

Thursday, August 30, 2018

Engineering Systems



Polar Vortex and Bomb Cyclone Review

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Purpose

In order to further understand the impact and extent of the Polar Vortex of 2014 and the Bomb Cyclone of 2018, this analysis will determine the temperatures experienced in each demand center affected by these events. These temperatures will be compared the twenty year recurrence interval temperatures in each major city. Polar Vortex cities reviewed include: Chicago, Milwaukee, and Minneapolis. Bomb Cyclone cities reviewed include: Atlanta, Columbia, Jacksonville, Philadelphia, Raleigh, and Richmond.

Analysis

Temperature data was collected for each location from the Utah Climate Center*. The data ranges from 1892 to present. Table 1 shows the date ranges for each demand center analyzed. In each case, enough data is present to draw statistically significant conclusions.

Table 1: Data Obtained from Utah Climate Center

Location	Oldest Value	Newest Value
Atlanta	1/1/1930	7/31/2018
Chicago	10/4/1928	7/31/2018
Columbia	1/1/1948	7/31/2018
Jacksonville	4/1/1938	7/31/2018
Milwaukee	4/1/1938	7/31/2018
Minneapolis	4/9/1938	7/31/2018
Philadelphia [†]	4/5/1951	7/31/2018
Raleigh	1/15/1892	7/31/2018
Richmond	3/1/1939	7/31/2018

In order to determine the 20-year recurrence interval temperatures, two probability distributions were used normal and Weibull distributions. The normal distributions were fitted to the heating season temperatures only. As the Weibull distribution is one of the extreme value theorem distributions, it was fitted to all the data. Table 2 shows the estimated 20-year recurrence intervals with each method.

* <https://climate.usu.edu/mapGUI/mapGUI.php>

[†] Data used for Philadelphia was taken from Norristown, a nearby weather station

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Table 2: Twenty-Year Recurrence Interval Temperature Estimates

Location	Normal Distribution	Weibull Distribution
Atlanta	11°F	9°F
Chicago	-14°F	-11°F
Columbia	13°F	10°F
Jacksonville	24°F	20°F
Milwaukee	-16°F	-14°F
Minneapolis	-29°F	-22°F
Philadelphia	0°F	-5°F
Raleigh	7°F	9°F
Richmond	4°F	3°F

Figures 1 through 9 show the temperatures experienced in the relevant events compared to the historical heating season temperatures along with the estimated 20-year recurrence interval. On these charts, the purple dots represent the temperatures and frequency experienced during the polar vortex and bomb cyclone events. As the charts show, for each of the cities shown, the polar vortex and bomb cyclone temperatures did not reach one in 20-year recurrence levels.

