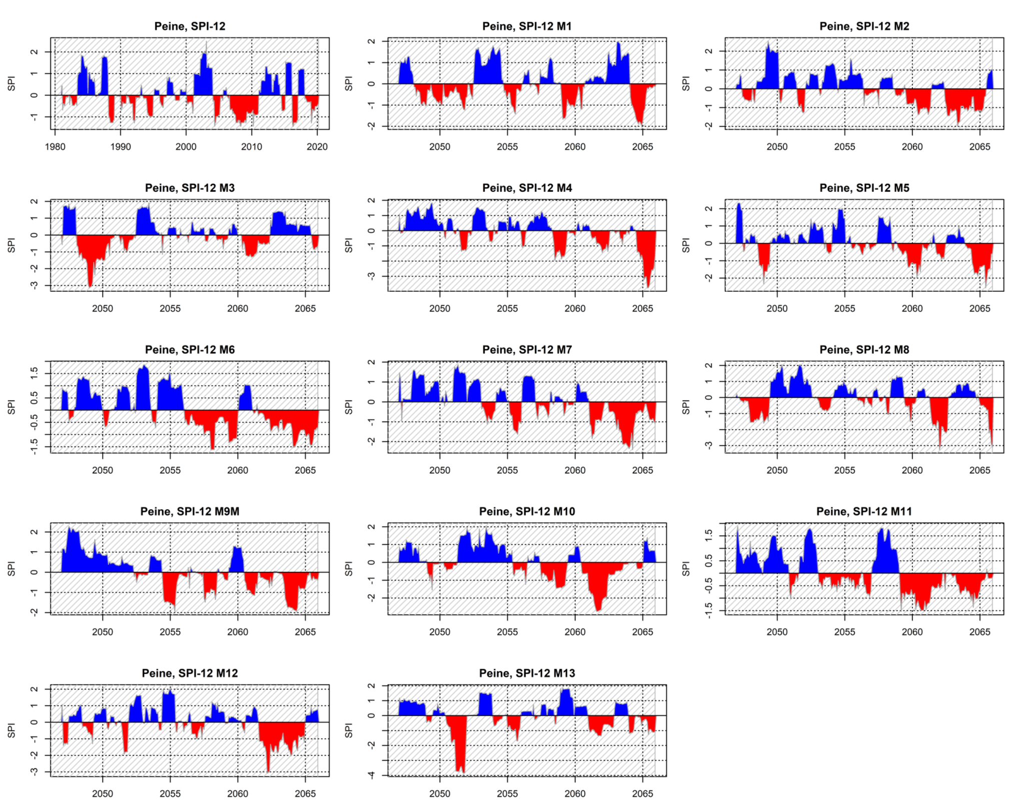


SPI-6

M1, M3, M6, M9 y M13 presented statistical significance at 99% of tendency to drought under RCP4.5.

M2, M4, M5, M6, M7, M8, M9, M10, M11 y M12 presented statistical significance at 99 % under RCP8.5.

In the future, severe drought could reach to 4% (4%) and extremes 1%(2%) of frequency under RCP4.5 (RCP8.5).



SPI-12

M1, M3, M5, M6, M9, M10 y M13 presented statistical significance at 99% of tendency to drought under RCP4.5

M2, M4, M5, M6, M7, M8, M9, M10, M11, M12 y M13 presented statistical significance at 99 % under RCP8.5.

In the future, severe drought could reach to 3% (4%) and extremes 2%(2%) of frequency under RCP4.5 (RCP8.5).

GCM: ACCESS1.0 (**M1**), ACCESS1.3 (**M2**), CanESM2 (**M3**), CMCC – CESM (**M4**), CMCC-CM (**M5**), CMCC-CMS (**M6**), CNRM-CM5 (**M7**), HadGEM2-CC (**M8**), MIROC-ESM (**M9**), MIROC–ESM-CHEM (**M10**), MPI–ESM-LR (**M11**), MPI-ESM-MR (**M12**) and NorESM1-M (**M13**).

4. CONCLUSIONS

- Tn and Tx will increase under RCP4.5 and RCP8.5 for 2046 - 2065 period, whilst pp will decrease. This affects directly to PET, which tendency to the future is to increase although there is no statistic significance that support it.
- MIROC-ESM model was the only one that presented the lowest values for CCS and PET under both scenarios, RCP4.5 and RCP8.5.
- SPI-6 and SPI-12 projected a driest future under both scenarios with statistically significance to the 99% in half of the models used according to RCP4.5 and over the half of the models under RCP8.5.
- This driest future must be considered in regional plans of development with the aim of complement all economics and social activities avoiding a negative effect in the ecosystem.

5. REFERENCES

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