

Historical Temperature Trends in Phoenix, AZ from 1896-2009

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The Study

The Phoenix, Arizona metropolitan area has experienced rapid growth since it was founded in 1868, particularly over the last fifty years. As the population of Phoenix grows, implications of the urban heat island have been found to have significant impacts on human health and environmental systems. Building upon the work of Meehl et al. (2004), this study analyzes the annual number of frost, and misery days recorded at the Phoenix regional weather station for the complete historical temperature record.

Frost Days: help regulate pest and disease outbreaks by maintaining seasonal breeding cycles.

Misery Days: have adverse impacts on human health and well-being as well as economic and environmental systems.

Research questions

1. What are the annual and decadal number of frost days and misery days for the Phoenix regional weather station between 1896-2009?

1. Using the results as a baseline, what are the likely or expected changes in climate over the next century?

Research Methodology and Data

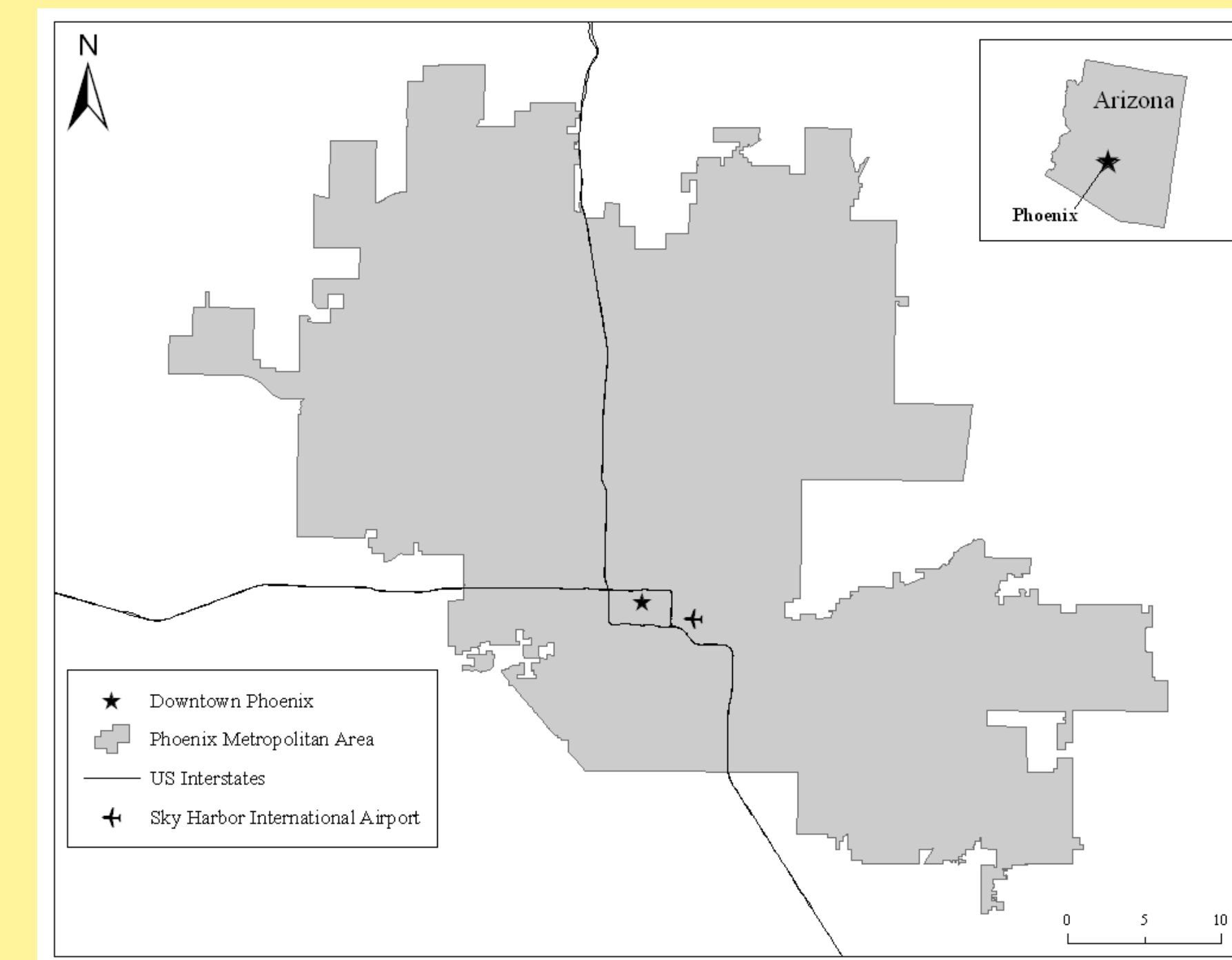
Study Area

