

Analysis of Extreme Minimum Temperatures in the Southeast Region

Hailey Long, Shawn Smith, David Zierden

Abstract

In recent years, summer has brought extreme heat to many parts of the United States, including the Southeast region. While maximum daytime temperatures are increasing, nighttime minimum temperatures are also rising resulting in record high warm nights. This study aims to analyze and identify trends in nighttime minimum temperatures across fifty weather stations in the Southeast region from 1950 to 2025. Python programs and Excel tools are applied to datasets accessed through the National Center for Environmental Information (NCEI), calculating the annual number of days where the minimum temperature does not go below 75°F and the diurnal temperature range (DTR) for each station. The resulting datasets are analyzed to determine long-term patterns and how temperatures vary by region over the past 75 years. Findings show that nearly every station exhibits positive trends in annual occurrences, indicating that the majority of the Southeast region is experiencing an increase in the number of warm nights each year, more severely in more southern, coastal areas. Most of the stations also display negative DTR slope values, suggesting that nighttime temperatures are warming at a faster rate than daytime temperatures. Nighttime minimum temperatures are an increasingly concerning aspect of climate change, affecting the human body's ability to cool down at night and leading to major health risks. Understanding the evolution of nighttime temperature trends is critical for assessing heat risk and preparing for conditions the future might bring.

