Putting Snowstorms into Perspective in Montana using a Montana Snowfall Impact Scale

Introduction

Snowfall impacts have been difficult to determine on a large scale. The mesoscale nature of heavy snowfall in Montana can make the larger-scale impacts extremely difficult to quantify. Paul Kocin and Louis Uccellini (Kocin and Uccellini, 2004) characterized and ranked northeast snowstorms according to distribution of snowfall amounts, as well as population density. The NESIS (Northeast Snowfall Impact Scale) has five categories: Extreme, Crippling, Major, Significant, and Notable. This index uses population information along with snowfall totals to determine a storm's societal impacts. The National Climatic Data Center (NCDC) (Squires et al. 2006) further refined the NESIS to calculate values operationally starting with the 2005-06 winter season. They first started with a northeast scale, expanding to the rest of the United States, using broadly defined regions.

Montana lies within the NCDC-defined Northern Rockies and Plains region. While this is a large area comprising the northern Rocky Mountains and the northern Plains, there are many storm systems that affect only the northern Plains with little impact on Montana. Conversely, there may be storms that affect only mountainous regions, with little snowfall over the plains. As a result, the NCDC regional values that include Montana often rate very low with heavy snows that fall mostly in Montana.

Data collection

To address this issue, a Montana-centric Snowfall Impact Scale is necessary. This would account for storms that mainly affect Montana, and the mesoscale nature of many snowfalls in the state.

To create a Montana-centric Snowfall Impact Scale (MontSIS), the largest storms in the period from 1890-2012 were taken from the NCDC RSI (Regional Snowfall Index) database. Afterwards, a search of climatic databases was performed, finding the ten highest three-day snowfalls at seventeen locations from across the state. This step helped to fill in areas were snowfall may have affected only a small area, in addition to larger scale storms. A storm that affected northeast Montana may have dropped little, if any, snow in western Montana. Even so, this was an important step to find the dates of significant snowfalls. Appendix A lists the highest 3-day snowfalls at all seventeen locations. After this step, 182 storms were identified in the period from 1890-2012.

Decade	Number of Snowstorms
1900	8
1910	7
1920	6
1930	10
1940	13
1950	18
1960	17
1970	27
1980	24
1990	17
2000	20
2010-12	10

Table 1. Snowstorms by decade used in this study.

Table 1 shows the number of storms by decade considered in the analysis.

Besides limiting storms to three-day totals, there are many other methods in which to assess the impact of snowfall. The geographic extent of heavy snowfall may show broad-scale effects of heavy snowfall on transportation, livestock and other activities. Table 2 shows the top 30 snowfalls since 1950 when considering the areal extent of seven inches or more.

Table 2. The top 30 ranked snowstorms based on the MontSIS scale since 1950. The area of the 7-inch and more region is listed, along with the MontSIS score.

Date	>7” area	MontSIS
Jan 15-18, 1954	78,600	8.9
Apr 2-4, 1955	83,200	9.5
Dec 4-7, 1958	84,200	7.9
Feb 15-17, 1959	72,200	7.1
Apr 22-25, 1960	61,500	7.6
Dec 19-23, 1964	65,900	8.5
Jan 19-22, 1969	113,800	8.9
Apr 26-29, 1970	78,200	7.9
Jan 6-10, 1971	105,100	9.2
Jan 24-26, 1975	69,600	6.1
Mar 22-27, 1975	71,100	6.1
Apr 4-9, 1975	99,300	9.9
Mar 27-30, 1977	72,400	6.7
Jan 5-10, 1980	110,300	10.9
Mar 17-20, 1982	65,500	4.4
May 9-15, 1983	99,500	11.3
Oct 7-9, 1985	59,200	6.4
Feb 13-19, 1986	137,900	14.6
Mar 18-22, 1987	87,700	6.6
Mar 13-17, 1989	89,300	7.4
Apr 10-13, 1991	65,500	8.0
Nov 18-22, 1996	65,900	7.2
Dec 24-29, 1996	117,500	12.9
Mar 6-10, 2002	64,600	7.6
Mar 6-9, 2003	115,200	9.5
Dec 25-30, 2003	98,800	11.7
Jan 24-30, 2004	75,800	7.1
Oct 10-13, 2008	79,300	6.6
Jan 16-20, 2012	79,300	7.0
Nov 8-10, 2012	66,600	6.4

Once the data were collected, a series of statistics was computed for each, including the average snowfall and the maximum value. This was more for interest and is not of great value when attempting to derive a regional impact scale. Additionally, GIS software was used to plot the data, not only to display the spatial distribution, but also compute areal coverage of threshold values. For the MontSIS, NCDC thresholds for the Northern Rockies and Plains were used (3, 7, 14 and greater than 21 inches). This information was necessary for inclusion in a regional snowfall index. The NCDC index formula is as follows:

$$ReSIS = \sum_{T1}^{T4} \left[n \left(\frac{An}{Amean} + \frac{Pn}{Pmean} \right) \right]$$

Where:

T = the regionally specific snowfall thresholds (3, 7, 14, 21)
n = the snow threshold
An = area affected by snowfall greater than threshold *T*
Amean = mean area affected by snowfall greater than threshold *T*
Pn = population affected by snowfall greater than threshold *T*
Pmean = mean population affected by snowfall greater than threshold *T*

For this study, the formula was simplified to the following:

$$MontSIS = \sum_{T1} T4 \, [n \left(\frac{An}{Amean} \right)]$$

The population element was removed due to the rural nature of Montana. Although population centers may be severely impacted by heavy snowfall, the traveling public is affected as well. Montana residents travel long distances to shop, visit medical facilities, attend sporting events, etc. As such, a snowstorm affecting large rural areas may have as much of an effect on populations that did not fully experience the storm. This creates a simplified Snowfall Impact Scale for Montana (MontSIS).

The computed values for the storms over the past century ranged from near one to over fourteen. The values were scaled using category definitions as with the ReSIS, and the categories are summarized in Table 3.

Table 3. MontSIS Category Definitions, along with the approximate percentage of total storms, and the NCDC Category descriptor.

MontSIS Category Definitions			
Category	**MontSIS Raw Score**	**Approximate Percent of Storms**	**Description**
5	>13	2.8%	Extreme
4	9 – 13	10%	Crippling
3	4.5 – 9	22.8%	Major
2	2.7 – 4.5	31.4%	Significant
1	1.0 – 2.7	32.8%	Notable

For the highest ranking storm, February 13-19, 1986, Figure 1 depicts the geographic distribution of the snowfall. The large red areas indicate amounts of more than 21-inches. In this case, most of the state received three or more inches of snow. This situation does not regularly occur with snowstorms, and as such had greater impact on the state. The large areas of more than 14 and more than 21 inches strongly skewed the index towards the highest value recorded. This storm ranked as a category 5, with a MontSIS of 14.6.

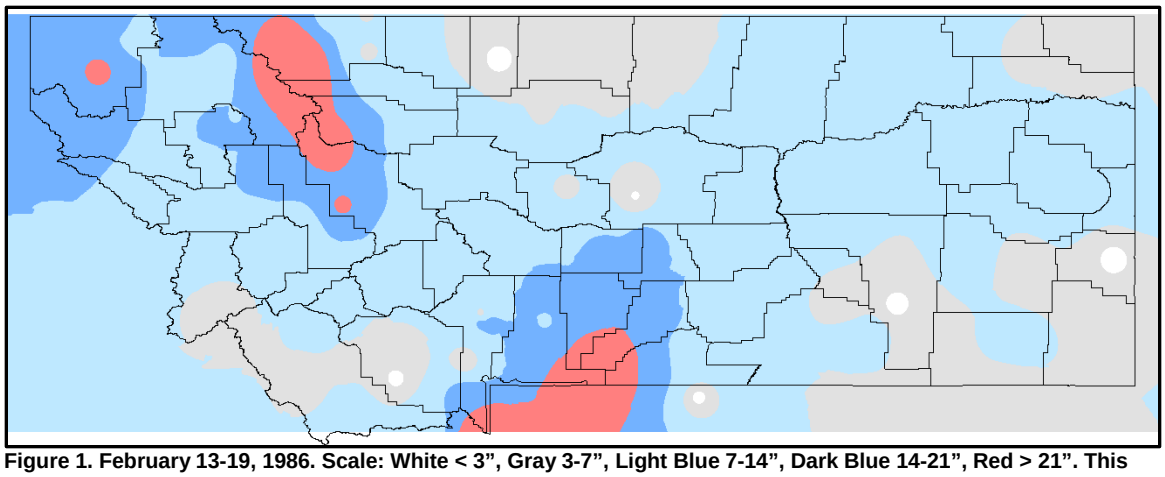


Figure 1. February 13-19, 1986. Scale: White < 3", Gray 3-7", Light Blue 7-14", Dark Blue 14-21", Red > 21". This was the storm that ranked the highest of all storms.

The second highest ranking storm, January 15-18, 1954 (Fig. 2), also produced widespread snow. There were areas in the east and extreme south that received lighter snowfall, but heavy snow fell across much of the western one-half of the state. This storm produced a category 5 with a MontSIS of 14.4.

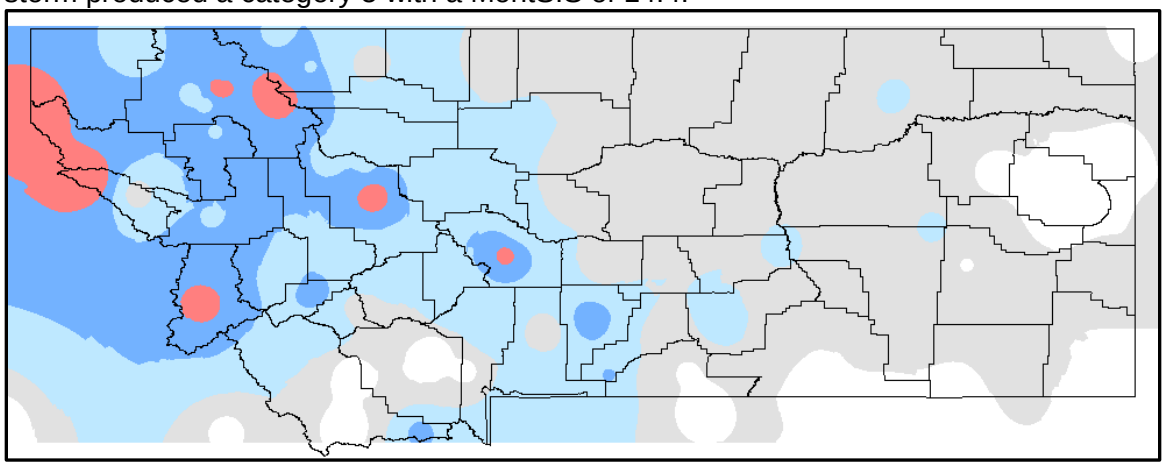


Figure 2. January 15-18, 1954 snowfall distribution. Scale as in previous figure. This was the second highest ranking snowstorm.

The most recent storm to rank as a category 4 snowstorm occurred December 24-29, 1996. This storm received a MontSIS value of 12.9. Again, snow fell across most of the state, with heaviest amounts in the west. A very large area of the northwest received more than 21-inches of snow, with a band of 14-21-inches from west central through south central Montana (Fig. 5e)

The highest ranking storm in the past five years occurred from January 16-20, 2012. This had a MontSIS value of 9.9, which ranked as a category 4. Though snowfall of more than 3 inches fell across much of the state, the heavier amounts covered a much smaller areas, with the highest amounts limited in area (Fig. 5e).

Most of the storms with heaviest snowfall occurred during January, with a secondary peak in March and April. Figure 3 shows the monthly distribution of all 182 storms in this study.

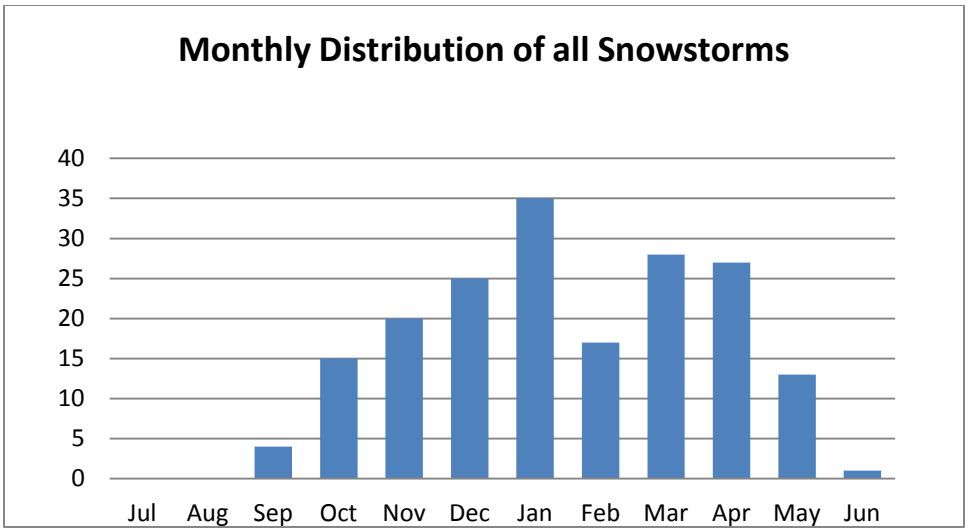


Figure 3. Monthly distribution of all snowstorms in all categories.

The distribution of only Category 3 and higher storms is slightly different. Though the highest number of storms still occurs during January, secondary peaks occur in December and April.

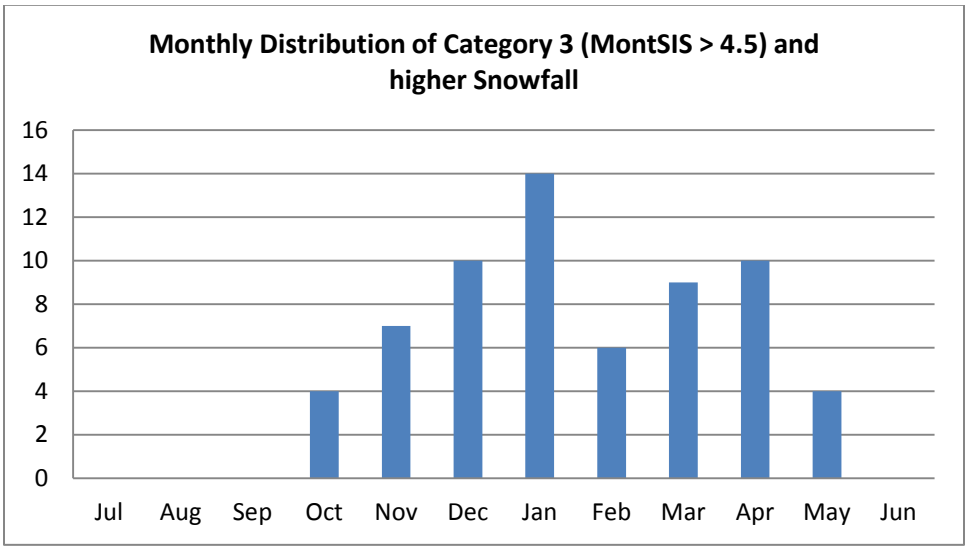


Figure 4. Monthly distribution of Category 3 and higher snowstorms.

To gain some sense of the distribution of snowfall from storms over the past 60 years, the top 20 storms are presented. Figure 5a-e shows the distributions. All but one of these storms was in Category 3 or greater, and using the MontSIS scale, they ranked from first to 66th. Again, it is notable how varied the distribution is from event to event.

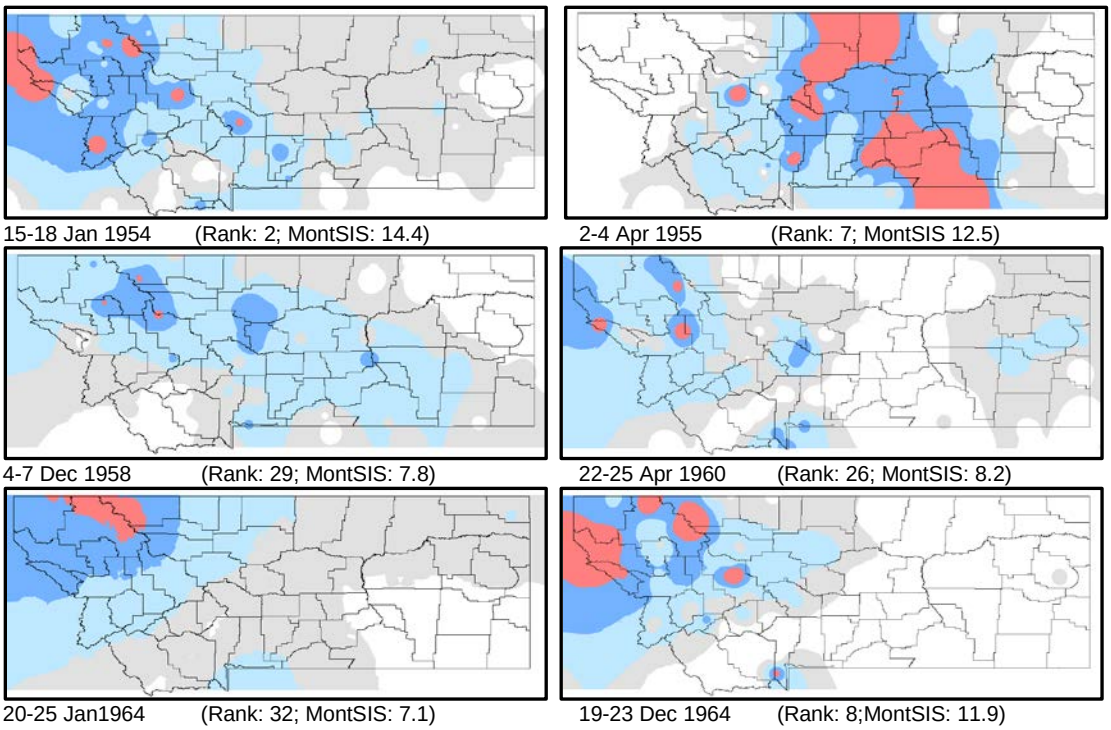


Figure 5a. Top ranked storms 1950-1964, by MontSIS scale. The raw ranking is also listed by each storm. The scale is: White: < 3"; Gray: 3-7"; light Blue: 7-14"; Dark Blue: 14-21"; Red: more than 21".

