

Are the All-time Daily, Monthly, and Yearly Record Minimum Temperatures for Tucson, Arizona Nearly (or virtually) Unbreakable?

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Introduction

There is an old sports adage that says, “All records are made to be broken”. In sports, there are a few that most likely will never be broken. A few to mention include 511 career wins in baseball by pitcher Cy Young; winning eleven straight golf tournaments like Byron Nelson did in 1945 or Wayne Gretzky scoring 92 goals in the 1981-82 hockey season. For climatic purposes temperature, rainfall and snowfall are records that are monitored on a daily, monthly and yearly basis. This paper will take a completely different look at the past low minimum temperature records set/tied in Tucson Arizona. It will look at how the population change of the past 50+ years, resulting in urban sprawl and the effects of the associated urban heat island, has made it harder to achieve daily low minimum temperature records and nearly impossible to break monthly and yearly low minimum temperature records at the Tucson International Airport.

What is “Urban Heat Island” Effect?

The urban heat island, in the simplest way to describe, is defined as an urban (or metropolitan) area often being warmer than its surroundings. As the size of an urban area (city) grows, there is a corresponding increase in average temperatures with the increase being most noticeable for low temperatures versus high temperatures. (Karl, et al. 1988; Cayan and Douglas 1984).

Data/Period of Record:

Weather record keeping in Tucson Arizona dates back to the 1860s. In November 1866, the United States Army Signal Corp set up the first weather station at Fort Lowell. This site remained the official weather site in Tucson through 1891 even as a different observation site, moved many times, was set up in downtown Tucson. The official observation point moved to the University of Arizona campus in October 1891. This site remained the official observation point for Tucson until early 1930 when the Tucson Municipal Airport (TMA) moved to the current site of Davis-Monthan Air Force Base to support both military and local aviation traffic. To support growing commercial aviation concerns during the 1940s, the current Tucson International Airport (TIA) was built about 5 miles southwest of Davis Monthan Air Force Base in 1948. This site has been the official observation point for Tucson ever since. For this paper, 1910 was used as a starting point for daily record low temperature since the previous 15 years of daily data had been recorded in Tucson. Due to this short initial database timeframe, the 1910s (227) and the 1920s (107) recorded the most number of record low minimum temperatures being set/tied.

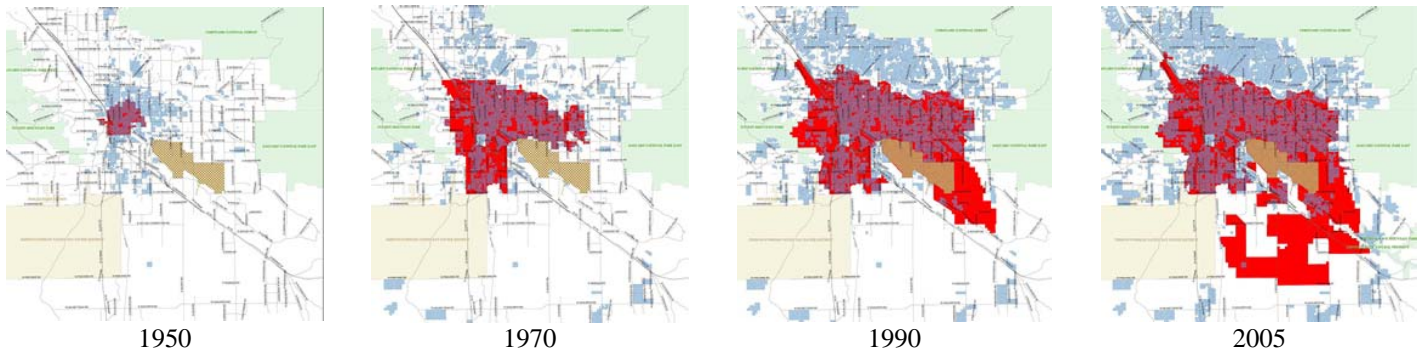
Instrumentation:

Temperature sensor equipment in Tucson has changed over the 110+ years of record keeping. Before 1960, the typical liquid-in-glass extreme thermometers were used for maximum and minimum temperatures. This type of thermometer was likely exposed in a wooden structure known as the Cotton Region shelter. Electronic instrumentation or hygrothermometers began in the 1950s and continues today. Three types of electronic

hygrothermometers have been used at the Tucson International airport (TIA). The first was the HO-50 series, which was used until November 1982 when it was replaced by the HO-63 series hygrothermometer. The HO-63 was replaced by the HO-83 series in February 1986. (Gall et al. 1982) In 1995, the Automated Surface Observing System (ASOS) was installed at TIA and was commissioned on January 1st 1996. ASOS uses an updated version of the HO-83 hygrothermometer as it aspirates the air differently than the previous version of the HO-83.

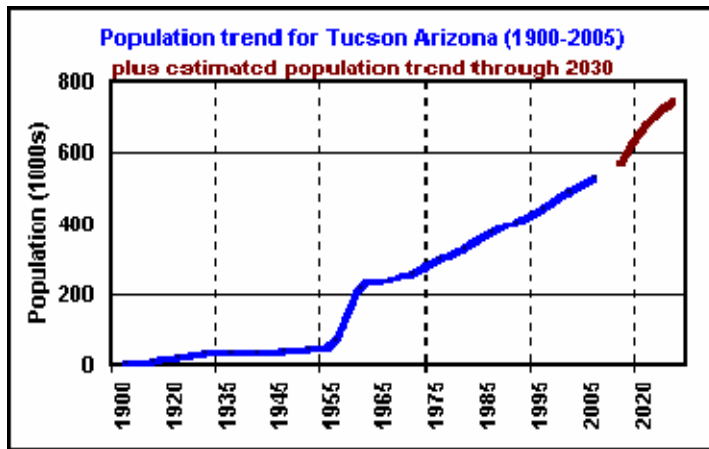
Population and the Size of the City of Tucson:

The first half of the 20th century saw the city of Tucson population grow from 7,500 people in 1900 to around 45,000 people in 1950. The size of the city increased 7 square miles (2 to 9) during this time frame. (City of Tucson website, <http://www.tucsonaz.gov>). The lure of a warmer and drier climate led to a population explosion during the 2nd half of the 20th century as the population grew to nearly a half a million people (486,699) while the size of the city grew from 9 square miles in 1950 to 195 square miles in 2000. (City of Tucson website, <http://www.tucsonaz.gov>). Figures 1 through 4 show the expansion of the size of Tucson through annexation between 1950 and 2005.



