The Power of Hourly Weather Data: Unveiling Climate Trends for Pragmatic Decision-Making

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Logan McLaurin, Sandra Yuter, Kevin Burris, Matthew Miller

Department of Marine, Earth, and Atmospheric Sciences and the Center for Geospatial Analytics, North Carolina State University, Raleigh, NC

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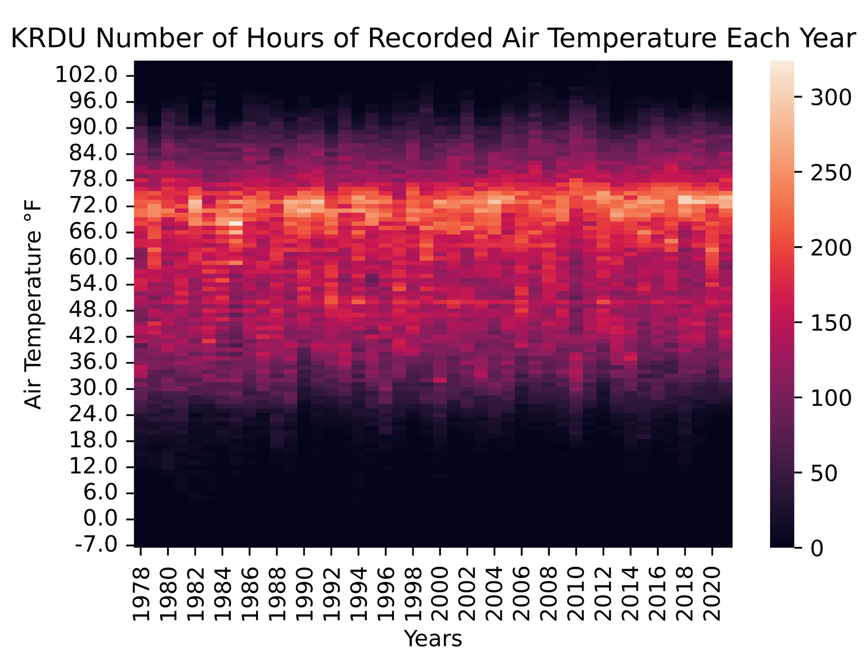
Motivation

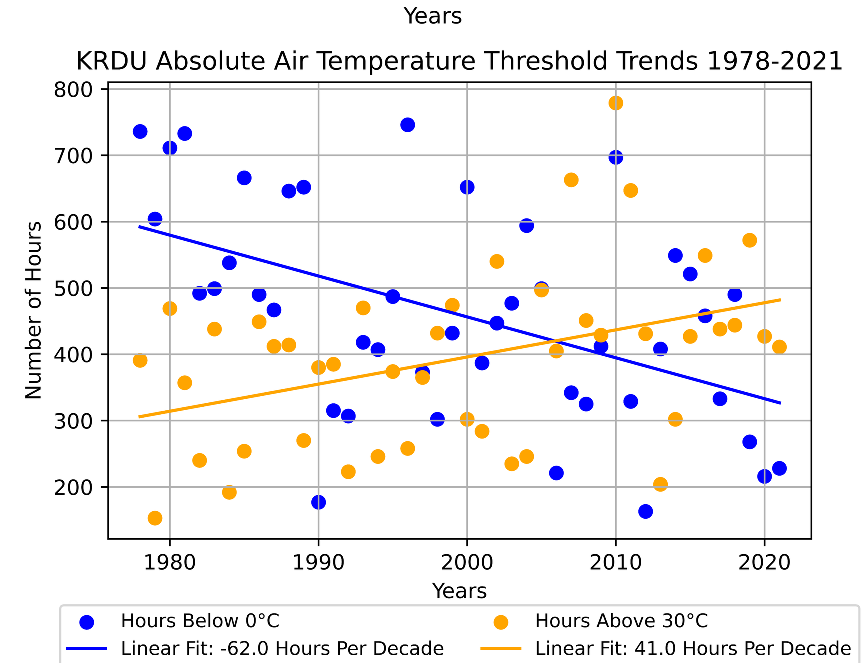
Historical climate changes are often presented in terms of averages and record daily minimums and maximums. However, these values are often hard to relate to lived experiences. People, animals, and plants experience temperature hour by hour. We utilize hourly weather data to quantify metrics for non-scientists.

