2010 Climate Summary For Southwest Michigan

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The year 2010 will be remembered as one of our warmest years on record. For Southwest Lower Michigan, it was the 5th warmest year since records began in 1895. Precipitation was on the dry side. Lansing was the 31st driest on record. Muskegon and Grand Rapids were closer to normal but still on the dry side of normal. Snowfall was well below normal, and most of the 36 long term climate sites fell in the bottom third of snowiest years. Severe weather was more active than normal in 2010.

TABLE 1. Reported temperature, precipitation and snowfall amounts for 2010 at the primary climate stations in Southwest Lower Michigan. Normals are computed from 30-year averages from 1971-2000.

Location		**Temperature (F)**	**Precipitation (inches)**	**Snowfall (inches)**
Grand Rapids	*Reported*	51.1°	35.87	47.6
	Normal	47.6°	37.13	72.2
	Departure	+3.5°	-1.26	-24.6
Lansing	*Reported*	49.8°	27.75	39.3
	Normal	46.8°	31.53	54.5
	Departure	+3.0°	-3.78	-15.2
Muskegon	*Reported*	50.6°	30.69	53.8
	Normal	47.1°	32.88	104.6
	Departure	+3.5°	-2.19	-50.8

Temperature Trends in 2010:

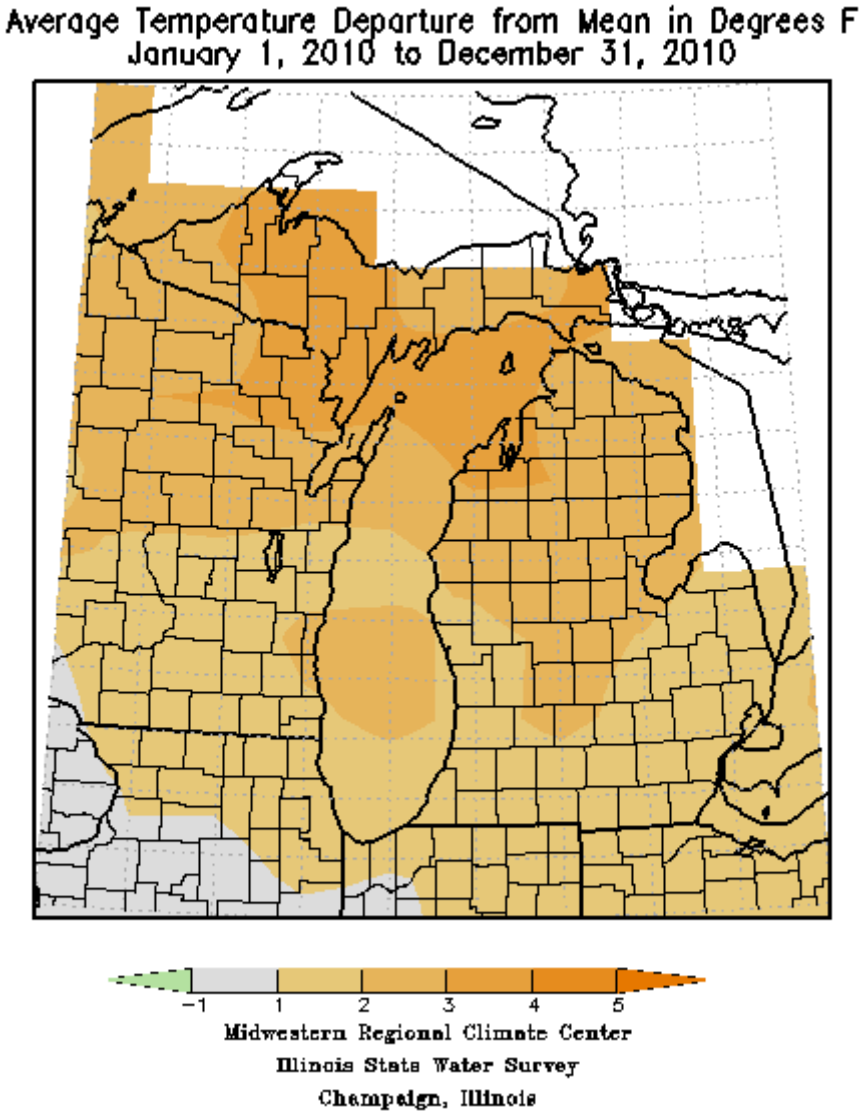

Figure 1. 2010 temperature departure from normal.

The average temperature for the 36 long term climate stations in Southwest Lower Michigan was **49.2 °.** That is **2.4°** above the normal mean of **46.8°.** Most of Southwest Lower Michigan was between one and three degrees above normal (Figure 1). The previous year warmer than 2010 was 1998, which had an areal average of **50.7°**.

Colder than normal years predominated in Southwest Lower Michigan from 1958 through 1997 (Figure 2). Since 1997, most years were warmer than normal, yet 2010 still stands out as unusually warm. Out of the 23 stations with complete daily temperature data, only two were not warmer than normal.

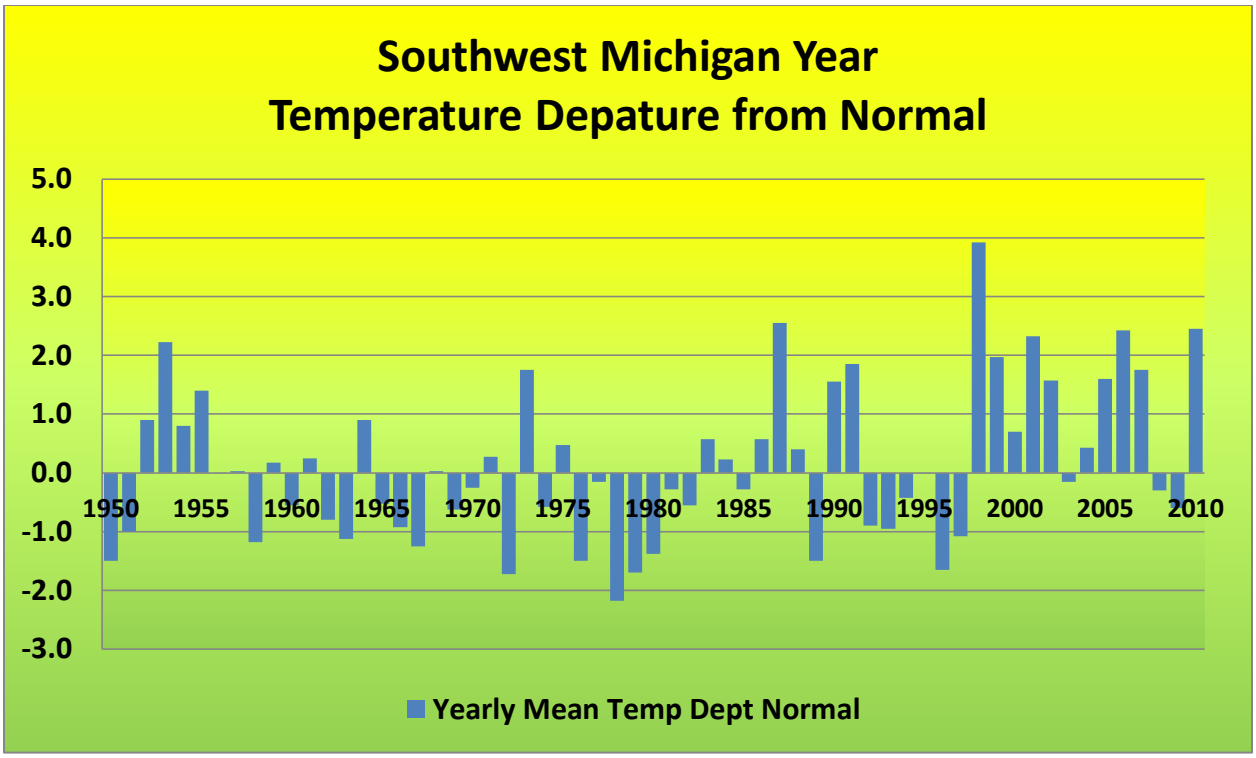

Figure 2. Mean areal temperature departure from normal for all of Southwest Michigan from 1950 through 2010, using the 36 available long term climate stations.

The warmest station in Southwest Lower Michigan in 2010 was South Haven with a mean temperature of 53.0°, which is 6.0° above normal. The Grand Rapids Airport was the second warmest at 51.1°, which is 3.5° above normal. Muskegon Airport was the third warmest with a mean of 50.6°, which is 3.5° above normal. The top three coldest stations were: White Cloud with a mean of 45.7°(0.3° degrees below normal), Albion with a mean of 45.9° (2.1° below normal), and Big Rapids with a mean of 47.3° (3.3° below normal).