Figures 1-4: Tucson city limits (red shading) at different time intervals

By 2007, the size of the city of Tucson was 227 square miles with about 550,000 people living within the city limits. It is estimated that the city of Tucson population will exceed 600,000 by 2014 and 700,000 by 2025 with little size change of the city limits. (Figure 5 and Table 1)



Year	City of Tucson population
1900	7,531
1910	13,191
1920	20,292
1930	32,506
1940	35,752
1950	45,454
1960	212,892
1970	262,933
1980	330,537
1990	405,390
2000	486,699
2010 (est.)	573,838
2020 (est.)	660,498
2030 (est.)	748,280

Figure 5 and Table 1: Population trend for the city of Tucson since 1900 and estimated growth out to 2030.
Source: <http://www.tucsonaz.gov/>

Determining when the urban heat island started to makes its impact on Tucson is highly subjective and up for debate. The data shown in Table 2 below may shed some light and give an approximate time frame.

Time period	# of years	# of years with no daily record low minimum temperatures being set/tied.	# of years with 1 daily record low minimum temperature being set/tied.	Total years with 1 or less daily record low minimum temperature being set /tied
1910-1960	51	5 of 51 (9.80%)	8 of 51 (15.69%)	13 of 51 (25.49%)
1961-2007	47	25 of 47 (53.19%)	13 of 47 (27.66%)	38 of 48 (80.85%)

Table 2: Since 1960, over 80% of those years recorded 0 or 1 record low minimum temperature being set/tied while in the previous 51 years, only 25% of those years recorded the same 0 or 1.

Year	City of Tucson population	Area square miles of Tucson	# of low temperature records set/tied	Year	City of Tucson population	Area square miles of Tucson	# of low temperature records set/tied
1950	45,454	9.547	1	1966	239,000	75.998	0
1951	46,900	9.547	0	1967	243,000	75.998	2
1952	48,700	9.547	1	1968	249,300	76.094	0
1953	51,100	9.913	1	1969	255,700	76.547	0
1954	60,200	12.608	1	1970	262,933	79.533	3
1955	67,600	13.777	12	1971	268,200	81.667	3
1956	95,100	20.369	4	1972	279,000	84.389	1
1957	106,100	23.857	0	1973	287,400	84.688	1
1958	105,400	23.858	0	1974	295,100	90.937	1
1959	107,300	24.553	0	1975	298,683	91.245	1
1960	212,892	45.870	4	1976	301,600	91.245	1
1961	219,300	70.902	0	1977	304,600	93.987	0
1962	223,200	70.993	4	1978	311,200	95.949	1
1963	225,800	70.993	2	1979	320,500	96.372	3
1964	224,000	71.033	4	1980	330,537	98.841	1

1965	236,877	75,998	8	1981	343,450	101,554	0
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Table 3: 1965 was the last year when over three record low minimum temperatures were set and/or tied during a year. During the 1982 to 2007 period, a total of **only** 8 record low temperatures were set/tied (2 in 1992 and 1 each in 1987-1988, 2002-2003 and 2006-2007).

Thus for this paper, instead of using a year, the decade of the 1960s will be used for when the urban heat island effect may have started to make its impact on low temperature records in Tucson.

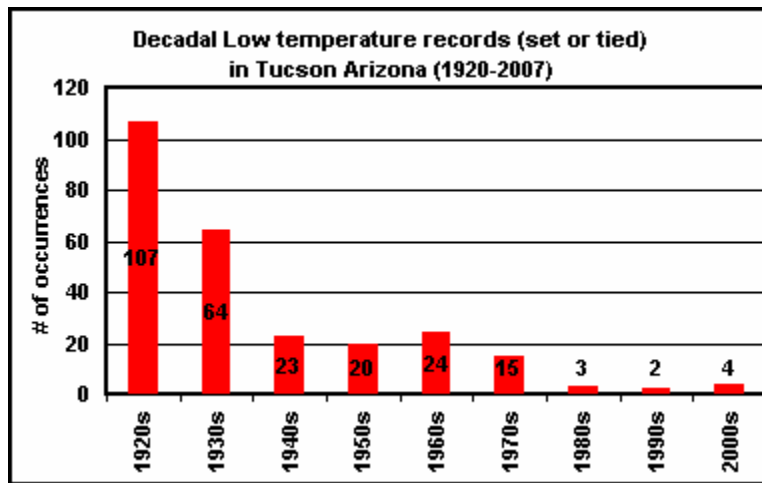


Figure 6: The above graphic shows the decadal breakdown of record low temperatures being set and/or tied.

Monthly Data Section

Monthly data was broken down to daily and monthly records along with supporting graphics and/or tables. Best fit linear regression lines were added to the graphics to show cooling and warming periods. You will notice that each month had different temperature variability and all but one month, December, showed warming in the last 25+ years.

January

Daily: Only seven daily record lows have been set/tied in the past five decades (four in the 1960s, one each 1970s, 1980s and 2000s) with the last one occurring on January 15, 2007 (20 degrees). The coldest low temperature since 1980 has been 19 degrees on January 17, 1987 that ranks as the 22nd (tied with 8 other January dates) coldest January low temperature on record. The all-time January record low is 6 degrees set on January 17, 1913.

Monthly: The top ten coldest average January low temperatures have all occurred before 1938 with the record being 27.1 degrees set in 1904. The coldest average January low temperatures in each of the last five decades are: **1960s:** 32.8 degrees in 1964; **1970s:** 35.0 degrees in 1972; **1980s:** 36.1 degrees in 1989; **1990s:** 37.2 degrees in 1999; and in the **2000s:** 36.5 degrees in 2007. The 1971-2000 30-year normal is 38.9 degrees.

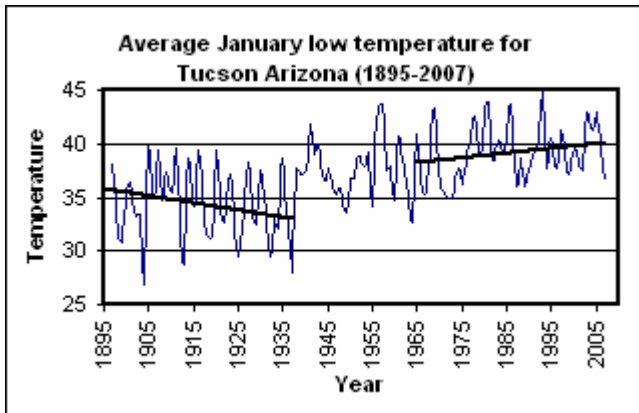


Figure 7: The average monthly low temperatures for January dating back to 1895.