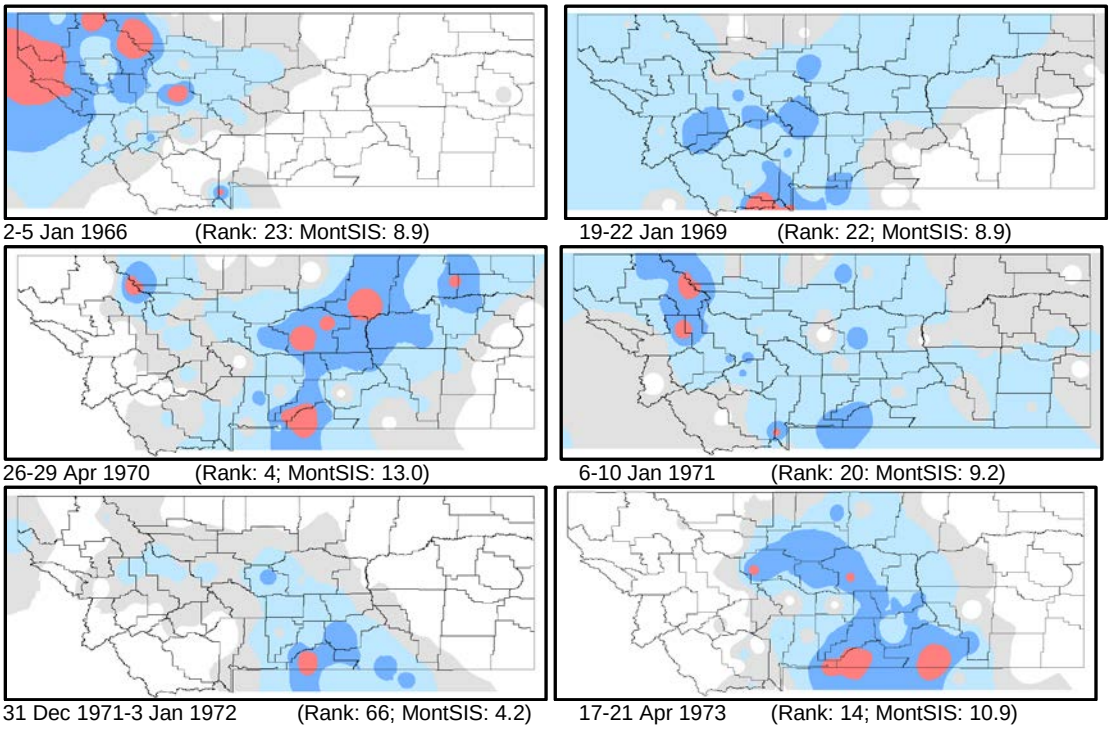
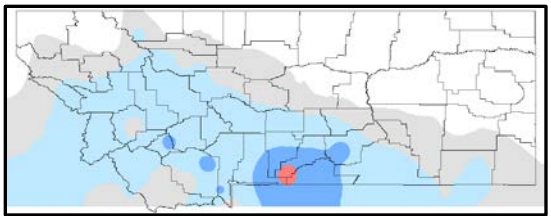
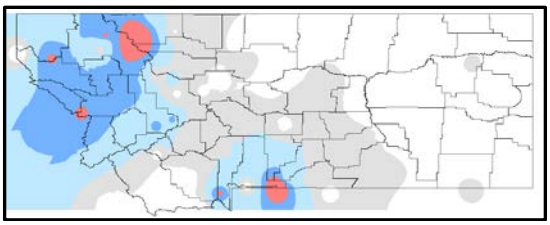


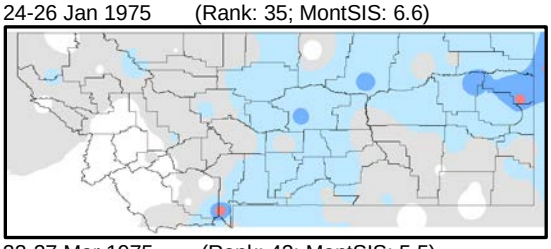
Figure 6b. Top ranked storms 1964-1973, by MontSIS scale. The raw ranking is also listed by each storm. The scale is: White: < 3"; Gray: 3-7"; light Blue: 7-14"; Dark Blue: 14-21"; Red: more than 21".



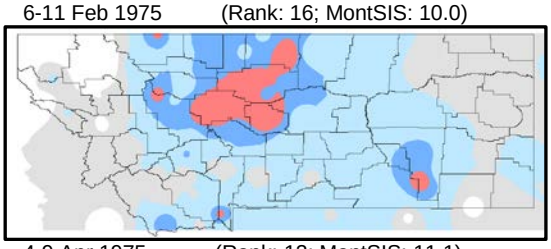
24-26 Jan 1975 (Rank: 35; MontSIS: 6.6)



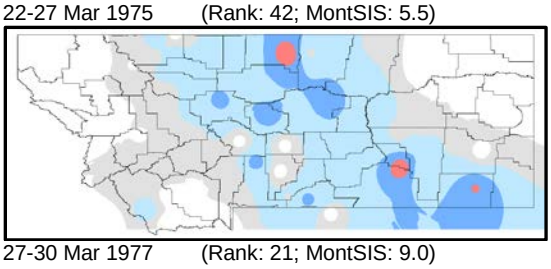
6-11 Feb 1975 (Rank: 16; MontSIS: 10.0)



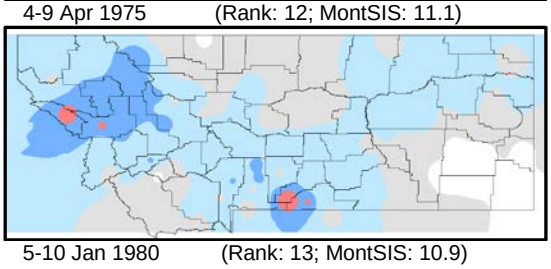
22-27 Mar 1975 (Rank: 42; MontSIS: 5.5)



4-9 Apr 1975 (Rank: 12; MontSIS: 11.1)

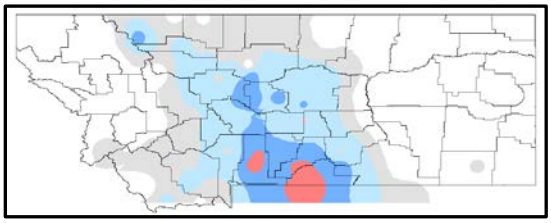


27-30 Mar 1977 (Rank: 21; MontSIS: 9.0)

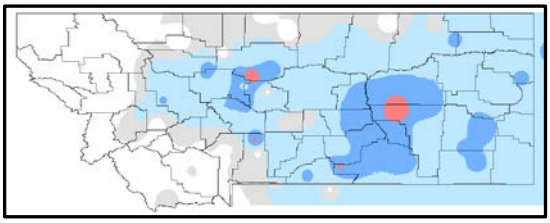


5-10 Jan 1980 (Rank: 13; MontSIS: 10.9)

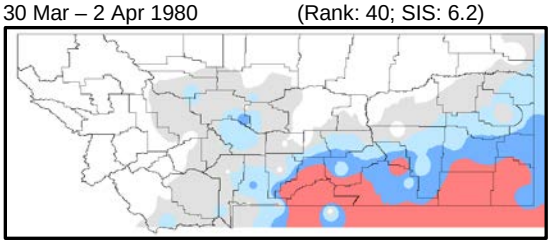
Figure 7c. Top ranked storms 1974-1980, by MontSIS scale. The raw ranking is also listed by each storm. The scale is: White: < 3"; Gray: 3-7"; light Blue: 7-14"; Dark Blue: 14-21"; Red: more than 21".



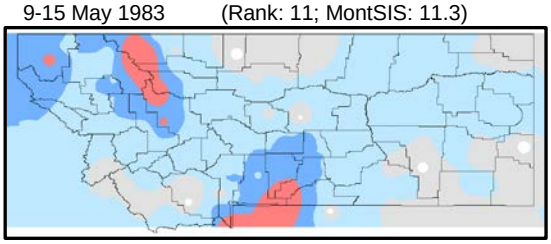
30 Mar – 2 Apr 1980 (Rank: 40; SIS: 6.2)



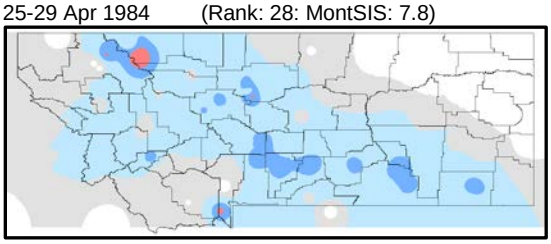
9-15 May 1983 (Rank: 11; MontSIS: 11.3)



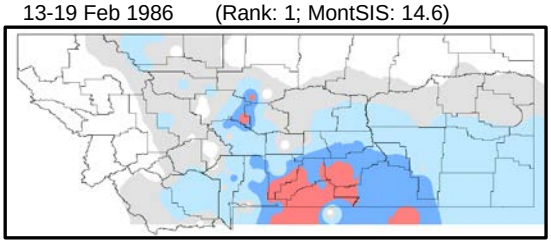
25-29 Apr 1984 (Rank: 28: MontSIS: 7.8)



13-19 Feb 1986 (Rank: 1; MontSIS: 14.6)



13-17 Mar 1989 (Rank: 31; MontSIS: 7.4)



10-13 Apr 1991 (Rank: 25; MontSIS: 8.4)

Figure 8d. Top ranked storms 1980-1991, by MontSIS scale. The raw ranking is also listed by each storm. The scale is: White: < 3"; Gray: 3-7"; light Blue: 7-14"; Dark Blue: 14-21"; Red: more than 21".

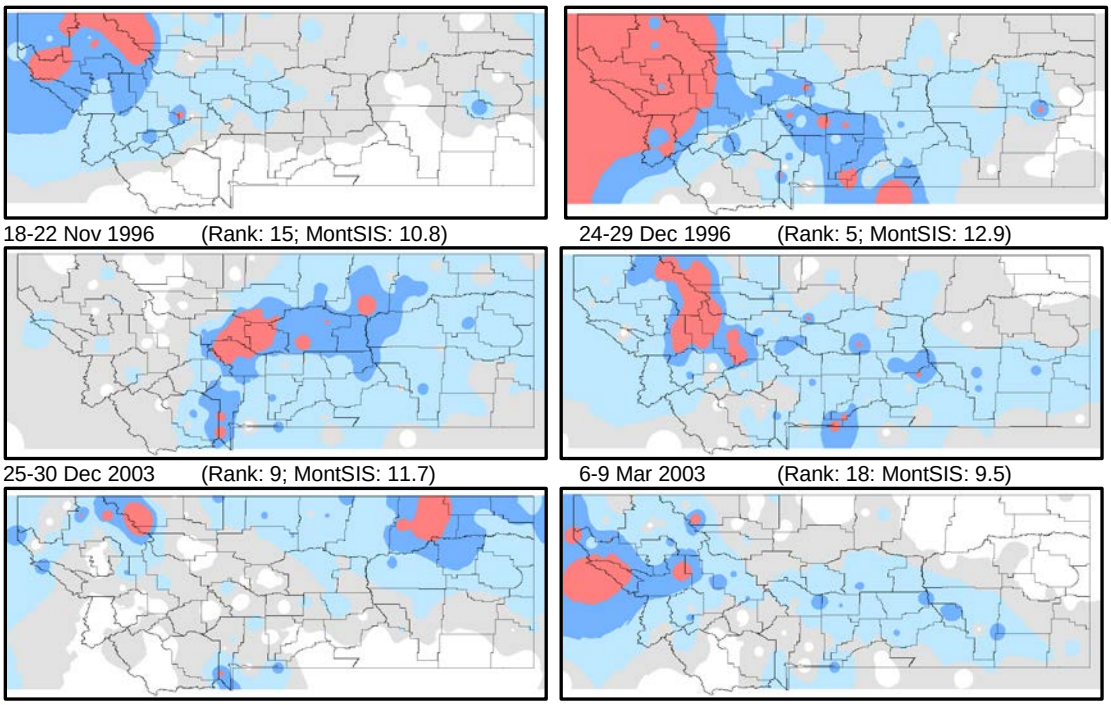


Figure 9e. Top ranked storms since 1992-2012, by MontSIS scale. The raw ranking is also listed by each storm. The scale is: White: < 3"; Gray: 3-7"; light Blue: 7-14"; Dark Blue: 14-21"; Red: more than 21".

Historical Snowfalls

The MontSIS was also applied to historical snowfalls. These are included in the list in Appendix B. Figure 6 shows the distribution of these that ranked among the top 30 storms (since 1896), and were all Category 3 or greater. It is noteworthy that three of the historical storms rank among the ten highest MontSIS values.

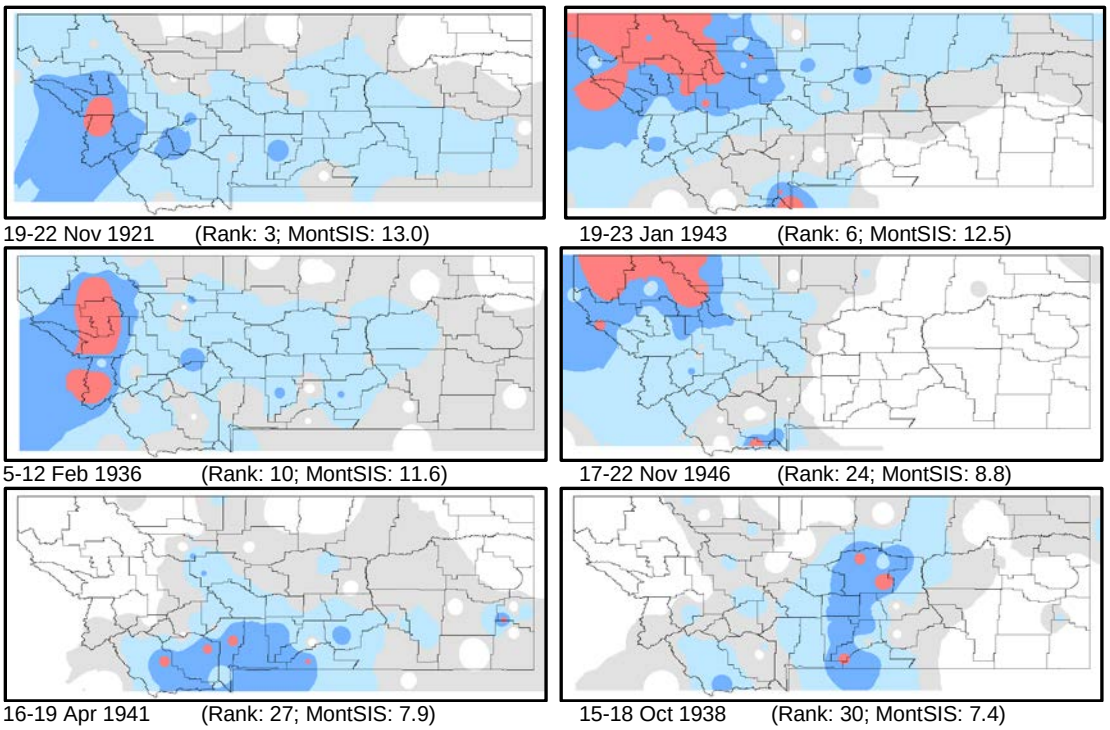


Figure 6. Top six historical storms, pre-1950, by MontSIS scale. The raw ranking is also listed by each storm. The scale is: White: < 3"; Gray: 3-7"; light Blue: 7-14"; Dark Blue: 14-21"; Red: more than 21".

Conclusions

Creating a state-centric snowfall impact scale makes sense for Montana. Its size, rural nature, and long distances between larger cities makes a Montana-centric scale useful in determining the impact of snowfall within the borders of the state. The regional scale developed by NCDC did not fully take into account snowfall that mostly fell in Montana. These systems would have been highly diluted within the NCDC-defined Northern Rockies and Plains region. The Montana Snowfall Impact Scale (MontSIS) reveals the impact of heavy snowfall on the state's population. It further shows that small-scale storms that may have significant impact locally, they do not have a large impact on the whole state. This scale helps to rank the significance of snowfall events on the whole state.

Appendix A. Highest three-day snowfall totals at select locations in Montana. The storms with the two highest ranking MontSIS values is listed at the end of each table, along with the highest ranking category 4 storm

Baker

Rank	Amount (inches)	Dates	MontSIS	Category
1	24.0	Jan 16-18, 1933	4.8	3
2	18.0	Apr 26-28, 1984	7.8	4
3	16.0	Apr 28-30, 1989	3.2	2
4	15.0	Apr 19-21, 2006	2.7	2
5	14.0	Mar 21-23, 1987	1.0	1
6	14.0	Feb 25-27, 1998	5.0	3
7	13.0	May 12-14, 1983	11.3	4
8	12.0	Oct 4-6, 2005	2.7	2
9	12.0	Mar 19-21, 2002	5.5	3
10	12.0	Mar 23-25, 1994	1.7	1
	2.0	Feb 13-19, 1986	14.6	5
	4.3	Jan 15-18, 1954	14.4	5
	1.0	Dec 24-29, 1996	12.9	5

Billings

Rank	Amount (inches)	Dates	MontSIS	Category
1	41.3	Apr 2-4, 1955	12.5	4
2	18.9	Oct 18-20, 1949	6.2	3
3	18.8	Nov 10-12, 1959	6.0	3
4	18.4	Apr 26-28, 1970	13.0	5
5	18.3	Apr 10-12, 1991	8.4	3
6	18.1	Dec 15-17, 1955	3.3	2
7	18.0	Apr 17-19, 1941	7.9	3
8	17.8	Apr 18-20, 2005	1.5	1
9	17.6	Dec 31, 1971-Jan 2, 1972	4.2	2
10	15.6	May 11-13, 1981	1.7	1
	9.1	Feb 13-19, 1986	14.6	5
	9.5	Jan 15-18, 1954	14.4	5
	14.0	Dec 24-29, 1996	12.9	5

Bozeman MSU

Rank	Amount (inches)	Dates	MontSIS	Category
1	39.8	Nov 17-19, 1941	6.5	3
2	29.5	Apr 2-4, 1955	12.5	4
3	27.8	Nov 12-14, 2009	1.5	1
4	23.0	Apr 16-18, 1941	7.9	3
5	22.0	Mar 17-19, 1968	3.3	2
6	21.7	May 5-7, 1965	3.2	2
7	20.3	Dec 3-5, 1998	2.9	2
8	19.0	Apr 10-12, 1991	8.4	3
9	17.5	Feb 6-8, 2011	3.1	2
10	17.5	May 5-7, 1975	3.1	2
	5.6	Feb 13-19, 1986	14.6	5
	11.0	Jan 15-18, 1954	14.4	5
	14.0	Dec 24-29, 1996	12.9	5

Butte

Rank	Amount (inches)	Dates	MontSIS	Category
1	30.0	Oct 10-12, 1911	1.4	1
2	21.0	Apr 25-27, 1958	7.8	3
3	19.2	May 18-20, 1938	1.9	1
4	19.0	Nov 19-21, 1921	13.0	5
5	18.4	Feb 23-25, 1996	2.9	2
6	18.0	Dec 9-11, 1919	3.9	2
7	17.2	Jan 24-26, 1975	6.6	3
8	16.9	Dec 24-26, 1996	12.9	5
9	16.8	Apr 25-27, 1975	1.7	1
10	16.6	Dec 31-Jan 2, 1943	2.6	1
	7.2	Feb 13-19, 1986	14.6	5
	4.0	Jan 15-18, 1954	14.4	5
	21.0	Dec 24-29, 1996	12.9	5