TABLE 2. The top ten warmest years on record (1895-2010)

Top 10 Warmest Years for Southwest Lower Michigan			
Rank	**Data**	**Value**	**Dept Normal**
1	1921	50.8	4.1
2	1998	50.7	3.9
3	1931	50.0	3.2
4	1987	49.3	2.5
5	2010	49.2	2.4
6	2006	49.2	2.4
7	2001	49.1	2.3
8	1953	49.0	2.2
9	1999	48.7	2.0
10	1991	48.6	1.8

The past decade has been unusually warm. Three of the past ten years are in the top ten warmest years since records began in 1895 (Table 2). Six of the ten warmest years have occurred in the past twenty years. The warmest year on record was 1921 with an areal mean temperature of 50.8°, or 4.1° above normal. Coming in a close second was 1998 with an areal mean of 50.7°, or 4.0° above normal.

Conversely, the most recent year to fall in the top ten coldest years is 1996 (Table 3). Prior to that, there are three years from the 1970s in the top ten. The remaining six years were before 1950.

Michigan had its 4th warmest year since records began in 1895 (Figure 3). For Southwest Lower Michigan, this was the 5th warmest year on record. The past ten years averaged 47.9°, or 1.1° warmer than normal.

TABLE 3. The top ten coldest years on record (1895-2010)

Top 10 Coldest Years for Southwest Lower Michigan			
Rank	Data	Value	Dept Normal
1	1917	43.3	-3.4
2	1904	44.2	-2.6
3	1978	44.6	-2.2
4	1972	45.0	-1.7
5	1979	45.1	-1.7
6	1924	45.1	-1.7
7	1996	45.1	-1.7
8	1912	45.1	-1.6
9	1943	45.2	-1.6
10	1940	45.2	-1.6

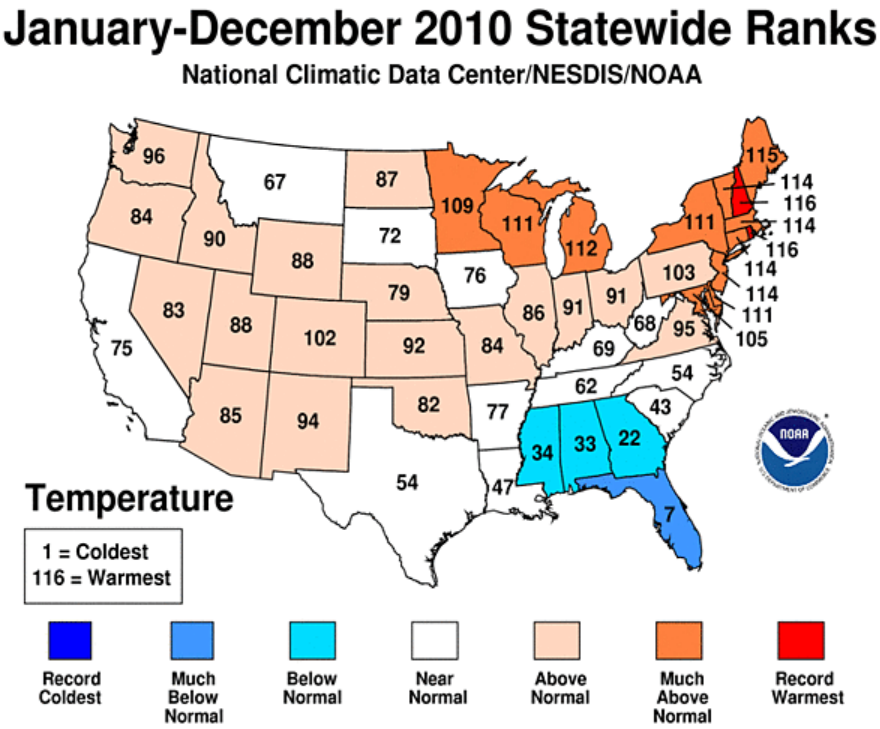

Figure 3. NCDC state temperature rankings for 2009. Numbers indicate the rank relative to the 115 years of available climate data.

TABLE 4. Year 2010 high temperature frequencies at the primary climate stations.

Number of days	Grand Rapids	Lansing	Muskegon
highs ≥ 90 (2010)	9	9	4
highs ≥ 90 (2009)	3	3	1
highs ≥ 90 (normal)	10	9	4
highs ≥ 90 (record)	37	44	20
year(s) of record	1988	1895	1955
highs ≥ 80 (2010)	89	85	72
highs ≥ 80 (2009)	48	38	30
highs ≥ 80 (normal)	67	69	52
highs ≥ 80 (record)	94	109	76
year(s) of record	1991	1896	2005
highs ≤ 32 (2010)	59	70	59
highs ≤ 32 (2009)	62	64	58
highs ≤ 32 (normal)	55	55	53
highs ≤ 32 (record)	84	85	86
year(s) of record	1978	1904	1978
highs ≤ 0 (2010)	0	0	0
highs ≤ 0 (2009)	0	0	0
highs ≤ 0 (normal)	0	0	0
highs ≤ 0 (record)	4	4	4
year(s) of record	1899	1899	1899

TABLE 5. Year 2010 low temperature frequencies at the primary climate stations.

Number of days	Grand Rapids	Lansing	Muskegon
lows ≥ 70 (2011)	21	13	21
lows ≥ 70 (2010)	5	4	4
lows ≥ 70 (normal)	6	5	5
lows ≥ 70 (record)	23	15	25
year(s) of record	1931	1955	1931
lows ≤ 60 (2010)	89	80	26
lows ≤ 60 (2009)	41	33	21
lows ≤ 60 (normal)	52	44	17.3
lows ≤ 60 (record)	98	81	24
year(s) of record	1921	1908	1989
lows ≤ 32 (2010)	127	141	129
lows ≤ 32 (2009)	124	137	129
lows ≤ 32 (normal)	142	149	139
lows ≤ 32 (record)	170	215	168
year(s) of record	1976	1868	1907
lows ≤ 0 (2010)	0	0	0
lows ≤ 0 (2009)	7	9	4
lows ≤ 0 (normal)	8	11	8
lows ≤ 0 (record)	19	44	21
year(s) of record	1978	1868	1912

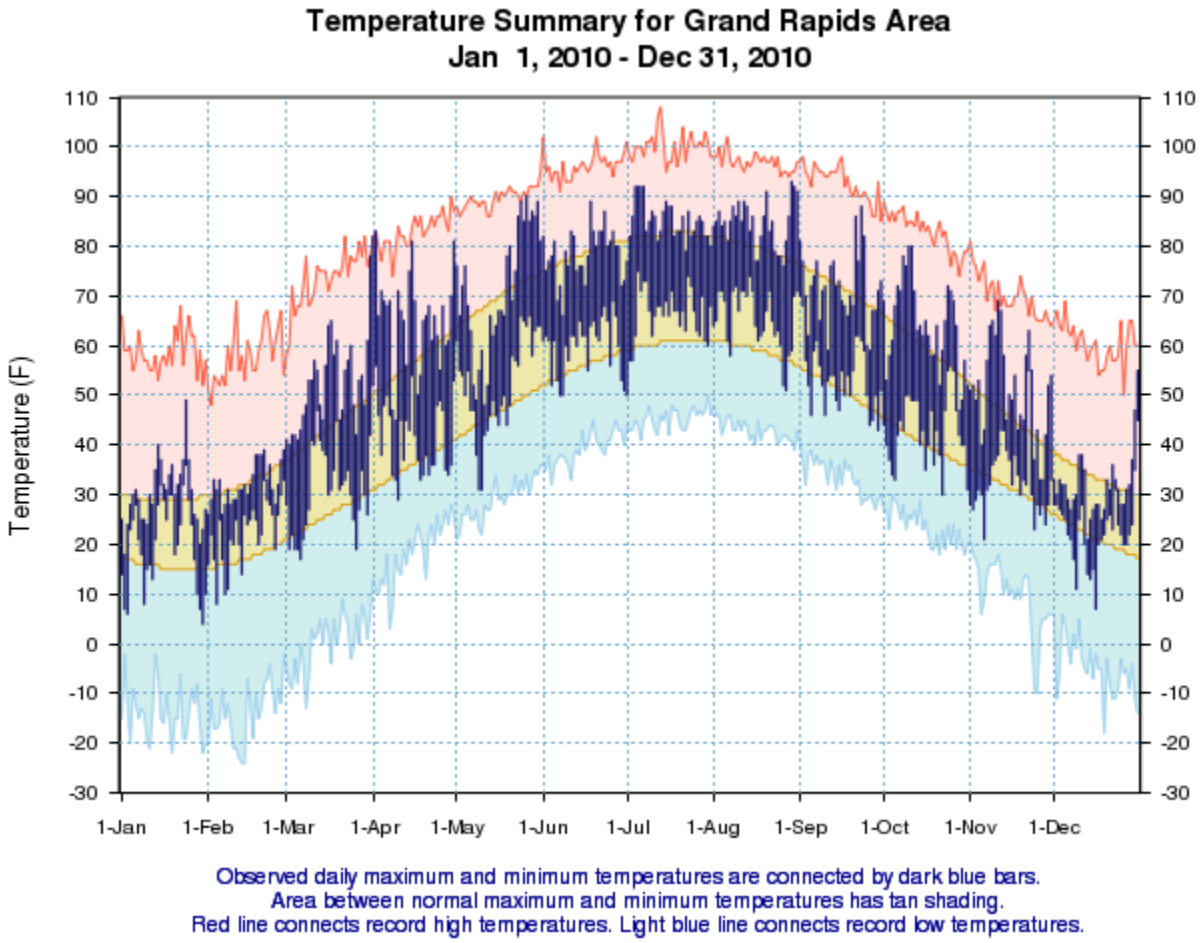

Figure 4. 2010 daily temperatures for Grand Rapids.

