PROJECTED TRENDS IN CLIMATE EXTREMES IN THE PASSAIC RIVER BASIN BASED ON GLOBAL CLIMATE MODEL SIMULATIONS

Montclair State University CESAC Clean Energy and Sustainability Analytics Center

Archana Prasad, Clement Alo

Department of Earth and Environmental Studies, Montclair State University, Montclair, NJ 07043, USA

Introduction

- By downscaling and bias-correcting Global Climate Model (GCM) outputs, more accurate predictions concerning specified regions can be made.
- Multivariate Adaptive Constructed Analogs (MACA) models provide daily precipitation and temperature information for point localities by modifying coarse resolution data from GCMs to a higher spatial resolution.
- In this study, trends in climate extremes over the Passaic River Basin (PRB) between 2051-2075 are estimated based on three MACA models (bcc-csm1-1m, CCSM4, and MRI-CGCM3) to determine potential impacts of climate change in emissions scenarios RCP 4.5 (medium emissions) and 8.5 (extreme emissions).

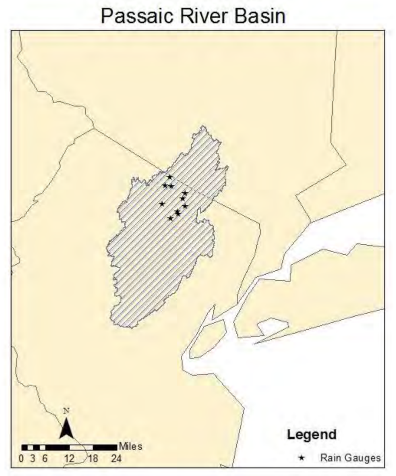

Fig. 1 – Study Site: Passaic River Basin

Methods

- Historical minimum and maximum temperature and precipitation raw data were downloaded from the MACA model. Observation data obtained from PRISM.
- MACA precipitation data correction methods include quantile mapping (Equation 1) and a linear correction factor method (Equations 2 and 3).

$$\hat{x}_m(t) = F_O^{-1}[F_m\{x_M(t)\}] \quad (1)$$

$$c = \frac{\frac{1}{n}\sum_{i=1}^{n} P_i^{obs}}{\frac{1}{n}\sum_{i=1}^{n} P_i^{model}} \quad (2)$$

$$\widetilde{P_{ij}}^{model} = c * P_{ij}^{model} \quad (3)$$

- Correction methods tested for reliability using a Cumulative Distribution Function (Figure 2).