Polar Vortex Temperatures

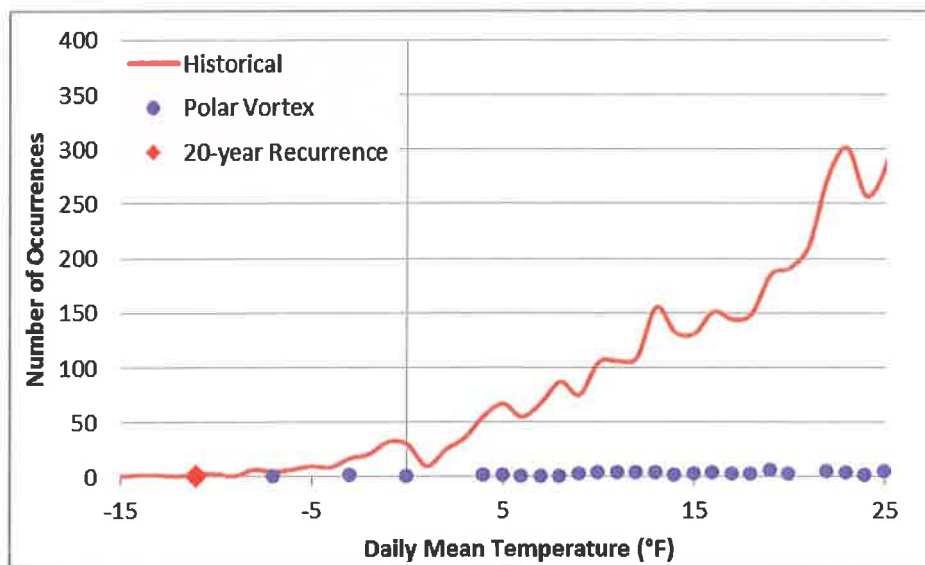


Figure 1: Chicago Temperature Comparison

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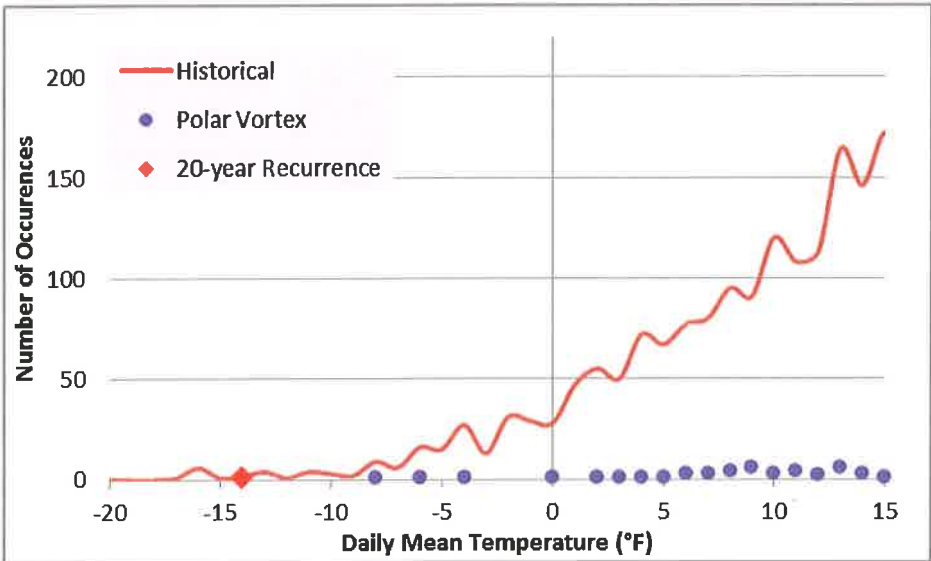