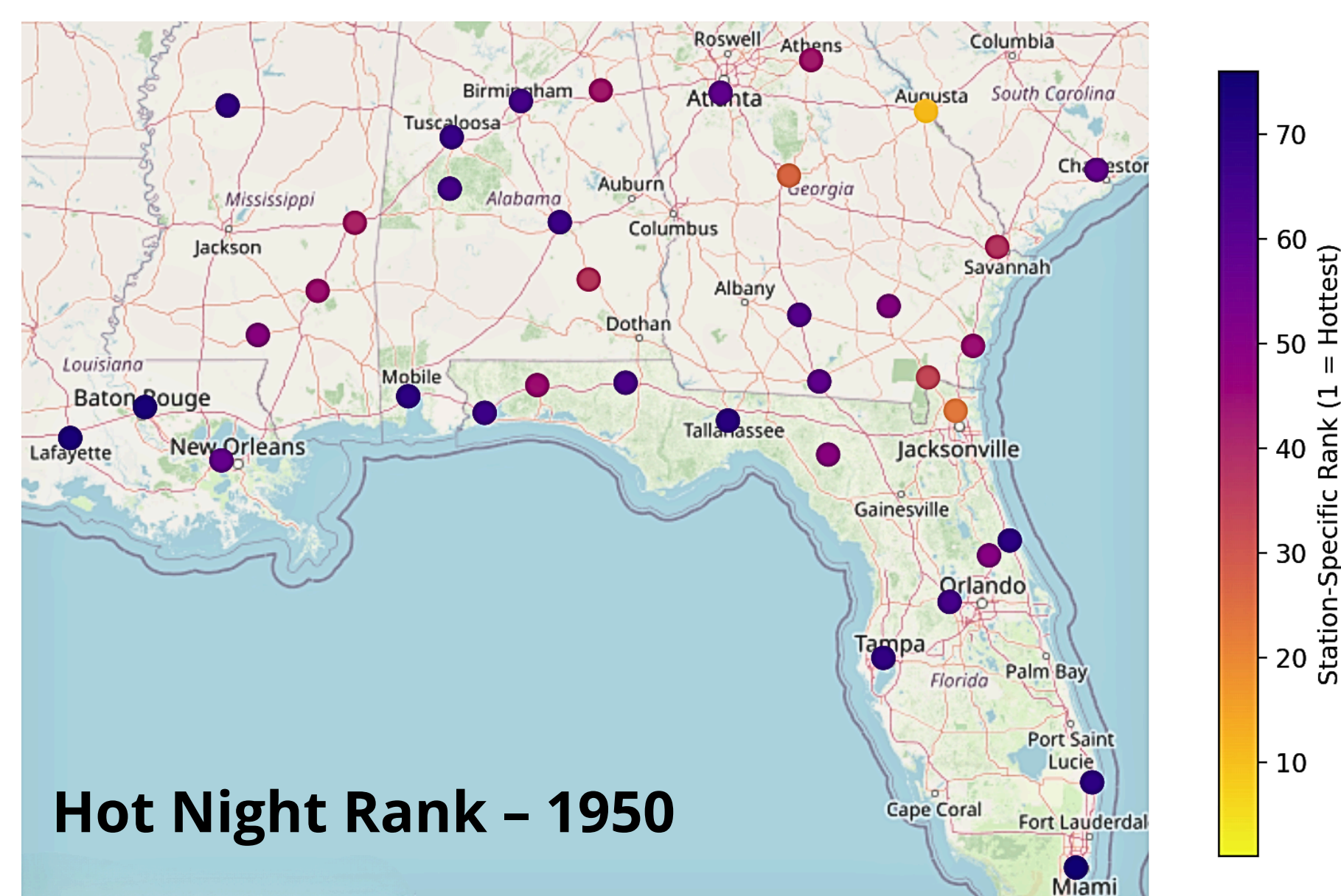


Fig 1a



Fig 1b

Warm Minimum Temperatures

Methods

- Collected 75 years of daily minimum temperature data from the NCEI from 50 stations throughout the Southeast United States.
- Filtered data, removing any outlier values (values more than 1.5 times the interquartile range below the 25th percentile or above the 75th), documenting missing data, and accounting for station location changes.
- Calculated the annual number of days where the minimum temperature remained $\geq 75^\circ\text{F}$.
- Ranked the annual number of “warm nights” (1 = highest number of days) at each station.
- Created color-coded spatial time-lapse animations to visualize regional and decadal trends (Fig 1a, 1b), including maps of 21-year centered running linear slopes and ranking annual slope values (1=highest slope) at each station.