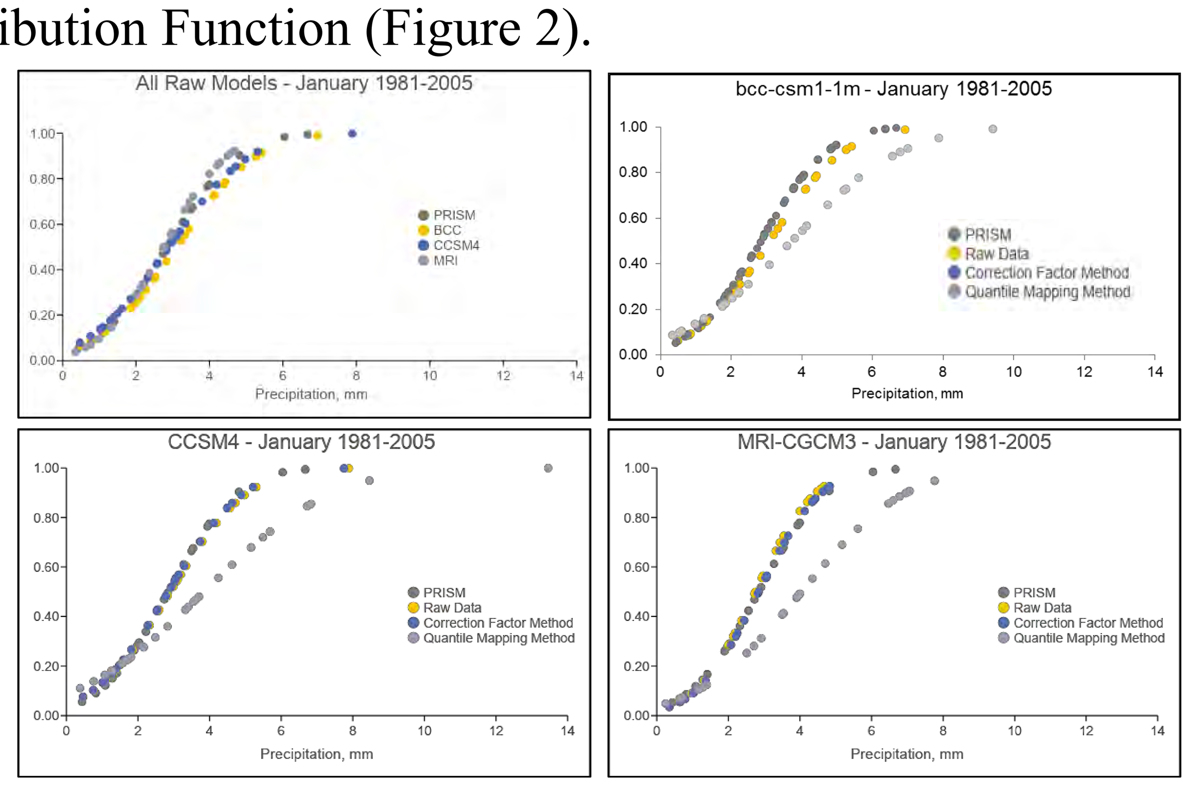

Fig. 2 – CDF comparison of bias correction methods used to determine most reliable dataset for climate analysis

- Bias correction applied to 2051-2075 precipitation projections.

Results

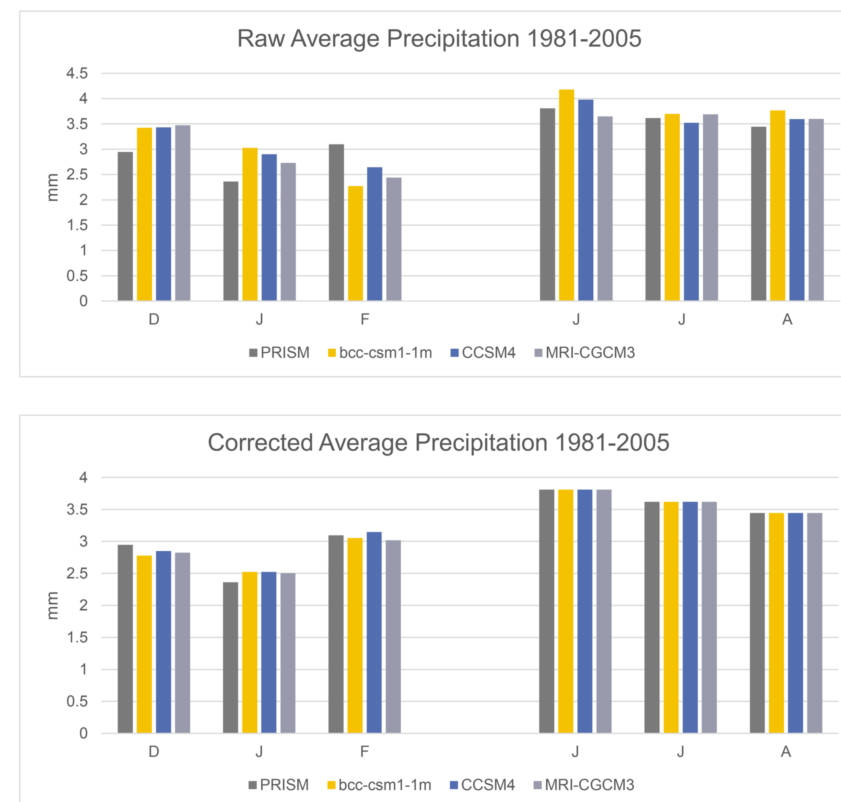

Fig. 3 – Bias correction results for historic average precipitation by season, showing improved data