Figure 2: Milwaukee Temperature Comparison

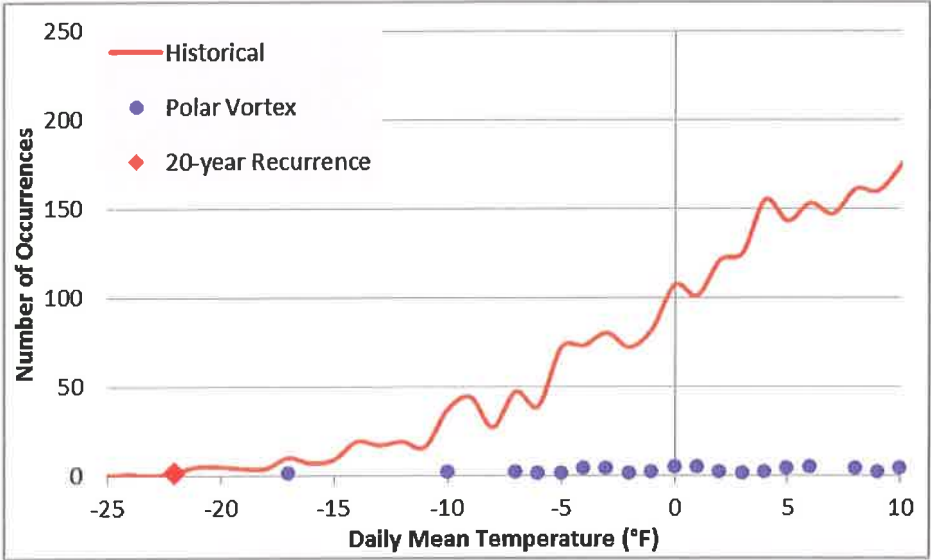


Figure 3: Minneapolis Temperature Comparison

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Bomb Cyclone Temperatures

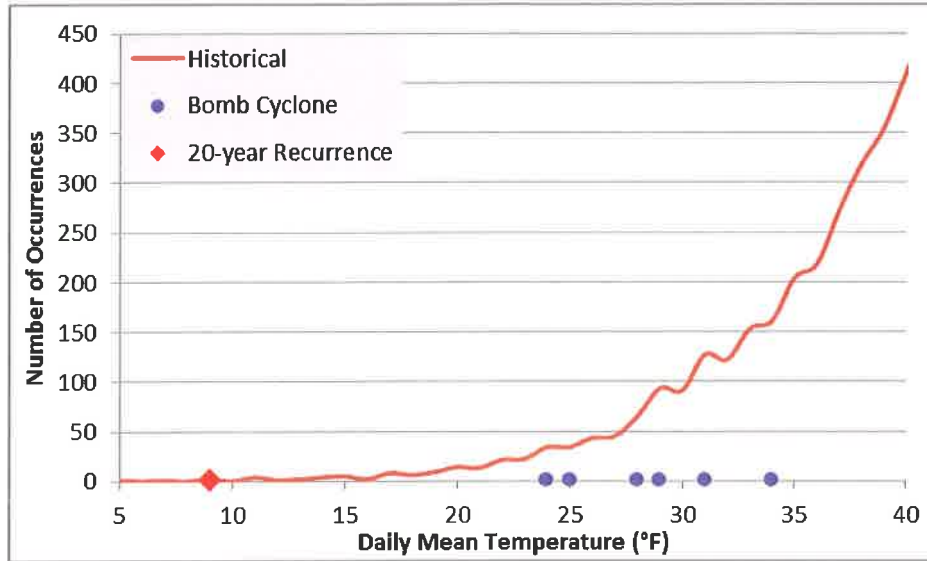


