May 2nd, 11:00 AM - 1:00 PM

Assessment of Observed Increases in Extreme Warm Exceedances in Locations with Short Warm Side Tails

Jacob S. Hunter
Portland State University

Paul C. Loikith
Portland State University

J. David Neelin
University of California, Los Angeles

Assessment of observed increases in extreme warm exceedances in locations with short warm side tails

Jacob S. Hunter[1a], Paul C. Loikith[1b], J. David Neelin[2]

1. Portland State University, (a) Systems Science Ph.D. Program, (b) Department of Geography, Portland, OR
2. University of California Los Angeles, Department of Atmospheric and Oceanic Sciences, Los Angeles, CA

I. Introduction

Locations with **shorter-than-Gaussian warm side temperature distribution tails** would experience a **more rapid increase** in extreme warm temperature threshold exceedances under a simple uniform shift. Such locations occur in spatially coherent regions[1] and are projected by CMIP5 to experience more rapid-than-Gaussian increases in warm exceedances by the mid-21st century, resulting in several "hotspots" of future warming.[2]

Scientific questions:

- Do **ground truth in situ weather station** data reproduce observed short tails from reanalysis?
- Can more rapid-than-Gaussian increases in warm exceedances be detected in observation records for locations with short warm tails?

II. Data

Station data from **GHCN-D**[3] were selected based on the following criteria:

- Region identified from reanalysis as having a **short warm tail**.
- Station has **60 years** of daily data or more.

III. Methods

- **Temperature anomaly** is obtained from daily temperature maximum for DJF.
  - Moving mean with a 5-day window is calculated and used to calculate the mean daily climatology over the entire data series.
  - Temperature anomaly distributions are obtained for the first and last 30 years of the time series.
- **Extreme warm threshold** is defined as the 95th percentile of the temperature anomaly distribution.
- **Short tails** are defined by shifting the initial distribution by 0.5σ.
  - If the % of days exceeding the 95th percentile of the initial distribution is significantly greater than would be expected from shifting a Gaussian, a short warm tail is defined.
  - **Shift ratio** is calculated by dividing % of days exceeding the 95th percentile after shifting the distribution by 0.5σ by that from shifting a Gaussian by 0.5σ.
- The % of days in the later distribution exceeding the initial 95th percentile is calculated and determined to be significantly different from a shifted Gaussian or not.
  - **Actual shift ratio is** calculated by dividing % of days exceeding the 95th percentile after shifting the distribution by the corresponding percent for a Gaussian distribution shifted by the actual warming as a fraction of the standard deviation, σ.
- **Statistical significance** is determined by randomly sampling and shifting a Gaussian by 0.5σ 10,000 times. If the % of days exceeding the pre-shifted 95th percentile of the temperature distribution is greater than the 95th percentile of the Gaussian shift distribution, the warm tail is significantly shorter than Gaussian.