Cut Bank

Rank	Amount (inches)	Dates	MontSIS	Category
1	20.4	Jan 21-23, 1943	12.4	4
2	17.3	Oct 25-27, 1946	3.0	2
3	16.8	Apr 22-24, 1960	8.2	3
4	15.5	Sep 22-24, 1934	3.5	2
5	14.7	Sep 16-18, 1947	1.5	1
6	12.0	Sep 27-29, 1925	1.6	1
7	11.0	May 5-7, 1961	1.4	1
8	11.0	Dec 9-11, 1933	4.6	3
9	10.3	Nov 19-21, 1970	2.0	1
10	10.1	Mar 18-20, 1987	5.4	6
	5.7	Feb 13-19, 1986	14.6	5
	3.5	Jan 15-18, 1954	14.4	5
	8.6	Dec 24-29, 1996	12.9	5

Dillon

Rank	Amount (inches)	Dates	MontSIS	Category
1	16.0	Apr 18-20, 1987	1.0	1
2	15.7	Oct 26-28, 1991	2.4	1
3	15.3	Mar 11-13, 1990	2.8	2
4	15.0	Jan 22-24, 1989	5.4	3
5	14.0	Oct 27-29, 1989	1.4	1
6	14.0	Mar 31-Apr 2, 1957	1.3	1
7	12.4	Apr 22-24, 1960	8.2	3
8	12.0	May 5-7, 1965	3.3	2
9	11.6	Mar 7-9, 1958	2.0	1
10	11.6	Apr 2-4, 1955	12.5	4
	6.3	Feb 13-19, 1986	14.6	5
	T	Jan 15-18, 1954	14.4	5
	M	Dec 24-29, 1996	12.9	5

Glasgow

Rank	Amount (inches)	Dates	MontSIS	Category
1	15.0	Apr 16-18, 1896	2.0	1
2	14.4	Dec 26-28, 2003	11.7	4
3	14.1	Apr 2-4, 1940	1.6	1
4	14.0	Nov 18-20, 1941	6.5	3
5	14.0	Jan 25-27, 1916	4.0	2
6	13.6	Oct 11-13, 2008	5.4	3
7	13.3	Jan 28-30, 2004	9.2	4
8	13.3	Nov 5-7, 2000	1.2	1
9	13.0	Apr 8-10, 1995	2.3	1
10	12.8	Nov 22-24, 1993	3.5	2
	7.2	Feb 13-19, 1986	14.6	5
	8.3	Jan 15-18, 1954	14.4	5
	6.6	Dec 24-29, 1996	12.9	5

Glendive

Rank	Amount (inches)	Dates	MontSIS	Category
1	14.0	Mar 13-15, 1902	0.9	
2	13.0	Mar 20-22, 1894		
3	13.0	Apr 15-17, 1896	6.9	3
4	12.5	Jan 16-18, 1933	4.8	3
5	12.0	Oct 5-7, 2005	2.7	2
6	12.0	Feb 18-20, 1986	14.6	5
7	12.0	Nov 25-27, 1964	2.6	1
8	12.0	Mar 13-15, 1957	2.3	1
9	12.0	May 20-22, 1908	5.1	3
10	12.0	Mar 13-15, 1898	3.8	2
	13.0	Feb 13-19, 1986	14.6	5
	1.6	Jan 15-18, 1954	14.4	5
	1.0	Dec 24-29, 1996	12.9	5

Great Falls

Rank	Amount (inches)	Dates	MontSIS	Category
1	25.4	Apr 27-29, 2009	4.9	3
2	18.1	Nov 26-28, 2005	3.9	2
3	17.6	Apr 19-21, 1973	10.9	4
4	16.8	Apr 29-May 1, 2009	4.9	3
5	16.2	Mar 27-29, 1977	9.0	4
6	16.1	Feb 5-7, 2011	3.1	2
7	16.1	Apr 22-24, 1960	8.2	3
8	16.0	Jan 25-27, 1893		
9	15.8	Nov 8-10, 2012	3.9	2
10	15.1	Apr 7-9, 1975	11.1	4
	7.6	Feb 13-19, 1986	14.6	5
	8.7	Jan 15-18, 1954	14.4	5
	16.2	Dec 24-29, 1996	12.9	5

Helena

Rank	Amount (inches)	Dates	MontSIS	Category
1	28.0	Jan 2-4, 1884		
2	24.8	Dec 25-27, 1880		
3	21.7	Nov 11-13, 1959	6.0	3
4	20.1	Feb 24-26, 1919	5.3	3
5	19.5	Dec 8-10, 1906	4.6	3
6	19.4	Apr 22-24, 1960	8.2	3
7	19.3	Nov 17-19, 1978	4.7	3
8	18.7	Feb 7-9, 1943	1.9	1
9	17.8	Dec 25-27, 1886		
10	17.6	Jan 19-21, 1969	8.9	3
	13.0	Feb 13-19, 1986	14.6	5
	11.5	Jan 15-18, 1954	14.4	5
	M	Dec 24-29, 1996	12.9	5

Havre

Rank	Amount (inches)	Dates	MontSIS	Category
1	33.4	May 1-3, 1899	5.2	3
2	30.2	Apr 19-21, 1967	4.6	3
3	29.4	Apr 2-4, 1955	12.5	4
4	27.7	Mar 28-30, 1977	9.0	4
5	25.9	May 28-30, 1982	3.4	2
6	17.3	Apr 4-6, 1975	11.1	4
7	16.5	Jan 8-10, 1971	9.2	4
8	15.8	Apr 19-21, 1973	10.9	4
9	14.1	Apr 8-10, 1933	2.2	1
10	13.0	Jan 10-12, 2013	2.3	1
	13.0	Feb 13-19, 1986	14.6	5
	5.5	Jan 15-18, 1954	14.4	5
	4.7	Dec 24-29, 1996	12.9	5

Kalispell

Rank	Amount (inches)	Dates	MontSIS	Category
1	28.4	Jan 2-4, 1901	2.0	1
2	26.8	Dec 31-Jan 2, 2009	3.0	2
3	23.5	Nov 19-21, 1996	10.8	4
4	22.2	Nov 17-19, 1900	1.2	1
5	21.9	Jan 2-4, 1907	3.8	2
6	21.8	Feb 4-6, 1936	11.6	4
7	21.6	Jan 4-6, 1926	1.4	1
8	21.5	Dec 11-13, 1917	6.5	3
9	20.8	Dec 27-29, 1911	1.5	1
10	20.4	Jan 19-21, 1943	12.5	4
	9.2	Feb 13-19, 1986	14.6	5
	12.0	Jan 15-18, 1954	14.4	5
	17.4	Dec 24-29, 1996	12.9	5

Lewistown

Rank	Amount (inches)	Dates	MontSIS	Category
1	28.1	Apr 27-29, 1970	13.0	5
2	27.7	May 28-30, 1982	3.4	2
3	22.8	Apr 19-21, 1973	10.9	4
4	22.0	Jan 22-24, 2010	4.0	2
5	20.0	May 17-19, 1903	5.4	3
6	20.0	Apr 14-16, 1896	2.0	1
7	18.0	Apr 3-5, 1955	12.5	4
8	18.0	Oct 27-29, 1925	6.5	3
9	17.9	Mar 25-27, 1995	3.2	2
10	17.6	Mar 30-Apr 1, 1999	1.7	1
	2.7	Feb 13-19, 1986	14.6	5
	6.1	Jan 15-18, 1954	14.4	5
	13.3	Dec 24-29, 1996	12.9	5

Livingston

Rank	Amount (inches)	Dates	MontSIS	Category
1	29.0	Nov 18-20, 1926	6.6	3
2	22.9	Dec 3-5, 1998	2.9	2
3	19.4	Jan 2-4, 1972	4.2	2
4	18.5	Mar 30-Apr 1, 1980	6.2	3
5	18.5	Jan 30-Feb 1, 1899	6.9	3
6	17.0	Mar 5-7, 1932	4.8	3
7	16.5	Mar 17-19, 1968	3.3	2
8	16.5	Apr 16-18, 1941	7.8	3
9	16.4	Dec 23-25, 1955	3.3	2
10	16.2	Feb 28-Mar 2, 1979	3.3	2
	13.5	Feb 13-19, 1986	14.6	5
	3.1	Jan 15-18, 1954	14.4	5
	13.9	Dec 24-29, 1996	12.9	5

Miles City

Rank	Amount (inches)	Dates	MontSIS	Category
1	30.3	Mar 20-22, 1894		
2	22.0	May 20-22, 1908	5.1	3
3	20.3	Dec 31-Jan 2, 1942	12.5	4
4	18.0	Mar 29-31, 1938	3.2	2
5	17.0	May 4-6, 1912	3.2	2
6	15.6	Apr 27-29, 1989	3.2	2
7	14.3	Jan 29-31, 1938	1.3	1
8	14.1	Dec 25-27, 1941	1.9	1
9	13.6	Mar 12-14, 1904	1.6	1
10	13.2	Feb 18-20, 1949	7.0	3
	12.3	Feb 13-19, 1986	14.6	5
	2.9	Jan 15-18, 1954	14.4	5
	5.5	Dec 24-29, 1996	12.9	5

Missoula

Rank	Amount (inches)	Dates	MontSIS	Category
1	27.5	Nov 30-Dec 2, 1893		
2	22.6	Nov 21-23, 1921	13.0	5
3	22.1	Dec 24-26, 1996	12.9	5
4	21.5	Jan 1-3, 1928	3.3	2
5	17.5	Oct 7-9, 1893		
6	16.3	Jan 15-17, 1954	14.4	5
7	15.7	Jan 17-19, 2012	9.1	4
8	15.5	Feb 7-9, 1975	10.0	4
9	15.5	Jan 16-18, 1970	3.6	2
10	15.2	Jan 13-15, 1963	4.4	2
	13.0	Feb 13-19, 1986	14.6	5
	10.2	Jan 15-18, 1954	14.4	5
	39.4	Dec 24-29, 1996	12.9	5

Sidney

Rank	Amount (inches)	Dates	MontSIS	Category
1	18.0	Apr 11-13, 1979	1.8	1
2	16.0	Oct 7-9, 1985	4.1	2
3	14.5	Feb 25-27, 1998	5.0	3
4	14.0	May 12-14, 1983	11.3	4
5	12.5	Mar 22-24, 2011	1.9	1
6	12.0	May 6-8, 2002	3.2	2
7	12.0	Nov 17-19, 1986	1.2	1
8	12.0	Apr 13-15, 1970	13.0	5
9	11.5	Apr 13-15, 1986	2.9	2
10	11.0	Sep 23-25, 1984	2.5	1
	11.0	Feb 13-19, 1986	14.6	5
	2.0	Jan 15-18, 1954	14.4	5
	6.4	Dec 24-29, 1996	12.9	5

Appendix B. All storms from 1896-Jan 2013. This list is a chronological list of all storms that ranked amongst the top 10 of the seventeen cities, along with other storms that deposited large amounts of snowfall across the state.

All Snowstorms, ranked				Chronological list of all Snowstorms		
Rank	Date	Max Snow	MontSIS	Date	Max Snow	MontSIS
1	1986, Feb 13-19	56	14.6	1896, Aug 14-18	24.5	2.0
2	1954, Jan 15-18	31	14.4	1898, Mar 13-15	15	3.8
3	1921, Nov 19-22	25.3	13.0	1899, Jan 30-Feb 1	18.5	6.9
4	1970, Apr 26-29	39	13.0	1899, May 1-3	33.4	5.2
5	1996, Dec 24-29	44.7	12.9	1900, Jan 17-19	10.5	1.2
6	1943, Jan 19-23	46.8	12.5	1901, Oct 2-4	28.4	2.0
7	1955, Apr 2-4	42.3	12.5	1902, Mar 13-15	5.2	0.9
8	1964, Dec 19-23	50	11.9	1903, May 15-19	35	5.4
9	2003, Dec 25-30	61	11.7	1904, Mar 12-14	13.6	1.6
10	1936, Feb 5-12	34.6	11.6	1906, Dec 8-14	21	4.6
11	1983, May 9-15	35	11.3	1907, Jan 2-7	21.9	3.8
12	1975, Apr 4-9	40	11.1	1908, May 20-23	30	5.1
13	1980, Jan 5-10	30.5	10.9	1911, Oct 10-12	27.7	1.4
14	1973, Apr 17-21	34	10.9	1911, Dec 27-29	20.8	1.5
15	1996, Nov 18-22	44	10.8	1912, May 2-8	38	3.2
16	1975, Feb 6-11	40.5	10.0	1916, Jan 24-27	16	4.0
17	2012, Jan 16-20	42	9.9	1917, Dec 11-13	32	6.5
18	2003, Mar 6-9	46.5	9.5	1919, Feb 22-27	31.5	5.3
19	2004, Jan 24-30	48	9.2	1919, Dec 9-11	18	3.9
20	1971, Jan 6-10	34.5	9.2	1921, Nov 19-22	25.3	13.0
21	1977, Mar 27-30	28	9.0	1925, Sep 27-29	19	1.6
22	1969, Jan 19-22	46	8.9	1925, Oct 25-29	37	6.5
23	1966, Jan 2-5	39	8.9	1926, Jan 2-6	21.6	1.4
24	1946, Nov 17-22	50	8.8	1926, Nov 16-20	36	6.6
25	1991, Apr 10-13	62	8.4	1928, Jan 1-3	22	3.3
26	1960, Apr 22-25	32	8.2	1932, Mar 3-7	29.5	4.8
27	1941, Apr 16-19	31	7.9	1933, Jan 15-19	24	4.8
28	1984, Apr 25-29	73	7.8	1933, Apr 7-10	16	2.2
29	1958, Dec 4-7	23.2	7.8	1933, Dec 9-12	31	4.6
30	1938, Oct 15-18	30	7.4	1934, Sep 22-24	28	3.5
31	1989, Mar 13-17	33	7.4	1936, Feb 5-12	34.6	11.6
32	1964, Jan 20-25	29	7.1	1938, Jan 29-31	14.4	1.3
33	1949, Feb 16-21	40.8	7.0	1938, Mar 27-31	21.1	3.2
34	1899, Jan 30-Feb 1	18.5	6.9	1938, May 18-20	21	1.9
35	1975, Jan 24-26	24	6.6	1938, Oct 15-18	30	7.4

Rank	Date	Max Snow	MontSIS	Date	Max Snow	MontSIS
36	1926, Nov 16-20	36	6.6	1940, Apr 2-4	14.1	1.6
37	1917, Dec 11-13	32	6.5	1941, Apr 16-19	31	7.9
38	1925, Oct 25-29	37	6.5	1941, Nov 16-21	39.8	6.5
39	1941, Nov 16-21	39.8	6.5	1941, Dec 25-27	16	1.9
40	1980, Mar 30-Apr 2	36.5	6.2	1943, Jan 1-3	22.3	2.6
41	1949, Oct 18-20	22	6.2	1943, Jan 19-23	46.8	12.5
42	1975, Mar 22-27	27	6.1	1943, Feb 7-10	25.1	1.9
43	1959, Nov 10-13	22	6.0	1946, Oct 25-27	25	3.0
44	2002, Mar 19-21	24.4	5.5	1946, Nov 17-22	50	8.8
45	1903, May 15-19	35	5.4	1947, Sep 16-18	20	1.5
46	2008, Oct 10-13	44	5.4	1948, Dec 20-24	23	2.2
47	1989, Jan 22-24	26	5.4	1949, Feb 16-21	40.8	7.0
48	1987, Mar 18-22	20	5.4	1949, Oct 18-20	22	6.2
49	1968, Dec 26-28	38	5.3	1951, Oct 31-31	35	3.0
50	1919, Feb 22-27	31.5	5.3	1951, Dec 21-23	32	4.1
51	1899, May 1-3	33.4	5.2	1952, Feb 16-18	17	2.7
52	1908, May 20-23	30	5.1	1953, Feb 27-Mar 1	15	3.3
53	2008, Dec 22-27	36	5.1	1954, Jan 15-18	31	14.4
54	1998, Feb 24-27	28.5	5.0	1954, Mar 11-12	20	3.1
55	2009, Apr 28-30	46	4.9	1955, Apr 2-4	42.3	12.5
56	1932, Mar 3-7	29.5	4.8	1955, Nov 11-14	17	2.7
57	1933, Jan 15-19	24	4.8	1955, Dec 18	18.8	3.3
58	2002, Mar 6-10	38	4.8	1955, Dec 23-24	17.5	3.3
59	1978, Nov 17-20	38	4.7	1957, Mar 12-16	17	2.3
60	1990, Dec 26-31	33	4.7	1957, Mar 31-Apr 2	15.5	1.3
61	1906, Dec 8-14	21	4.6	1958, Feb 26-28	50	2.0
62	1967, Apr 17-21	21	4.6	1958, Mar 8-11	37	2.0
63	1933, Dec 9-12	31	4.6	1958, Dec 4-7	23.2	7.8
64	1968, Jan 3-11	25	4.5	1959, Jan 22-25	26	2.8
65	1963, Jan 13-17	24.5	4.4	1959, Feb 15-17	20	4.1
66	1972, Jan 1-3	39	4.2	1959, Nov 10-13	22	6.0
67	1976, Apr 25-28	35	4.2	1960, Apr 22-25	32	8.2
68	1959, Feb 15-17	20	4.1	1961, May 5-7	16	1.4
69	1985, Oct 7-9	31	4.1	1963, Jan 13-17	24.5	4.4
70	1951, Dec 21-23	32	4.1	1963, Jan 30-Feb 1	19.8	2.4
71	2010, Dec 27-30	24	4.0	1963, Dec 15-18	30.5	3.2
72	1916, Jan 24-27	16	4.0	1964, Jan 20-25	29	7.1
73	2010, Jan 22-24	40	4.0	1964, Nov 24-27	20	2.6
74	1982, Jan 22-25	26	4.0	1964, Dec 19-23	50	11.9
75	1982, Mar 17-20	18	3.9	1965, May 5-7	42	3.3

