

Does an Increasing Quantity of Extreme High Temperatures Signify Global Warming?

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Background

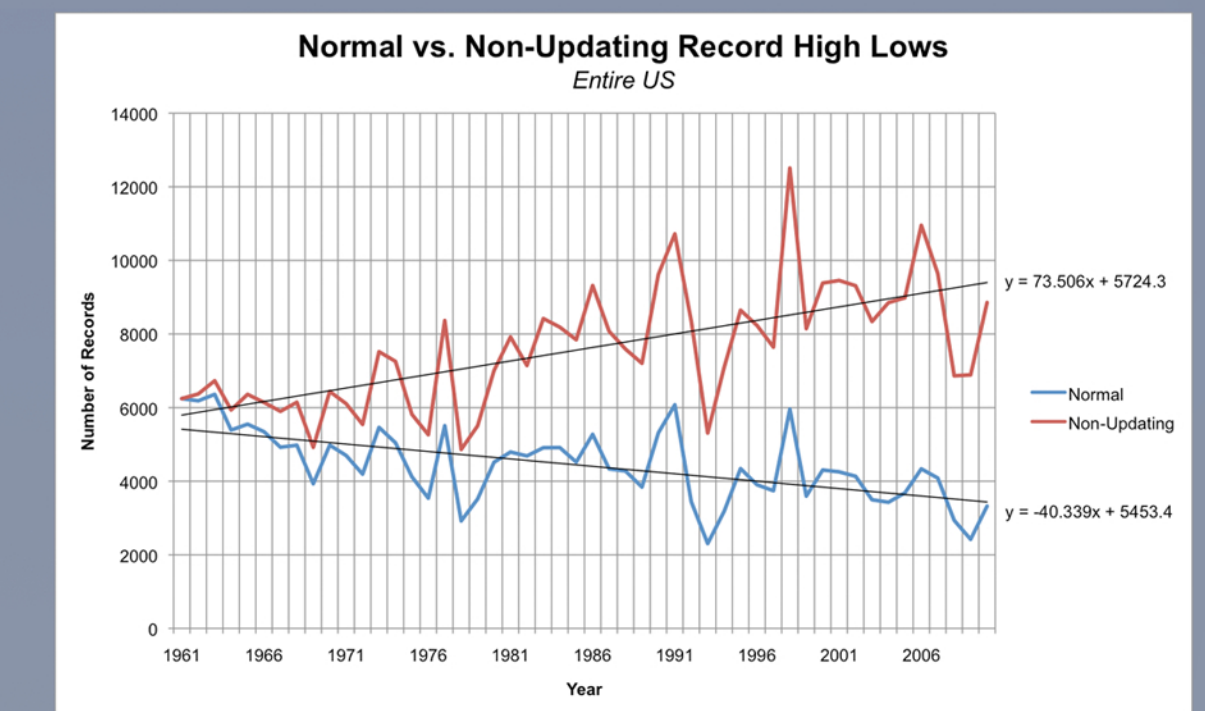
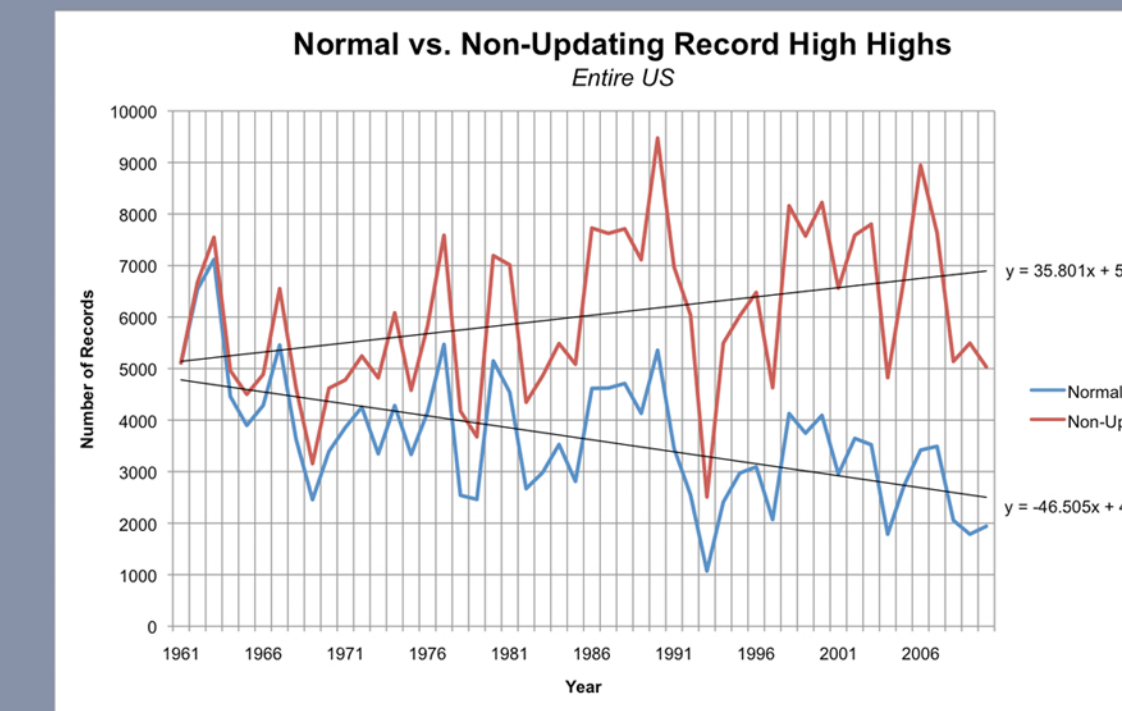
The practice of recording daily high and low temperatures has taken place at weather stations across the United States, in some places for over 100 years. The distribution of record-breaking temperatures over time is of interest for climate studies because this can indicate patterns or changes. As records are occasionally broken, logic would suggest that it would become more and more difficult to break a record over time. Each time a new record is created, it becomes harder to break. Previous research indicates that the total number of records broken each year does show a decreasing trend over time, as expected. However, the overall decrease appears to be deviating from the expected trend and has slowed down for record highs, meaning that records are being broken at an increasing rate. This raises an interesting question: if it is becoming "easier" to break high temperature records, is this indicative of a warming climate?