Top 5 coldest average January monthly low temperatures		
Rank	Avg. low temp.	Year
1.	27.1 F	1904
2.	28.0 F	1937
3.	29.0 F	1913
4.	29.4 F	1932
5.	29.5 F	1925
Coldest average January monthly low temperature since 1980		
42.	36.1 F	1989

Table 4: Top 5 coldest average January monthly low temperatures and the ranking of the coldest since 1980

February

Daily: Only three daily record lows have been set/tied in the past five decades (two in the 1960s and one in the 1970s) with the last occurring on February 23, 1975 (25 degrees). The coldest low since 1980 has been 23 degrees on February 16, 1990 that ranks as the 18th (tied with 7 other February dates) coldest February low temperature on record. The all-time February record low temperature is 17 degrees set on February 7, 1899.

Monthly: Eight of the top ten coldest average February low temperatures occurred before 1940 (the others occurred in 1955 & 1964) with the record being 31.1 degrees set in 1903. The coldest average February low temperatures in each of the last five decades are: **1960s:** 32.7 degrees in 1964; **1970s:** 36.5 degrees in 1975; **1980s:** 38.7 degrees in 1984; **1990s:** 38.3 degrees in 1990; and in the **2000s:** 37.6 degrees in 2004. The 1971-2000 30-year normal is 41.6 degrees.

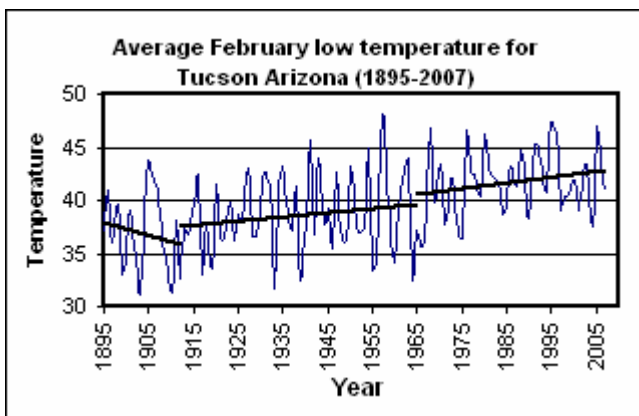


Figure 8: The average monthly low temperatures for February dating back to 1895.

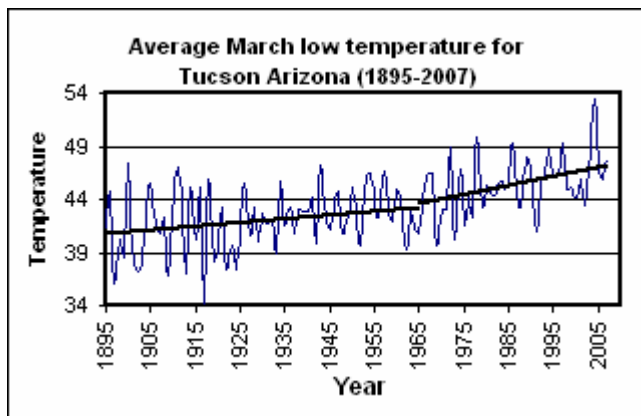
Top 5 coldest average February monthly low temperatures		
Rank	Avg. low temp.	Year
1.	31.1 F	1903
2.	31.3 F	1910
3.	31.7 F	1933
4.	32.5 F	1939
5T.	32.7 F	1912/1964
Coldest average February monthly low temperature since 1980		
37.	37.6 F	2004

Table 5: Top 5 coldest average February monthly low temperatures and the ranking of the coldest since 1980

March

Daily: Only six daily record lows have been set/tied in the past five decades (four in the 1960s and two in the 1970s) with the last occurring on March 3, 1971 (22 degrees). The coldest low temperature since 1980 has been 24 degrees on March 3, 2002 that ranks as the 6th (tied with 10 other March dates) coldest March low temperature on record. The all-time March record low temperature is 20 degrees set on March 4, 1965.

Monthly: The top 10 coldest average March low temperatures all occurred before 1934 with the record being 34.2 degrees set in 1917. The coldest average March low temperatures in each of the last five decades are: **1960s:** 39.2 degrees in 1962; **1970s:** 40.2 degrees in 1973; **1980s:** 43.5 degrees in 1987; **1990s:** 41.0 degrees in 1991; and in the **2000s:** 43.4 degrees in 2002. The 1971-2000 30-year normal is 45.1 degrees while the 1998-2007 average is 46.4 degrees.



Top 5 coldest average March monthly low temperatures		
Rank	Avg. low temp.	Year
1.	34.2 F	1917
2.	36.0 F	1897
3.	36.8 F	1909
4.	37.1 F	1913
5.	37.2 F	1902
Coldest average March monthly low temperature since 1980		
26.	41.0 F	1991

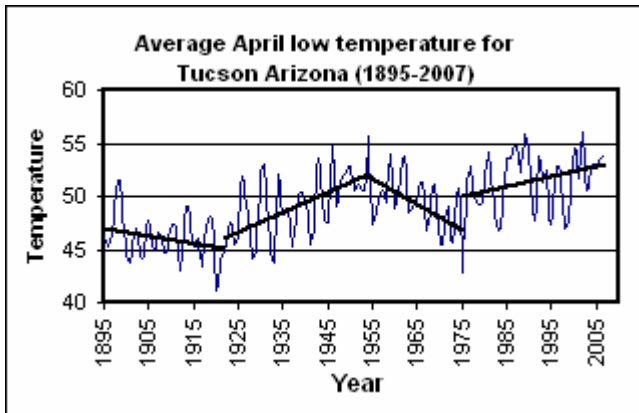
Figure 9: The average monthly low temperatures for March dating back to 1895.

Table 6: Top 5 coldest average March monthly low temperatures and the ranking of the coldest since 1980

April

Daily: Only four daily record lows have been set/tied in the past five decades (two each in the 1960s and the 1970s) with the last occurring on April 16, 1976 (34 degrees). The coldest low temperature since 1980 has been 34 degrees on April 4, 1999 that ranks as the 36th (tied with 22 other April dates) coldest April low temperature on record. The all-time April record low temperature is 27 degrees on April 4, 1945.