Figure 4: Atlanta Temperature Comparison

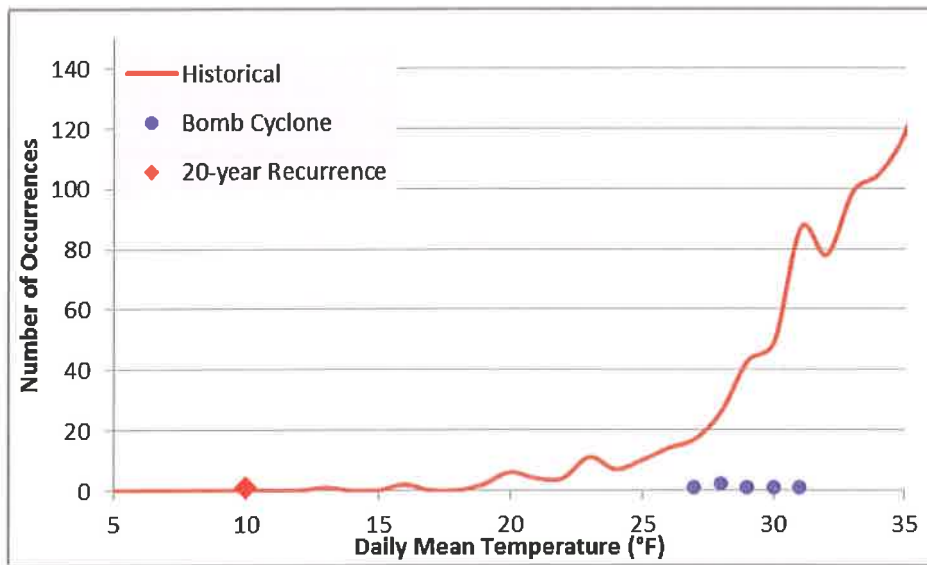


Figure 5: Columbia Temperature Comparison

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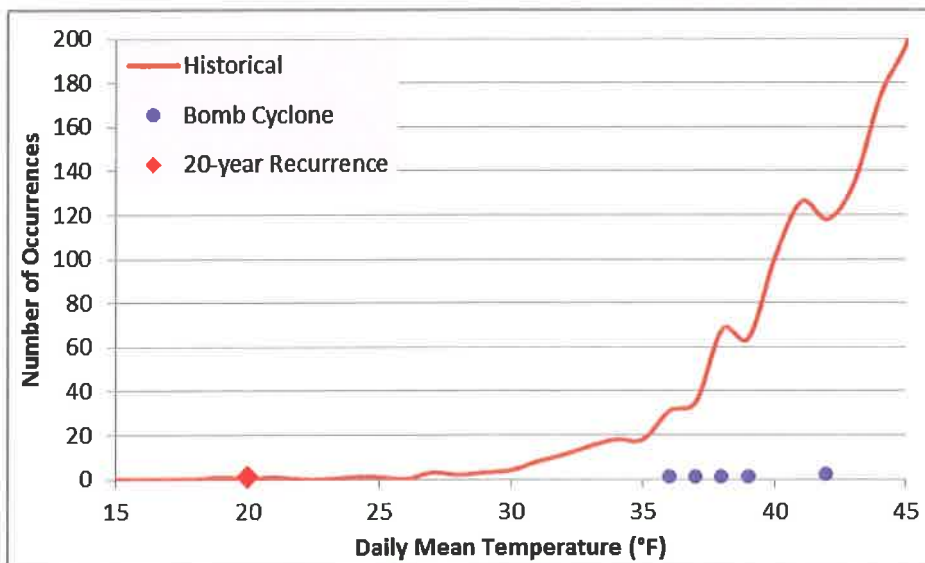