Data

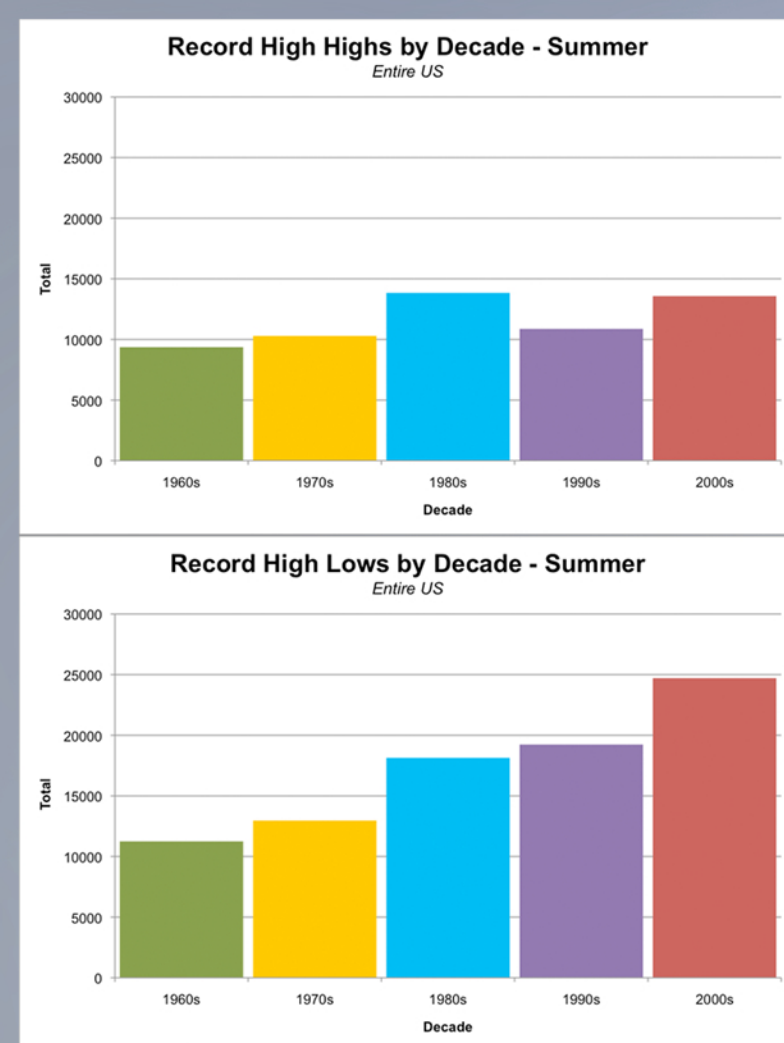
This research utilizes an 80 year dataset derived from the US Historical Climate Network containing daily high and low temperature data from 1217 weather stations across the country. This is a robust dataset that has been corrected for quality according to factors such as changes in each station's location or instrumentation. For this research, the data was trimmed further to contain 747 stations that have been collecting a complete set of daily temperatures since 1931. The National Climatic Data Center divides the country into nine regions for climate studies. This research uses these areas for regional analyses. The record totals are weighted according to the number of stations in each region. Record high highs are of interest as are record high low temperatures. In addition to daytime high temperatures increasing, there appears to be an even stronger increase in overnight low temperatures, both of which could be indicative of climate change.