Rank	Date	Max Snow	MontSIS		Date	Max Snow	MontSIS
76	2012, Nov 8-10	18	3.9		1966, Jan 2-5	39	8.9
77	2005, Nov 26-30	40.5	3.9		1966, Mar 1-3	31.5	2.9
78	1919, Dec 9-11	18	3.9		1967, Apr 17-21	21	4.6
79	1898, Mar 13-15	15	3.8		1967, May 10-13	13	2.0
80	1907, Jan 2-7	21.9	3.8		1968, Jan 3-11	25	4.5
81	1970, Jan 16-19	26	3.6		1968, Mar 17-20	36.5	3.3
82	1970, Apr 12-16	28	3.5		1968, Dec 26-28	38	5.3
83	1993, Nov 21-24	21	3.5		1969, Jan 19-22	46	8.9
84	1977, Jan 13-16	30	3.5		1970, Jan 16-19	26	3.6
85	1934, Sep 22-24	28	3.5		1970, Apr 12-16	28	3.5
86	1982, May 28-30	66	3.4		1970, Apr 26-29	39	13.0
87	1955, Dec 18	18.8	3.3		1970, Nov 18-21	21	2.0
88	1928, Jan 1-3	22	3.3		1971, Jan 6-10	34.5	9.2
89	1953, Feb 27-Mar 1	15	3.3		1971, Jan 29-31	16	3.1
90	1979, Feb 28-Mar 2	24	3.3		1971, Dec 22-26	38	3.2
91	1955, Dec 23-24	17.5	3.3		1972, Jan 1-3	39	4.2
92	1968, Mar 17-20	36.5	3.3		1972,Jan 17-21	77.5	3.0
93	1965, May 5-7	42	3.3		1973, Apr 17-21	34	10.9
94	1995, Mar 23-28	55	3.2		1973, Oct 31-Nov 2	16	1.5
95	1971, Dec 22-26	38	3.2		1975, Jan 24-26	24	6.6
96	1963, Dec 15-18	30.5	3.2		1975, Feb 6-11	40.5	10.0
97	1912, May 2-8	38	3.2		1975, Mar 22-27	27	6.1
98	1989, Apr 25-28	20	3.2		1975, Apr 4-9	40	11.1
99	1938, Mar 27-31	21.1	3.2		1975, Apr 24-27	23	1.7
100	2002, May 6-9	20	3.2		1975, May 4-7	41	3.1
101	1954, Mar 11-12	20	3.1		1976, Apr 25-28	35	4.2
102	2011, Feb 17-22	28	3.1		1977, Jan 13-16	30	3.5
103	1971, Jan 29-31	16	3.1		1977, Mar 27-30	28	9.0
104	1975, May 4-7	41	3.1		1977, Nov 17-20	30	3.0
105	2011, Apr 17-23	32.8	3.1		1978, Feb 10-12	13	2.9
106	1946, Oct 25-27	25	3.0		1978, Nov 17-20	38	4.7
107	2009, Jan 1-3	22.4	3.0		1978, Dec 3-6	19.5	2.2
108	1977, Nov 17-20	30	3.0		1979, Feb 28-Mar 2	24	3.3
109	2011, Feb 6-9	29.1	3.0		1979, Apr 10-14	18	1.8
110	1972, Jan 17-22	77.5	3.0		1979, Apr 23-25	20	1.4
111	1982, Apr 6-9	31	3.0		1980, Jan 5-10	30.5	10.9
112	1951, Oct 31-31	35	3.0		1980, Oct 14-17	18.5	2.6
113	1998, Dec 3-5	22.8	2.9		1980, Mar 30-Apr 2	36.5	6.2
114	1966, Mar 1-3	31.5	2.9		1981, Apr 17-20	22	1.6
115	1996, Feb 23-25	26	2.9		1981, May 11-14	26	1.7

Rank	Date	Max Snow	MontSIS	Date	Max Snow	MontSIS
116	1986, Apr 11-14	18.9	2.9	1981, Oct 11-13	18	1.7
117	1978, Feb 10-12	13	2.9	1982, Jan 22-25	26	4.0
118	1990, Mar 11-14	27	2.8	1982, Mar 17-20	18	3.9
119	1959, Jan 22-25	26	2.8	1982, Apr 6-9	31	3.0
120	2006, Apr 16-19	26	2.7	1982, May 28-30	66	3.4
121	2005, Oct 4-6	15	2.7	1983, May 9-15	35	11.3
122	1955, Nov 11-14	17	2.7	1983, Dec 23-26	17	1.5
123	1952, Feb 16-18	17	2.7	1984, Apr 25-29	73	7.8
124	2012, Mar 18-22	23	2.6	1984, Sep 23-26	17	2.5
125	1943, Jan 1-3	22.3	2.6	1985, Oct 7-9	31	4.1
126	2004, Dec 30-Jan 1	29.5	2.6	1986, Feb 13-19	56	14.6
127	1980, Oct 14-17	18.5	2.6	1986, Apr 11-14	18.9	2.9
128	1964, Nov 24-27	20	2.6	1986, Nov 17-20	15	1.2
129	1984, Sep 23-26	17	2.5	1987, Mar 18-22	20	5.4
130	1991, Oct 26-29	21	2.4	1987, Apr 18-20	16	1.0
131	1963, Jan 30-Feb 1	19.8	2.4	1989, Jan 22-24	26	5.4
132	1957, Mar 12-16	17	2.3	1989, Mar 13-17	33	7.4
133	1995, Apr 8-10	25	2.3	1989, Apr 25-28	20	3.2
134	2013, Jan 9-13	27	2.3	1989, Oct 27-29	18	1.4
135	2002, Jun 6-10	17	2.3	1990, Mar 11-14	27	2.8
136	1948, Dec 20-24	23	2.2	1990, Dec 26-31	33	4.7
137	1978, Dec 3-6	19.5	2.2	1991, Apr 10-13	62	8.4
138	1933, Apr 7-10	16	2.2	1991, Oct 26-29	21	2.4
139	2008, Dec 12-14	12	2.1	1993, Jan 22-25	16.5	1.5
140	1970, Nov 18-21	21	2.0	1993, Nov 21-24	21	3.5
141	1958, Feb 26-28	50	2.0	1994, Mar 21-24	21	1.7
142	1958, Mar 8-11	37	2.0	1995, Jan 15-18	14	1.5
143	1896, Aug 14-18	24.5	2.0	1995, Mar 23-28	55	3.2
144	1967, May 10-13	13	2.0	1995, Apr 8-10	25	2.3
145	1901, Oct 2-4	28.4	2.0	1996, Feb 23-25	26	2.9
146	2011, Mar 21-25	17.8	1.9	1996, Nov 18-22	44	10.8
147	1943, Feb 7-10	25.1	1.9	1996, Dec 24-29	44.7	12.9
148	1941, Dec 25-27	16	1.9	1997, Feb 25-28	16	1.4
149	1938, May 18-20	21	1.9	1998, Feb 24-27	28.5	5.0
150	1979, Apr 10-14	18	1.8	1998, Dec 3-5	22.8	2.9
151	1981, May 11-14	26	1.7	1999, Mar 30-Apr 2	22	1.7
152	1975, Apr 24-27	23	1.7	2000, Nov 8-11	11.5	1.2
153	1994, Mar 21-24	21	1.7	2002, Mar 6-10	38	4.8
154	1981, Oct 11-13	18	1.7	2002, Mar 19-21	24.4	5.5
155	1999, Mar 30-Apr 2	22	1.7	2002, May 6-9	20	3.2

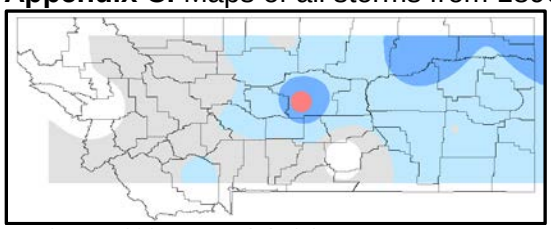
Rank	Date	Max Snow	MontSIS	Date	Max Snow	MontSIS
156	1904, Mar 12-14	13.6	1.6	2002, Jun 6-10	17	2.3
157	1940, Apr 2-4	14.1	1.6	2003, Mar 6-9	46.5	9.5
158	1925, Sep 27-29	19	1.6	2003, Dec 25-30	61	11.7
159	1981, Apr 17-20	22	1.6	2004, Jan 24-30	48	9.2
160	2008, Apr 19-22	21	1.6	2004, Dec 30-Jan 1	29.5	2.6
161	1995, Jan 15-18	14	1.5	2005, Apr 18-21	18	1.5
162	1947, Sep 16-18	20	1.5	2005, Oct 4-6	15	2.7
163	1983, Dec 23-26	17	1.5	2005, Nov 26-30	40.5	3.9
164	2009, Nov 13-15	27.8	1.5	2006, Apr 16-19	26	2.7
165	1993, Jan 22-25	16.5	1.5	2008, Apr 19-22	21	1.6
166	2005, Apr 18-21	18	1.5	2008, Oct 10-13	44	5.4
167	2012, Dec 6-9	15.3	1.5	2008, Dec 12-14	12	2.1
168	1911, Dec 27-29	20.8	1.5	2008, Dec 22-27	36	5.1
169	1973, Oct 31-Nov 2	16	1.5	2009, Jan 1-3	22.4	3.0
170	1997, Feb 25-28	16	1.4	2009, Apr 28-30	46	4.9
171	1979, Apr 23-25	20	1.4	2009, Nov 13-15	27.8	1.5
172	1911, Oct 10-12	27.7	1.4	2010, Jan 22-24	40	4.0
173	1926, Jan 2-6	21.6	1.4	2010, Dec 27-30	24	4.0
174	1961, May 5-7	16	1.4	2011, Feb 6-9	29.1	3.0
175	1989, Oct 27-29	18	1.4	2011, Feb 17-22	28	3.1
176	1957, Mar 31-Apr 2	15.5	1.3	2011, Mar 21-25	17.8	1.9
177	1938, Jan 29-31	14.4	1.3	2011, Apr 17-23	32.8	3.1
178	2000, Nov 8-11	11.5	1.2	2012, Jan 16-20	42	9.9
179	1986, Nov 17-20	15	1.2	2012, Mar 18-22	23	2.6
180	1900, Jan 17-19	10.5	1.2	2012, Nov 8-10	18	3.9
181	1987, Apr 18-20	16	1.0	2012, Dec 6-9	15.3	1.5
182	1902, Mar 13-15	5.2	0.9	2013, Jan 9-13	27	2.3

References

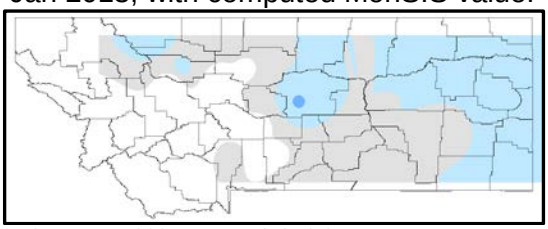
Kocin, P.J. and L.W. Uccellini,2004: A snowfall impact scale derived from northeast storm snowfall distributions. *Bull. Amer. Meteor. Soc.,* **85**, 177-194.

Squires, M.F. and J.H. Lawrimore, 2006: Development of an operational northeast snowfall impact scale. 22nd IIPS, Atlanta, GA.

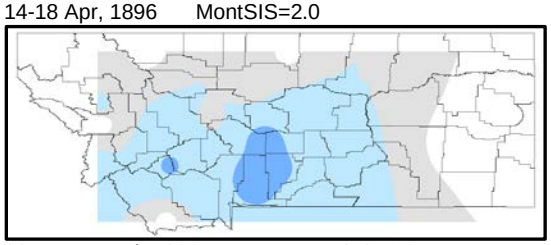
Appendix C. Maps of all storms from 1896-Jan 2013, with computed MonSIS value.



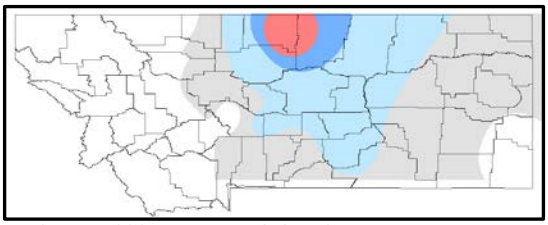
14-18 Apr, 1896 MontSIS=2.0



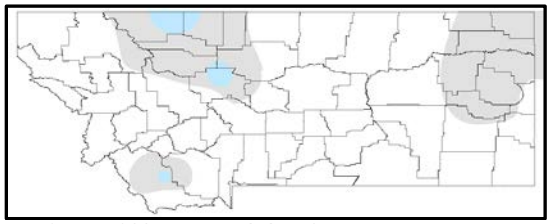
13-15 Mar 1898 MontSIS=3.8



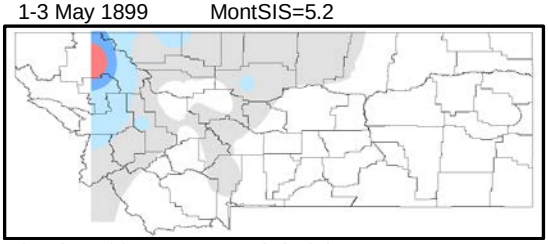
30 Jan – 1 Feb 1899 MontSIS=6.9



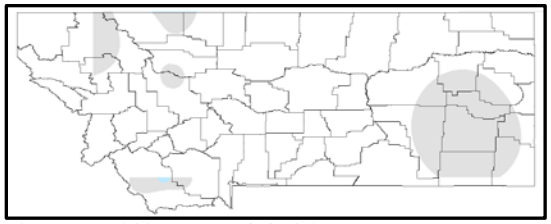
1-3 May 1899 MontSIS=5.2



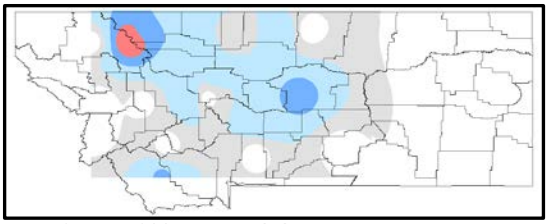
17-19 Jan 1900 MontSIS=1.2



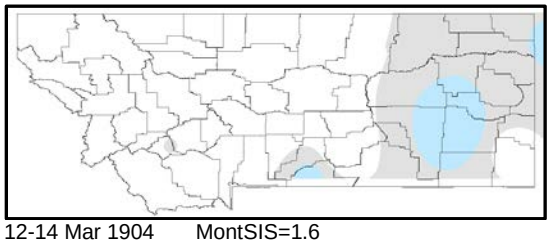
2-4 Oct 1901 MontSIS=2.0



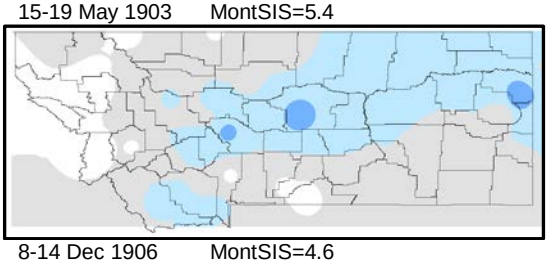
13-15 Mar 1902 MontSIS=0.9



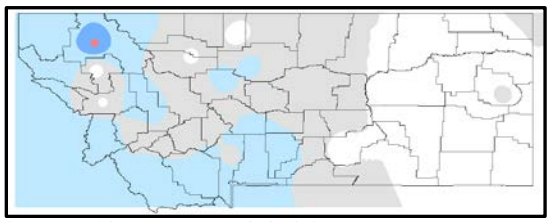
15-19 May 1903 MontSIS=5.4



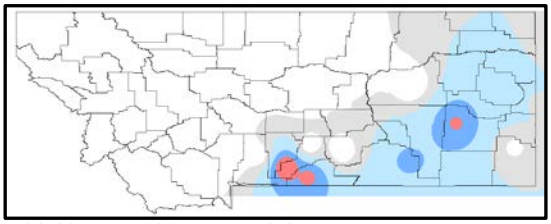
12-14 Mar 1904 MontSIS=1.6



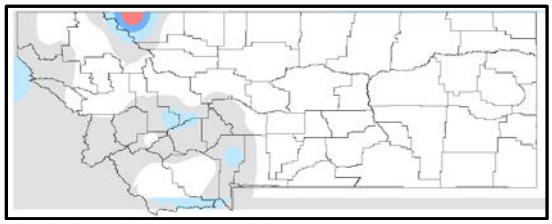
8-14 Dec 1906 MontSIS=4.6



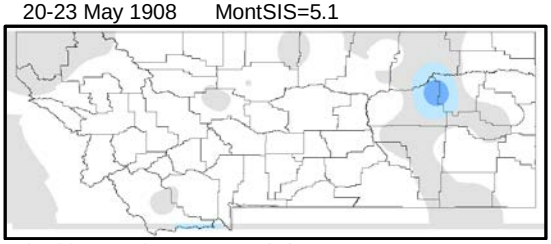
2-7 Jan 1907 MontSIS=3.8



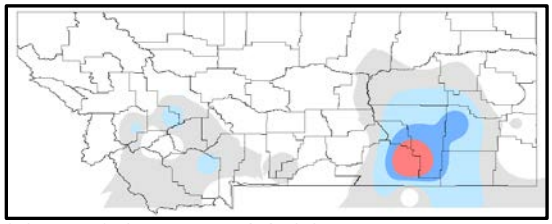
20-23 May 1908 MontSIS=5.1



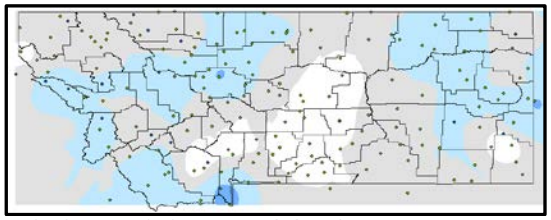
10-12 Oct 1911 MontSIS=1.4



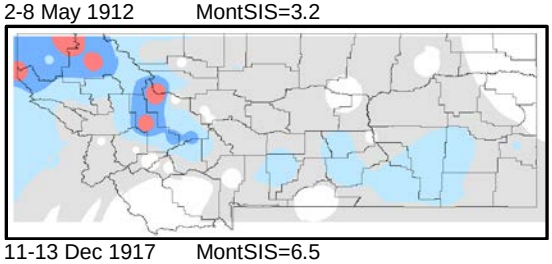
27-29 Dec 1911 MontSIS=1.5



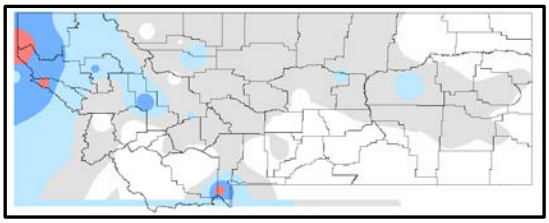
2-8 May 1912 MontSIS=3.2



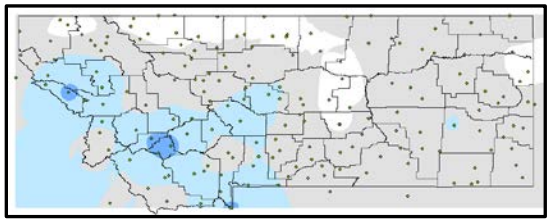
24-27 Jan 1916 MontSIS=4.0



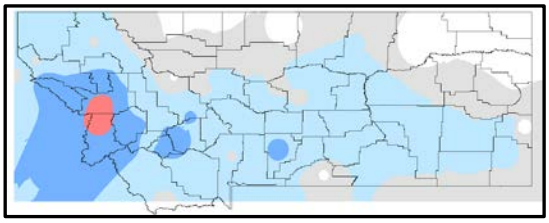
11-13 Dec 1917 MontSIS=6.5



22-27 Feb 1919 MontSIS=5.3



9-11 Dec 1919 MontSIS=3.9



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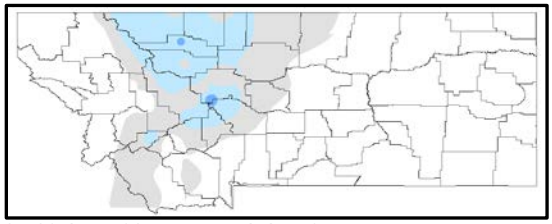
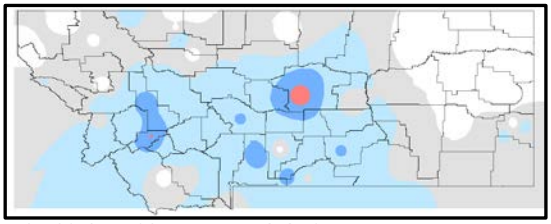
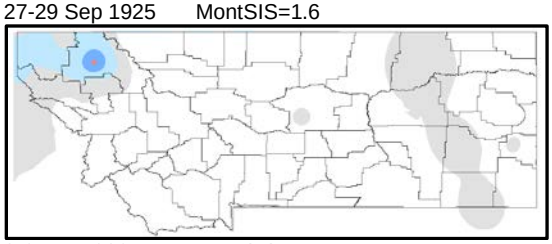