Daily features in the temperature can be seen in Figures 4 through 6. The warmth of the entire year is rather obvious as most of the curves are on the high side of normal. The first 11 months of 2010 were all warmer than normal. Even so, the frequency rate of highs in the 90s was not above normal, but only near normal (Table 4). The frequency of highs in the 80s and lows in the 70s, however, were near all time records at all three climate sites (Table 4 and Table 5).

Another feature of this past year was the lack of the typical cold spells. In a typical year this area averages 13 cold spells, which are at least 3 consecutive days with the mean daily temperature 5 or more degrees below normal. In 2010 there were only 5 cold spells and 2 of those 5 were in December. December was the only month to have 2 cold spells in 2010. Of the 120 years of records at Grand Rapids, only 1998 had fewer cold spells (3). Warm spells are defined as at least 3 consecutive days with the mean daily temperature 5 or more degrees above normal. There are typically 14 warm spells in a year, and in 2010 there were 18.

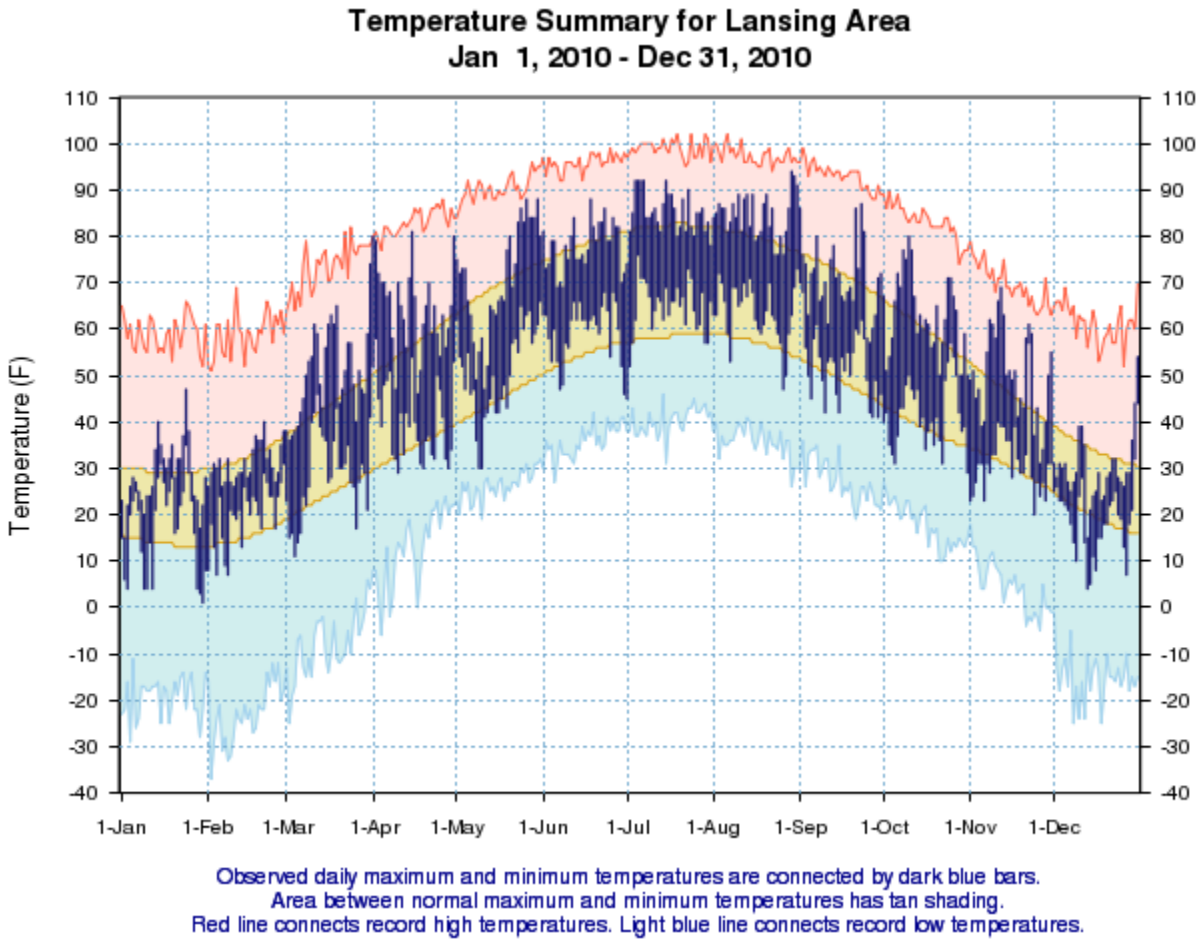

Figure 5. 2010 daily temperatures for Lansing.

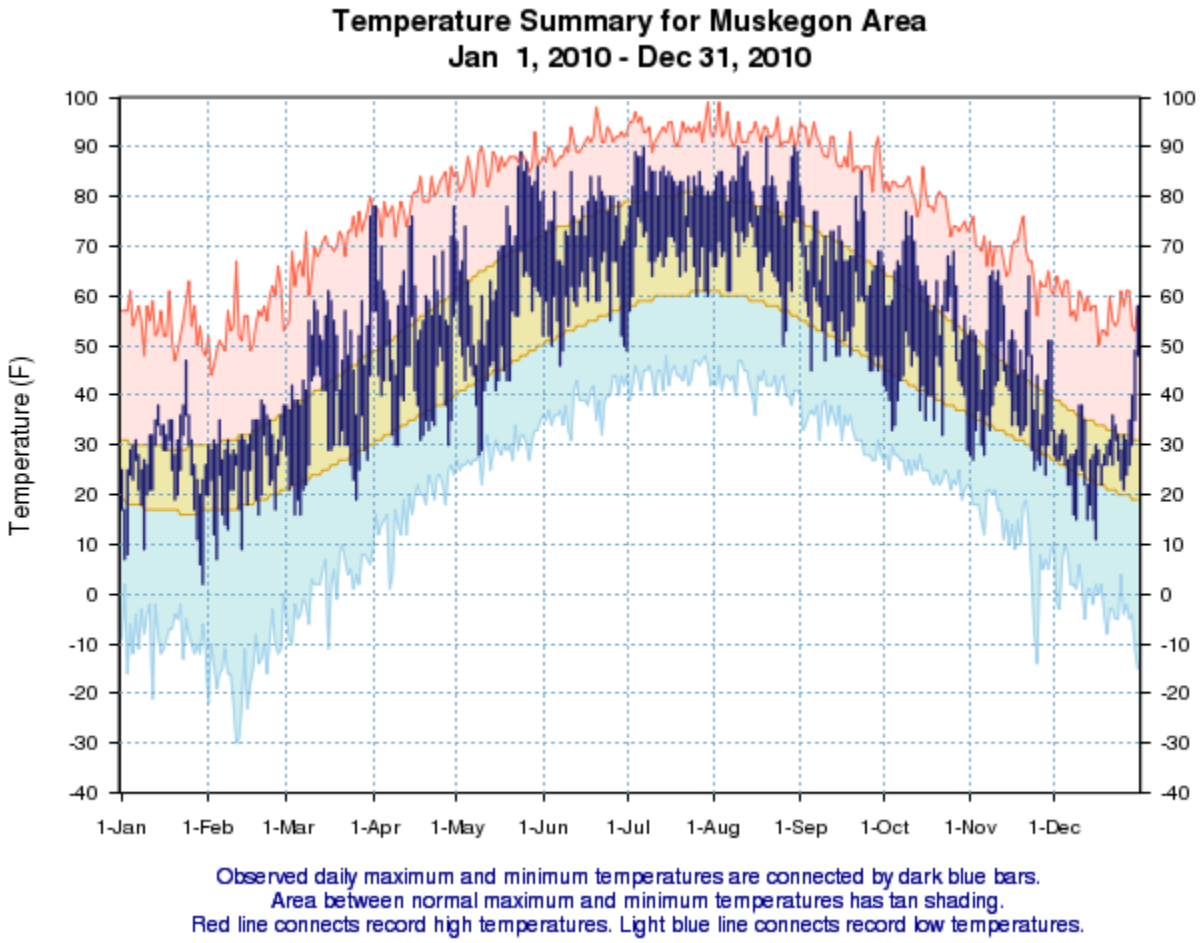

Figure 6. 2010 daily temperatures at Muskegon.

