

Effect of Baseline Period on Quantification of Climate Extremes over the United States

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Introduction

As global and regional climate continues to change, the interpretation of extreme events is increasingly reliant on the choice of baseline climatology period, and this can be a source of uncertainty for the public.

Question: *how does updating the baseline period affect the quantification and classification of climate extremes in the contiguous United States?*

Data and Methods

Percentiles and corresponding extreme indices (Alexander et al. 2006) were derived using daily mean precipitation and daily mean, max, and min 2-m temperature (T2M) from NASA's Modern Era Retrospective Analysis for Research and Applications, version 2 (MERRA-2; Gelaro et al. 2017).

Three baseline periods are used for the percentile calculations: 1981-2010, 1981-2020, and 1991-2020; indices are created monthly for 1980-2021 (GMAO 2020, 2022):

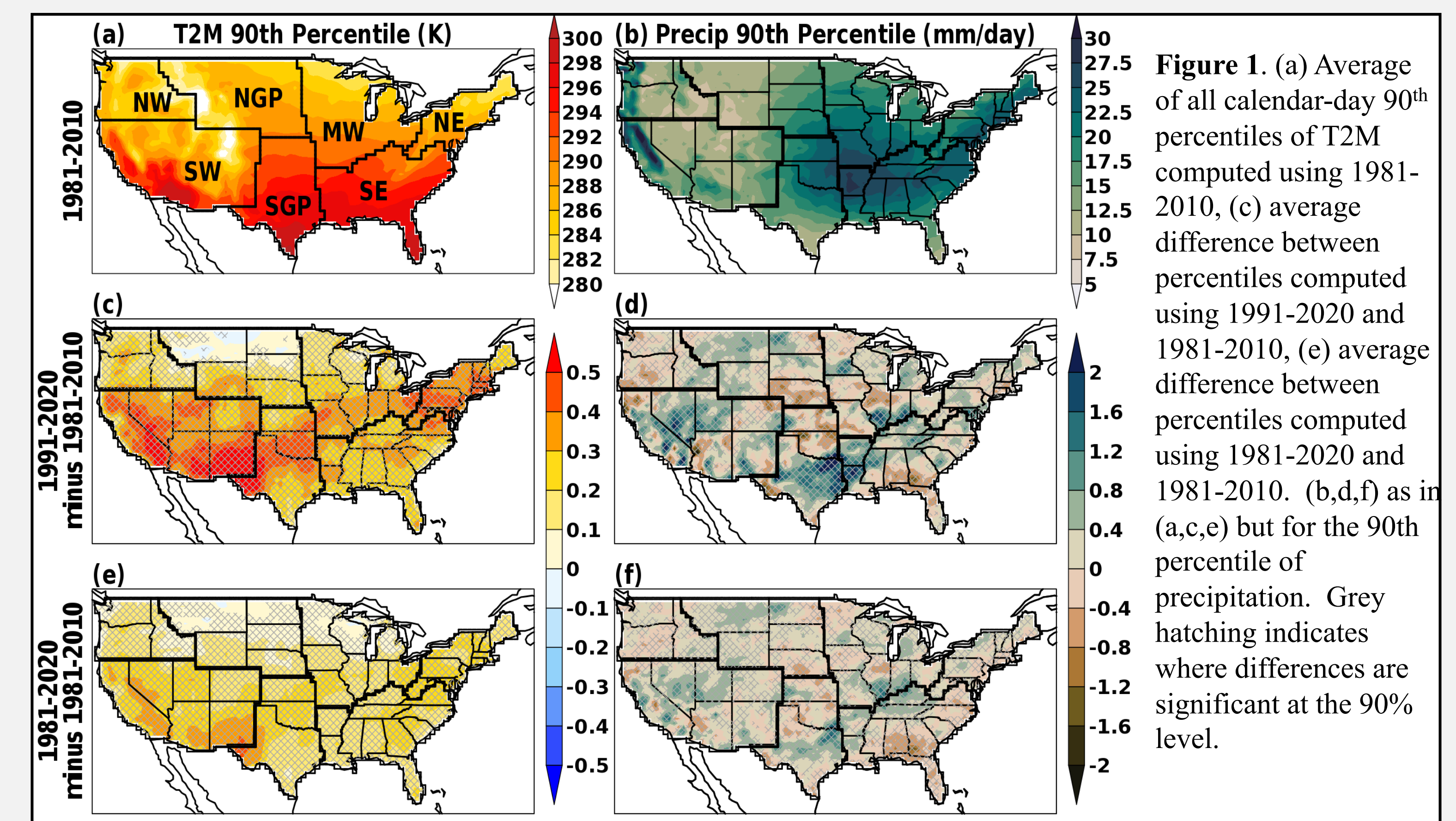
Index	Name	Calculation
HWD	Heat wave duration	Maximum length of consecutive days that satisfy heat wave criteria in which daily mean T2M exceeds the 90 th percentile for at least 3 consecutive days
HWF	Heat wave frequency	Count of days that satisfy heat wave criteria
HWM	Heat wave magnitude	Mean T2M anomaly on days that satisfy heat wave criteria
R90p	Wet day precipitation	Mean precipitation on days that exceed the 90 th percentile of precipitation
R90d	Wet days	Count of days that exceed the 90 th percentile of precipitation
R95p	Very wet precipitation	Mean precipitation on days that exceed the 95 th percentile of precipitation
R95d	Very wet days	Count of days that exceed the 95 th percentile of precipitation
R99p	Extremely wet precipitation	Mean precipitation on days that exceed the 99 th percentile of precipitation
R99d	Extremely wet days	Count of days that exceed the 99 th percentile of precipitation
Tn10p	Cold Night	% of days with a minimum T2M below the 10 th percentile
Tx10p	Cold Days	% of days with a maximum T2M below the 10 th percentile
Tn90p	Warm Nights	% of days with a minimum T2M above the 90 th percentile
Tx90p	Warm Days	% of days with a maximum T2M above the 90 th percentile