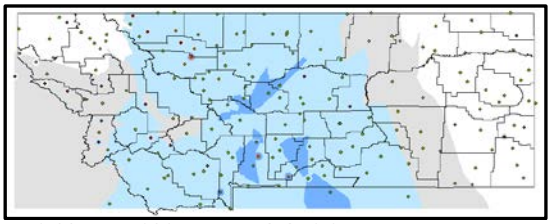
27-29 Sep 1925 MontSIS=1.6



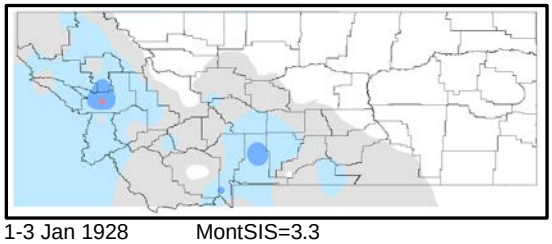
25-29 Oct 1925 MontSIS=6.5



2-6 Jan 1926 MontSIS=1.4



16-20 Nov 1926 MontSIS=6.6



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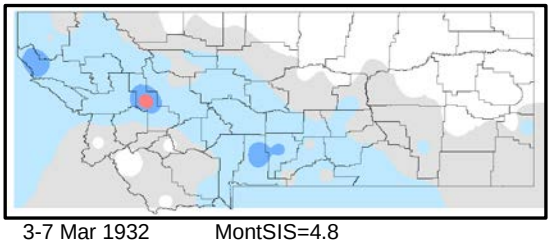
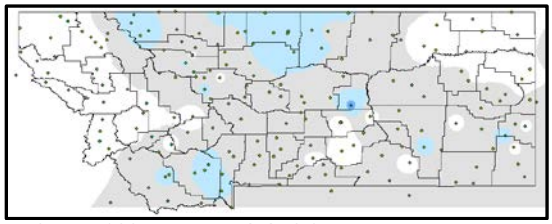
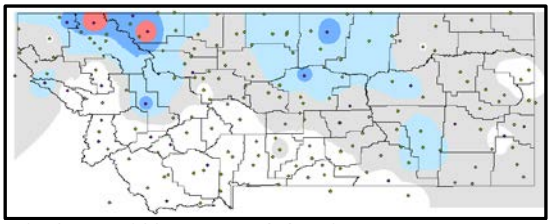


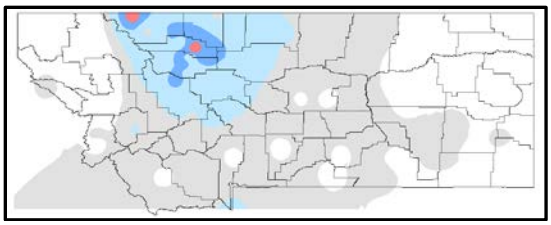
3-7 Mar 1932 MontSIS=4.8



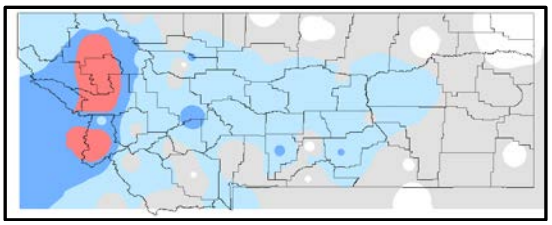
7-10 Apr 1933 MontSIS=2.2



9-12 Dec 1933 MontSIS=4.6



22-24 Sep 1934 MontSIS=3.5



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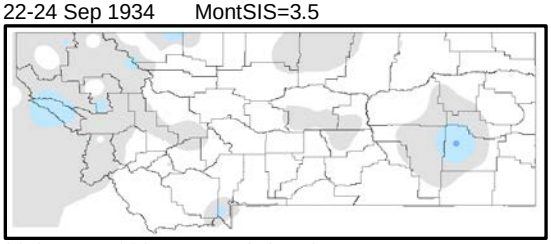
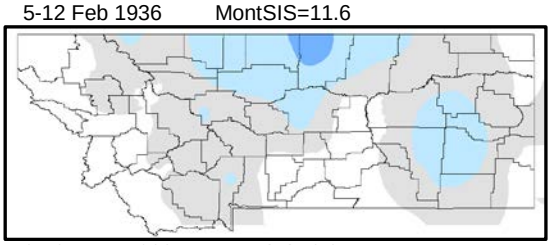
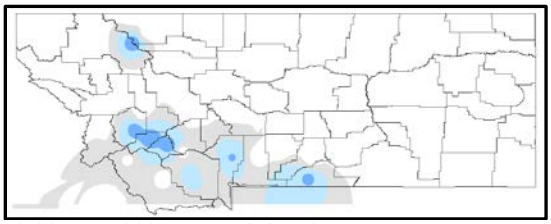


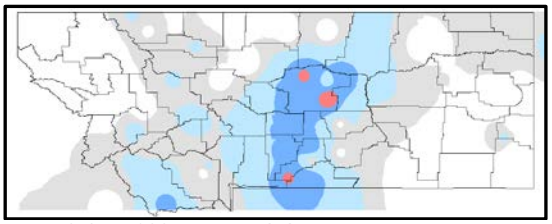
29-31 Jan 1938 MontSIS=1.3



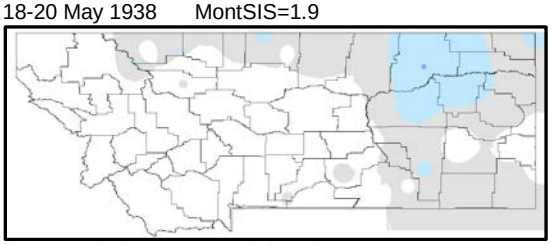
27-31 Mar 1938 MontSIS=3.2



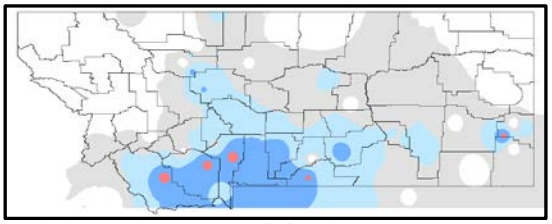
18-20 May 1938 MontSIS=1.9



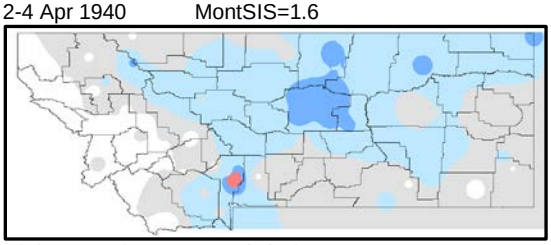
15-18 Oct 1938 MontSIS=7.4



2-4 Apr 1940 MontSIS=1.6



16-19 Apr 1941 MontSIS=7.9



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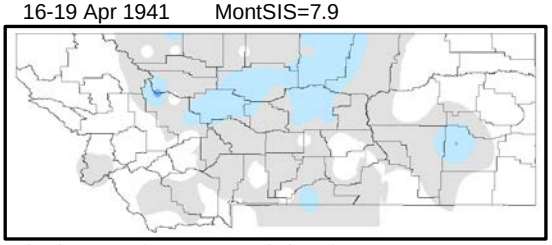
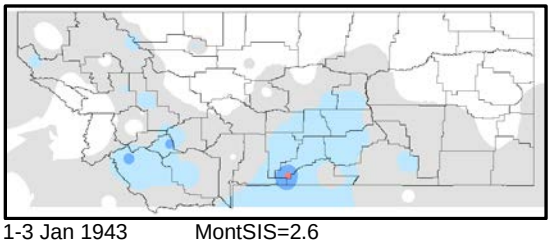
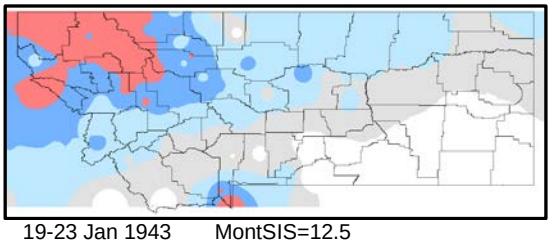


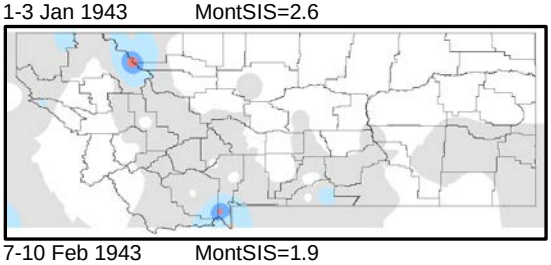
25-27 Dec 1941 MontSIS=1.9



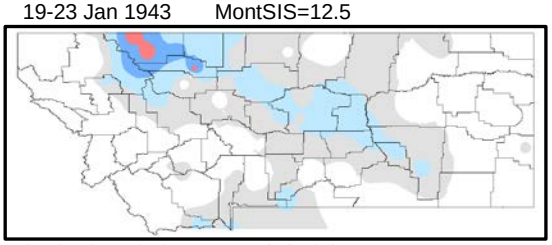
1-3 Jan 1943 MontSIS=2.6



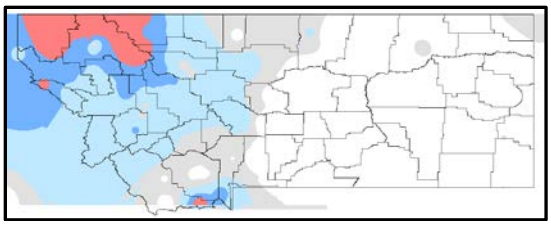
19-23 Jan 1943 MontSIS=12.5



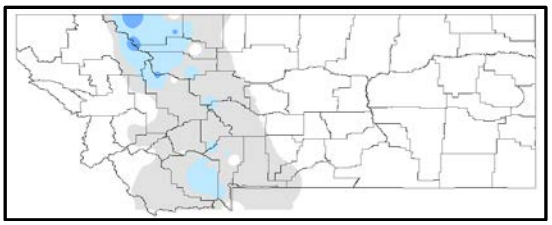
7-10 Feb 1943 MontSIS=1.9



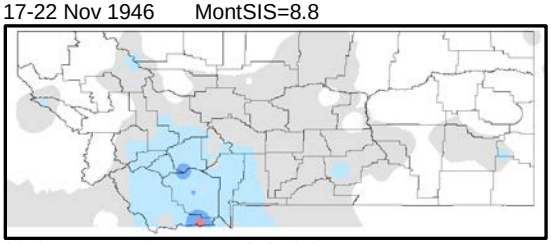
25-27 Oct 1946 MontSIS=3.0



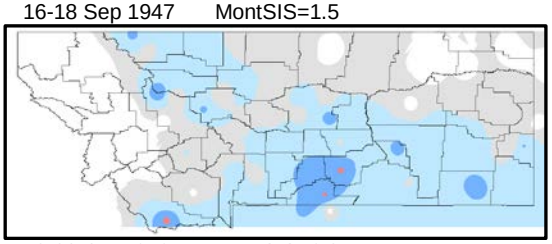
17-22 Nov 1946 MontSIS=8.8



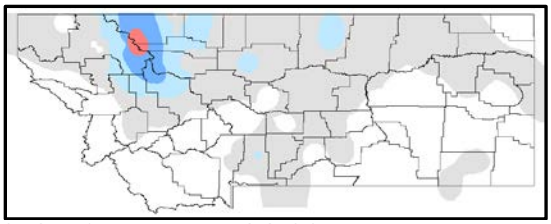
16-18 Sep 1947 MontSIS=1.5



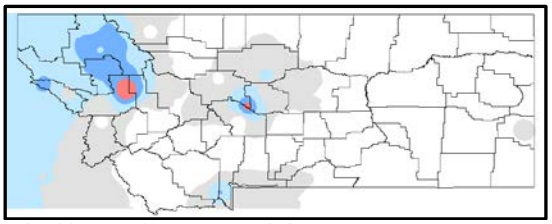
20-24 Dec 1948 MontSIS=2.2



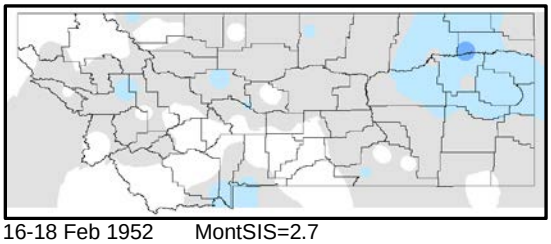
18-20 Oct 1949 MontSIS=6.2



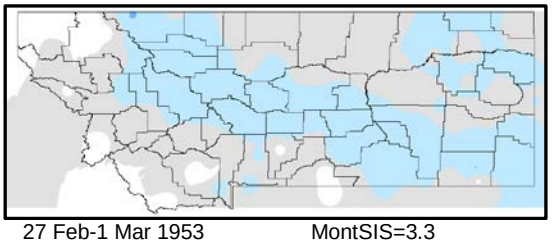
31 Oct 1951 MontSIS=3.0



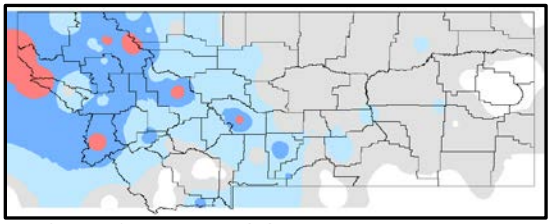
21-23 Dec 1951 MontSIS=4.1



16-18 Feb 1952 MontSIS=2.7



27 Feb-1 Mar 1953 MontSIS=3.3



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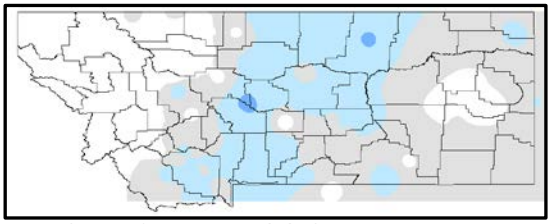
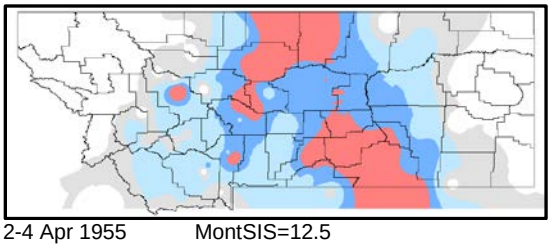
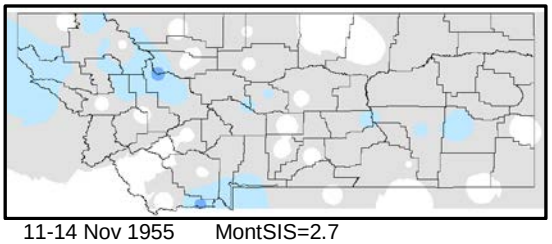


11-12 Mar 1954 MontSIS=3.1



2-4 Apr 1955 MontSIS=12.5



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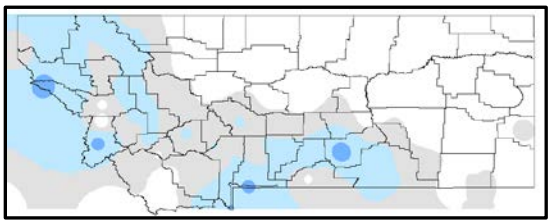
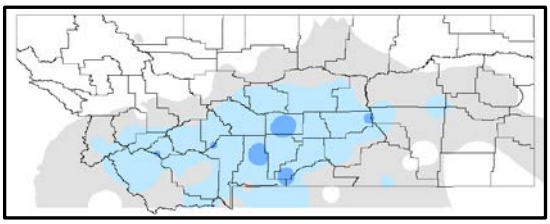
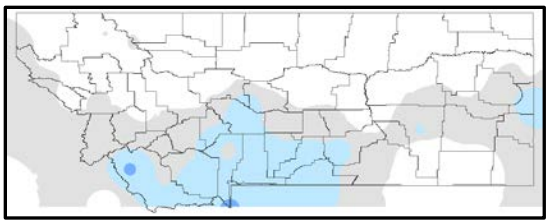