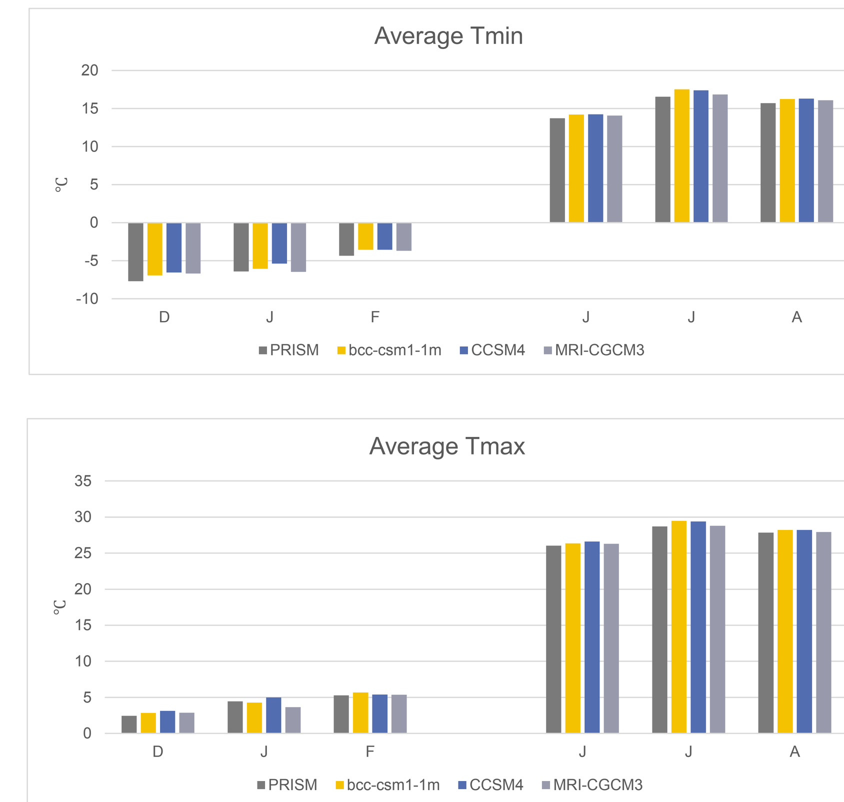

Fig. 4 – Bias correction results for historic average minimum and maximum temperature by season, showing improved data

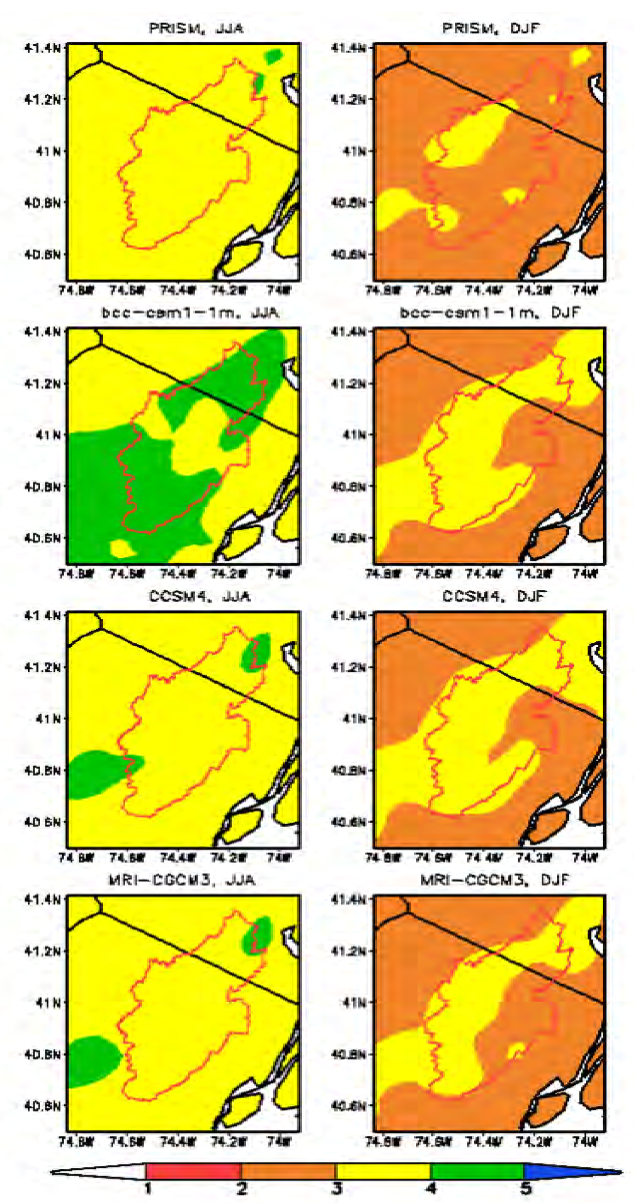

Fig. 5 – Summer and winter precipitation (mm/day) from observed (PRISM) and bias-corrected and statistically downscaled CMIP5 MACA models