The Phoenix metropolitan area is located in the Southwestern United States. The large-scale population growth and urbanization of metropolitan Phoenix has been a mixed blessing: while growth has provided a valuable economic base for the city, the transformation of the fragile Sonoran Desert ecosystem into an urban metropolis has resulted in significant changes in regional temperatures, which, in turn, present serious risks and challenges to the health and well-being of local residents.

Figure 1: Phoenix sunset



Figure 2: Metropolitan Phoenix



Methods

Temperature readings were taken from the Phoenix metropolitan regional weather station by the National Weather Service (NWS) and National Oceanic and Atmospheric Administration (NOAA). This study examined local temperature readings to investigate historical changes in climate in Phoenix, Arizona.

Data

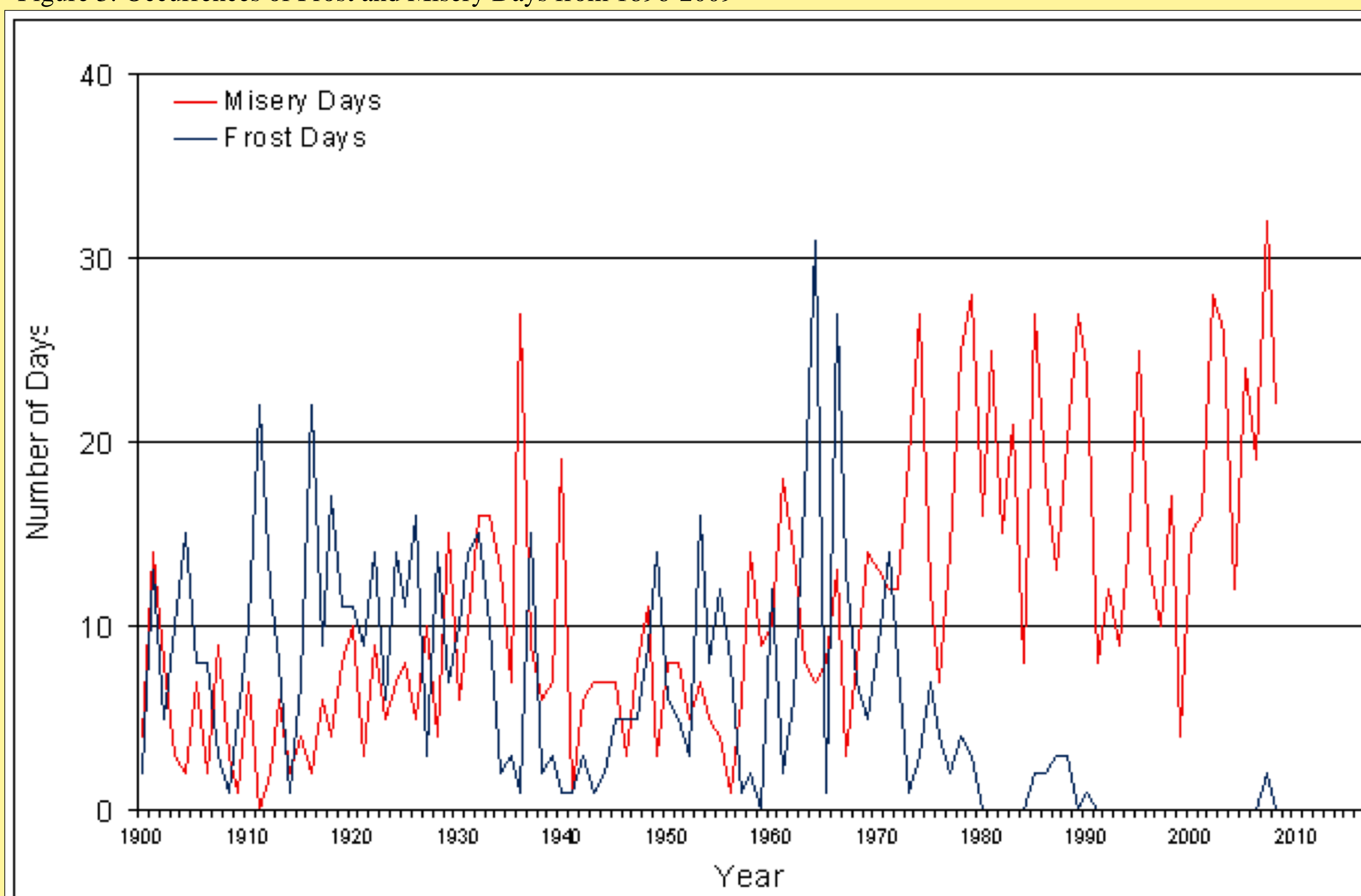
The data was provided by the Arizona State Climate Office and reflects temperature readings taken from the Phoenix weather station (operational from 1895-1999) as well as the weather station at Sky Harbor International Airport (1930-Present). The study examined the changing number of *frost days*, and *misery days* in the downtown Phoenix area from 1896-2009.

