43-Year Temperature Trends Based Upon Observed Hourly Weather Station Data

NC STATE

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ENVIRONMENT ANALYTICS

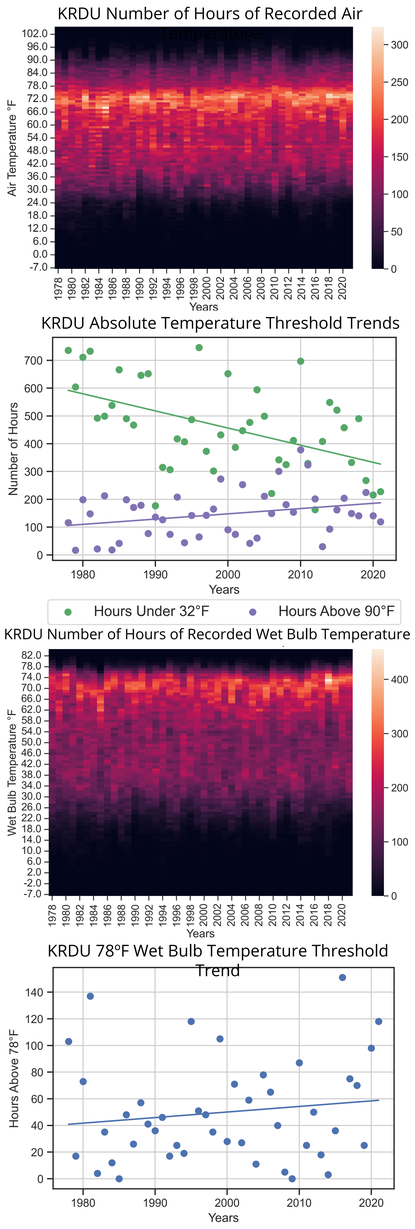
Motivation

Changes to the average and extreme values of daily temperatures illustrate changing climate but tell only part of the story. The impacts on people, animals, plants, and buildings are substantially different on a day with five consecutive hours at 95°F as compared to one hour at 95°F but would be recorded as the same daily high temperature.

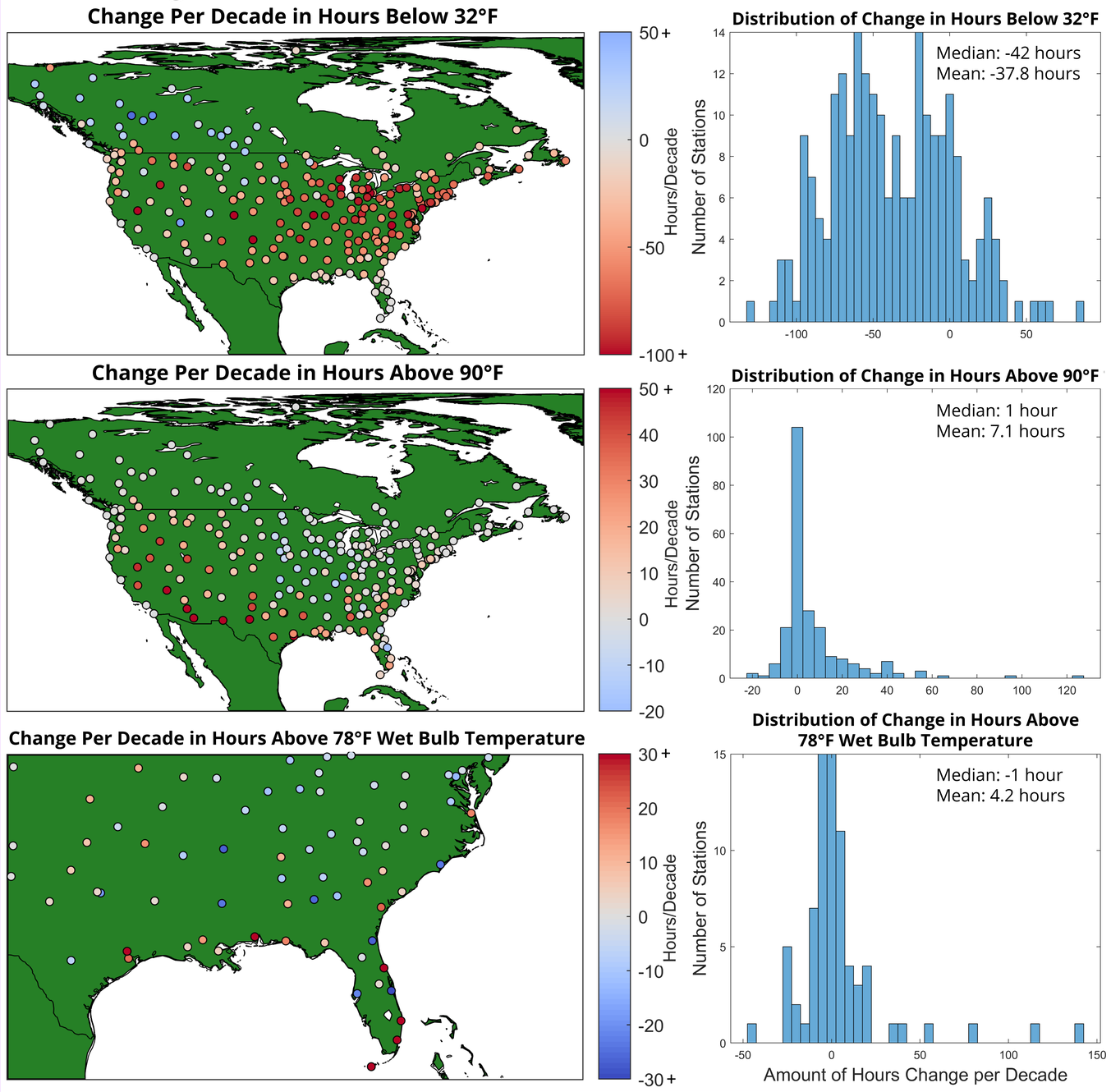
Methods

We use hourly data for 227 stations from the Integrated Surface Database (ISD) from 1978 to 2021. For each station, the number of hours at a given air temperature was compiled for each year, and the corresponding wet bulb temperatures were computed. Wet bulb temperature is a function of the air temperature and humidity and is a measure of how effectively the human body can cool itself.

Data for the Raleigh-Durham Airport, NC (KRDU) are shown as an example on the right. The number of hours over or under specific temperature thresholds are determined for each year. Trends are calculated using a linear fit for each station over the 43-year hourly record.



Evaluating Past Trends



We use the freezing point (32°F) to characterize winter impacts. An air temperature of 90°F and wet bulb temperature of 78°F are related to heat stress during summer.

The maps and corresponding distributions show that most stations have a decreasing number of hours below 32°F and an increasing number of hours above 90°F. Included are effects of changes in greenhouse gases and land use near the stations (mostly airports). On average, winter is warming faster than summer.

The wet bulb temperature map has a high degree of variability between nearby stations. Large increases > 30 hours/decade have occurred along the Florida and Gulf coasts

Initial Insights: Much of winter tourism depends on maintaining snow. Sharp decreases in the numbers of hours < 32°F occur throughout the US. The southwest US has seen a more rapid increase in hours > 90°F than the southeast US. Local geography has a strong influence. Trends are not uniform with latitude or proximity to the coast.

Acknowledgements

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ISD data from NOAA National Centers for Environmental Information (2001): Global Surface Hourly. NOAA National Centers for Environmental Information.