Monthly: Nine of the top ten coldest average April low temperatures occurred before 1934 (the other occurred in 1975) with the record being 41.1 degrees set in 1920. The coldest average April low temperatures in each of the last five decades are: **1960s:** 46.7 degrees in 1967; **1970s:** 42.9 degrees in 1975; **1980s:** 46.8 degrees in 1983; **1990s:** 47.0 degrees in 1998; and in the **2000s:** 50.6 degrees in 2003. The 1971-2000 30-year normal is 50.5 degrees while the 1998-2007 average is 52.1 degrees.



Top 5 coldest average April monthly low temperatures		
Rank	Avg. low temp.	Year
1.	41.1 F	1920
2.	42.9 F	1975
3.	43.0 F	1912
4.	43.4 F	1917
5.	43.7 F	1901
Coldest average April monthly low temperature since 1980		
29.	46.8 F	1983

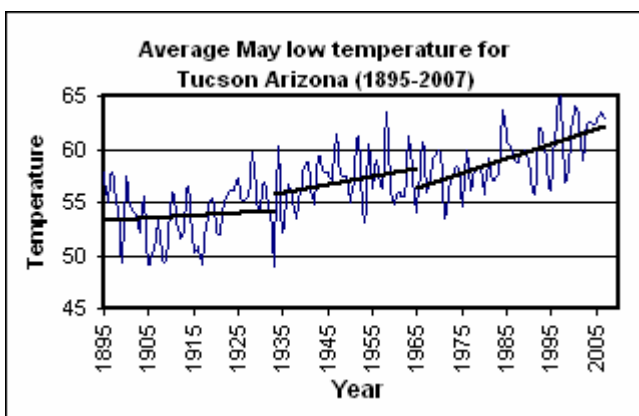
Figure 10: The average monthly low temperatures for April dating back to 1895.

Table 7: Top 5 coldest average April monthly low temperatures and the ranking of the coldest since 1980

May

Daily: Only five daily record lows have been set/tied in the past seven decades (three in the 1960s and one each in the 1950s and 1980s) with the last occurring on May 25, 1980 (43 degrees). The coldest low since 1980 has been 40 degrees on May 2, 1988 that ranks as the 25th (tied with 10 other May dates) coldest May low temperature on record. The all-time May record low temperature is 32 degrees on May 3, 1899.

Monthly: Nine of the top ten coldest average May low temperatures occurred before 1918 (the other occurred in 1933) with the record being 48.9 degrees set in 1933. The coldest average May low temperatures in each of the last five decades are: **1960s:** 54.0 degrees in 1965; **1970s:** 53.5 degrees in 1971; **1980s:** 55.8 degrees in 1980; **1990s:** 55.8 degrees in 1991; and in the **2000s:** 59.0 degrees in 2002. The 1971-2000 30-year normal is 58.6 degrees while the 1998-2007 average is 61.5 degrees.



Top 5 coldest average May monthly low temperatures		
Rank	Avg. low temp.	Year
1.	48.9 F	1933
2.	49.1 F	1917
3T.	49.3 F	1905
	49.3 F	1899
5.	49.5 F	1909
Coldest average May monthly low temperature since 1980		
42T.	55.8 F	1980/1991

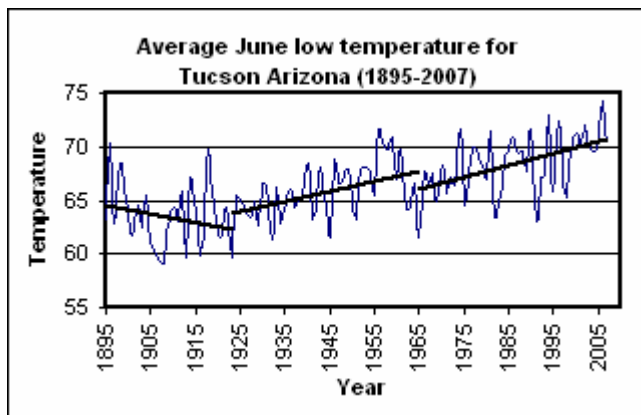
Figure 11: The average monthly low temperatures for May dating back to 1895.

Table 8: Top 5 coldest average May monthly low temperatures and the ranking of the coldest since 1980

June

Daily: Only seven daily record lows have been set/tied in the past eight decades (three each in the 1940s and 1960s and one in the 1950s) with the last occurring on June 27, 1965 (57 degrees). The coldest low since 1980 has been 51 degrees on June 7, 1993 that ranks as the 39th (tied with 12 other June dates) coldest June low temperature on record. The all-time June record low temperature is 43 degrees on June 4, 1908.

Monthly: Eight of the top ten coldest average June low temperatures occurred before 1933 (the others occurred in 1945 and 1965) with the record being 59.1 degrees set in 1908. The coldest average June low temperatures in each of the last five decades are: **1960s:** 61.6 degrees in 1965; **1970s:** 64.7 degrees in 1975; **1980s:** 63.6 degrees in 1982; **1990s:** 63.1 degrees in 1991; and in the **2000s:** 69.5 degrees in 2004. The 1971-2000 30-year normal is 68.0 degrees while the 1998-2007 average is 70.4 degrees.



Top 5 coldest average June monthly low temperatures		
Rank	Avg. low temp.	Year
1.	59.1 F	1908
2.	59.3 F	1907
3T.	59.6 F	1923
	59.6 F	1913
5.	59.9 F	1916
Coldest average June monthly low temperature since 1980		
20T.	63.1 F	1991/1911

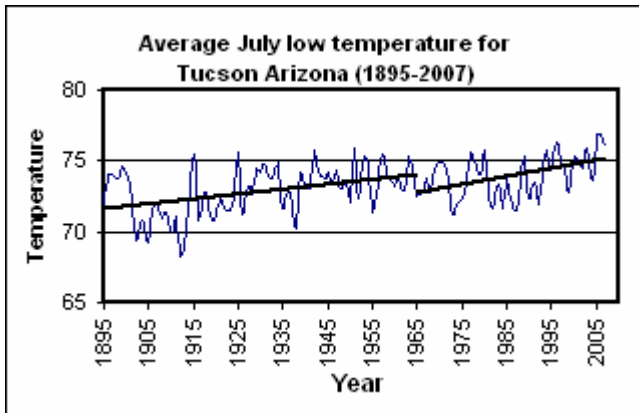
Figure 12: The average monthly low temperatures for June dating back to 1895.