Method

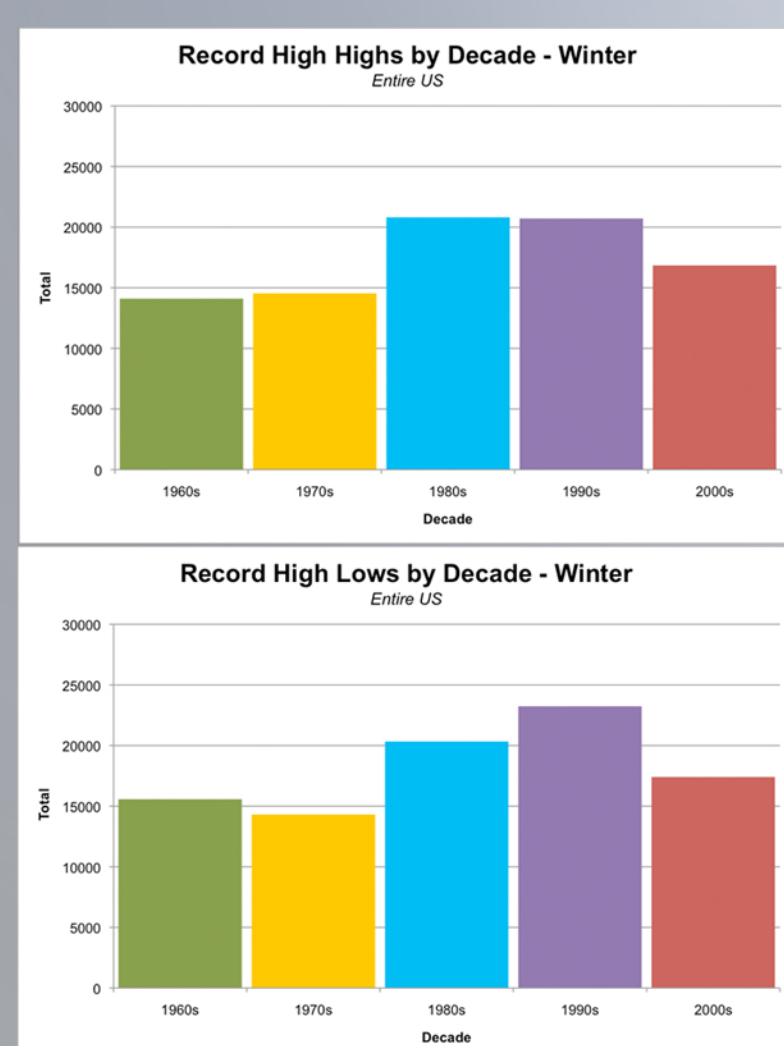
The distribution of record temperatures over time should follow a general decreasing relationship proportional to $(1/n)$, where n represents the number of years in the dataset. Traditionally, each time a record is broken, the record-breaking temperature becomes the new record. If this record is eventually broken, a newer record is created, and so on. The expected overall decrease can make it difficult to clearly observe any trends in the number of records being broken. Instead, a different method of analyzing daily temperatures wherein a constant record threshold is established can be used. In this way, the number of records broken can be compared to a constant baseline instead of a decreasing $(1/n)$ relationship. A record temperature is established for each day of the year from a 30 year establishing period (1931-1960). Then, the number of records for each year over the ensuing years (1961-2010) can be summed by comparing each day's high and low temperature from each weather station to this constant, previously established value. Using this method, the number of record temperatures over time would be expected to remain constant, making it much easier to notice any subtle increases. This research uses this "non-updating" method.