IV. Results

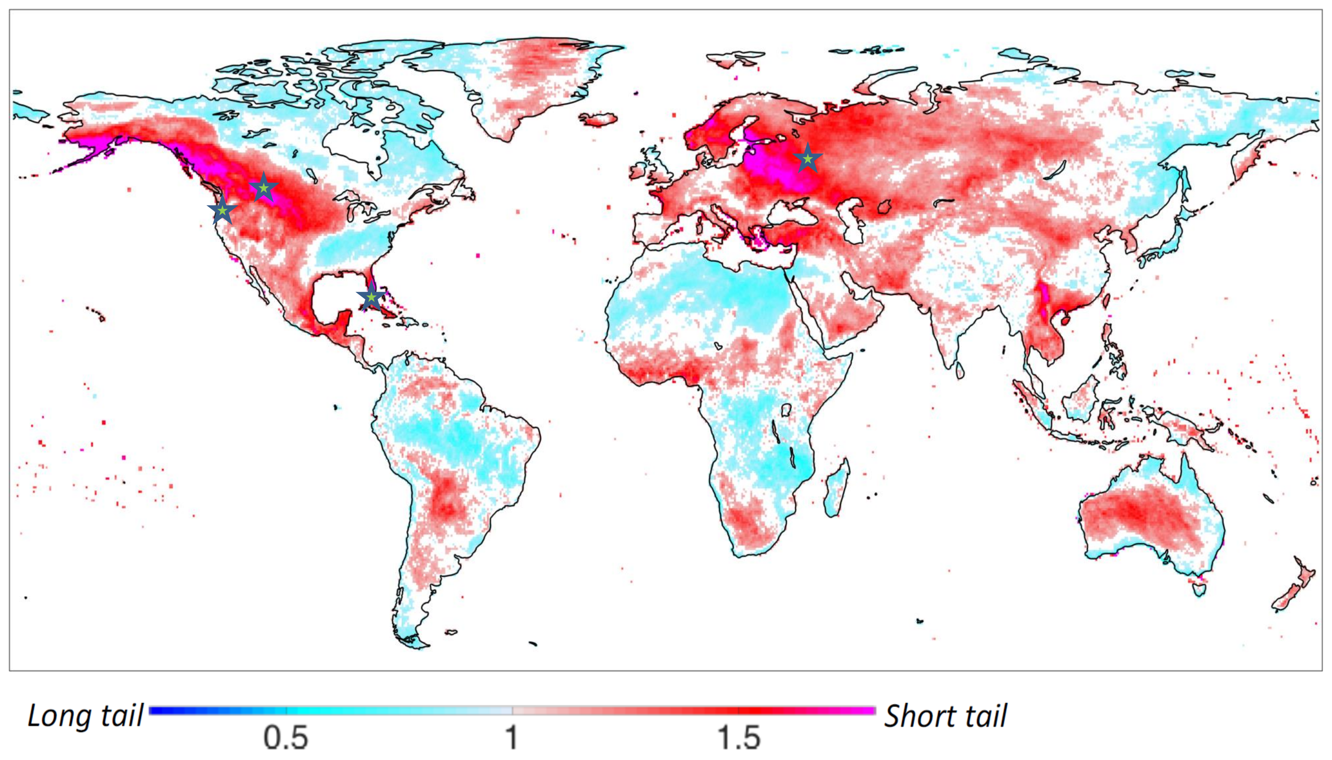

Figure 1. Shift ratio using a 0.5 σ warm shift in MERRA-CRU reanalysis[4]. Red cells indicate significant short warm tails. Locations used for this case study are marked with green stars.

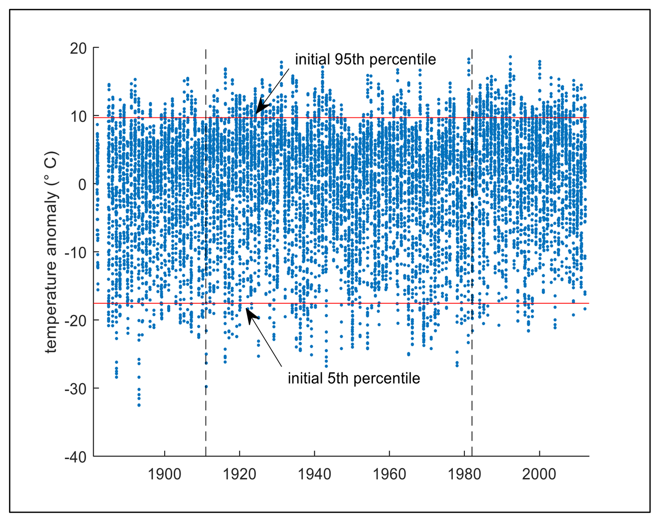

Figure 2. Time series of DJF daily maximum temperature anomaly for Calgary, Alberta. The first and last 30 years are used to construct the histograms used in the analysis.