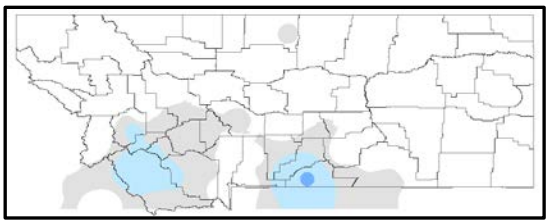
18 Dec 1955 MontSIS=3.3



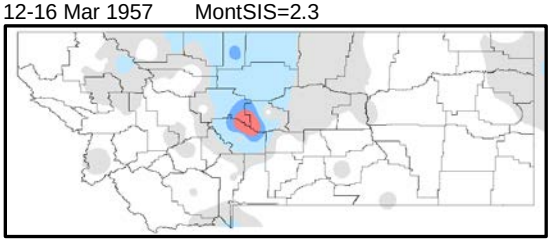
23-24 Dec 1955 MontSIS=3.3



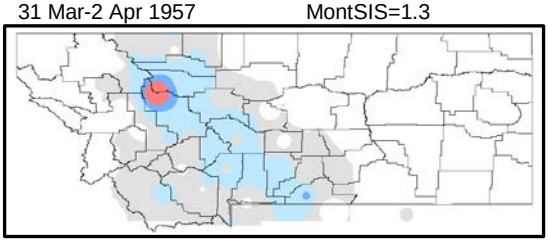
12-16 Mar 1957 MontSIS=2.3



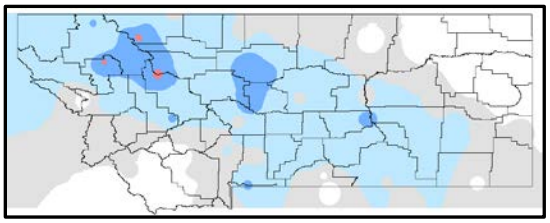
31 Mar-2 Apr 1957 MontSIS=1.3



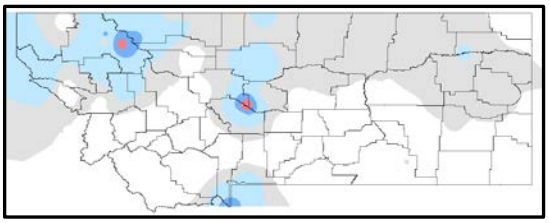
26-28 Feb 1958 MontSIS=2.0



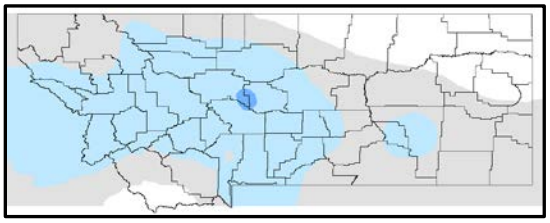
8-11 Mar 1958 MontSIS=2.0



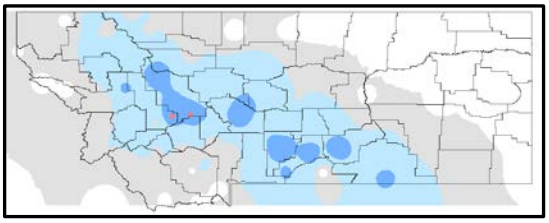
4-7 Dec 1958 MontSIS=7.8



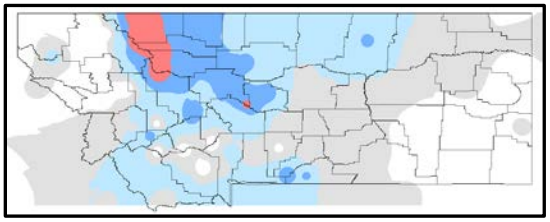
22-25 Jan 1959 MontSIS=2.8



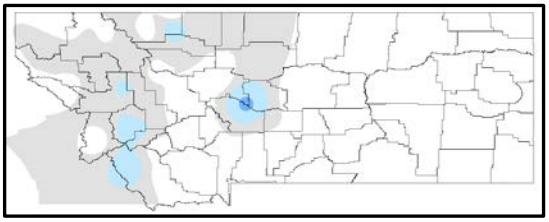
15-17 Feb 1959 MontSIS=4.1



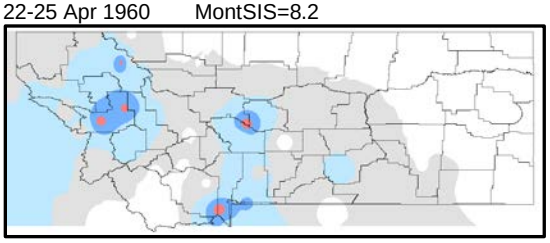
10-13 Nov 1959 MontSIS=6.0



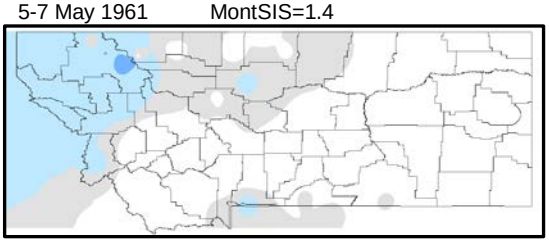
22-25 Apr 1960 MontSIS=8.2



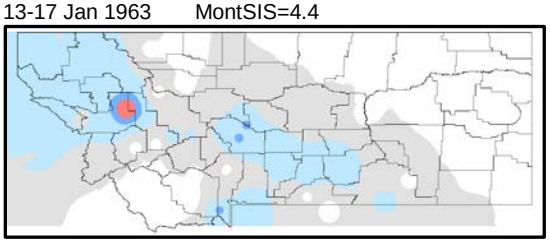
5-7 May 1961 MontSIS=1.4



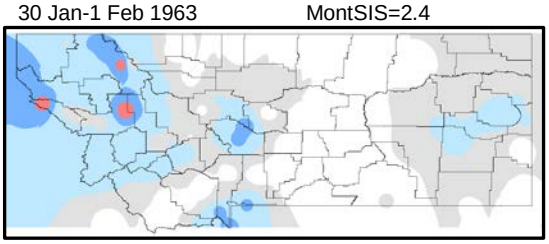
13-17 Jan 1963 MontSIS=4.4



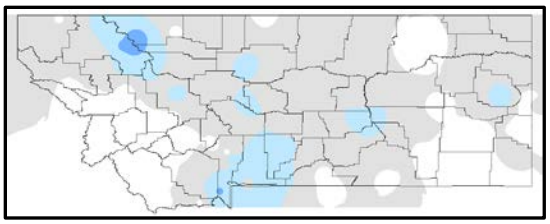
30 Jan-1 Feb 1963 MontSIS=2.4



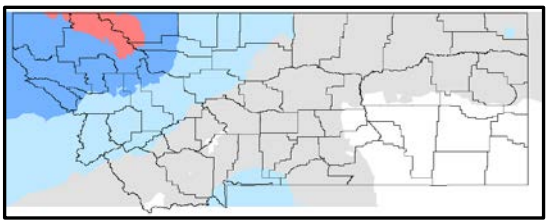
15-18 Dec 1963 MontSIS=3.2



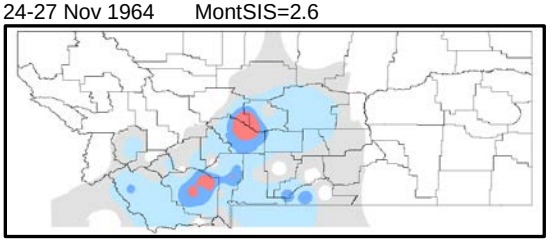
20-25 Jan 1964 MontSIS=7.1



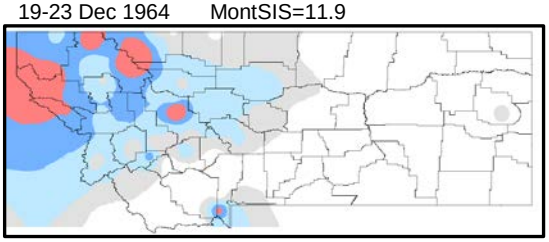
24-27 Nov 1964 MontSIS=2.6



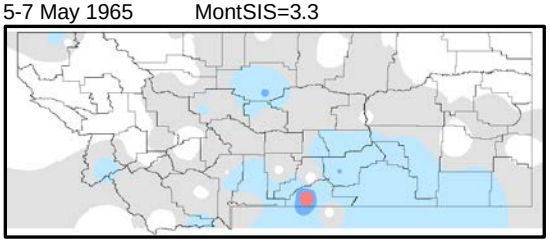
19-23 Dec 1964 MontSIS=11.9



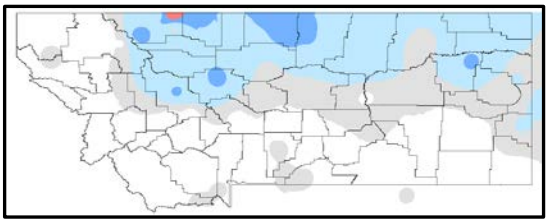
5-7 May 1965 MontSIS=3.3



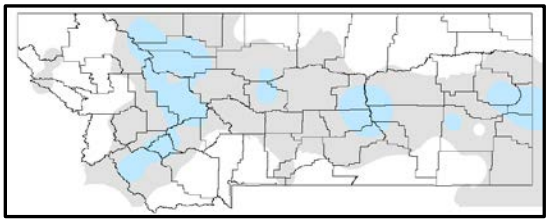
2-5 Jan 1966 MontSIS=8.9



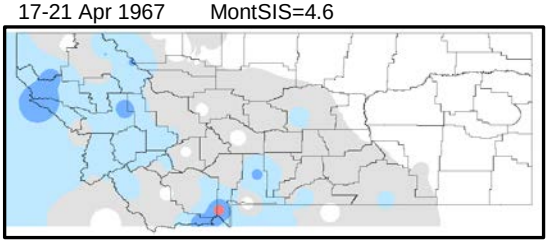
1-3 Mar 1966 MontSIS=2.9



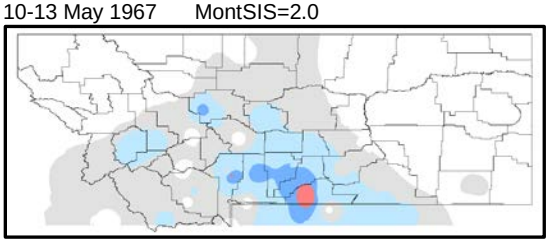
17-21 Apr 1967 MontSIS=4.6



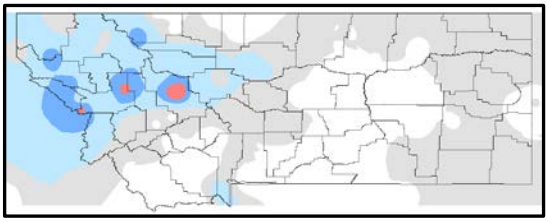
10-13 May 1967 MontSIS=2.0



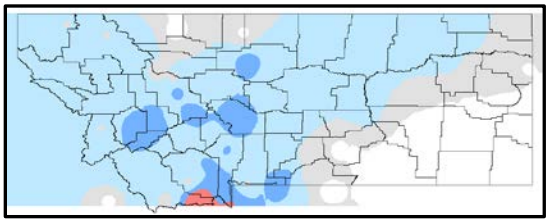
3-11 Jan 1968 MontSIS=4.5



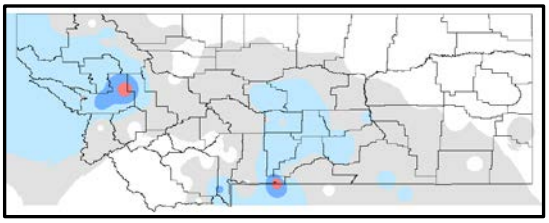
17-20 Mar 1968 MontSIS=3.3



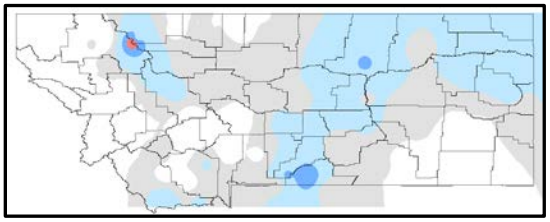
26-28 Dec 1968 MontSIS=5.3



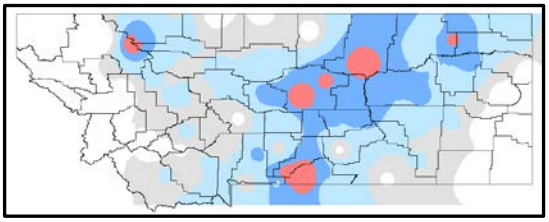
19-22 Jan 1969 MontSIS=8.9



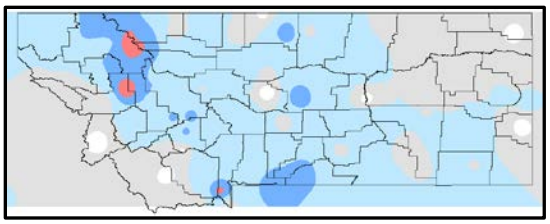
16-19 Jan 1970 MontSIS=3.6



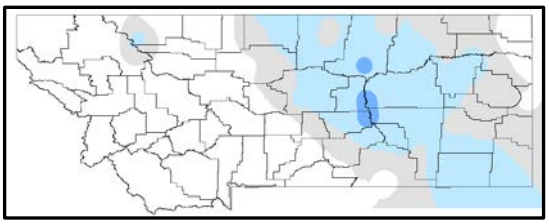
12-16 Apr 1970 MontSIS=3.5



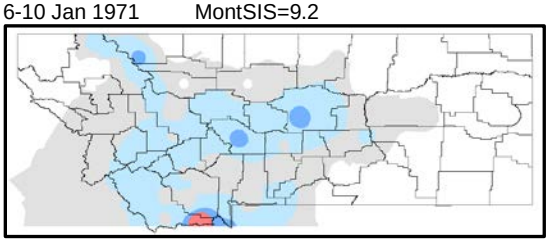
26-29 Apr 1970 MontSIS=13.0



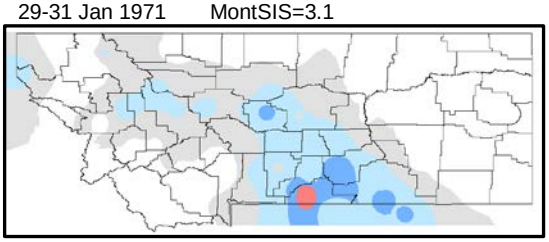
6-10 Jan 1971 MontSIS=9.2



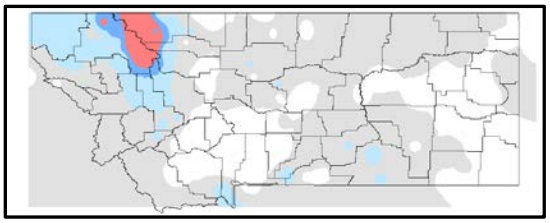
29-31 Jan 1971 MontSIS=3.1



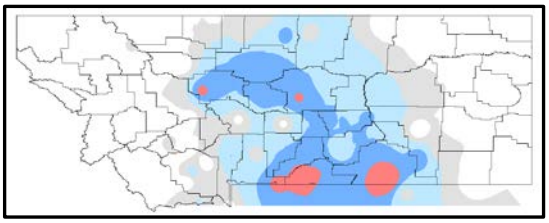
22-26 Dec 1971 MontSIS=3.2



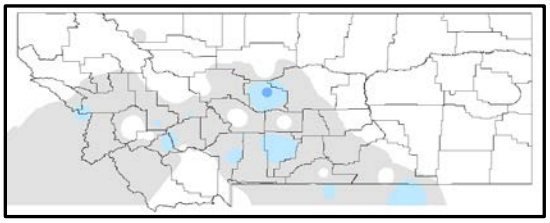
1-3 Jan 1972 MontSIS=4.2



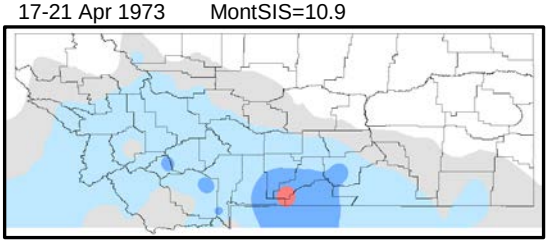
17-22 Jan 1972 MontSIS=3.0



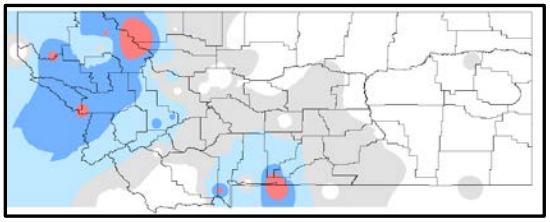
17-21 Apr 1973 MontSIS=10.9



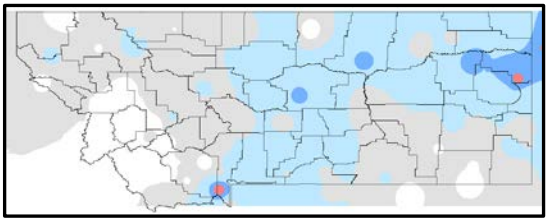
31 Oct-2 Nov 1973 MontSIS=1.5



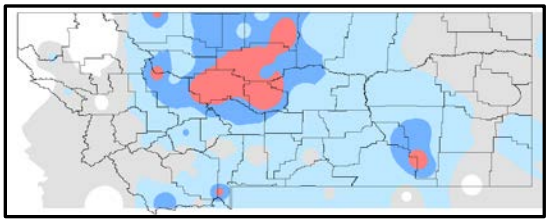
24-26 Jan 1975 MontSIS=6.6



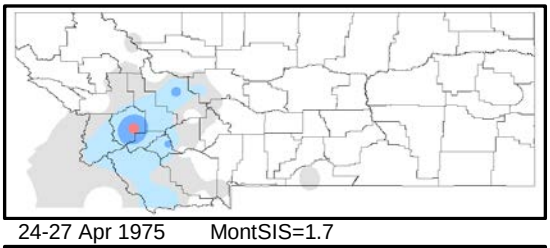
6-11 Feb 1975 MontSIS=10.0



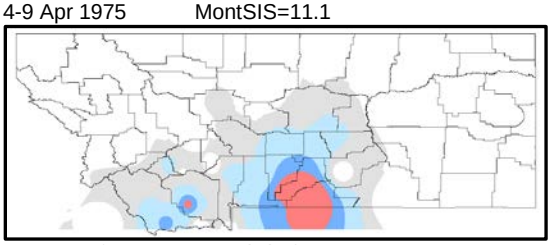
22-27 Mar 1975 MontSIS=6.1



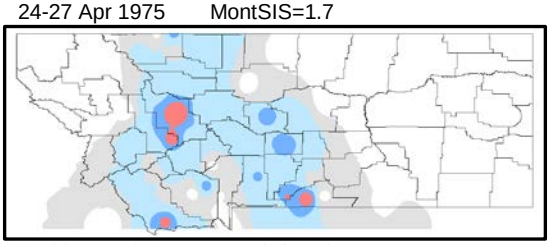
4-9 Apr 1975 MontSIS=11.1