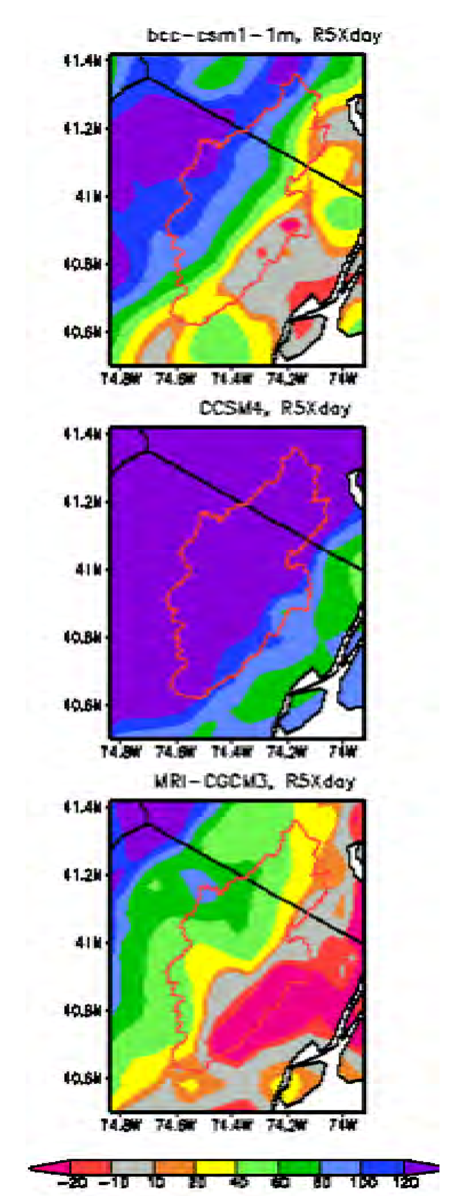

Fig. 6 - Projected trends of maximum consecutive 5-day precipitation (R5xDay) using RCP 8.5

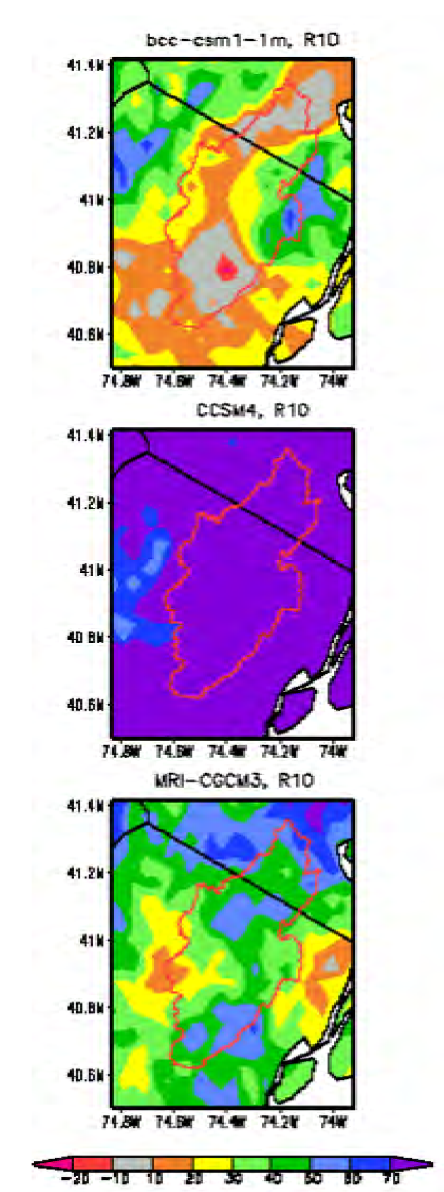

Fig. 7 - Projected trends of heavy wet-weather days in which precipitation is greater than or equal to 10 mm (R10) using RCP 8.5