Frost days are defined as the nighttime minima temperature less than freezing (minimum temperature below 32°F)

Misery days are defined as daily maximum temperature $\geq 110^\circ\text{F}$.

Historical Changes in Frost/Misery Days in Phoenix, AZ

Figure 3: Occurrences of Frost and Misery Days from 1896-2009



Analysis of Frost and Misery Days

The analysis of frost days and misery days by decade show two distinct patterns.

- 1) A natural oscillating trend in temperature variability between 1896-1970.
- 2) A pronounced departure from historical temperature patterns beginning in 1970 extending to present.

Table 1: Decadal Occurrences of Frost and Misery Days (1896-2009)

Decade	Frost Days		Misery Days	
	N	Annual Average	N	Annual Average
1896-1900	59	11.8	24	4.8
1901-1910	78	7.8	56	5.6
1911-1920	120	12	44	4.4
1921-1930	104	10.4	72	7.2
1931-1940	66	6.6	130	13
1941-1950	51	5.1	61	6.1
1951-1960	67	6.7	69	6.9
1961-1970	118	11.8	106	10.6
1971-1980	46	4.6	172	17.2
1981-1990	11	1.1	214	21.4
1991-2000	0	0	127	12.7
2001-2009	2	0.2	179	17.9
Total	722	6.3	1,254	11

Conclusions

Key Findings:

1. Frost day analyses show: 1) natural temperature variability from 1896-1970; and 2) a significant decrease in the number of frost days beginning in 1970.
2. The analysis of misery days shows natural variations in annual occurrences, and a marked rise in misery days beginning in the 1970s.
3. If recent temperature trends continue it is very likely that the annual number of misery days will increase while frost days will become less frequent.
4. Changes in temperature patterns (i.e. frost and misery days) are likely to present new challenges for economic, environmental, and social systems.

Future Research

1. Correlate warming conditions in Phoenix, AZ with population growth and land use/land cover change.
2. Identify mitigation strategies for the Phoenix urban heat island.
3. Evaluate heat storage among urban structures such as surface parking lots and parking garages.

References

- [1] Meehl GA, Tebaldi C, & Nychka D (2004). Changes in frost days in simulations of twenty-first century climate. *Climate Dynamics*, (23), 495-511.
- [2] Meehl GA & Tebaldi C (2005) More Intense, More Frequent, and Longer Lasting Heat Waves in the 21st Century. *Science* 305:994-997.