Precipitation Trends in 2010:

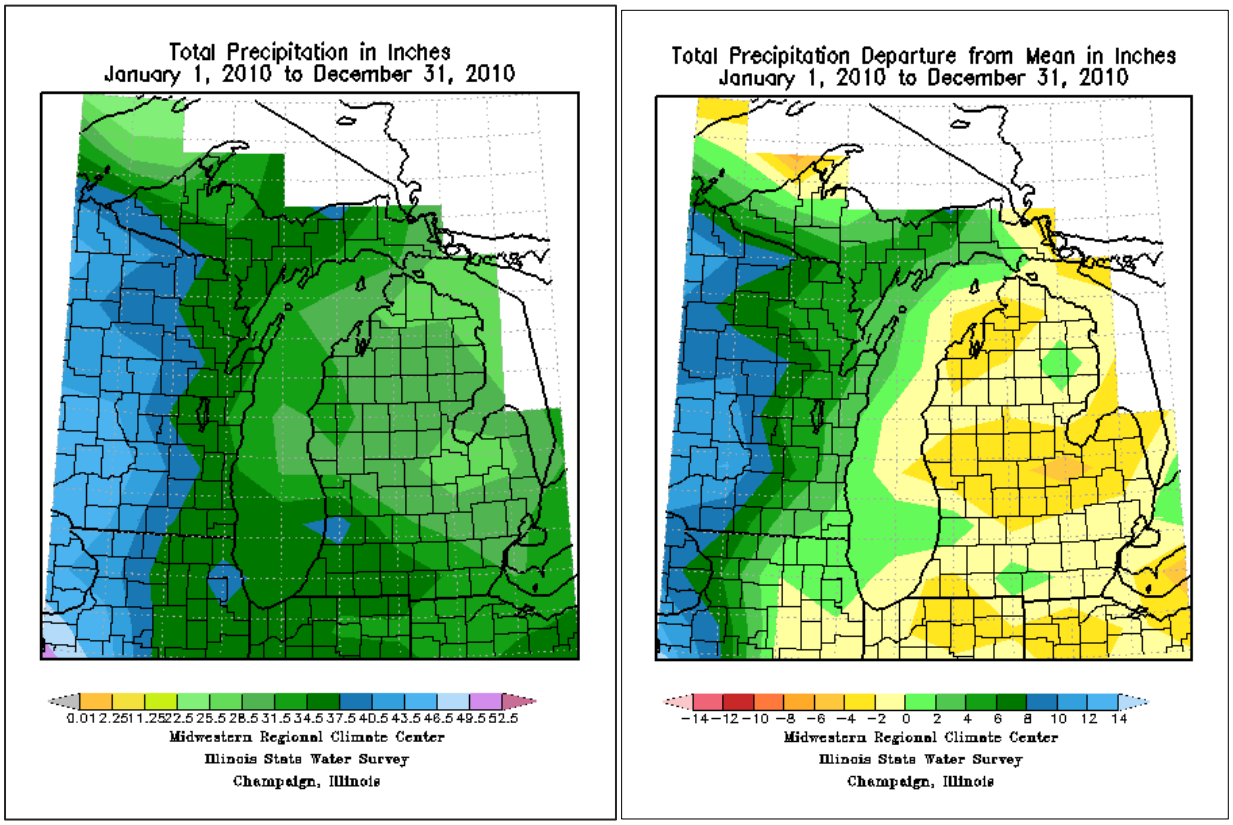

Figure 7a. 2010 total precipitation and **Figure 7b.** departure from normal.

The year was the 36th driest year out of 116 years of records with an areal mean precipitation of 30.85 inches. That was 3.77 inches below the 1971 to 2000 normal for total annual precipitation. It also is a significant drop in areal mean total precipitation from the previous two years, which were in the top 10 wettest on record. The year 2008 was the wettest on record with a total areal mean precipitation of 42.55 inches while 2009 was the 10th wettest with an areal mean total precipitation of 38.61 inches.

Out of the 45 reporting stations, 27 stations had at least 90 percent of the daily precipitation records. Of those stations, only five reported above normal precipitation. Total yearly precipitation is shown in Figure 7a. Far Southwest Lower Michigan received the heaviest precipitation relative to normal, while the remainder of Southwest Lower Michigan was drier than normal (Figure 7b). The wettest station that had all of the reporting data in 2010 for Southwest Lower Michigan was Bloomingdale with 42.55 inches of precipitation. That was 5.31 inches above normal. The driest station was 5 miles northwest of Battle Creek, with a total precipitation of 23.90 inches, which was 10.53 inches below normal. Curiously, the Battle Creek Airport was significantly wetter with a precipitation total at 32.17 inches.

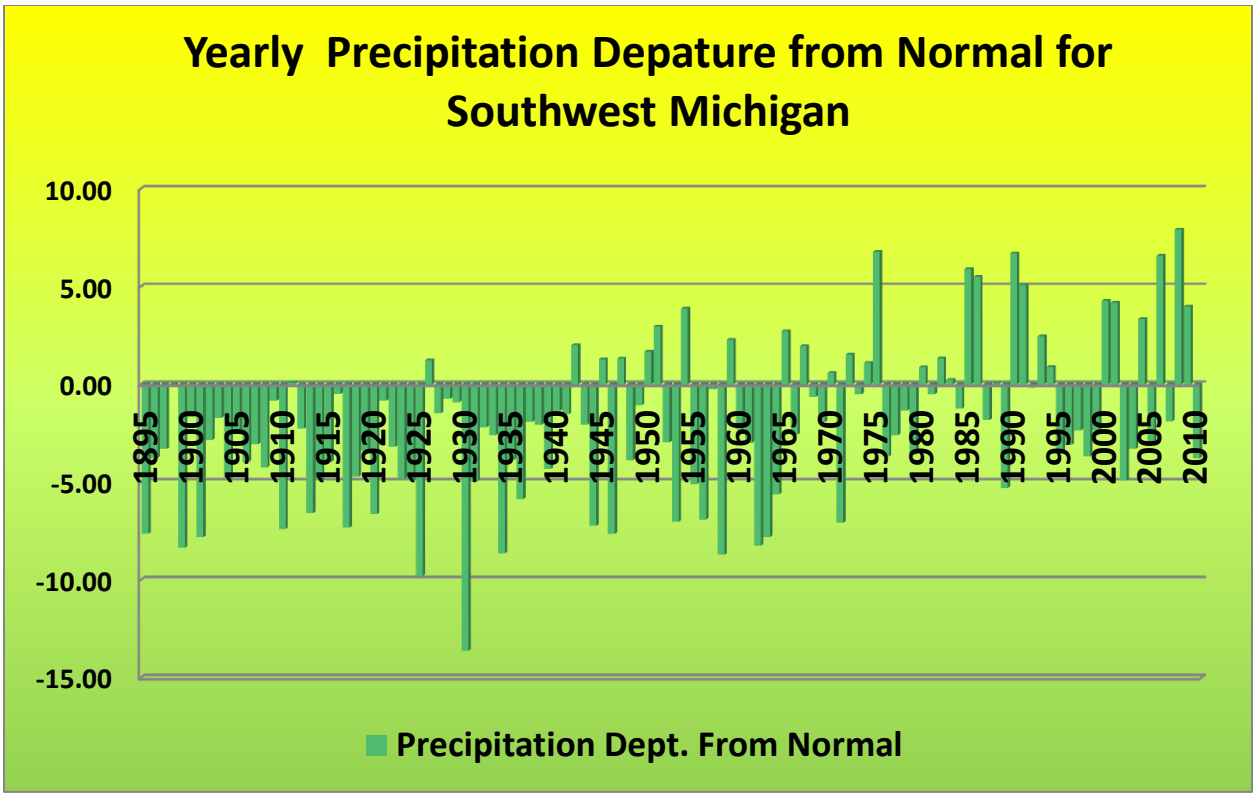

Figure 8. Yearly precipitation departure from normal based on all climate stations in Southwest Lower Michigan.