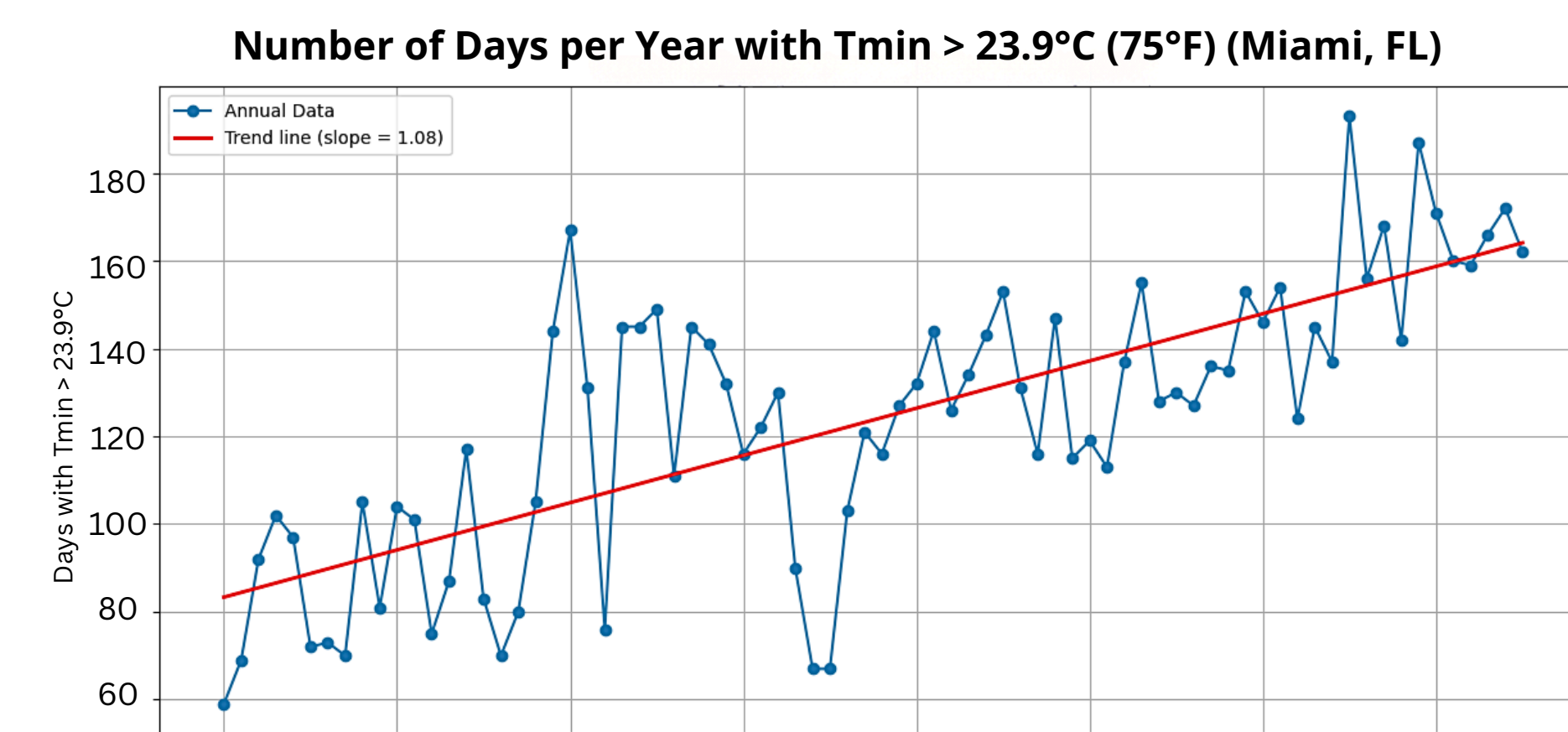


Fig 2a

Results

- Positive linear trends in 49 out of the 50 stations (e.g. Fig 2a).
- Stations located on the coast had higher slope values than those more inland, indicating a relationship where coastal locations are receiving greater nighttime warming rates.
- Although Miami had the greatest number of occurrences in one year (187 hot nights), Tampa had the largest slope value of 1.35 within the 75 year time period (Fig 2b).
- 2024 was the overall warmest year in terms of nighttime temperatures (Fig 1b), with the highest number of stations exhibiting a top 5 rank of number of hot nights in a year (33 stations).