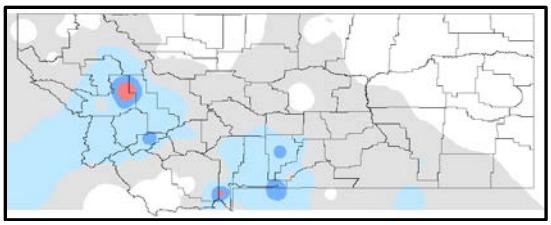
24-27 Apr 1975 MontSIS=1.7



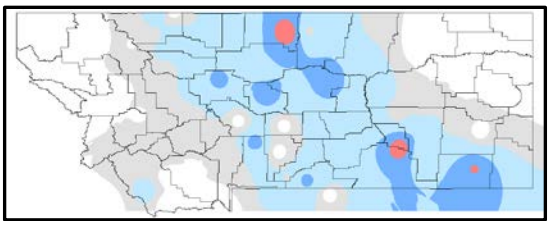
4-7 May 1975 MontSIS=3.1



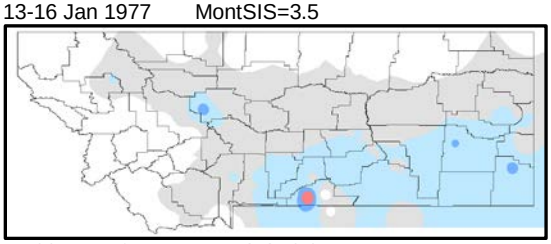
25-28 Apr 1976 MontSIS=4.2



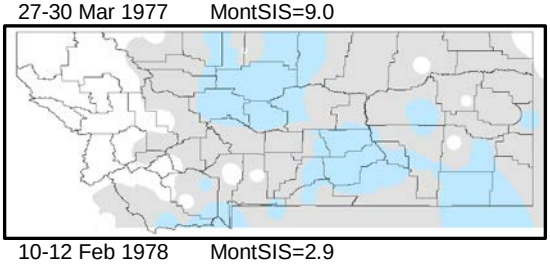
13-16 Jan 1977 MontSIS=3.5



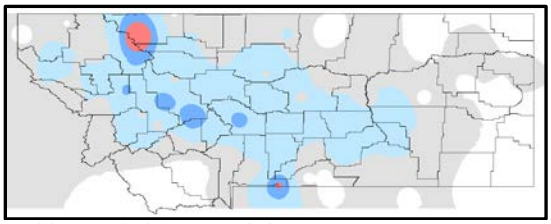
27-30 Mar 1977 MontSIS=9.0



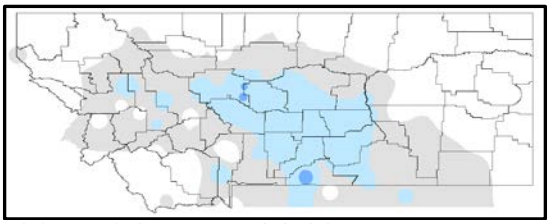
17-20 Nov 1977 MontSIS=3.0



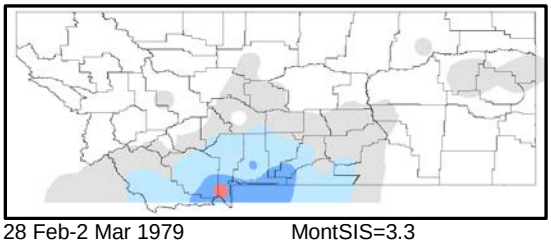
10-12 Feb 1978 MontSIS=2.9



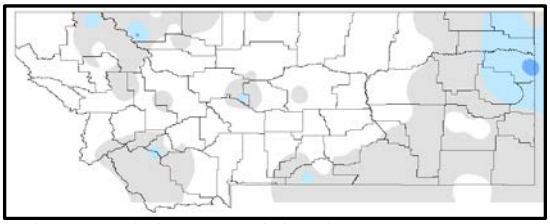
17-20 Nov 1978 MontSIS=4.7



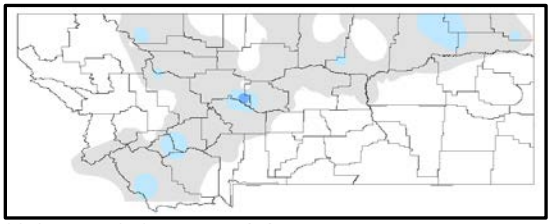
3-6 Dec 1978 MontSIS=2.2



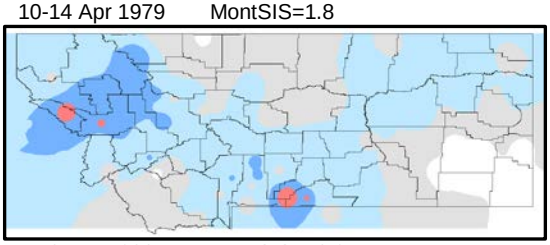
28 Feb-2 Mar 1979 MontSIS=3.3



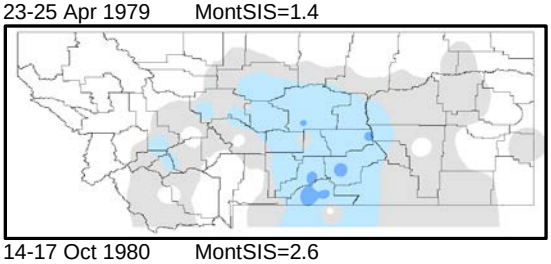
10-14 Apr 1979 MontSIS=1.8



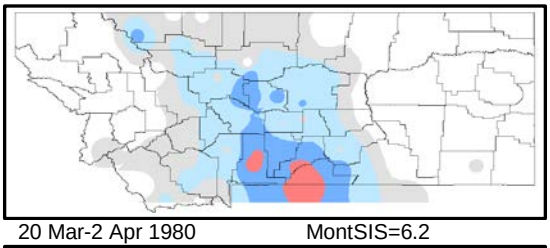
23-25 Apr 1979 MontSIS=1.4



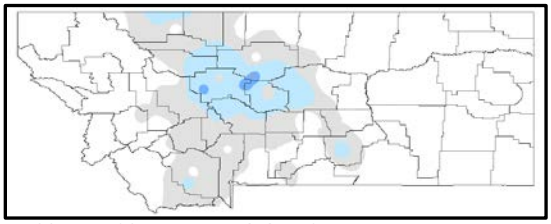
5-10 Jan 1980 MontSIS=10.9



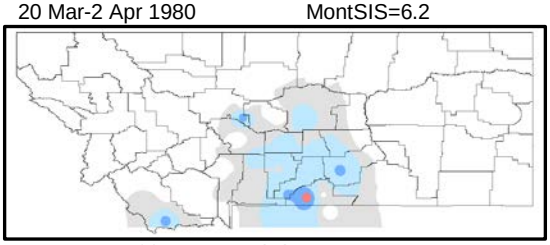
14-17 Oct 1980 MontSIS=2.6



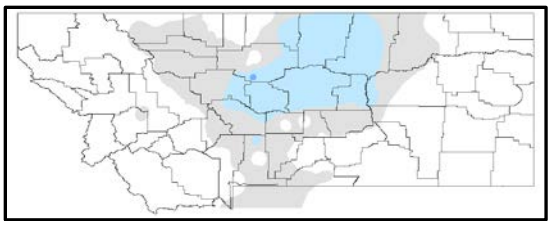
20 Mar-2 Apr 1980 MontSIS=6.2



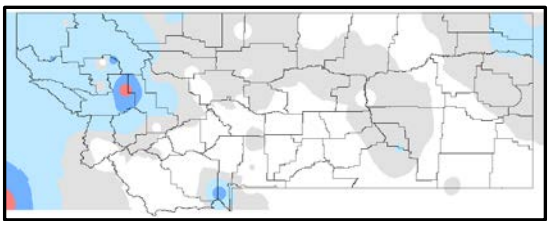
17-20 Apr 1981 MontSIS=1.6



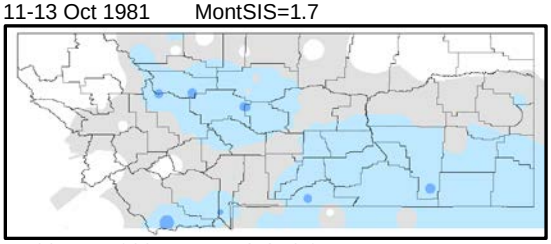
11-14 May 1981 MontSIS=1.7



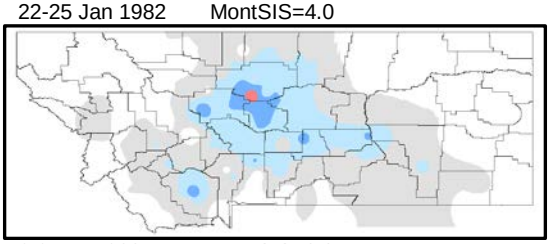
11-13 Oct 1981 MontSIS=1.7



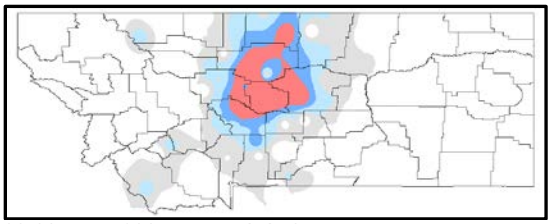
22-25 Jan 1982 MontSIS=4.0



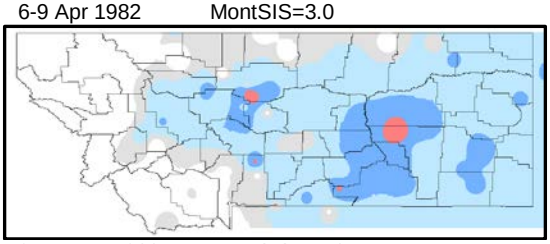
17-20 Mar 1982 MontSIS=3.9



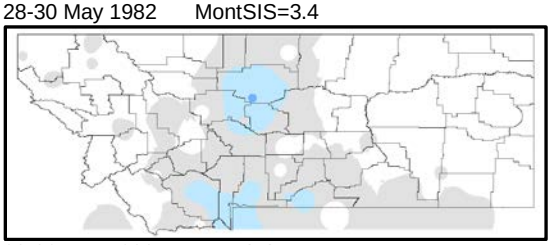
6-9 Apr 1982 MontSIS=3.0



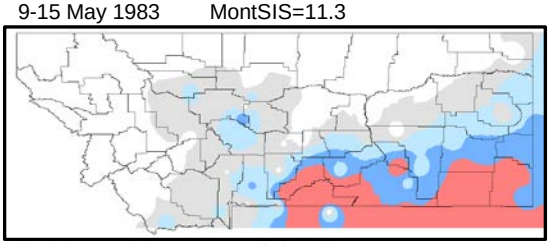
28-30 May 1982 MontSIS=3.4



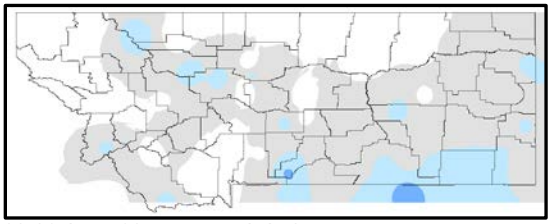
9-15 May 1983 MontSIS=11.3



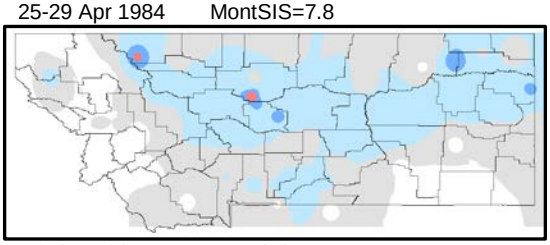
23-26 Dec 1983 MontSIS=1.5



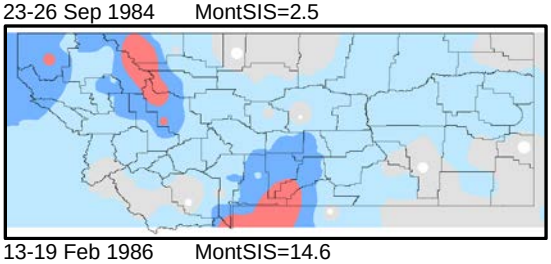
25-29 Apr 1984 MontSIS=7.8



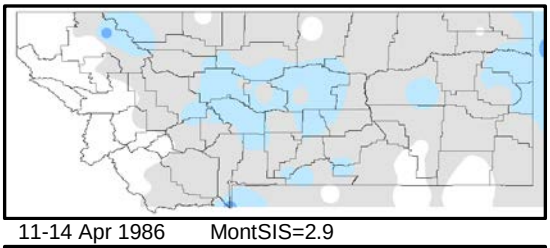
23-26 Sep 1984 MontSIS=2.5



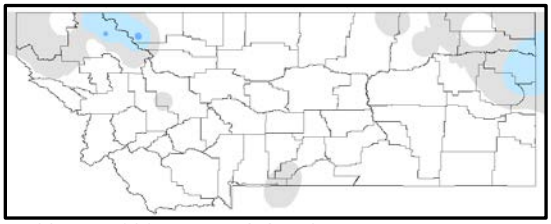
7-9 Oct 1985 MontSIS=4.1



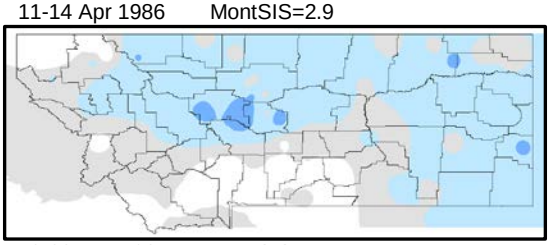
13-19 Feb 1986 MontSIS=14.6



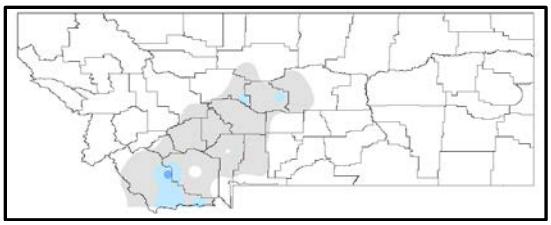
11-14 Apr 1986 MontSIS=2.9



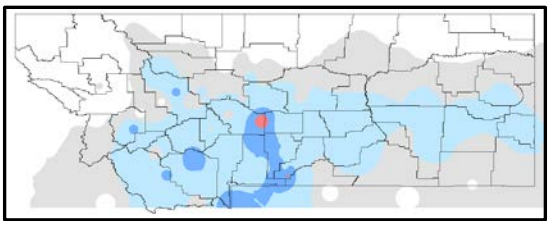
17-20 Nov 1986 MontSIS=1.2



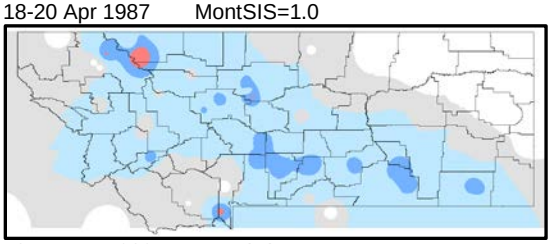
18-22 Mar 1987 MontSIS=5.4



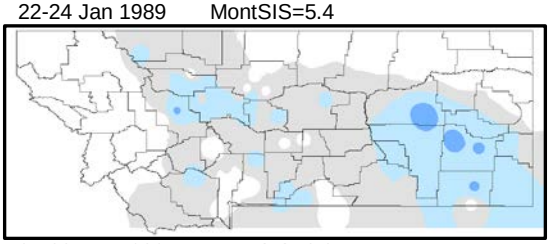
18-20 Apr 1987 MontSIS=1.0



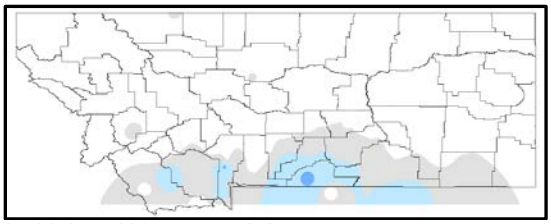
22-24 Jan 1989 MontSIS=5.4



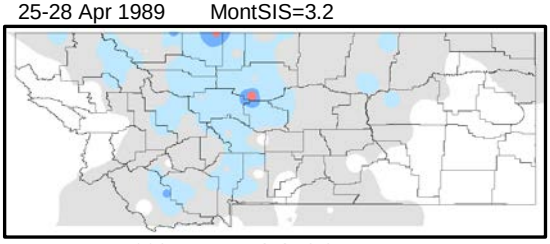
13-17 Mar 1989 MontSIS=7.4



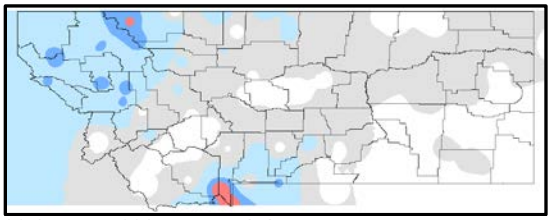
25-28 Apr 1989 MontSIS=3.2



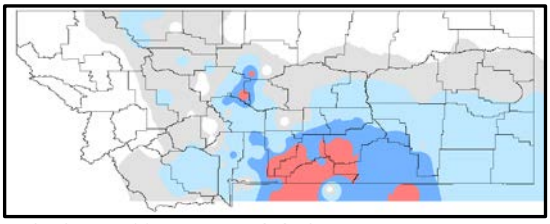
27-29 Oct 1989 MontSIS=1.4



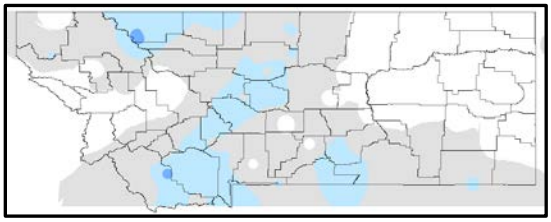
11-14 Mar 1990 MontSIS=2.8



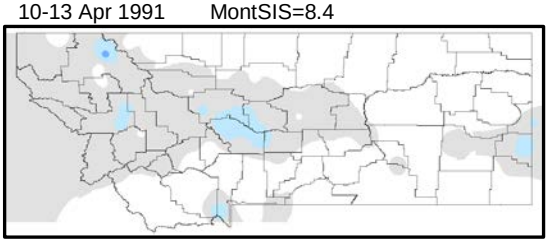
26-31 Dec 1990 MontSIS=4.7



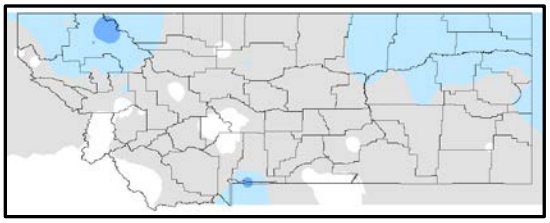
10-13 Apr 1991 MontSIS=8.4



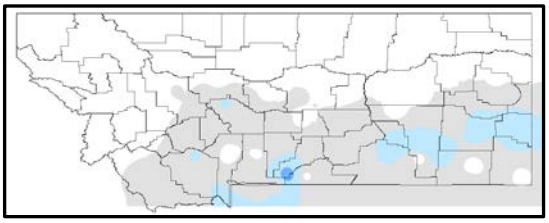
26-29 Oct 1991 MontSIS=2.4



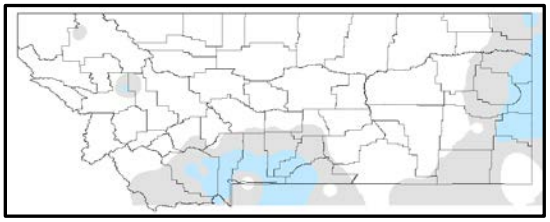
22-25 Jan 1993 MontSIS=1.5



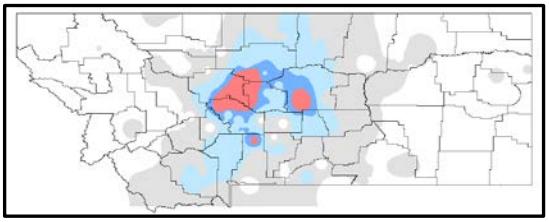