Since the 1940s, there has been a trend toward wetter years over Southwest Lower Michigan (Figure 8). Prior to 1945, nearly every year was below the 1971 to 2000 normal. The "Dust Bowl" years in the 1930s really stand out with four years more than five inches below normal. The 30 year running mean ending in 1960 was 31.99 inches, and the same 30 year running mean ending in 2010 was 35.21 inches – a greater than 3 inch increase in the past 50 years. In the past 10 years, the 30 year running mean has increased 0.59 inches. Since the year 2001, five years were wetter than normal, and five were drier than normal.

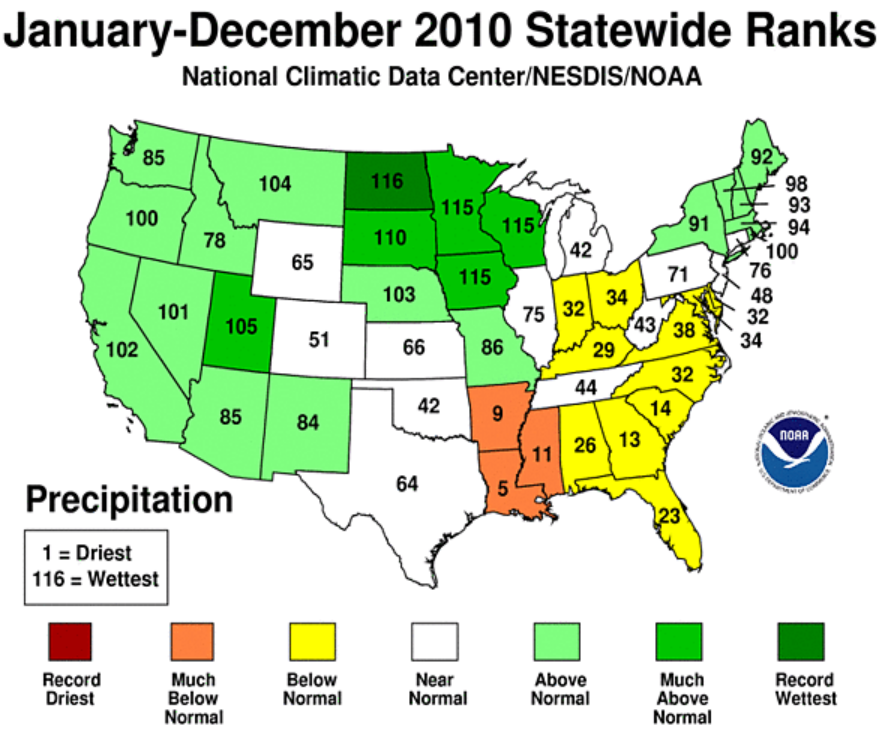

Figure 9. As in Figure 3, except for 2009 annual precipitation.

Michigan had its 42nd driest year since records began in 1895 (Figure 9). For Southwest Lower Michigan, this was the 36th driest year on record. Grand Rapids was drier than normal during the spring and fall of 2010 (Figure 10). The period from mid June until mid September was slightly wetter than normal. Lansing (Figure 11) was below normal through the entire year while Muskegon (Figure 12), similar to Grand Rapids, had a short period of slightly wetter than normal conditions from early September to early October.

Of the 27 stations with nearly complete precipitation datasets, Grand Rapids was the 5th wettest in 2010. Lansing was the 5th driest, and Muskegon was the 14th wettest.

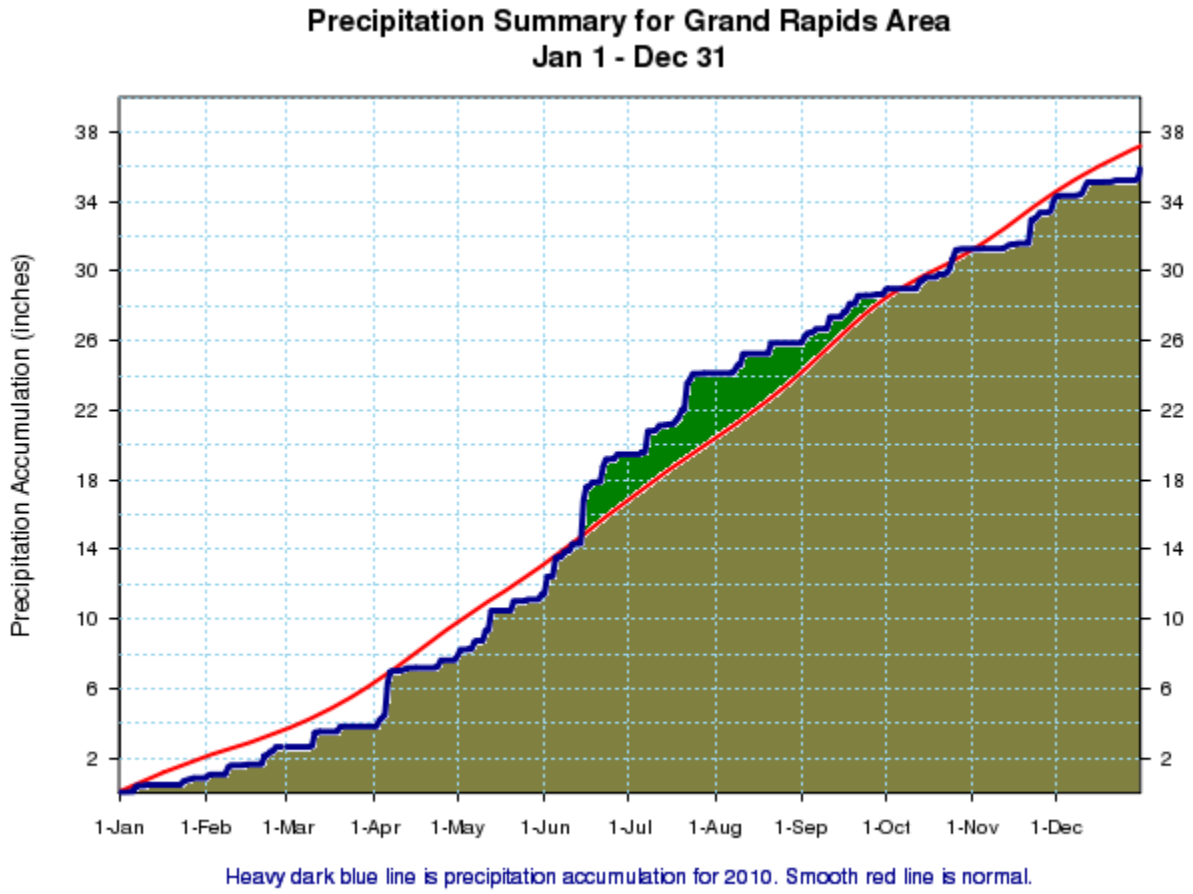

Figure 10. Grand Rapids 2010 accumulated precipitation. The red curve represents the normal accumulation, and the top of the green curve is observed precipitation.