Percentiles and baseline period

When the baseline period is updated to 1991-2020:

- The 90th percentile of daily mean T2M increases throughout the US, with strongest differences in the Southwest
- The 90th percentile of precipitation increases throughout the Southern Great Plains through Midwest and Southwest US

With the 1981-2020 baseline period, the changes are more muted, but still significantly positive in these regions.



Extreme Indices and baseline period

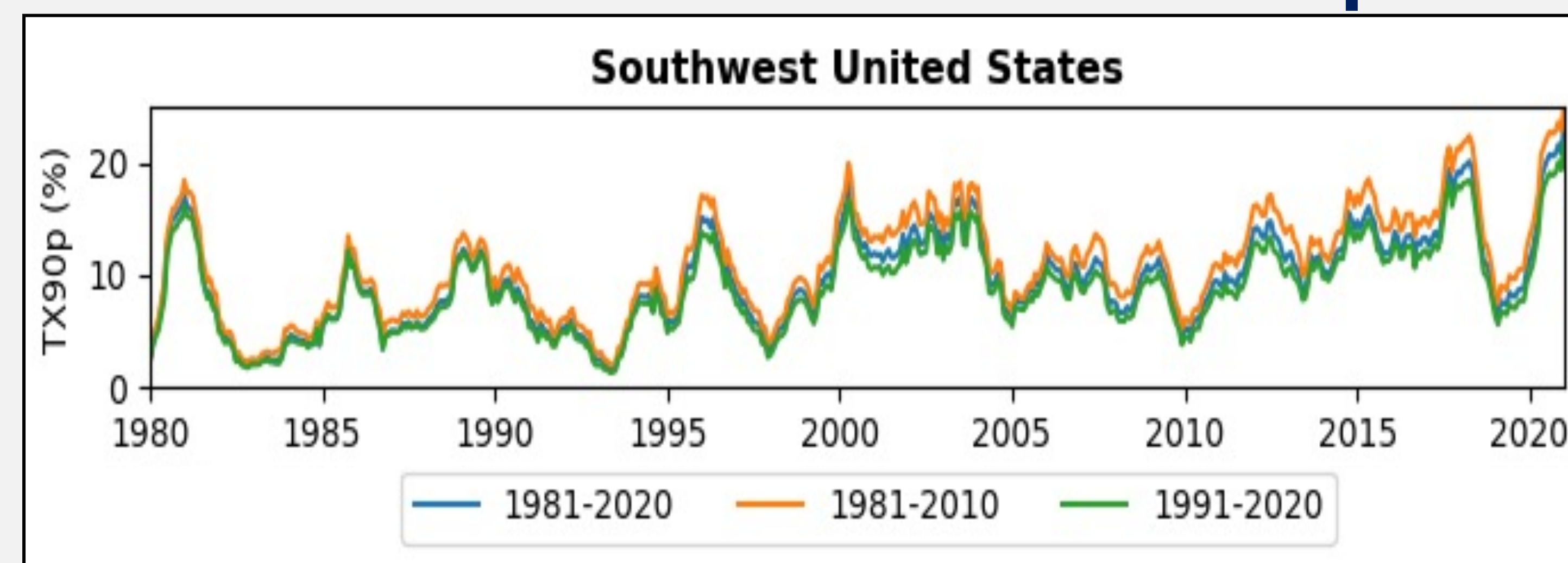


Figure 2. Time series of 12-month running means for TX90p area averaged over the Southwest region using a base climatology of 1981-2020, 1981-2010, and 1991-2020.

Indices are computed for each month in 1980-2021 (example above); differences are averaged over this period for regions of the US (right)

With the 1991-2020 baseline: indices *generally* show an increase in the frequency of cold extremes, a decrease in the frequency of warm extremes, fewer extreme precipitation days, but more precipitation on these days. There is regional variability across the US.

When updating to 1981-2020 baseline, differences have similar patterns, but often weaker in magnitude and/or statistical significance.