Figure 6: Jacksonville Temperature Comparison

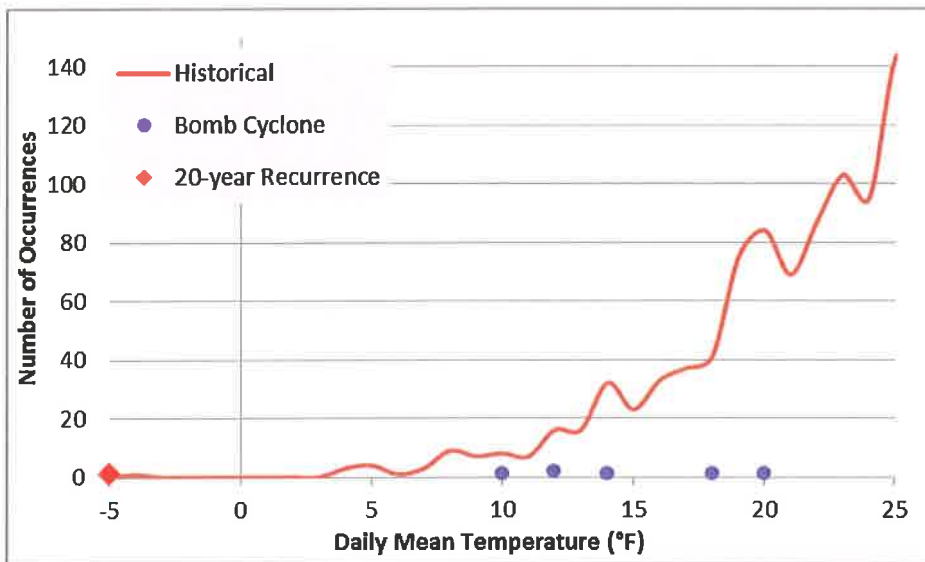


Figure 7: Philadelphia Temperature Comparison

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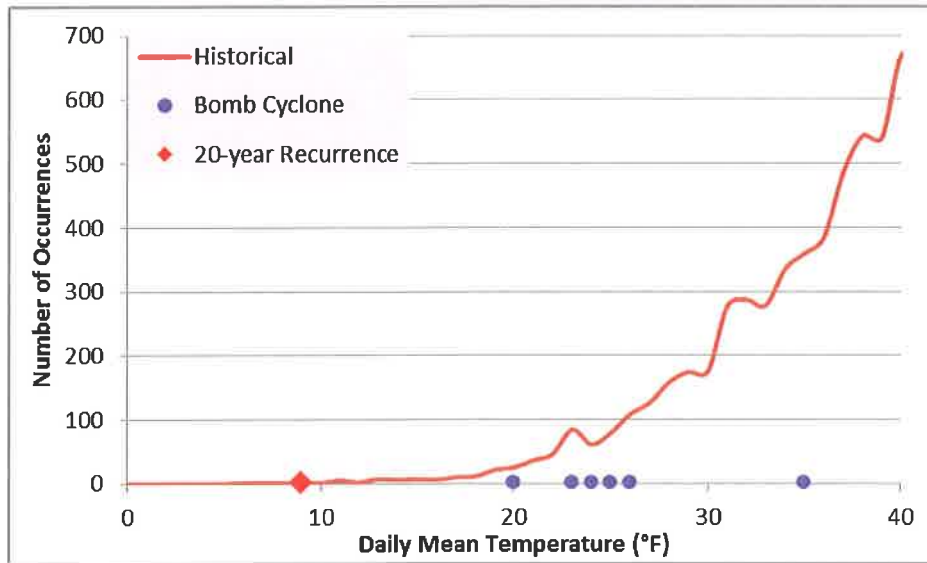


Figure 8: Raleigh Temperature Comparison

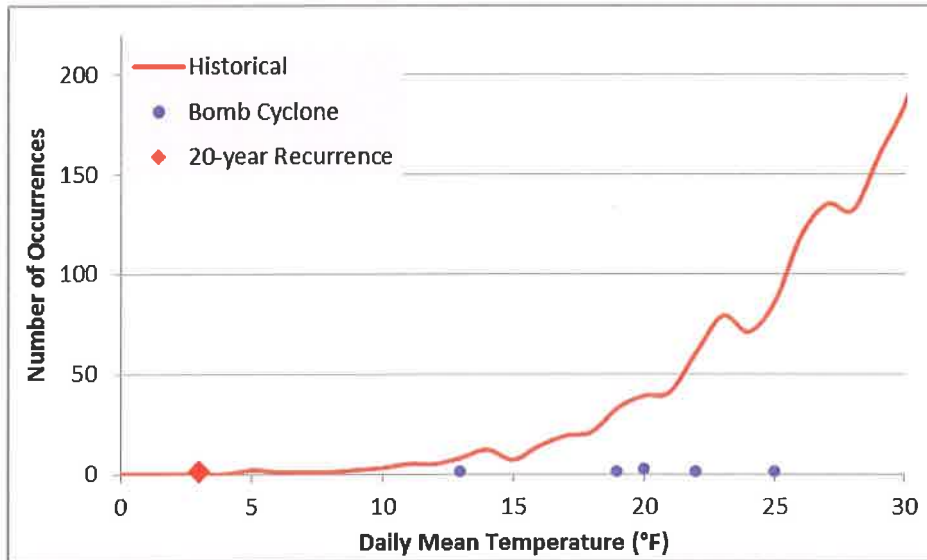


Figure 9: Richmond Temperature Comparison

Conclusion

Temperatures experienced in each demand center remained above the 20-year recurrence interval in each event.