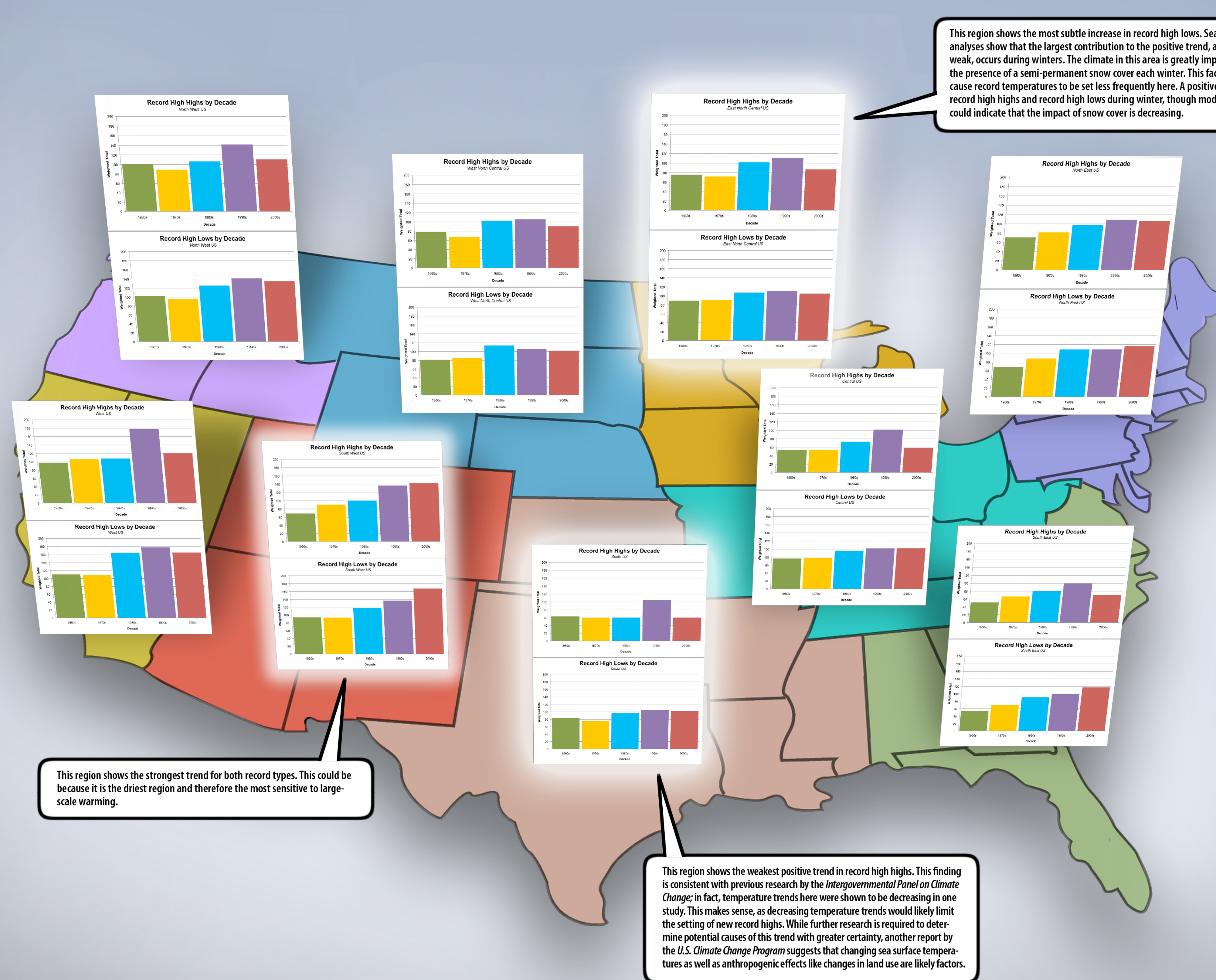
Seasonal Analysis



- There is an extremely pronounced increase in record high lows during summers for the entire country accompanied by a positive but more modest trend in record high highs during this season.
- There is an increase in both record high highs and high lows for the entire country during winters, with record high lows showing a slightly stronger positive trend.



Regional Analysis



Conclusion

- All regions show an increasing trend in number of record high temperatures over the past 50 years.
- The average increase in record high lows is approximately twice that of record high highs, indicating that overnight temperatures are experiencing a more rapid warming in all regions.
- The greatest increase in record high high and record high low temperatures is occurring in the *South West US*.
- The most subtle increase in record high highs is occurring in the *South*.
- The most subtle increase in record high lows is occurring in the *East North Central Region*.
- Future work will examine these trends at a higher resolution- i.e. at the state and monthly level in order to provide a more detailed look into where and how trends in record temperatures are occurring. Potential causal explanations for the trends will also be proposed and explored in greater detail.