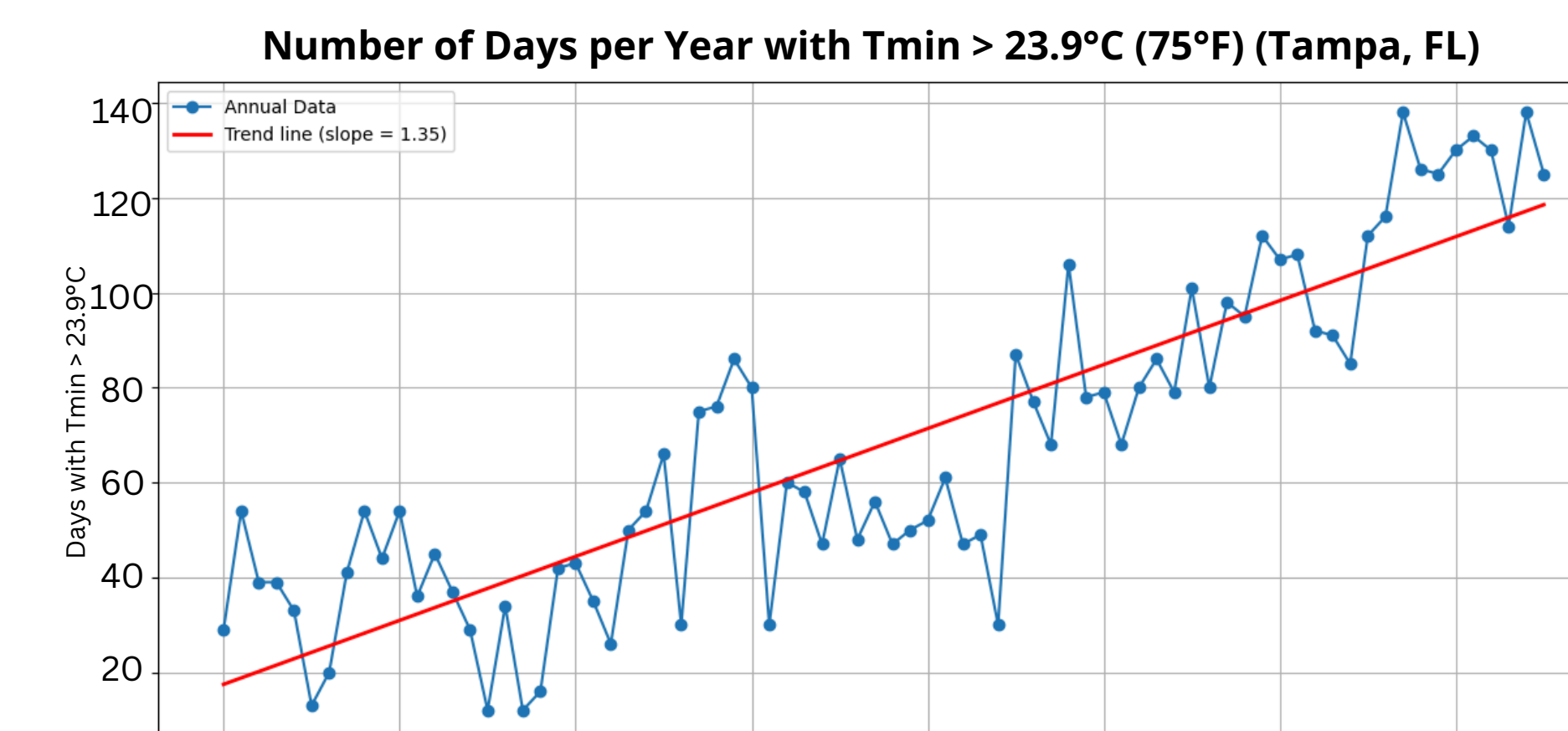


Fig 2b

Diurnal Temperature Range

Methods

- Calculated annual median minimum temperature and median maximum temperature for each year at each station using the previous dataset from the NCEI
- Plotted both median temperature values using scatterplots to determine long term variability (Fig 5a).
- Computed the diurnal temperature range (DTR) = median maximum temperature - median minimum temperature.
- Analyzed DTR trends using the scatterplots to determine regional and decadal trends (Fig 5b).
- Calculated linear DTR slope trends at each station and used slope values to create spatial maps (Fig 4).

