Quantile Mapping CMIP6 simulations for Canada

Chandra Rupa Rajulapati[1]*, Hebatallah Mohamed Abdelmoaty[1,2], Sofia D. Nerantzaki[1], and Simon Michael Papalexiou[1,3]

[1]University of Saskatchewan, Saskatoon, Canada; [2]Cairo University, Giza, Egypt; [3]University of Calgary, Calgary, Canada

*Contact Information: chandra.rajulapati@usask.ca

Introduction

- Climate model projections are developed with an aim to better predict the future climate under different Shared Socio-economic Pathways (SSPs).
- In this study, CMIP6 simulations are quantile mapped to obtain projected temperature and precipitation for Canada.
- Non-stationarity in biases is typically considered in the quantile mapping techniques, yet, the non-stationarity in the observed time series is mostly ignored.
- The specific objectives are to:
  - quantile map the future projections using a novel SPQM technique, considering non-stationarity in the observations, if present.
  - obtain the changes in the projected temperature and precipitation, and
  - check the variability among different CMIP6 models in simulating the temperature and precipitation trends
- Three variables, minimum and maximum temperature and precipitation are considered at daily scale.

Data and Methods

- Daily minimum and maximum temperature and precipitation observations are from an Ensemble Meteorological Dataset for North America (EMDNA) for the 1979-2014 time period. Spatial resolution is 0.1°
- more than 40 CMIP6 models are considered for four Tier-1 Shared Socioeconomic Pathways (SSPs).
- A total of 652 simulations each for maximum and minimum temperature and 759 simulations for precipitation are considered.
- A novel Semi-Parametric Quantile Mapping (SPQM) is introduced to bias-correct the simulations

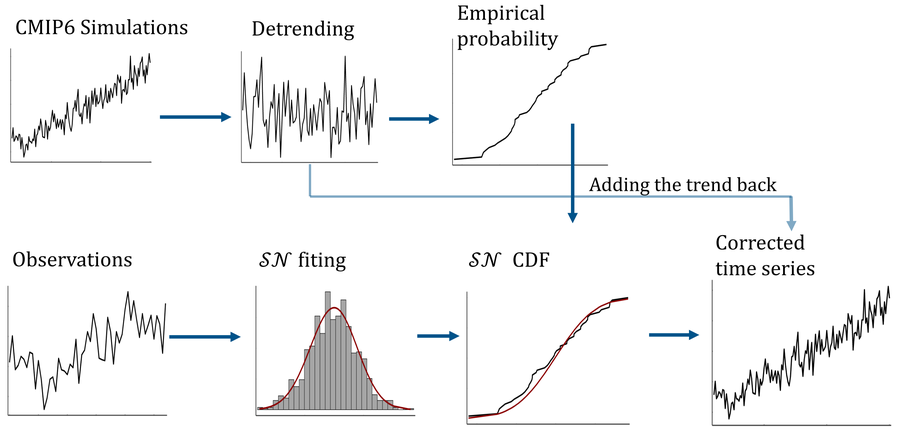

Figure 1. Semi-Parametric Quantile Mapping methodology.

Results

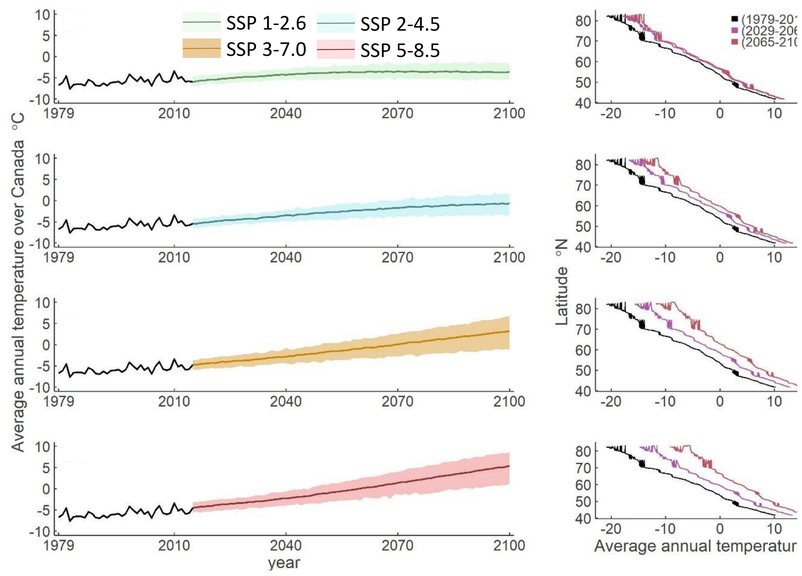

Figure 2. Annual mean temperature for Canada for all CMIP6 socio-economic pathways. The first column is the time series of the annual average temperature. The patch shows all 652 simulations, and the darl lines show the multi-model mean. The second column shows the latitudinal variations of the average annual temperature.