Table 9: Top 5 coldest average June monthly low temperatures and the ranking of the coldest since 1980

July

Daily: July is the only month that has recorded three daily record low temperatures being set/tied in the past two decades with the last occurring on July 31, 2006 (66 degrees during a thunderstorm). The coldest low since 1980 has been 59 degrees on July 2, 1992 that ranks as the 8th (tied with 4 other July dates) coldest July low temperature on record. The all-time July record low temperature is 49 degrees on July 3, 1911.

Monthly: Nine of the top ten coldest average July low temperatures occurred before 1920 (the other occurred in 1938) with the record being 68.2 degrees set in 1912. The coldest average July low temperatures in each of the last five decades are: **1960s:** 72.5 degrees in 1965; **1970s:** 71.2 degrees in 1973; **1980s:** 71.5 degrees in 1987; **1990s:** 71.9 degrees in 1992; and in the **2000s:** 74.1 degrees in 2004. The 1971-2000 30-year normal is 73.4 degrees while the 1998-2007 average is 75.2 degrees.



Top 5 coldest average July monthly low temperatures		
Rank	Avg. low temp.	Year
1.	68.2 F	1912
2.	68.8 F	1913
3.	69.3 F	1905
4.	69.5 F	1902
5.	70.0 F	1910
Coldest average July monthly low temperature since 1980		
18T.	71.5 F	1987/1923

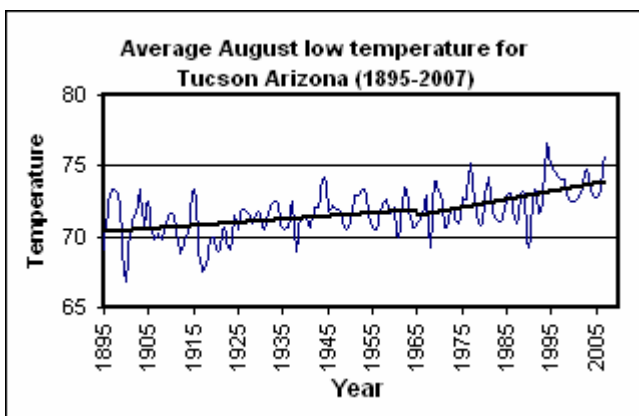
Figure 13: The average monthly low temperatures for July dating back to 1895.

Table 10: Top 5 coldest average July monthly low temperatures and the ranking of the coldest since 1980

August

Daily: Only one daily record low, 63 degrees on August 3, 1955, has been set/tied in the past eight decades. The coldest low since 1980 has been 63 degrees on August 30, 1992 that ranks as the 38th (tied with 34 other August dates) coldest August low temperature on record. The all-time August record low temperature is 55 degrees on August 20, 1917.

Monthly: Eight of the top ten coldest average August low temperatures occurred before 1924 (the others occurred in 1938 and 1968) with the record being 66.8 degrees set in 1900. The coldest average August low temperatures in each of the last five decades are: **1960s:** 69.2 degrees in 1968; **1970s:** 70.6 degrees in 1971; **1980s:** 71.0 degrees in 1987; **1990s:** 69.3 degrees in 1990; and in the **2000s:** 72.5 degrees in 2000. The 1971-2000 30-year normal is 72.4 degrees while the 1998-2007 average is 73.5 degrees.



Top 5 coldest average August monthly low temperatures		
Rank	Avg. low temp.	Year
1.	66.8 F	1900
2.	67.5 F	1917
3.	68.1 F	1918
4.	68.8 F	1912
5.	69.0 F	1938
Coldest average August monthly low temperature since 1980		
11.	69.3 F	1990

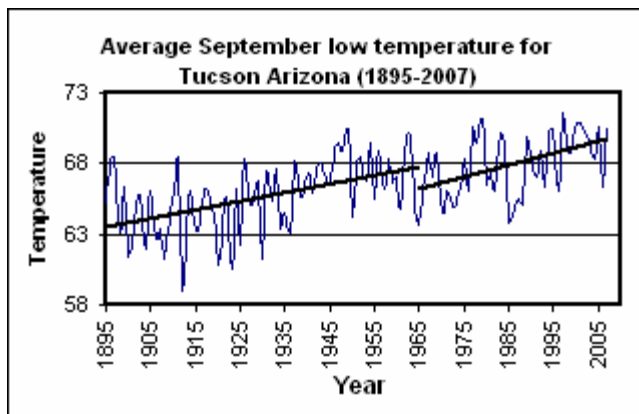
Figure 14: The average monthly low temperatures for August dating back to 1895.

Table 11: Top 5 coldest average August monthly low temperatures and the ranking of the coldest since 1980

September

Daily: Only five daily record lows have been set/tied in the past seven decades (three in the 1960s and one each in the 1940s and 1950s) with the last occurring on September 30, 1965 (44 degrees). The coldest low since 1980 has been 53 degrees on September 23, 1988 that ranks as the 77th (tied with 17 other September dates) coldest September low temperature on record. The all-time September record low temperature is 43 degrees on September 26, 1913.

Monthly: The top ten coldest average monthly September temperatures all occurred before 1931 with the record being 59.1 degrees set in 1912. The coldest average September low temperatures in each of the last five decades are: **1960s:** 63.7 degrees in 1965; **1970s:** 64.5 degrees in 1970; **1980s:** 63.8 degrees in 1985; **1990s:** 66.0 degrees in 1996; and in the **2000s:** 66.4 degrees in 2006. The 1971-2000 30-year normal is 67.7 degrees while the 1998-2007 average is 69.5 degrees.



Top 5 coldest average September monthly low temperatures		
Rank	Avg. low temp.	Year
1.	59.1 F	1912
2.	60.6 F	1923
3.	60.9 F	1920
4.	61.2 F	1908
5.	61.3 F	1930
Coldest average September monthly low temperature since 1980		
20.	63.8 F	1985

Figure 15: The average monthly low temperatures for September dating back to 1895.

Table 12: Top 5 coldest average September monthly low temperatures and the ranking of the coldest since 1980

October

Daily: Only four daily record lows have been set/tied in the past seven decades (three in the 1970s and one in the 1940s) with the last occurring on October 31, 1981 (35 degrees). The coldest low since 1980 has been 35 degrees on October 31, 1981 that ranks as the 26th (tied with 18 other October dates) coldest October low temperature on record. The all-time October record low temperature is 26 degrees on October 30, 1971.