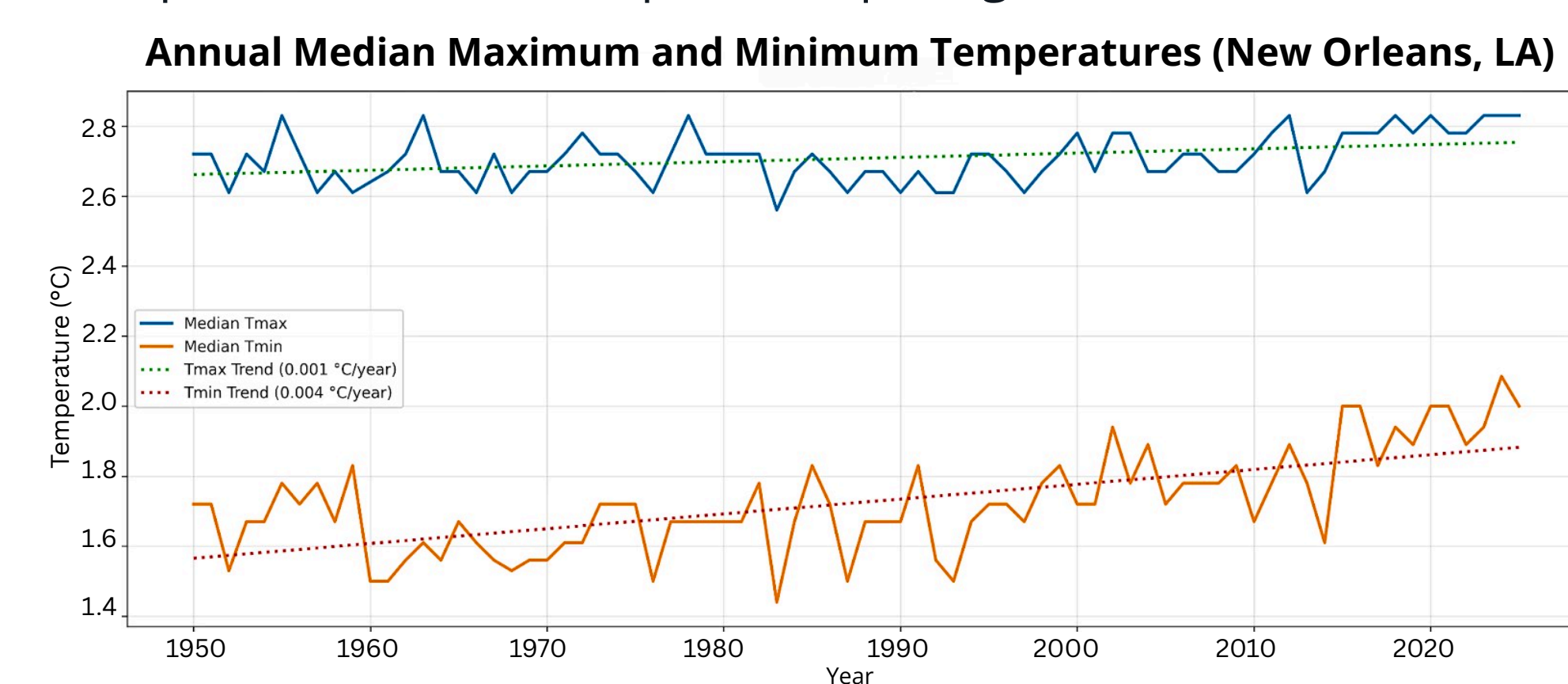


Fig 5a

Results

- More than half of the stations exhibit negative DTR slope values (60% or 30 stations), whereas only 24% had positive DTR slope values (12 stations), the rest giving zero values (16% or 8 stations).
- Many stations that contained the largest negative DTR slope values were located on/near the coast (Fig 4).
- For all the stations that have positive DTR slope values, none of the values are above 0.001.