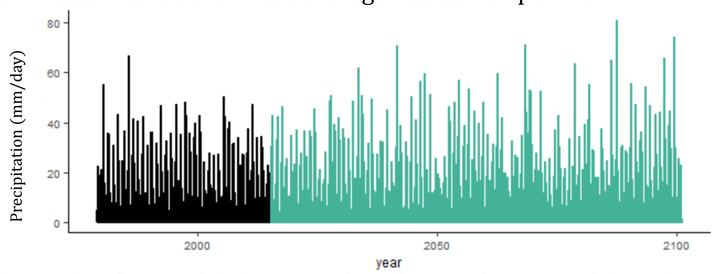

Figure 4. Observed (1979-2014) and quantile mapped (2015-2100) precipitation for a grid for a climate model

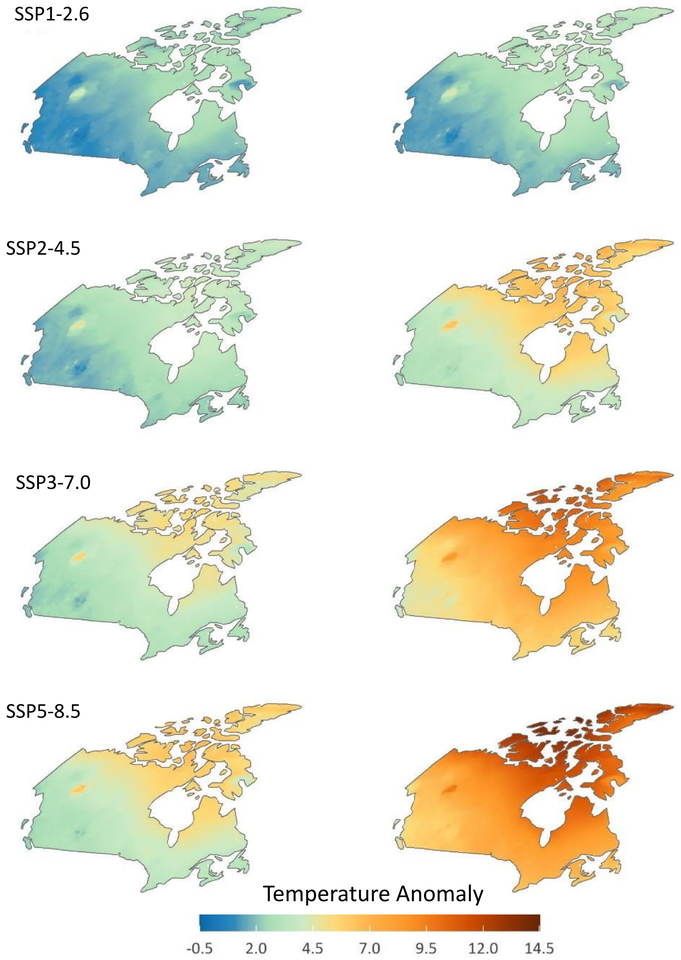

Figure 3. Temperature anomaly in Canada for the near future (2029-2064; the first column) and far future (2065-2100) compared to observations (1979-2014) in the four SSPs

Conclusions

- Over the latter half of the century, the average temperature is projected to increase by 79.02%, 123.81%, and 152.11% in SSP1-2.6, SSP2-4.5, SSP3-7.0, and SSP5-8.5, respectively, compared to 1979-2014.
- In the most optimistic scenario (SSP1-2.6), the average temperature is expected to remain constant at around -3.6 °C over the last half of the century which is about 38.51% more compared to observations.
- Temperature variation per latitude is stronger in Northern Canada for latitudes above 70 °N, and a small variation per latitude is also noticed for some regions in Southern Canada around 50 °N.
- Among the CMIP6 models, a huge variability is noted, further increasing as the warming increases.
- Temporally, all climate indices have steeper slopes for the far future (2066-2100) compared to the near future (2031-2065). Yet the variability among CMIP6 models in near future is high compared to the far future for cold indices.