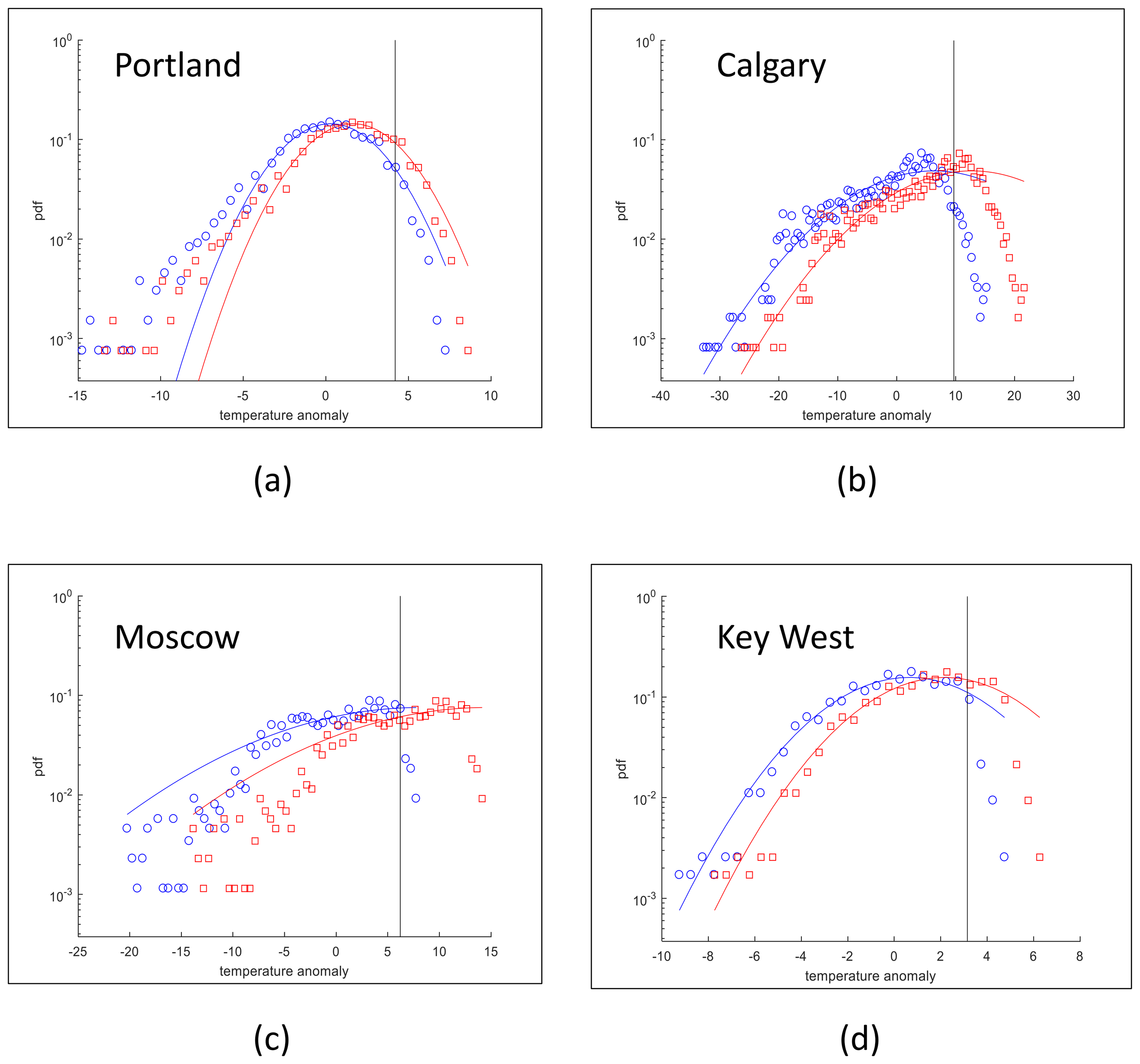

Figure 3. Histogram of temperature anomalies for first 30 years, along with the same distribution under a 0.5 σ warm shift and Gaussian fits for each distribution, at (a) Portland, OR; (b) Calgary, Alberta; (c) Moscow, Russia; (d) Key West, Florida. The black line shows the 95th percentile of the original distribution.