Monthly: The top ten coldest average October low temperatures all occurred before 1925 with the record being 44.7 degrees set in 1908. The coldest average October low temperatures in each of the last five decades are: **1960s:** 52.4 degrees in 1969; **1970s:** 50.8 degrees in 1970; **1980s:** 50.7 degrees in 1982; **1990s:** 55.5 degrees in 1998; and in the **2000s:** 56.5 degrees in 2002. The 1971-2000 30-year normal is 57.0 degrees while the 1998-2007 average is 58.0 degrees.

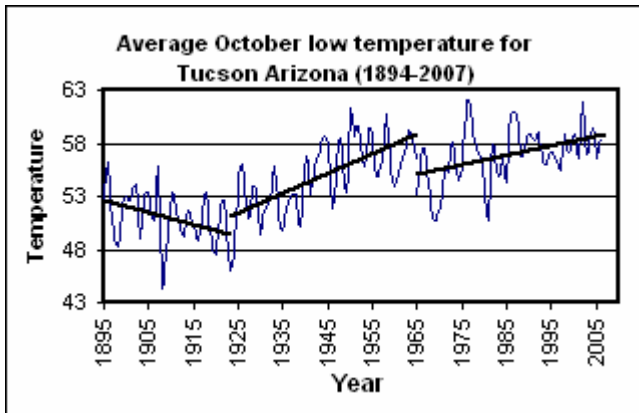


Figure 16: The average monthly low temperatures for October dating back to 1895.

Top 5 coldest average October monthly low temperatures		
Rank	Avg. low temp.	Year
1.	44.7 F	1908
2.	46.0 F	1923
3.	47.4 F	1924
4T.	47.6 F	1909
	47.6 F	1920
Coldest average October monthly low temperature since 1980		
15.	50.7 F	1982

Table 13: Top 5 coldest average October monthly low temperatures and the ranking of the coldest since 1980

November

Daily: Only seven daily record lows have been set/tied in the past six decades (three each in the 1950s and 1970s and one in the 1990s) with the last occurring on November 25, 1992 (26 degrees). The coldest low since 1980 has been 26 degrees on November 25, 1992 that ranks as the 20th (tied with 5 other November dates) coldest November low temperature on record. The all-time record is 19 degrees set on November 19, 1921.

Monthly: Seven of the top ten coldest average November low temperatures occurred before 1930 (the others occurred in 1935, 1938 and 1948) with the record being 35.4 degrees set in 1922. The coldest average November low temperatures in each of the last five decades are: **1960s:** 41.9 degrees in 1964; **1970s:** 40.2 degrees in 1972; **1980s:** 43.8 degrees in 1984; **1990s:** 40.7 degrees in 1992; and in the **2000s:** 40.3 degrees in 2000. The 1971-2000 30-year normal is 45.1 degrees while the 1998-2007 average is 46.8 degrees.

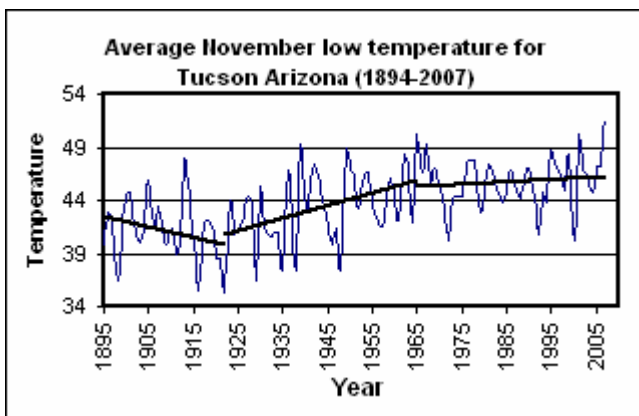


Figure 17: The average monthly low temperatures for November dating back to 1895.

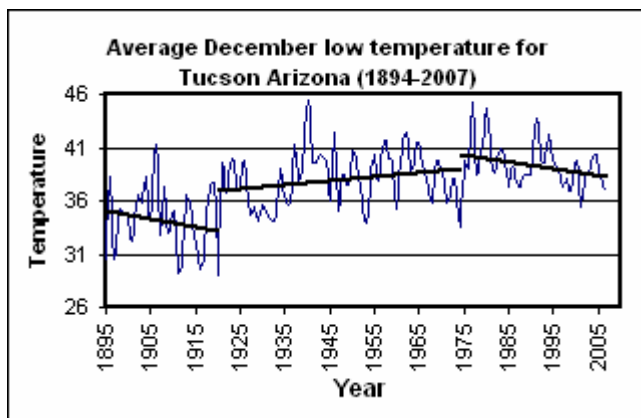
Top 5 coldest average November monthly low temperatures		
Rank	Avg. low temp.	Year
1.	35.4 F	1922
2.	35.6 F	1916
3.	36.4 F	1929
4.	36.5 F	1898
5.	37.5 F	1935
Coldest average November monthly low temperature since 1980		
17.	40.3 F	2000

Table 14: Top 5 coldest average November monthly low temperatures and the ranking of the coldest since 1980

December

Daily: Only six daily record lows have been set/tied in the past seven decades (two in the 1970s and one each in the 1950s, 1960s, 1980s and 2000s) with the last occurring on December 29, 2003 (19 degrees). The coldest low since 1980 has been 19 degrees on December 29, 2003 that ranks as the 12th (tied with 13 other December dates) coldest December low temperature on record. The all-time record is 10 degrees set on December 14, 1901.

Monthly: The top ten coldest average December low temperatures occurred before 1921 with the record being 29.0 degrees set in 1920. The coldest average December low temperatures in each of the last five decades are: **1960s:** 35.2 degrees in 1960; **1970s:** 33.6 degrees in 1974; **1980s:** 37.3 degrees in 1987 & 1985; **1990s:** 37.0 degrees in 1999; and in the **2000s:** 35.4 degrees in 2001. The 1971-2000 30-year normal is 39.2 degrees while the 1998-2007 average is 38.1 degrees.