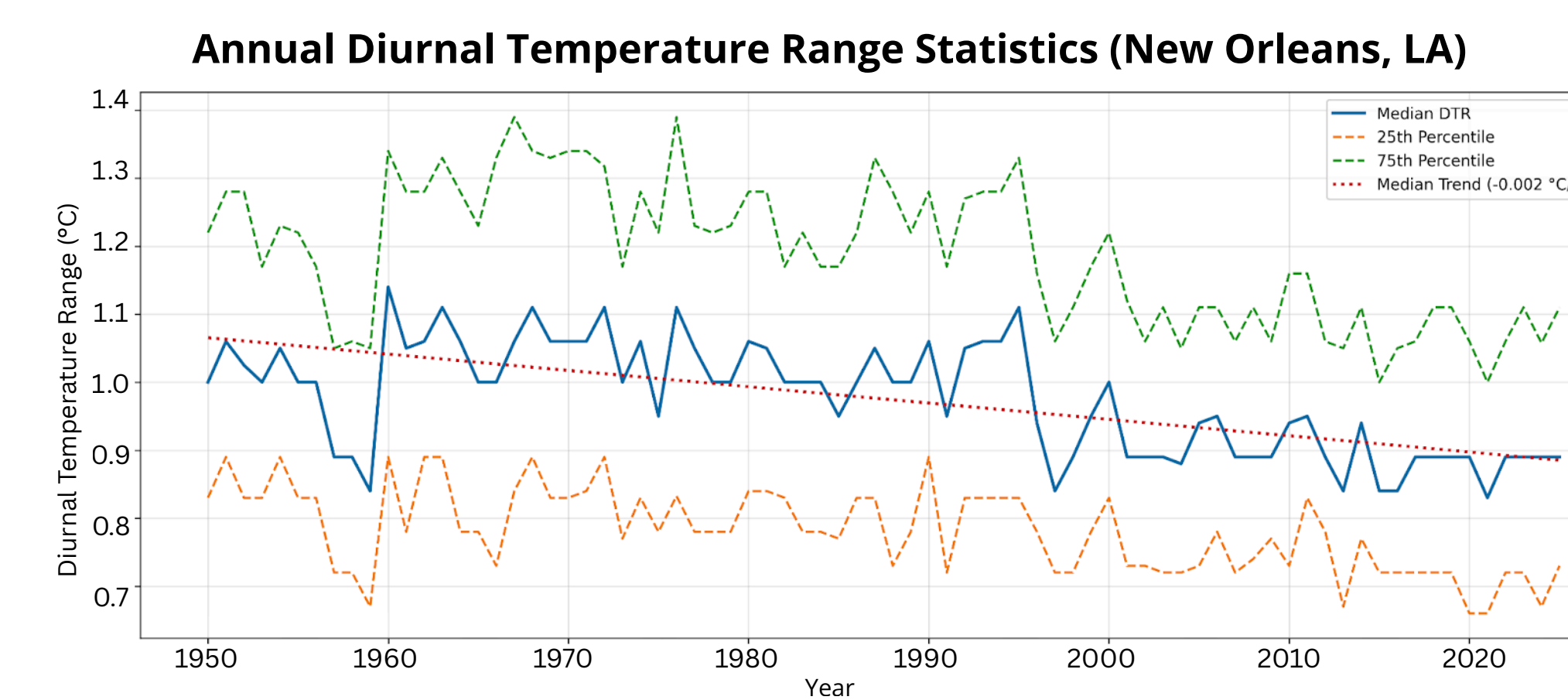


Fig 5b

Conclusion

- There is a positive increase in the number of “warm nights” over the past 75 years across the Southeast of the United States, primarily affecting places on/near the coast.
- The median maximum temperatures and median minimum temperatures are converging and are increasing at different rates in the majority of the Southeast.
- The coastal stations may be more affected in nighttime temperatures and DTRs due to an increase in sea surface temperatures in the Gulf and the Atlantic Ocean (Fig 3), however, additional research is needed to confirm this relationship.