21-24 Nov 1993 MontSIS=3.5



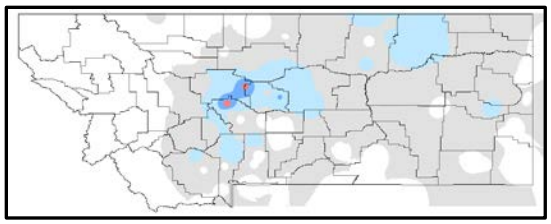
21-24 Mar 1993 MontSIS=1.7



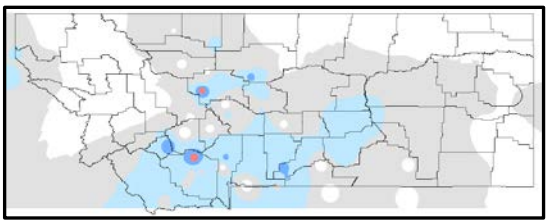
15-18 Jan 1995 MontSIS=1.5



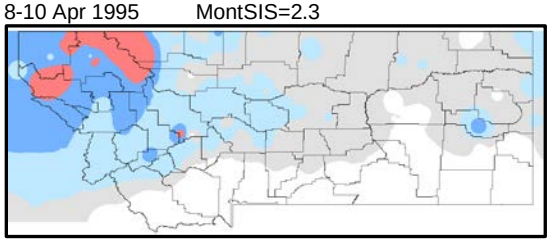
23-28 Mar 1995 MontSIS=3.2



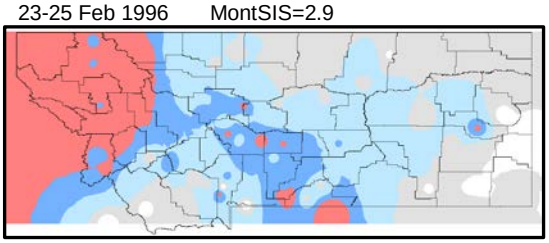
8-10 Apr 1995 MontSIS=2.3



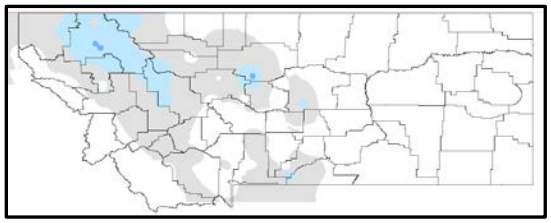
23-25 Feb 1996 MontSIS=2.9



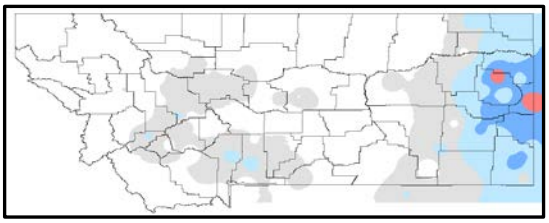
18-22 Nov 1996 MontSIS=10.8



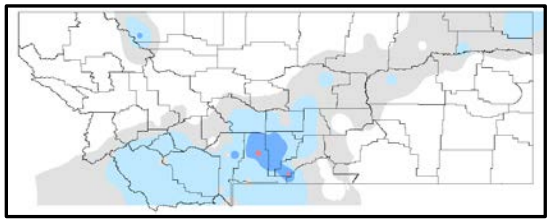
24-29 Dec 1996 MontSIS=12.9



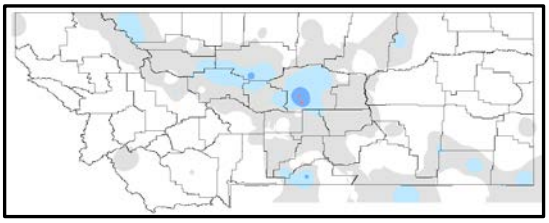
25-28 Feb 1997 MontSIS=1.4



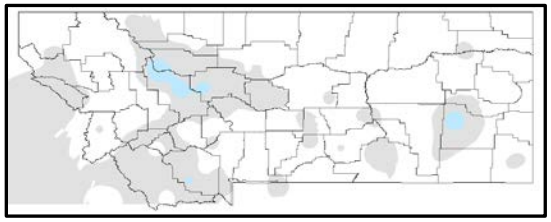
24-28 Feb 1998 MontSIS=5.0



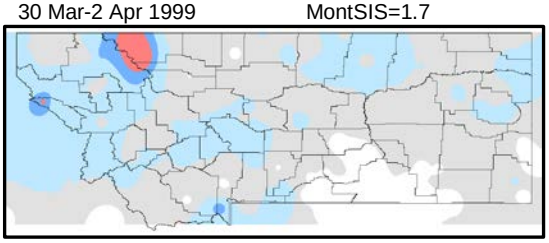
3-5 Dec 1998 MontSIS=2.9



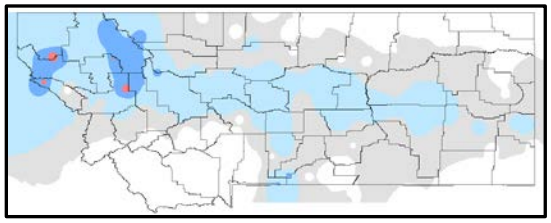
30 Mar-2 Apr 1999 MontSIS=1.7



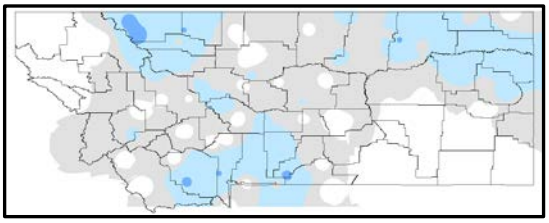
8-11 Nov 2000 MontSIS=1.2



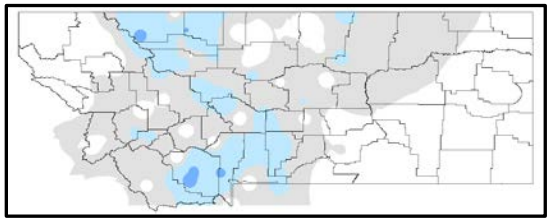
6-10 Mar 2002 MontSIS=4.8



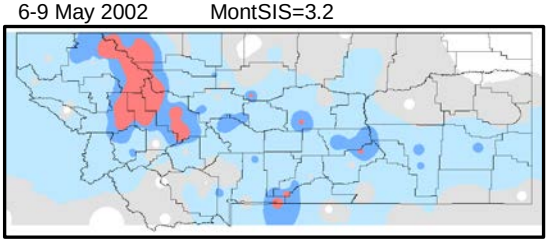
19-21 Mar 2002 MontSIS=5.5



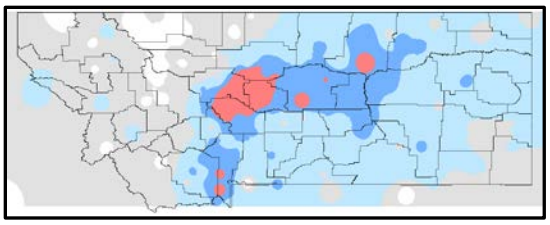
6-9 May 2002 MontSIS=3.2



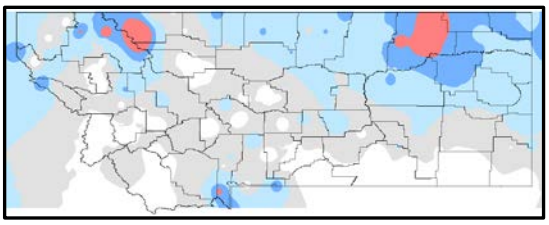
6-10 Jun 2002 MontSIS=2.3



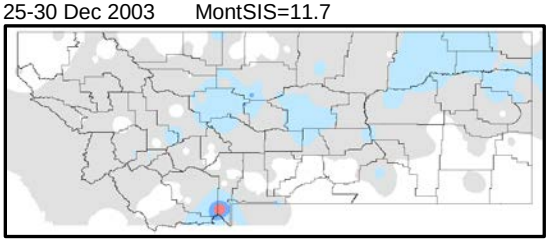
6-9 Mar 2003 MontSIS=9.5



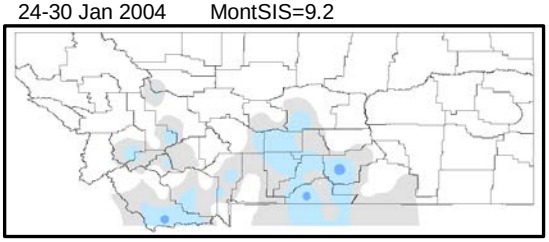
25-30 Dec 2003 MontSIS=11.7



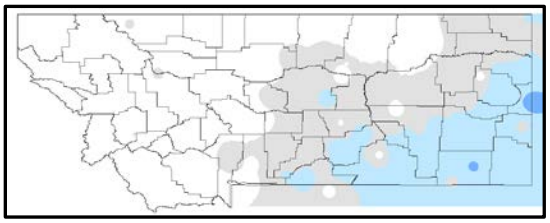
24-30 Jan 2004 MontSIS=9.2



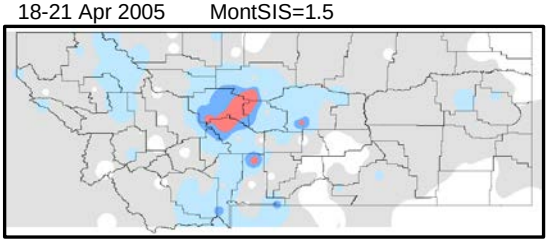
30 Dec-1 Jan 2005 MontSIS=2.6



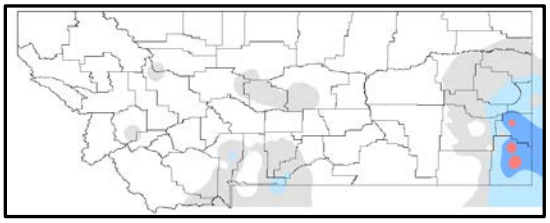
18-21 Apr 2005 MontSIS=1.5



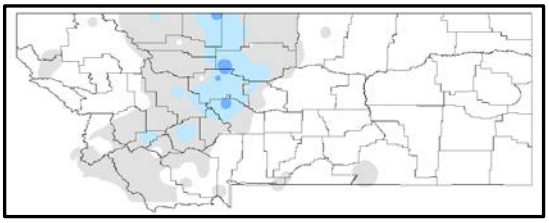
4-6 Oct 2005 MontSIS=2.7



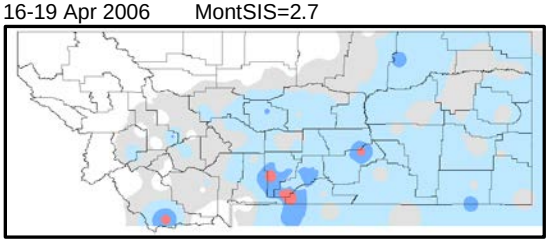
26-30 Nov 2005 MontSIS=3.9



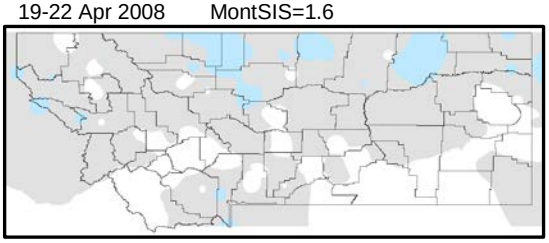
16-19 Apr 2006 MontSIS=2.7



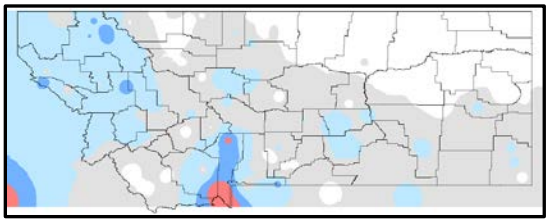
19-22 Apr 2008 MontSIS=1.6



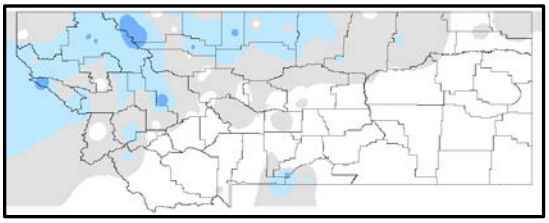
10-13 Oct 2008 MontSIS=5.4



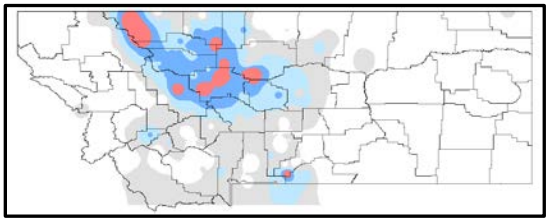
12-14 Dec 2008 MontSIS=2.1



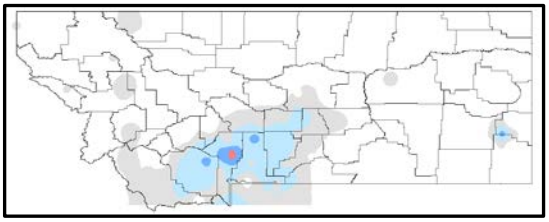
22-27 Dec 2008 MontSIS=5.1



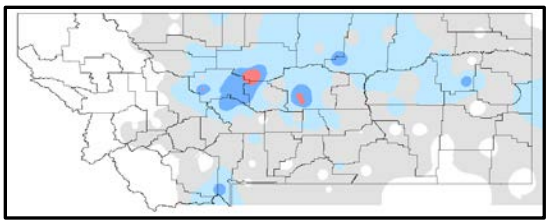
1-3 Jan 2009 MontSIS=3.0



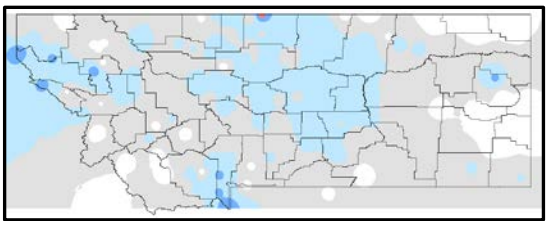
28-30 Apr 2009 MontSIS=4.9



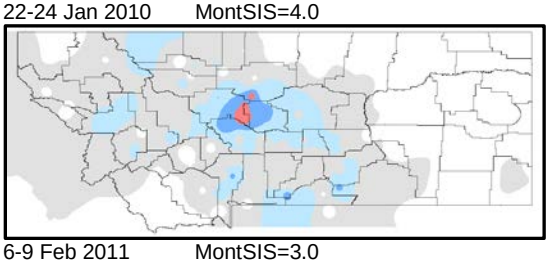
13-15 Nov 2009 MontSIS=1.5



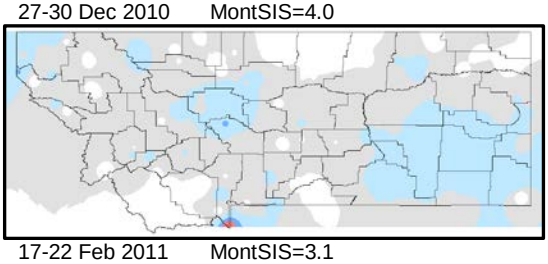
22-24 Jan 2010 MontSIS=4.0



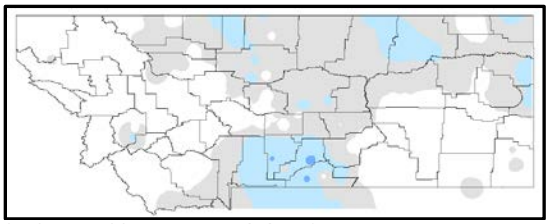
27-30 Dec 2010 MontSIS=4.0



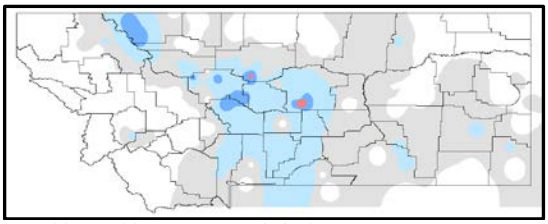
6-9 Feb 2011 MontSIS=3.0



17-22 Feb 2011 MontSIS=3.1



21-25 Mar 2011 MontSIS=1.9



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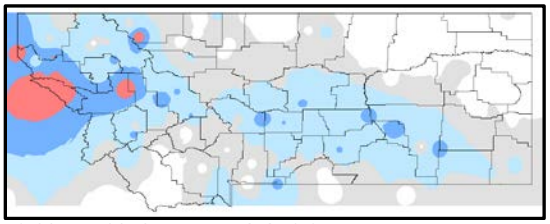
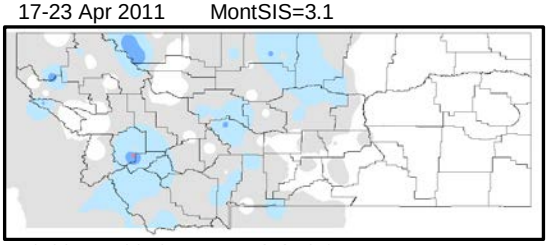
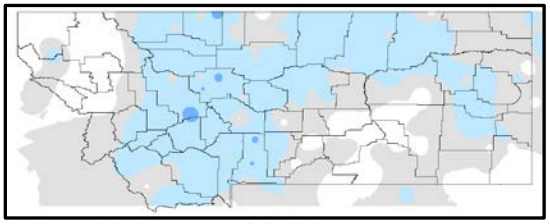


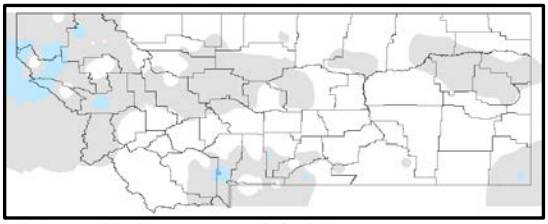
16-20 Jan 2012 MontSIS=9.9



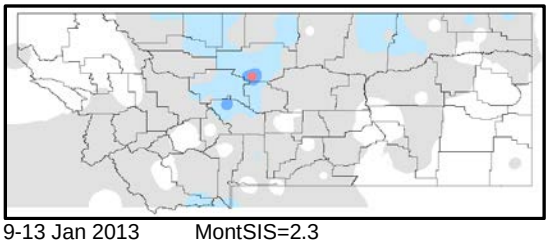
18-22 Mar 2012 MontSIS=2.6



8-10 Nov 2012 MontSIS=3.9



6-9 Dec 2012 MontSIS=2.3



9-13 Jan 2013 MontSIS=2.3