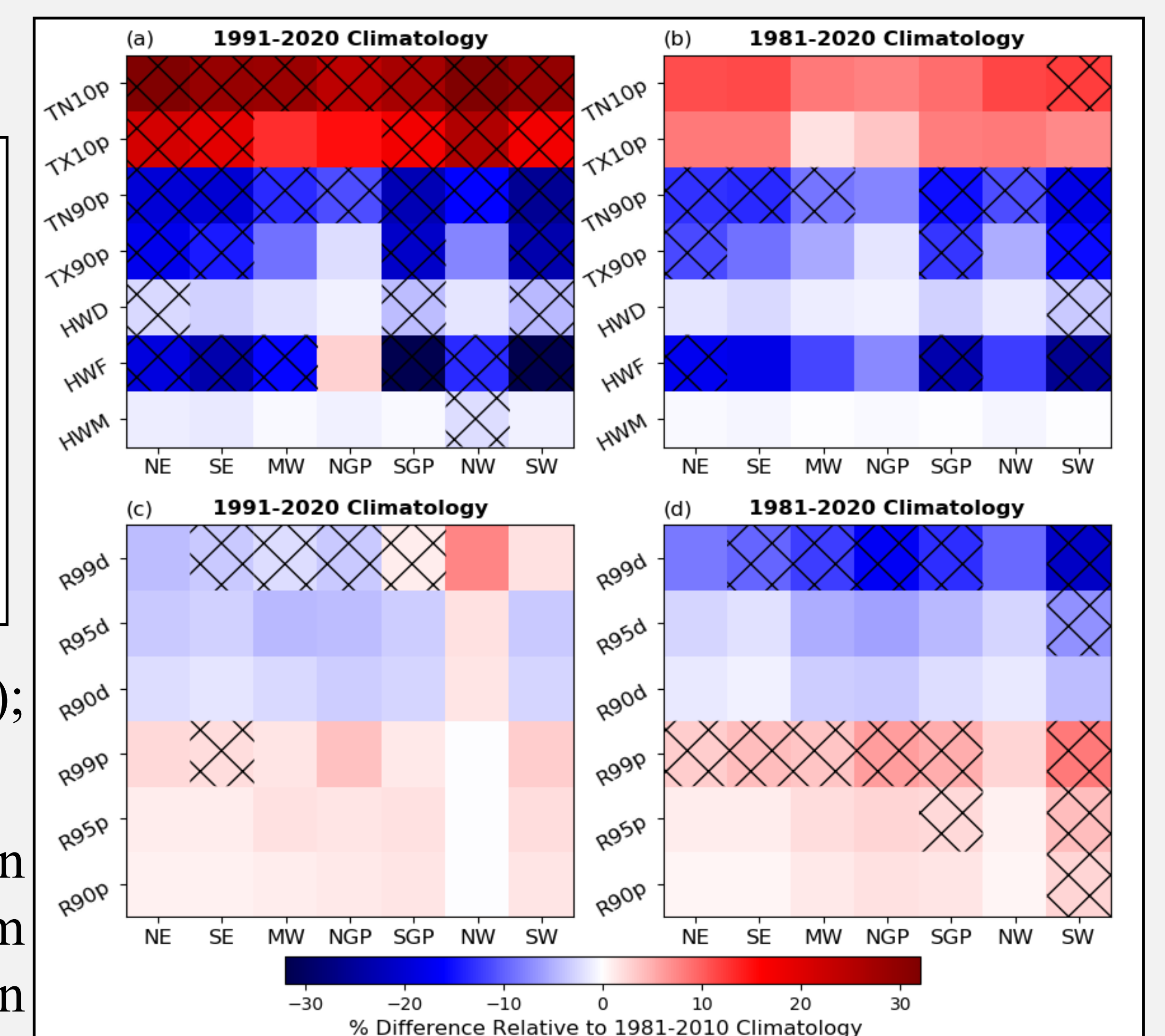


Figure 3. Average percent difference relative to the baseline climatology of 1981-2010 in area averaged over regions of the United States for (a) temperature indices using a baseline climatology of 1991-2020, (b) temperature indices using a baseline climatology of 1981-2020, (c) precipitation indices using a baseline climatology of 1991-2020, and (d) precipitation indices using a baseline climatology of 1981-2020. Hatching denotes the two climatologies result in statistically significant differences at 90% confidence.

Conclusions

- Changing the baseline period can lead to significant changes in the quantification of temperature and precipitation extremes.
- This has the potential to mislead the public and decision makers, so it is crucial to understand and communicate how to interpret this change.

References

- Alexander et al. 2006: <https://doi.org/10.1029/2005JD006290>
 Gelaro et al. 2017: <https://doi.org/10.1175/JCLI-D-16-0758.1>
 GMAO 2020: <https://doi.org/10.5067/QFJ13GEGD199>
 GMAO 2022: <https://doi.org/10.5067/O8AX56DO60MI>