Distance From the Ocean vs Slope Value

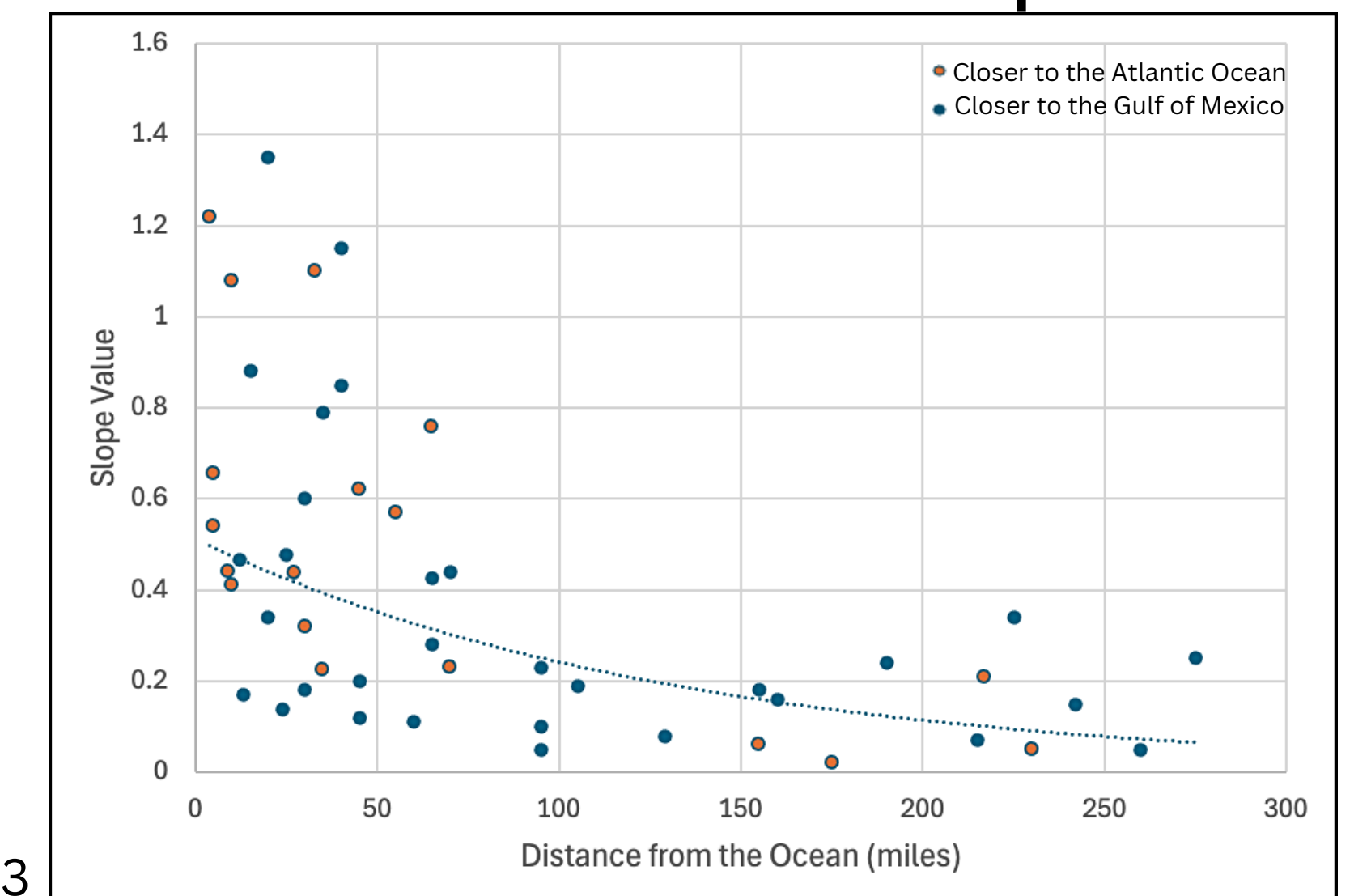


Fig 3

Acknowledgements/References

Special thanks to my mentors, Shawn Smith and David Zierden for guiding me throughout this project and teaching me so much about the weather world. Another warm thank you to the faculty at the Center for Ocean-Atmospheric Prediction Studies (COAPS) and my Undergraduate Research Opportunity Program (UROP) leaders.