Top 5 coldest average December monthly low temperatures		
Rank	Avg. low temp.	Year
1.	29.0 F	1920
2.	29.3 F	1911
3.	29.5 F	1916
4.	30.0 F	1912
5.	30.5 F	1895
Coldest average December monthly low temperature since 1980		
25T.	35.4 F	2001/1928

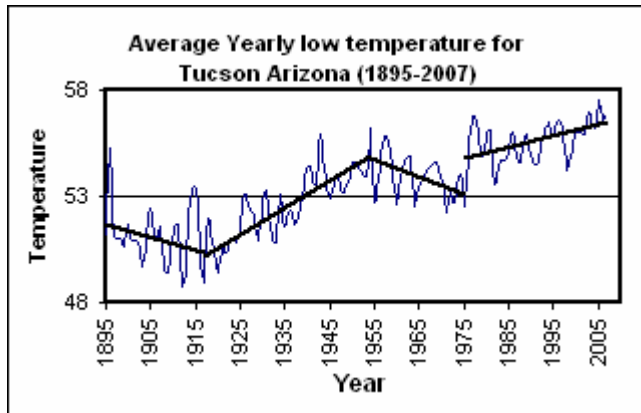
Figure 18: The average monthly low temperatures for December dating back to 1895.

Table 15: Top 5 coldest average December monthly low temperatures and the ranking of the coldest since 1980

Year

Daily: Only nine daily record lows have been set/tied in the past three decades (four in the 2000s, three in the 1980s and two in the 1990s). The previous four decades had 15 (1970s), 4 (1960s), 20 (1950s) and 23 (1940s) record lows set/tied. The last record low occurred on January 15, 2007 (20 degrees). The coldest low since 1980 has been 19 degrees on December 29, 2003 and January 17, 1987. They rank as the as the 35th (tied with 23 other December dates) coldest yearly low temperature on record. The all-time record is 6 degrees January 17, 1913.

Yearly: The top ten coldest average yearly low temperatures all occurred before 1923 with the record being 48.8 degrees set in 1912. The coldest average yearly low temperatures in each of the last five decades are: **1960s:** 52.6 degrees in 1964 and 1960; **1970s:** 52.2 degrees in 1971; **1980s:** 53.6 degrees in 1982; **1990s:** 54.3 degrees in 1998; and in the **2000s:** 55.9 degrees in 2002. The 1971-2000 30-year normal is 54.8 degrees while the 1998-2007 average is 56.1 degrees.



Top 5 coldest average Yearly low temperatures		
Rank	Avg. low temp.	Year
1.	48.8 F	1912
2.	48.9 F	1917
3.	49.4 F	1909
4.	49.4 F	1920
5.	49.5 F	1908
Coldest average Yearly low temperature since 1980		
46.	53.6 F	1982

Figure 19: The average yearly low temperatures dating back to 1895.

Table 16: Top 5 coldest average yearly low temperatures and the ranking of the coldest since 1980

Table 17 compares the difference between the all-time daily low and average monthly temperature records against the records if data from the Tucson International Airport (TIA) were only used.

	Monthly daily record lows			Monthly average low temperatures		
	All-time record 1895-2007	TIA only records 1948-2007	TIA Since 1980	All-time record 1895-2007	TIA only records 1948-2007	TIA Since 1980
January	6 – 1/17/1913	16 – 1/4/1949	19 – 1/17/1987	27.1 / 1904	32.8 / 1964	36.1 / 1989
February	17 – 2/17/1899	20 – 2/22/1955*	23 – 2/16/1990	31.1 / 1903	32.7 / 1964	37.6 / 2004
March	20 – 3/4/1965	20 – 3/4/1965	24 – 3/3/2002	34.2 / 1920	39.2 / 1962	41.0 / 1991
April	27 – 4/4/1945	33 – 4/17/1976	34 – 4/4/1999	41.1 / 1920	42.9 / 1975	46.8 / 1987
May	32 – 5/3/1899	38 – 5/5/1953	40 – 5/2/1988	48.9 / 1933	53.1 / 1953	55.8 / 1991*
June	43 – 6/4/1908	47 – 6/2/1955	51 – 6/7/1993	59.1 / 1908	61.6 / 1965	63.1 / 1991*
July	49 – 7/3/1911	59 – 7/2/1992	59 – 7/2/1992	68.2 / 1912	71.2 / 1973	71.5 / 1987*
August	55 – 8/20/1917	61 – 8/29/1956	63 – 8/30/1992	66.8 / 1900	69.2 / 1968	69.3 / 1990
September	43 – 9/26/1913	44 – 9/30/1965	53 – 9/23/1988	59.1 / 1912	63.7 / 1965	63.8 / 1985
October	26 – 10/30/1971	26 – 10/30/1971	35 – 10/31/1981	44.7 / 1908	50.7 / 1982	50.7 / 1982
November	19 – 11/19/1921	24 – 11/22/1979	26 – 11/25/1992	35.4 / 1922	37.6 / 1948	40.3 / 2000
December	10 – 12/14/1901	16 – 12/24/1974	19 – 12/29/2003	29.0 / 1920	33.6 / 1974	35.4 / 2001*
Year	6 – 1/17/1913	16 – 12/24/1974*	19 – 12/29/2003*	48.8 / 1912	52.2 / 1971	53.6 / 1982

* - Last of several occurrences

Table 17: Historical records (1895-2007) versus Tucson International Airport (TIA) records (1948-2007)

What are the odds?

The data that has been presented so far should give you an idea that achieving record daily/monthly and yearly record low temperatures in Tucson are becoming less likely. But how unlikely has it become? What are the odds that a daily/monthly/yearly record can be achieved in Tucson? For this, statistical analysis was done on the historical database. Since the climate period of record for Tucson is over 110+ years, and the temperature data is normally distributed, I used statistical methods in Excel (i.e. NORMDIST) to calculate the odds on exceeding all-time record temperatures. The results are shown in Tables 18 and 19.

Table 18: Chance of hitting the all-time record low temperature for each month.