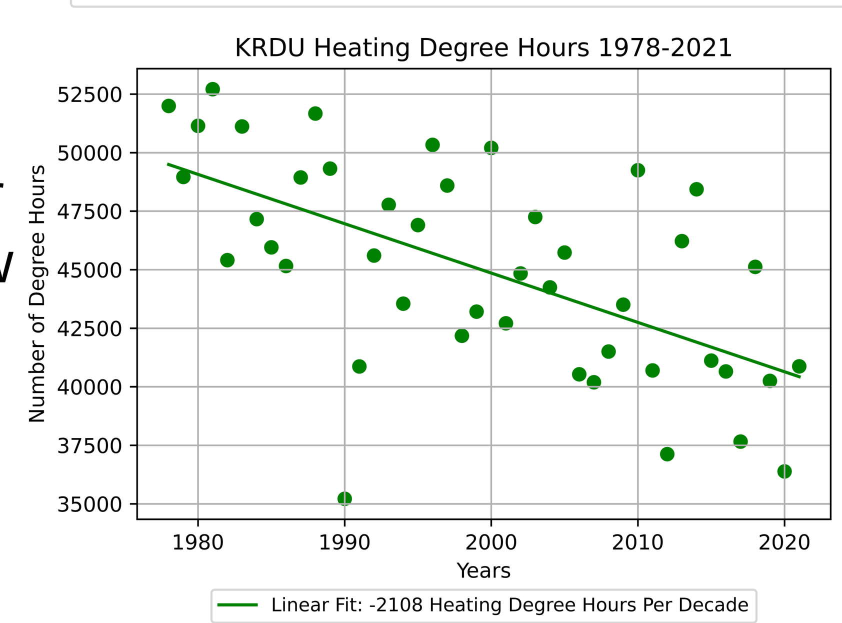
Methods

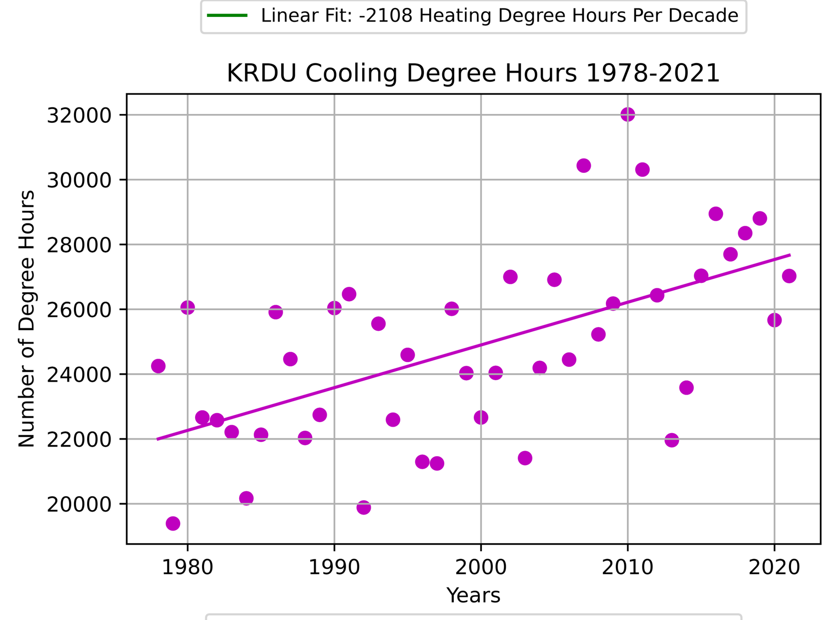
We use observed hourly weather station data from the Integrated Surface Database (ISD) for 361 stations spanning the years 1978 to 2021. For each location, the number of hours at each temperature are determined for each year. Data mining reveals climate changes that have already occurred. Trends are depicted by linear regression in terms of hours per decade.