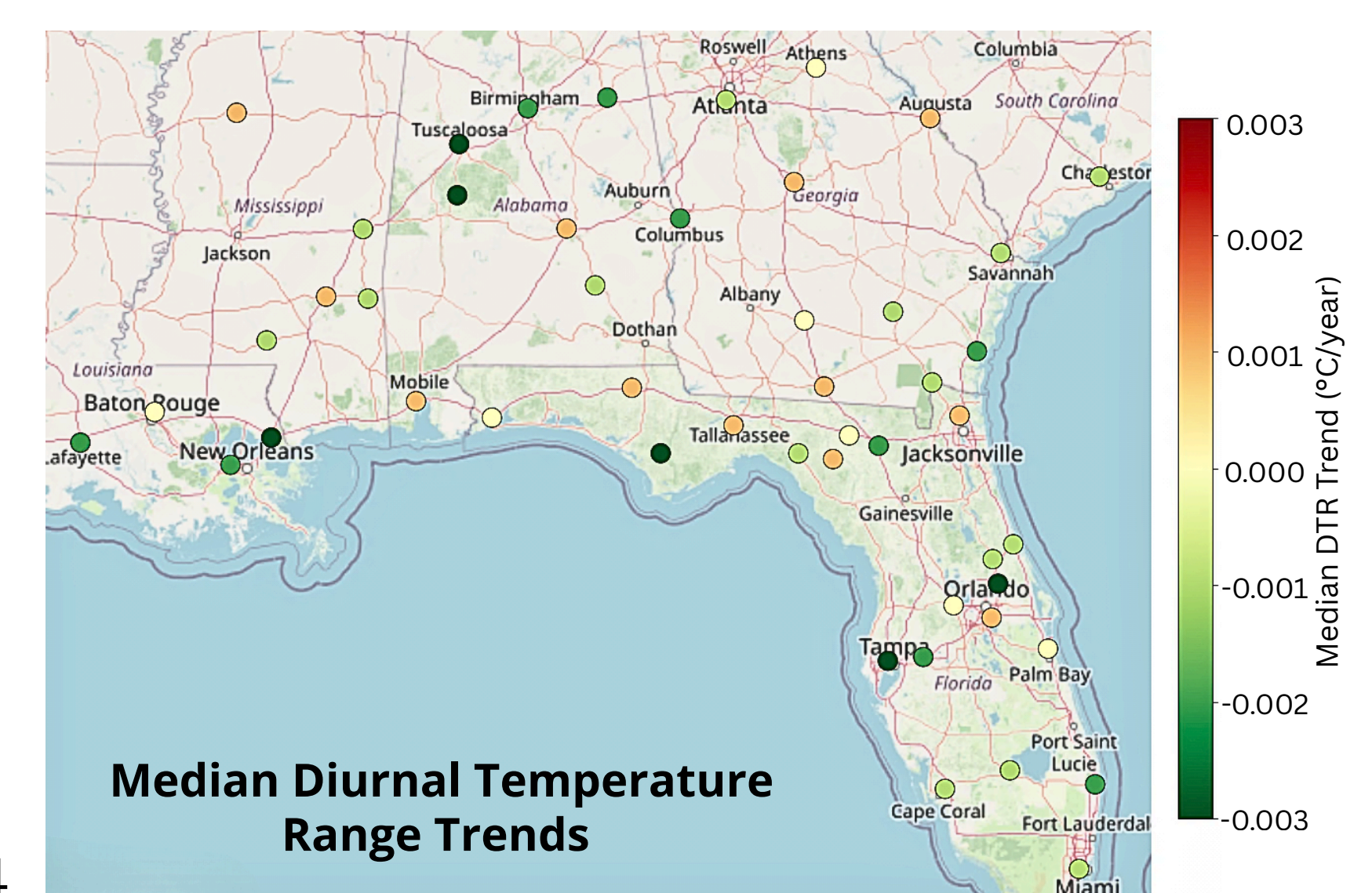
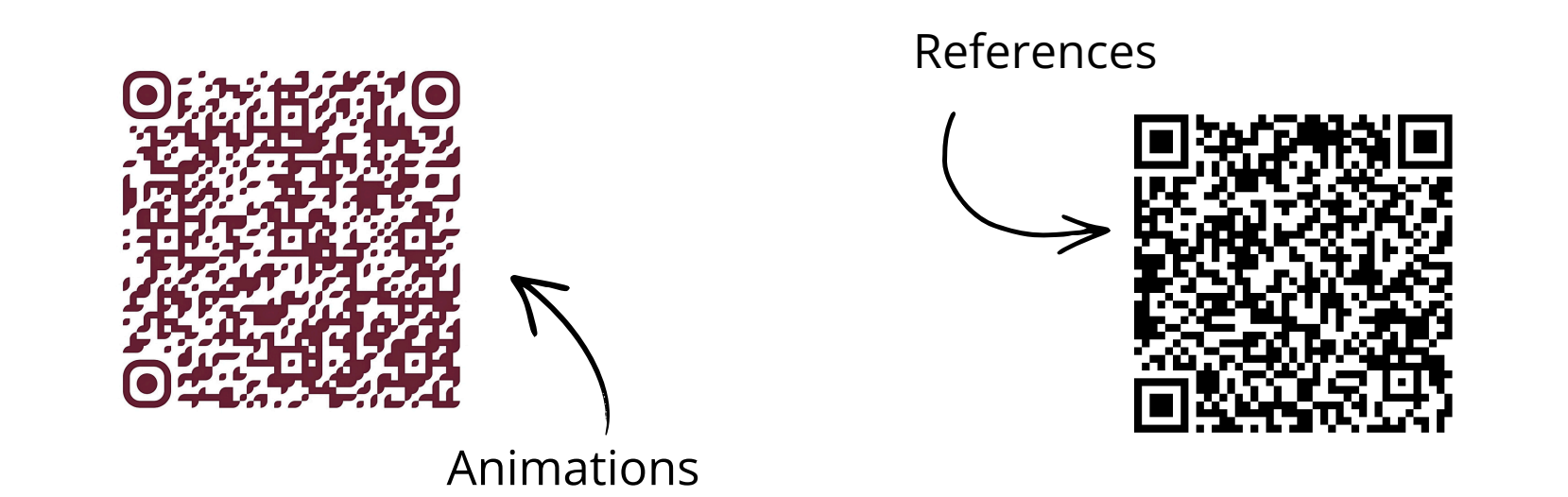


Fig 4