Month	Period of record	All-time record monthly low temperature (Deg F)	Average low temperature for period of record	Standard deviation (Deg F) plus sd () away from the mean	Chance of hitting all-time record monthly low temperature
January	1895-2007	6	37	7.5 (5 th)	1 in 56,632
	1965-2007		39	6.6 (5 th)	1 in 2,984,951
February	1895-2007	17	40	7.3 (4 th)	1 in 1,002
	1965-2007		42	6.5 (4 th)	1 in 13,704
March	1895-2007	20	43	7.1 (4 th)	1 in 2,114
	1965-2007		45	6.5 (4 th)	1 in 19,756
April	1895-2007	27	49	7.0 (4 th)	1 in 1,260
	1965-2007		51	6.8 (4 th)	1 in 4,493
May	1895-2007	32	57	6.9 (4 th)	1 in 5,792
	1965-2007		59	6.4 (5 th)	1 in 99,760
June	1895-2007	43	66	7.0 (4 th)	1 in 2,453
	1965-2007		68	6.1 (5 th)	1 in 58,028
July	1895-2007	49	73	4.3 (6 th)	1 in 115,201,560
	1965-2007		74	4.0 (7 th)	1 in 6,215,204,907
August	1895-2007	55	72	3.7 (5 th)	1 in 283,323
	1965-2007		73	3.5 (6 th)	1 in 4,239,818
September	1895-2007	43	67	5.8 (5 th)	1 in 35,543
	1965-2007		68	5.1 (5 th)	1 in 1,681,003
October	1895-2007	26	55	7.9 (4 th)	1 in 7,424
	1965-2007		57	7.0 (5 th)	1 in 205,530
November	1895-2007	19	44	7.5 (4 th)	1 in 2,008
	1965-2007		46	6.9 (4 th)	1 in 19,429
December	1895-2007	10	38	7.4 (4 th)	1 in 11,637
	1965-2007		39	6.7 (5 th)	1 in 137,570

Table 19: Chance of hitting the all-time record average low temperature for each month and the year.

Month	Period of record	All-time record average monthly low temperature (Deg F)	Average monthly low temperature for period of record	Standard deviation (Deg F) plus sd () away from the mean	Chance of hitting all-time record average monthly low temperature
January	1895-2007	27.1	37.0	3.6 (3 rd)	1 in 314
	1965-2007		39.2	2.7 (5 th)	1 in 319,574
February	1895-2007	31.1	39.6	3.9 (3 rd)	1 in 70
	1965-2007		41.7	3.0 (4 th)	1 in 3,988
March	1895-2007	34.2	43.3	3.3 (3 rd)	1 in 349
	1965-2007		45.4	2.8 (5 th)	1 in 44,599
April	1895-2007	41.1	49.1	3.4 (3 rd)	1 in 111
	1965-2007		50.8	3.0 (4 th)	1 in 1,525
May	1895-2007	48.9	56.8	3.6 (3 rd)	1 in 67
	1965-2007		59.3	2.9 (4 th)	1 in 6,960
June	1895-2007	59.1	66.3	3.3 (3 rd)	1 in 62
	1965-2007		68.4	2.8 (4 th)	1 in 2,243
July	1895-2007	68.2	73.3	1.8 (2 nd)	1 in 491
	1965-2007		74.0	1.5 (3 rd)	1 in 11,446
August	1895-2007	66.8	71.7	1.7 (2 nd)	1 in 547
	1965-2007		72.7	1.6 (3 rd)	1 in 11,485
September	1895-2007	59.1	66.5	2.7 (3 rd)	1 in 361
	1965-2007		67.9	2.2 (4 th)	1 in 23,077
October	1895-2007	44.7	54.7	3.7 (2 nd)	1 in 288
	1965-2007		56.8	2.7 (5 th)	1 in 345,187
November	1895-2007	35.4	43.7	3.4 (3 rd)	1 in 143
	1965-2007		45.8	2.5 (4 th)	1 in 97,349
December	1895-2007	29.0	37.6	3.3 (3 rd)	1 in 226
	1965-2007		39.0	2.3 (4 th)	1 in 141,273
Period	Period of record	All-time record average yearly low temperature (Deg F)	Average yearly low temperature for period of record	Standard deviation (Deg F) plus sd () away from the mean	Chance of hitting all-time record average yearly low temperature
Year	1895-2007	48.8	53.4	2.1 (2 nd)	1 in 65
	1965-2007		55.2	1.3 (3 rd)	1 in 2,301,142

Conclusions

Population growth in Tucson and the surrounding areas will continue through the 21st century. It is estimated that the city of Tucson population will exceed 600,000 in 2014; 700,000 in 2025 and 800,000 in 2037. The aerial size of the city of Tucson will grow little in the next 30 years, but the population density per square mile will grow from around 2400 in 2007 to around 3500 in 2037. This will only enhance the urban heat island across the city that may have started to make its impact during the 1960s, if not as early as the 1940s. **The data presented in this paper shows that the likelihood that any of the current all-time daily, monthly and yearly record low minimum temperatures will be broken is slim at best, if not virtually impossible.** Other factors that are tied to climate change and or global warming may have influences in Tucson, but were not addressed in this paper.

References:

- Cayan D.R., A. V. Douglas, 1984. "Urban Influences on Surface Temperatures in the Southwestern United States during Recent Decades." *Journal of Climate and Applied Meteorology*, **23**, pp. 1520-1530.
- City of Tucson website (<http://www.tucsonaz.gov>)
- Dierking, C., 2005: Xclimate Version 1.5.
- Environmental Protection Agency, 2008: Heat Island Effect. (<http://www.epa.gov/heatislands>)
- Gall, R., K. Young, R. Schotland, and J. Schmitz, 1992. "The Recent Maximum Temperature Anomalies in Tucson: Are They Real or an Instrumental Problem?" *Journal of Climate*, **5**, pp. 657-665.
- Global security website (<http://www.globalsecurity.org/military/facility/davis-monthan.htm>)
- Karl, T.R., H.F. Diaz, and G. Kukla, 1988, "Urbanization: its detection and effect in the United States climate record." *Journal of Climate*, **1**, pp. 1099-1123.
- Kukla, G., J. Gavin and T. R. Karl, 1986. "Urban warming." *Journal of Climate and Applied Meteorology*, **25**, pp. 1265-1270.
- Tucson International Airport website (<http://www.tucsonairport.org>)
- U.S. Department of Commerce, Environmental Science Services Administration, Local Climatological Data, Annual Summary with Comparative Data, 1968, Tucson, Arizona.
- U.S. Department of Commerce, National Climatic Data Center, Local Climatological Data, Annual Summary with Comparative Data, 1986, Tucson, Arizona.

U.S. Department of Commerce, National Climatic Data Center, Local Climatological Data, Annual Summary with Comparative Data, 1996, Tucson, Arizona.

U.S. Department of Commerce, Weather Bureau, Local Climatological Data with Comparative Data, 1960, Tucson, Arizona.