We derive metrics related to changes over time of the hours below freezing, related to winter season impacts, and hours above 30°C (86°F), representing heat stress. Heating and cooling degree hours are proxies for energy usage and are calculated using a base temperature of 18°C (65°F). The analysis for Raleigh-Durham International Airport (KRDU) is shown (*right*).

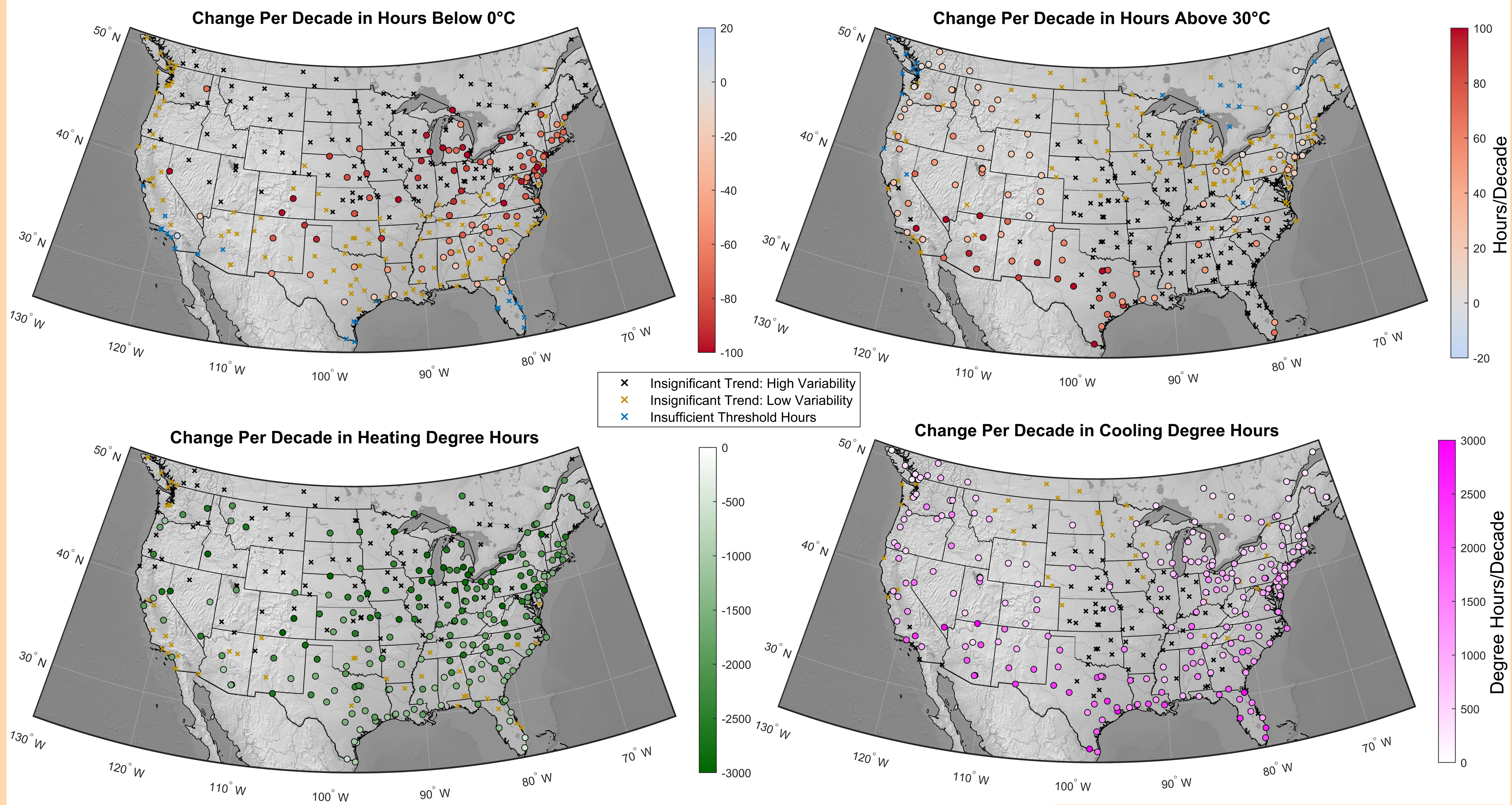




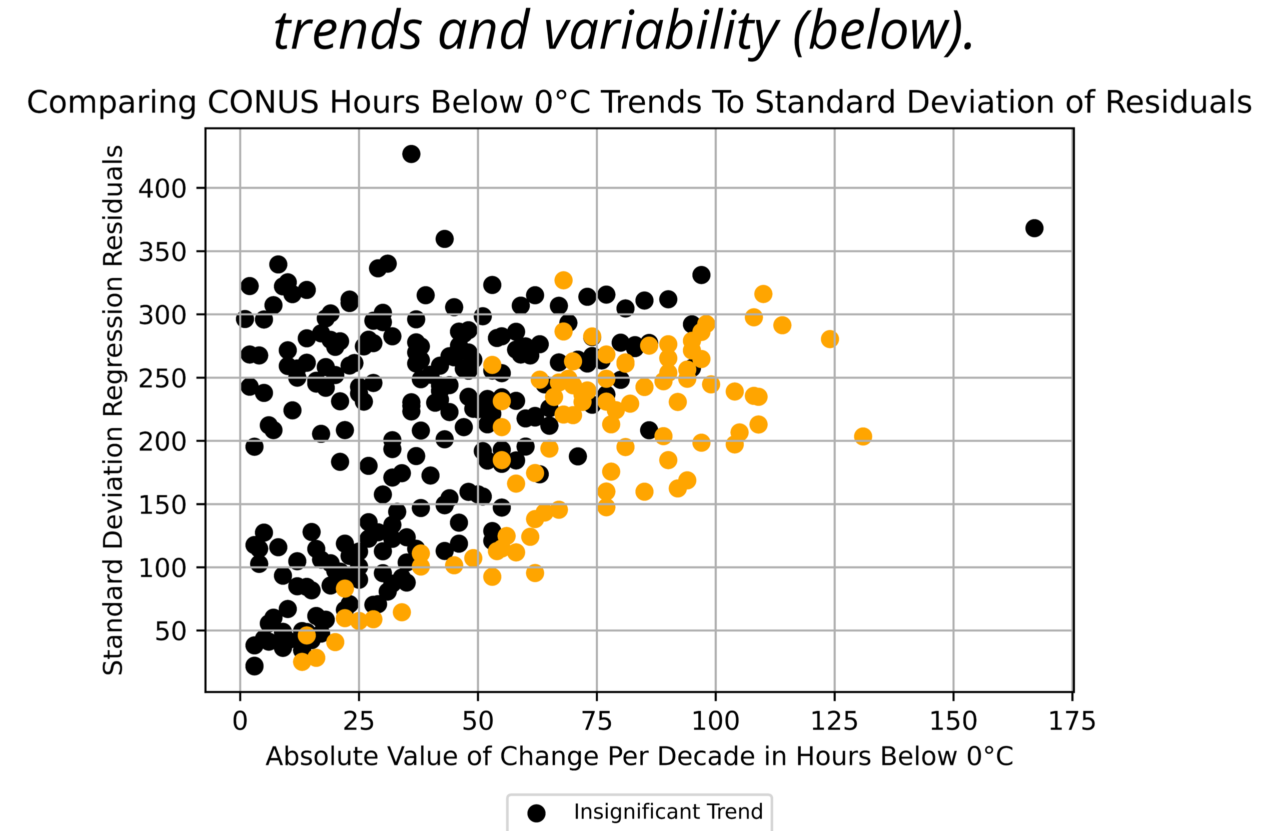




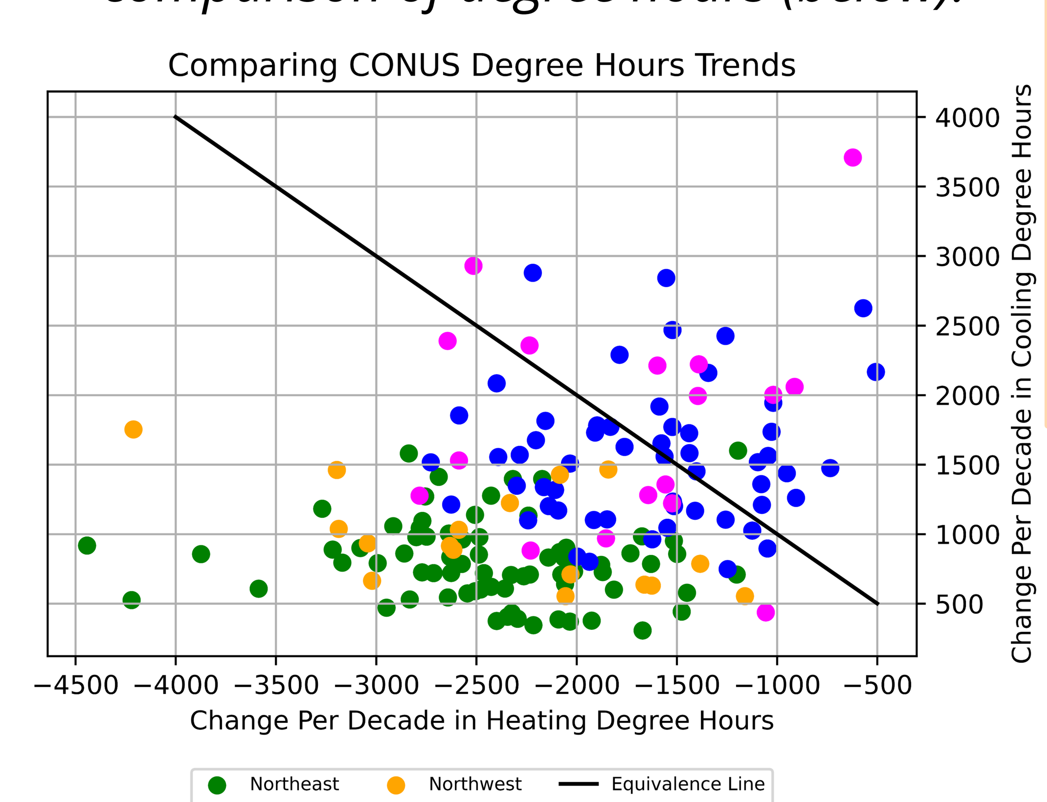
Regional summer and winter warming patterns are a key input for local adaptation decisions.



Significance of trends (>95th percentile) was determined using a stationary block bootstrap method. Variability is described in terms of the standard deviation of linear regression residuals. Hours less than freezing decadal trends and variability (below).



A majority of locations exhibit a net yearly energy demand reduction indicating winter warming outpaced summer warming. Regional comparison of degree hours (below).



In the last few decades, most locations have experienced greater changes in winter than in summer. The Midwest and Northeast US have lost more than 1.5 weeks of hours < freezing. Energy savings from winter warm spells are larger than increased energy use from summer heat waves. Analyses based on hourly data can help quantify and communicate recent regional climate changes that have already occurred.

Acknowledgements

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