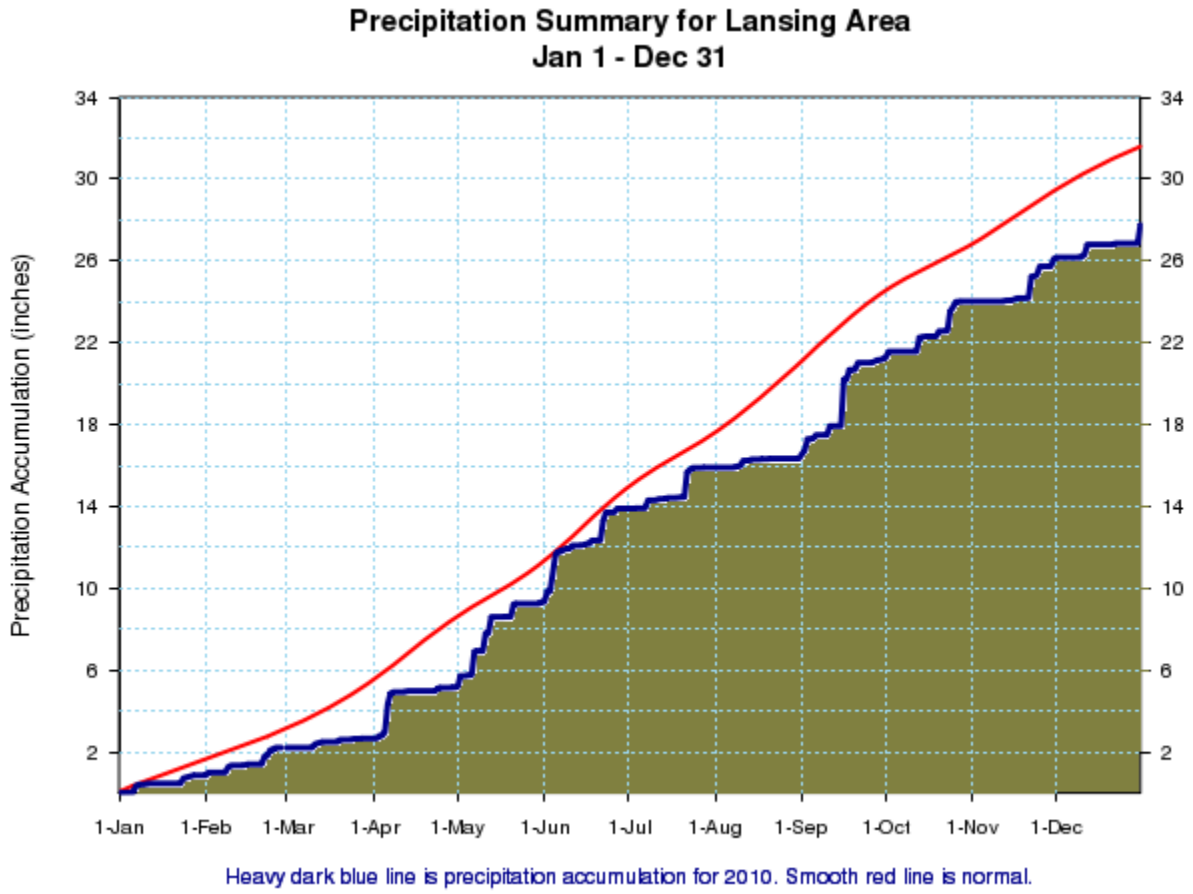

Figure 11. As in Figure 10, except for Lansing.

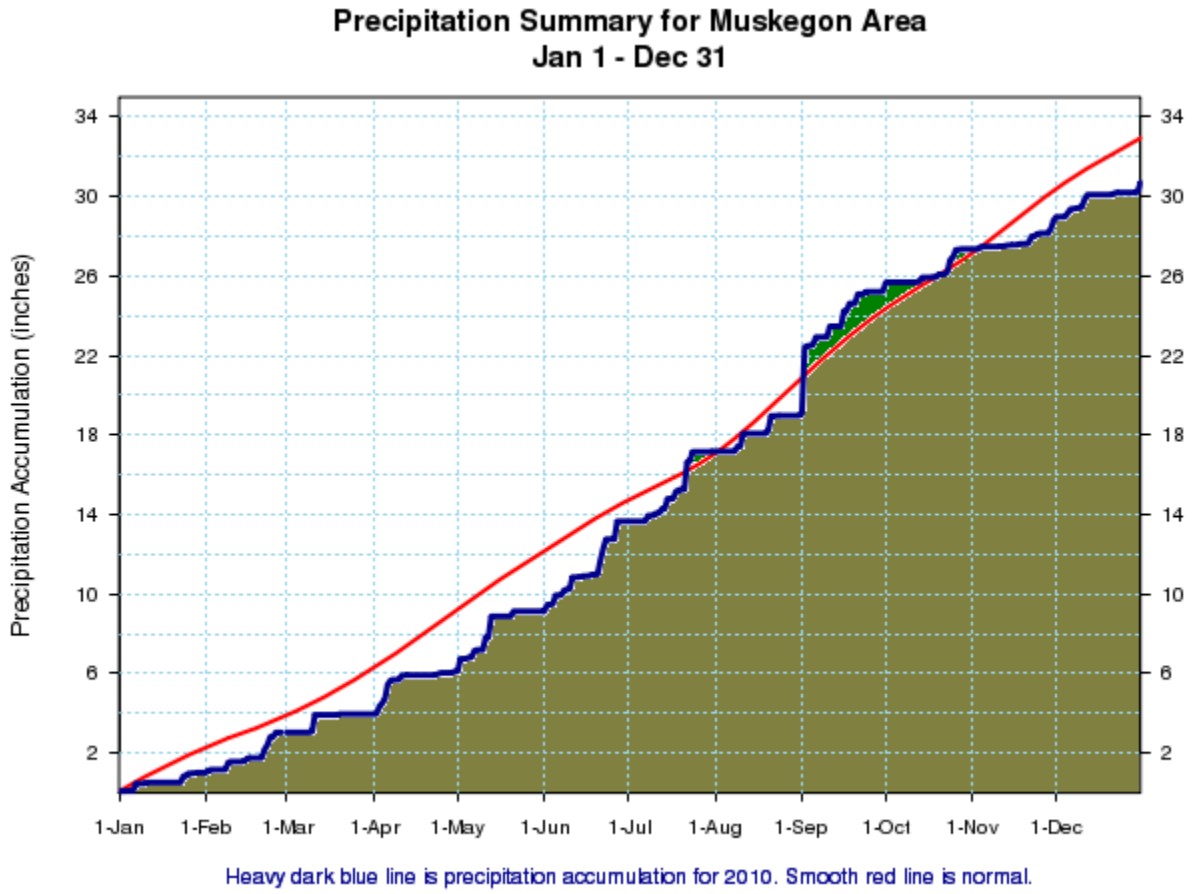

Figure 12. As in Figure 10, except for Muskegon.

Snowfall Trends in 2010:

The total areal snowfall was below normal across all of Southwest Lower Michigan in 2010 (Figure 13). The heaviest snowfall in 2010 was in the southwest section of Southwest Lower Michigan (Figure 14), similar to where the precipatation maximum was (Figure 7a). Snowfall has been near to above normal for 2007, 2008, and 2009. The last time snowfall was below normal across the area was 2006.

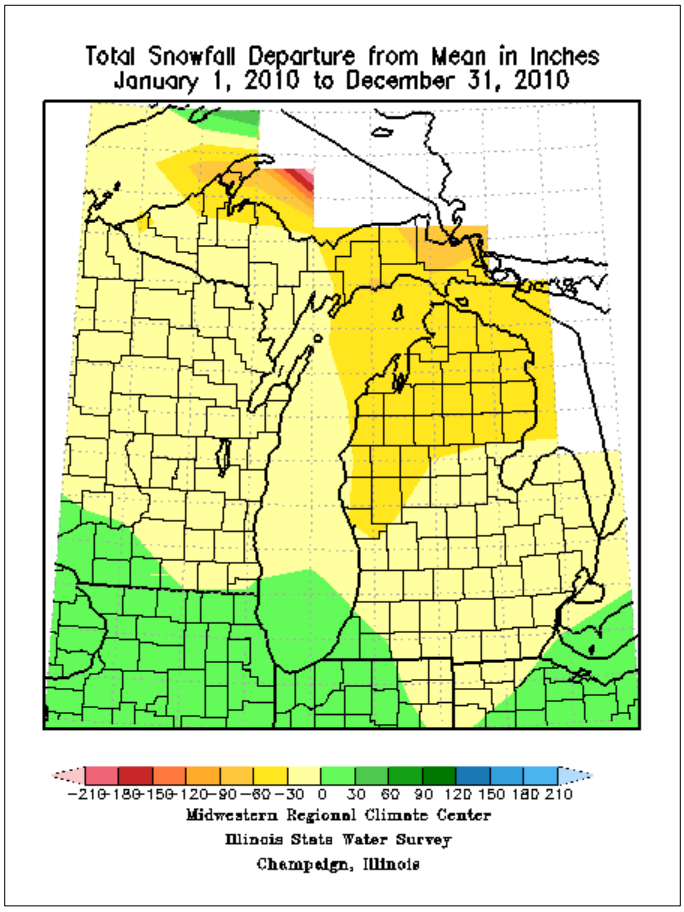

Figure 13. Total snowfall departure from normal for 2010 for the western Great Lakes.

Looking at the average of our three primary climate sites, the mean yearly snowfall for 2010 was 46.9”; that was 24.9 inches below our normal average of 71.8”. It was also the 6th least snowiest in the past 50 years. That is much less than in 2009 when the mean total snowfall was 73.2 inches or in 2008, which was the snowiest year of the past 50 with a mean of 134”.