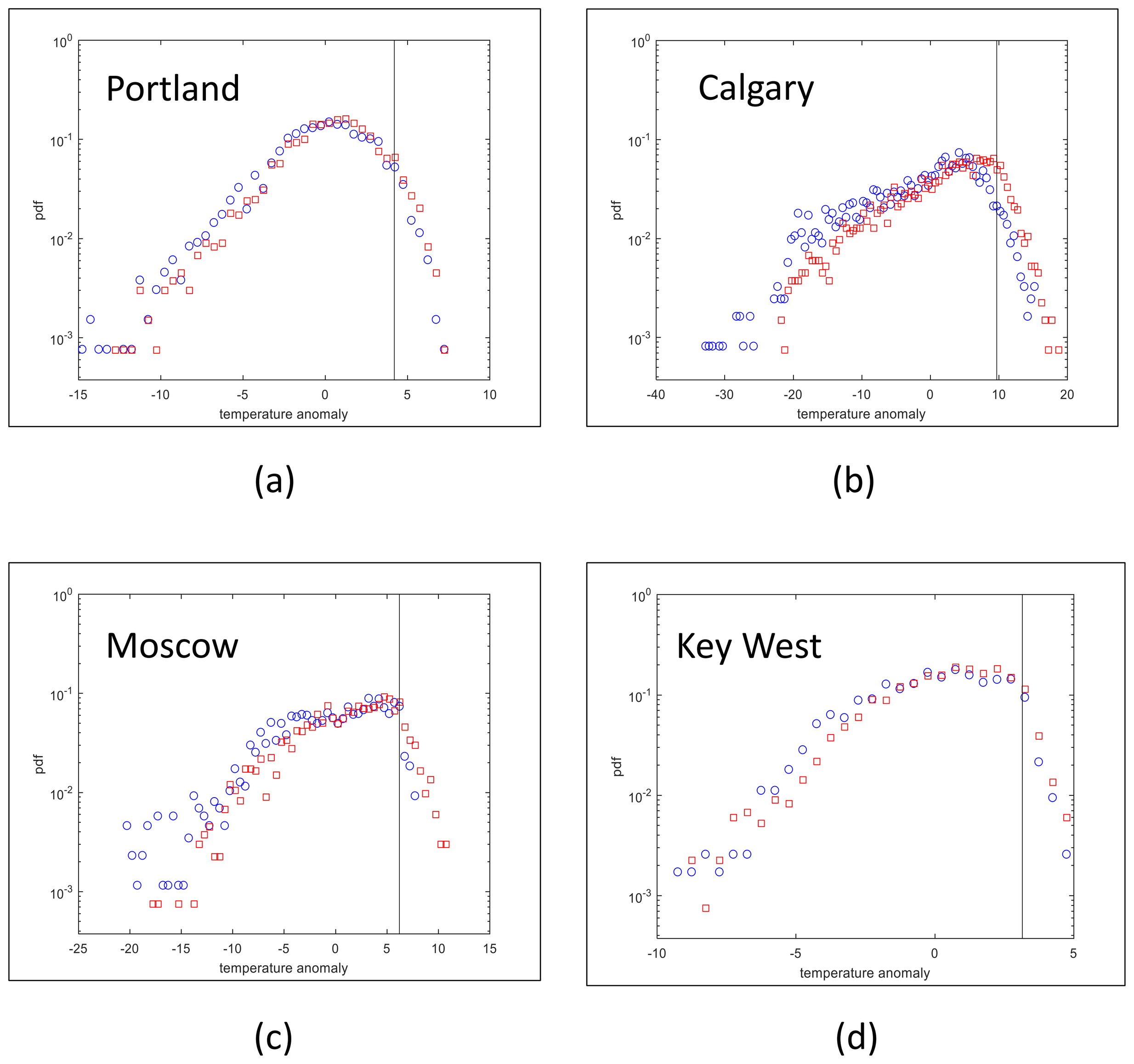

Figure 4. Histogram of temperature anomalies for first and last 30 years at (a) Portland, OR; (b) Calgary, Alberta; (c) Moscow, Russia; (d) Key West, Florida. The black line shows the 95th percentile of the initial period.

Location	Mean warming (°C); (σ)	Shift ratio	
		Uniform shift (0.5 σ)	Actual
Portland, Oregon	0.49; (0.16)	**1.15**	1.04
Calgary, Alberta	3.3; (0.39)	**1.63**	**1.31**
Moscow, Russia	1.7; (0.31)	**1.81**	**1.14**
Key West, Florida	0.45; (0.19)	**1.41**	0.93

Table 1. Locations analyzed along with local mean warming in degrees Celsius and as a fraction of the standard deviation, and shift ratio for the uniformly shifted original distribution and the actual change. Bold signifies the quantity is statistically significant.

V. Conclusions and Future Direction

- 4 stations with short warm tails are assessed for greater-than-Gaussian increases in warm extremes in the observed record.
- 2 stations show greater-than-Gaussian increases while 2 do not and show a shortening of the warm tail.
- Future work will analyze more stations and investigate mechanisms for deviations from expectations of a short tail

References

1. Loikith, P. C., and J. D. Neelin, 2015: Short-tailed temperature distributions over North America and implications for future changes in extremes. *Geophys. Res. Lett.*, **42**, doi:10.1002/2015GL065602.
2. Loikith, P.C., J. D. Neelin, and J. Meyerson: Short warm-side temperature distribution tails drive hotspots of warm temperature extreme increases under near-future warming. *In review.*
3. Menne, M.J., I. Durre, B. Korzeniewski, S. McNeal, K. Thomas, X. Yin, S. Anthony, R. Ray, R.S. Vose, B.Gleason, and T.G. Houston, 2012: Global Historical Climatology Network - Daily (GHCN-Daily), Version 3.22. NOAA National Climatic Data Center. http://doi.org/10.7289/V5D21VHZ.
4. Wang, A., and X. Zeng (2013), Development of Global Hourly 0.5° Land Surface Air Temperature Datasets, J. Climate, 26, 7676-7691.

Support for this work was provided by the US National Science Foundation AGS-1621554.

J. S. Hunter thanks Dmitri Kalashnikov for his expertise on weather station data.

Contact: Jacob S. Hunter, hunter33@pdx.edu