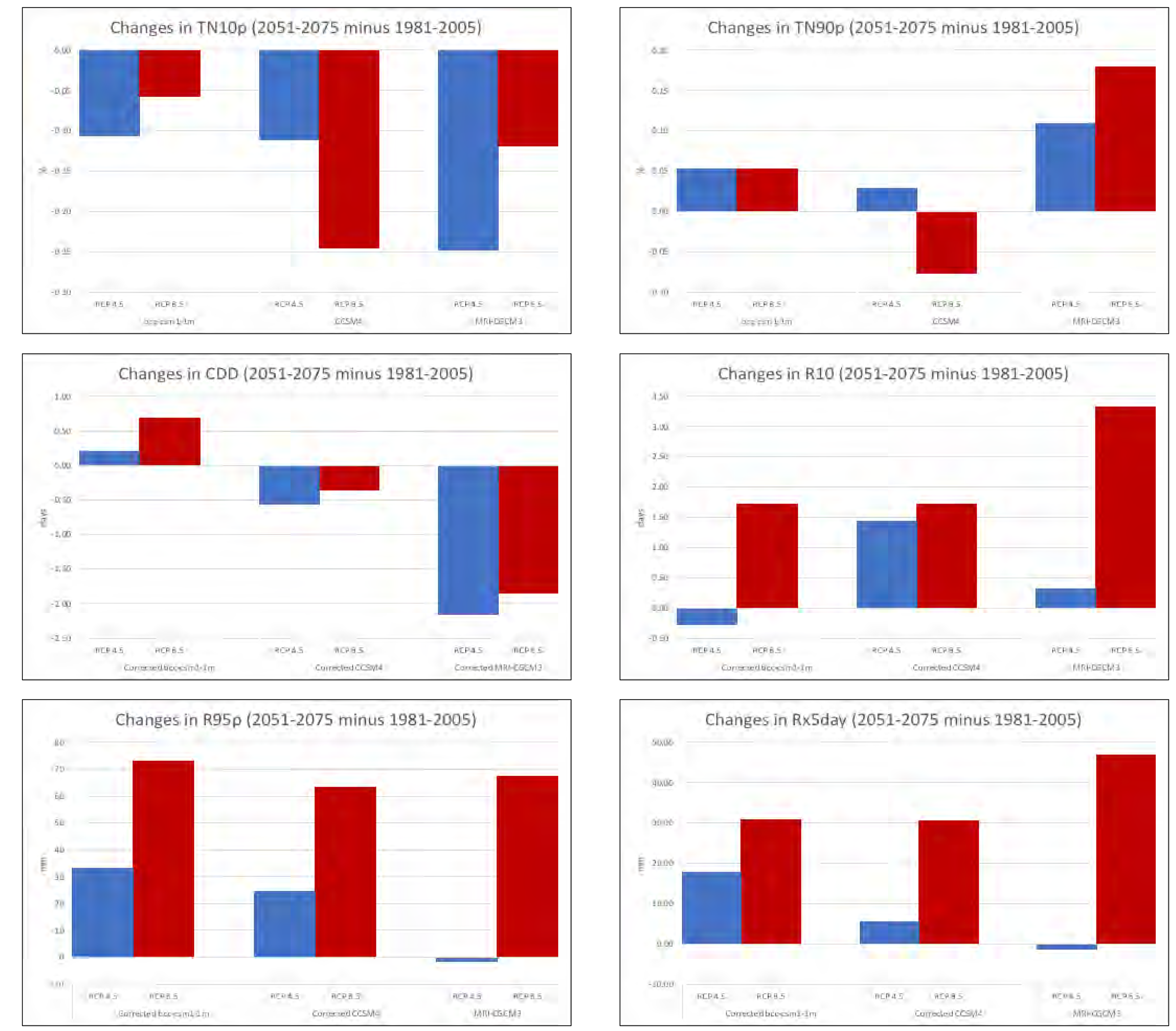

Fig. 8 – Extreme climatology results for future changes in the PRB for emissions scenarios RCP 4.5 and RCP 8.5

Discussion and Future Work

- The linear method of correction is more accurate than quantile mapping for this dataset.
- MACA is more accurate at the seasonal level than the daily.
- We hypothesize that the impacts on temperature are due to increased precipitation and associated cloudiness given that there is an overall increase in wet days, extreme precipitation, and consecutive precipitation,.
- The increase in rainfall is most likely due to decreased longwave cooling at nights—therefore, there would be a reduced amount of very cool nights and an increase in warm nights.
- For TN10p, the models agree that there will less extremely cold days, but RCP 8.5 for bcc-csm1-1m and MRI-CGCM3 shows less of a decrease than RCP 4.5. The models generally also see an increase in the days per year that will experience warmer nights, except in the case of CCSM4 RCP 8.5, which sees a decrease in the 90th percentile of warm nights.
- Given the continuous deforestation and urbanization of the PRB and the "heat island effect," temperatures may increase further.
- Future work can involve incorporating more MACA models for a fuller analysis.

References

Hempel, S. et al., 2013. A trend-preserving bias correction – the ISI-MIP approach. *Earth System Dynamics,* Volume 4, pp. 219-236.

Thibeault, J. M. & Seth, A., 2014. Changing climate extremes in the Northeast United States: observations and projections from CMIP5. *Climatic Change,* Volume 127, pp. 273-287.

Acknowledgments

Acknowledgements to Clean Energy and Sustainability Analytics Center and the ISS at Montclair State University.