Evaluating Constraints on Future Climate Change Based on Model Skill Over the Historical Record

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Introduction

The Sixth assessment report of the Intergovernmental Panel on Climate Change (IPCC AR6) took the innovative step to weight general circulation model (GCM) projections of global temperature change by how well GCMs are able to reproduce historical warming trends over the last four decades. These constraints have been shown to produce skillful forecasts for global temperature using cross-validation. However, the IPCC only provided weighted predictions for global temperature.

Here, we evaluate whether model weighting based on recent trends in global-mean temperature provides skillful constraints for other metrics of interest, particularly regional temperature and precipitation, evaluated for changes in both means and extremes.

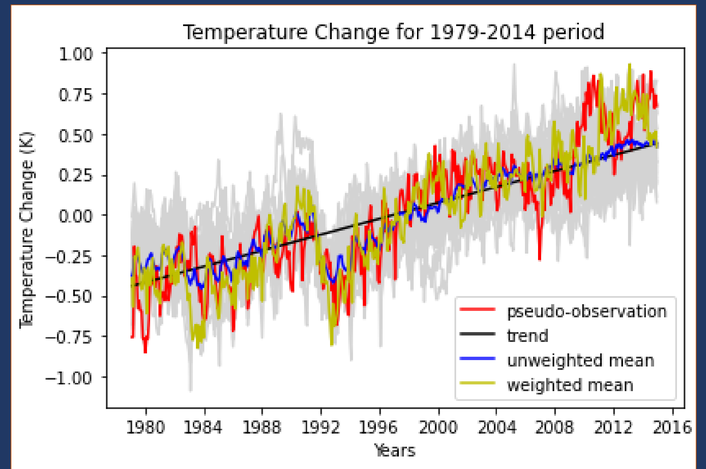

Figure 1) Training period between 1979-2014

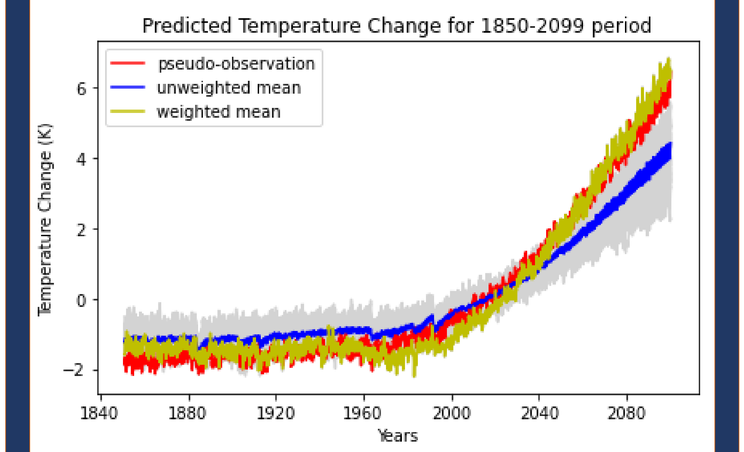

Figure 2) Predictions of global temperature change for 2000-2099 period

Methods

Training Period

- Carried out perfect model test to assess model skill
- Determined distance between pseudo-observation and each ensemble member for historical period
- Calculated weights based on historical performance to a chosen pseudo-observation according to Liang *et al.*, 2020 weighting method

Prediction Period

- Applied weights from the historical period to global temperature change for the 2000-2099 period.
- Plotted comparisons between weighted mean and unweighted mean for global mean temperature rise

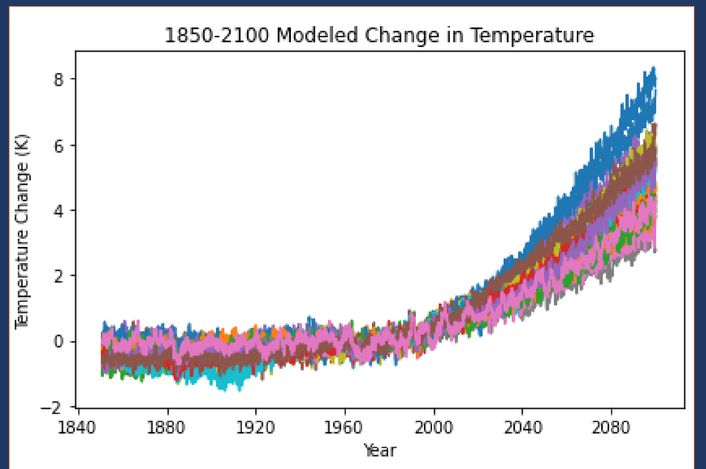

Figure 3) Modeled change in temperature (K) over 1850-2099 relative to mean temperature from 1950-2000

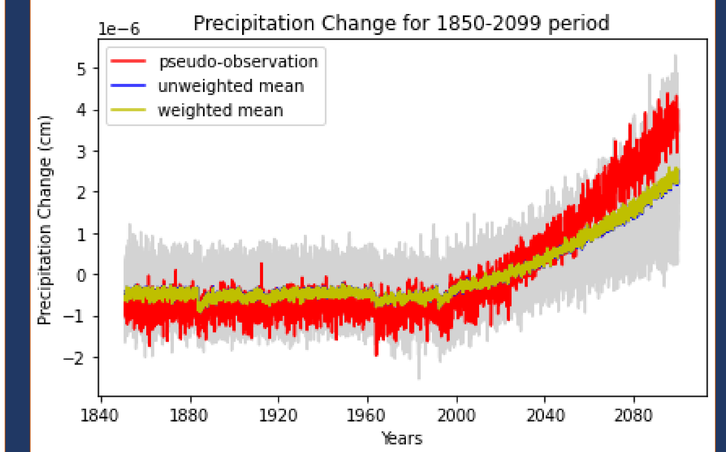

Figure 4) Global precipitation models with unweighted mean, weighted mean, and pseudo observation using the global temperature weighting method

Key Question

How would model weighting impact other metrics of interest, particularly regional temperature change and precipitation?

Results

Weighting global temperature models by ability to replicate a historical temperature pseudo observation improves out-of-sample temperature predictions (replicated result from IPCC). Weighting by ability to replicate historical temperature pseudo observations does not improve precipitation predictions.

Next Steps

- Optimize weighting scheme
- Apply weights to regional temperature change and precipitation

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