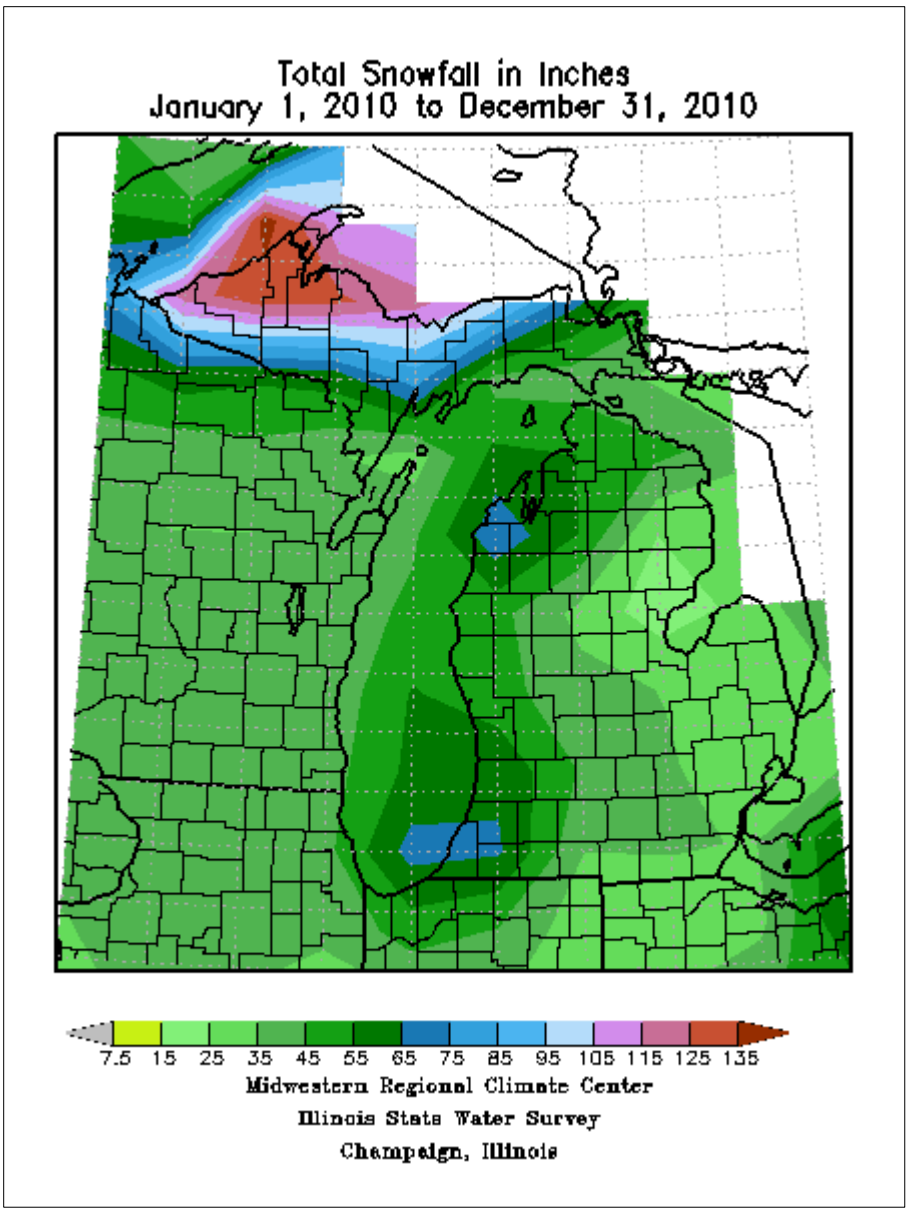

Figure 14. The total snowfall for 2010 over the western Great Lakes.

Severe Weather Trends for 2010:

There were 180 severe weather events in 2010 (Figure 15). The total of 180 severe weather events was the third highest on record (1986-2010). The average from 1986 through 2009 is 105 events per year. The all time record was 231 in 2008. Most of the severe storms were in the months of June and July, with a total for those two months of 107 events. In a typical June and July there would only be 51 events. September had a very unusual spike with 51 events. That was largely due to the severe storm episode on the 21st with 35 events in one day. A typical September would have only 10 severe storm events.

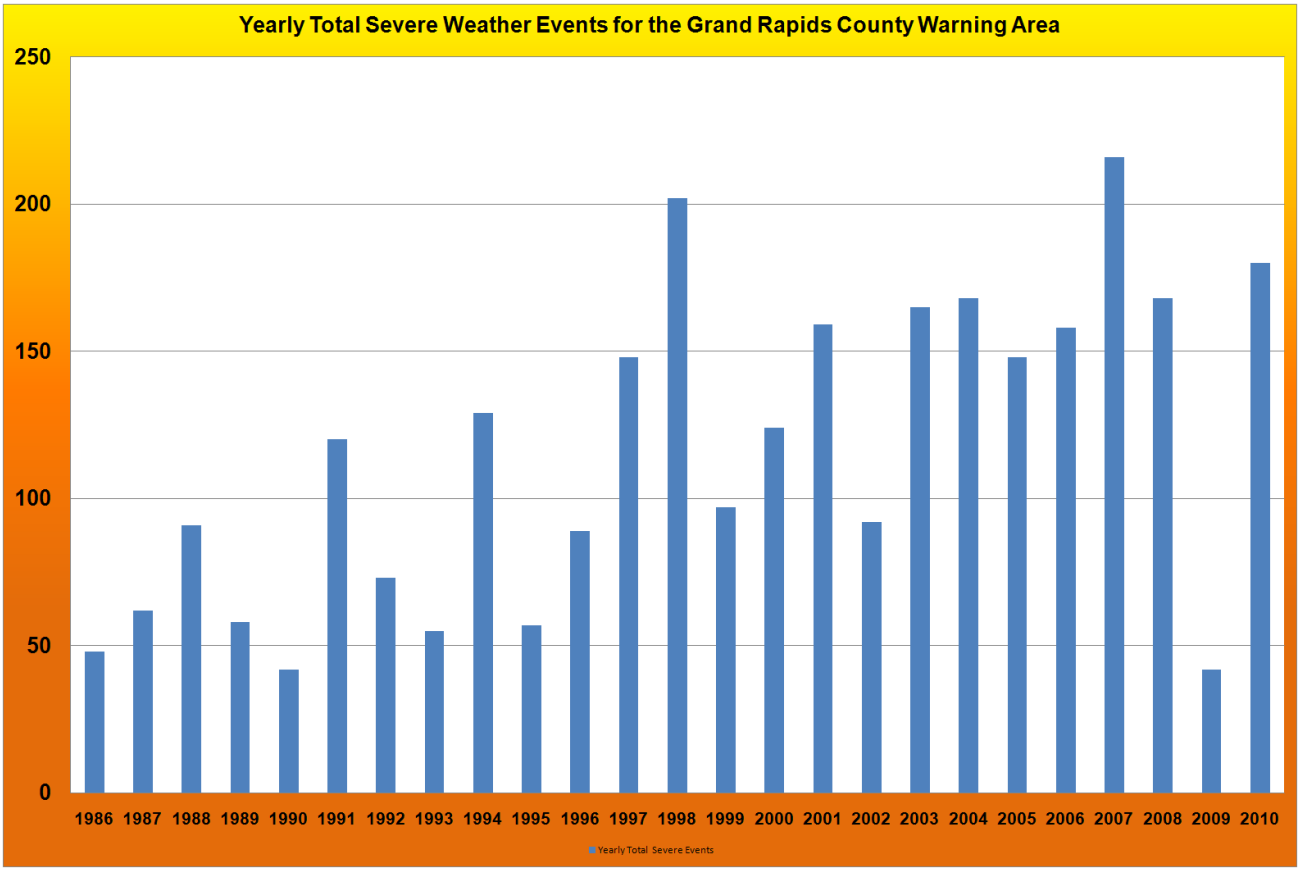

Figure 15. **Southwest Lower Michigan total yearly severe weather events from 1986 through 2009.**

Looking at severe weather episodes (i.e., three severe storm events occurring within 6 hours), 2010 recorded 22, while only 10 were recorded in 2009 (Fig 16). 2009 was the 2nd least active year for episodes since records began in 1986. The 22 episodes in 2010 were mostly concentrated in the summer months, which is typical. As is typical for years when there is a fading El Niño during the spring, the severe season got off to a later than usual start.

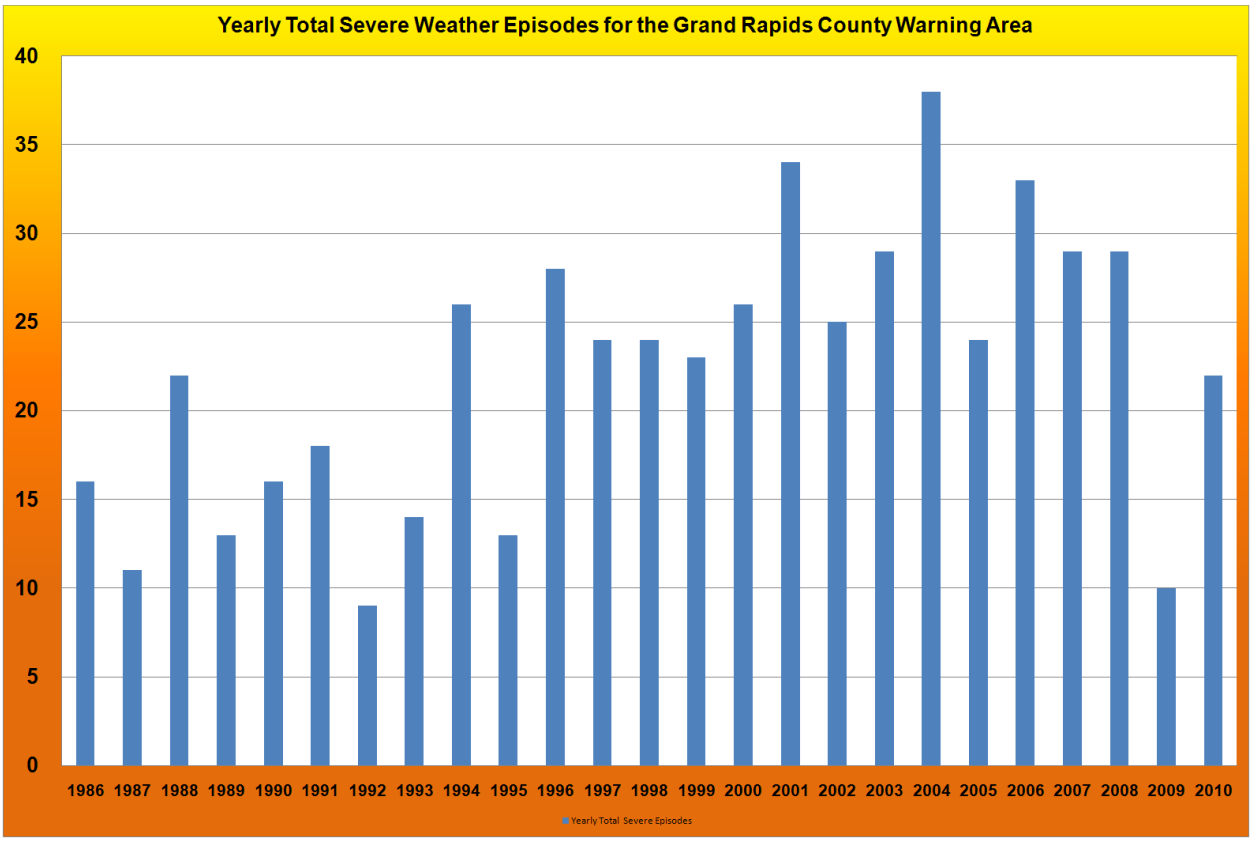

Figure 16. Southwest Michigan total yearly severe weather episodes from 1986 through 2010.

Top 10 Impact Weather Events of 2010:

1) **April 5th - 6th severe storm event**
   Wind gusts to 80 mph occurred near Vicksburg in Kalamazoo County on the night of the 5th. Numerous reports of hail also occurred, with the largest being a report of 1.50 inches (ping-pong size) during the very early morning hours of the 7th in the Village of Paris in Mecosta County. This storm did the most damage of any event in 2010, with an estimated **$50,000,000** cost.

2) **August 11th – 12th flood event with isolated severe storms.**
   An isolated severe storm event and a fairly significant rain event impacted Southwest Lower Michigan on August 11th into the 12th. Several locations received one to three inches of rain and some localized flooding. There was localized very heavy rain in excess of four inches that impacted Mount Pleasant in Isabella County. This resulted in some flash flooding. A hospital was flooded and several roads and intersections were washed out. The estimated cost of damage was **$4,000,000**.

3) **June 5th - 6th EF-1 tornado**
   A series of systems moved across Southwest Lower Michigan in early June. Thunderstorms caused wind damage and produced some hail with diameters below an inch. An EF-1 tornado occurred at 12:03 am on the 6th two miles south of Battle Creek in Calhoun County. This resulted in property damage around **$2,000,000**.

4) **June 4th severe storm event**
   This produced an area of 65 to 80 mph winds and nickel size hail just west of Lake Lansing between East Lansing and Haslett. A small home was destroyed when a tree fell on it. Up to 100 trees were uprooted by the storm that had a 5 mile long and 1 ¼ mile wide damage path. This event caused **$1,000,000** worth of damage.

5) **May 31st flash flood event**
   This occurred in the Belmont area of Kent County due to a heavy thunderstorm that moved very little. A car was submerged, and numerous basements flooded as up to 3 feet of water flowed into the town of Belmont. This caused **$200,000** in damage.

6) **September 21st**
   A fairly significant late season severe weather event with 35 severe storm reports - the most in one day since the 63 severe reports that occurred on October 19th in 2007. Storms well out ahead of a cold front during the afternoon hours produced hail up to golf ball size from Mecosta County to Isabella County. Later at night, a line of thunderstorms along the cold front produced damaging winds in the 65 to 75 mph range along the lakeshore in Muskegon, Ottawa, and Allegan counties. These severe winds moved inland across Kent and Ionia Counties, producing localized tree damage. Both Tulip City Airport in Holland and Gerald R. Ford International Airport in Grand Rapids recorded 72 mph wind gusts. At Grand Rapids, this was one of the highest wind gusts ever measured at the airport. This storm did about **$50,000** in damage.

TABLE 6. The top ten warmest summers on record for Southwest Michigan based on the 36 climate station means (1895-2010)

Top Ten Warmest Summers			
	Year	Data	Dept
1	1921	72.7	4.3
2	1955	72.4	4.1
3	1901	71.9	3.6
4	1995	71.9	3.6
5	1988	71.7	3.3
6	1949	71.5	3.2
7	2005	71.5	3.1
8	2010	71.4	3.0
9	1919	71.2	2.9
10	1983	71.1	2.8
NCDC	Normal	68.3	

7) **Warm summer**

It was the eighth warmest summer on record for Southwest Lower Michigan since records began in 1895 (Table 6). The warmest summer on record was the summer of 1921, which averaged 72.7 degrees. Half of the top ten warmest summers have occurred in the past 30 years (yellow shading in Table 6). By comparison, the 65.9°F mean for the summer of 2009 was the fourth coldest on record. The NCDC state ranking map, shown in Figure 3, reveals the state of Michigan also had the eighth warmest summer on record.

TABLE 7. The top ten warmest springs on record for Southwest Michigan based on the 36 climate station means (1895-2010)

Top Ten Warmest Springs			
	Year	Data	Dept
1	1977	50.9	5.7
2	1921	50.4	5.2
3	2010	50.1	4.9
4	1991	49.9	4.6
5	1987	49.0	3.8
6	1998	48.9	3.7
7	1985	48.6	3.4
8	1903	48.4	3.2
9	1896	48.4	3.1
10	2000	48.1	2.9
NCDC	Normal	45.2	

8) **Warm spring**

It was the third warmest spring for Southwest Lower Michigan since records began in 1892 (Table 7). Like in with the summer temperatures in Table 6, six of the top 10 warmest springs were within the past 30 years (the most recent 30 years have yellow shading over the year). At Grand Rapids and Lansing there were fourteen days with highs at or above 80 degrees during the spring. At Muskegon there were eight days with highs of 80 degrees or more during the spring. At Grand Rapids and Lansing there are normally seven days with highs of 80 degrees or warmer during the spring. At Muskegon there are normally four days with highs of 80 degrees or warmer during the spring. At all three locations, the number of days with highs of 80 degrees or more was double what is normal for the spring. By comparison, the total number of days with highs of at least 80 degrees in 2009 was less than half the normal at Grand Rapids and Lansing, while Muskegon had no such days.

9) **February 9th-10th snow**

Heavy snow fell over a large part of Southwest Lower Michigan from Tuesday morning of February 9th through the mid morning hours of Wednesday, February 10th. The snowfall was heaviest during the late afternoon until around midnight. Grand Rapids reported 4 inches of snow between 7 PM and 10 PM in the evening. Most of the area south of a Muskegon to Alma line reported between 8 and 12 inches of snow. Battle Creek reported the heaviest snowfall with 12 inches. Grand Rapids had the fifth heaviest

midnight to midnight snowfall ever measured in February with 8.1 inches on the 9th. The two day total of 9.7 inches is the 8th greatest for February. The 17.2 inches that fell between February 1st and 2nd in 2011 was the greatest two day snowfall for Grand Rapids. The greatest February one day total was 11.3 inches on the 3rd of February in 2007.

10) **January 4-5th snow**

This lake effect snow event was significantly more limited in coverage. It only impacted the extreme southwestern section of Allegan County, near South Haven and the western third of Van Buren County. That area saw up to 1 ½ feet of snow from this event, which added to the 1 ½ feet received around New Year's Day. Snow depths were reported to be over 2 feet in some areas of western Van Buren County after the second event.

Seasonal and monthly weather summaries are found at the National Weather Service Grand Rapids webpage (http://www.crh.noaa.gov/grr/climate/).