Climate Change and Climate Trends in Our Own Backyard

Dr. Mark Seeley
Department of Soil, Water, and Climate
University of Minnesota
St Paul, MN 55108

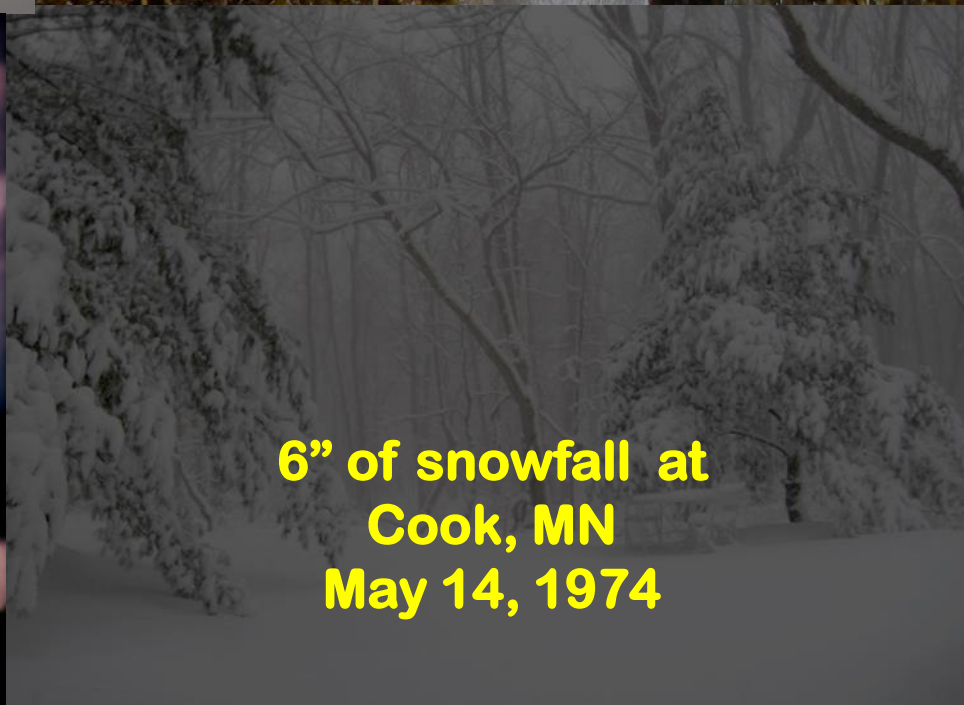
For IATP: Rural Climate Dialogue
Grand Rapids, MN
May 14, 2015

UNIVERSITY OF MINNESOTA
EXTENSION

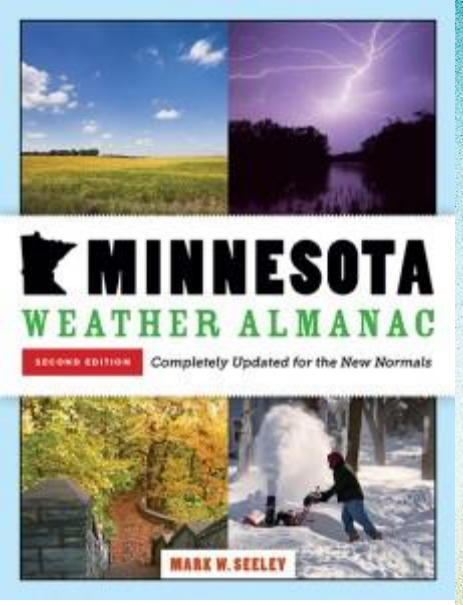
102 degrees F at Amboy, MN
May 14, 2013

11 degrees F at Alborn, MN
May 14, 1945
(with 1” of fresh snow cover)

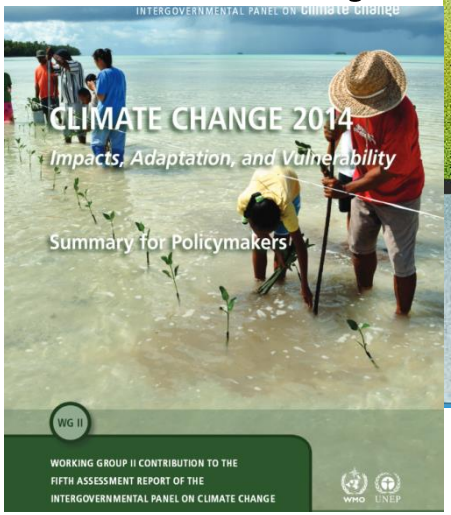
3.82 inches of thunderstorm rainfall at Crookston, MN
May 14, 1941



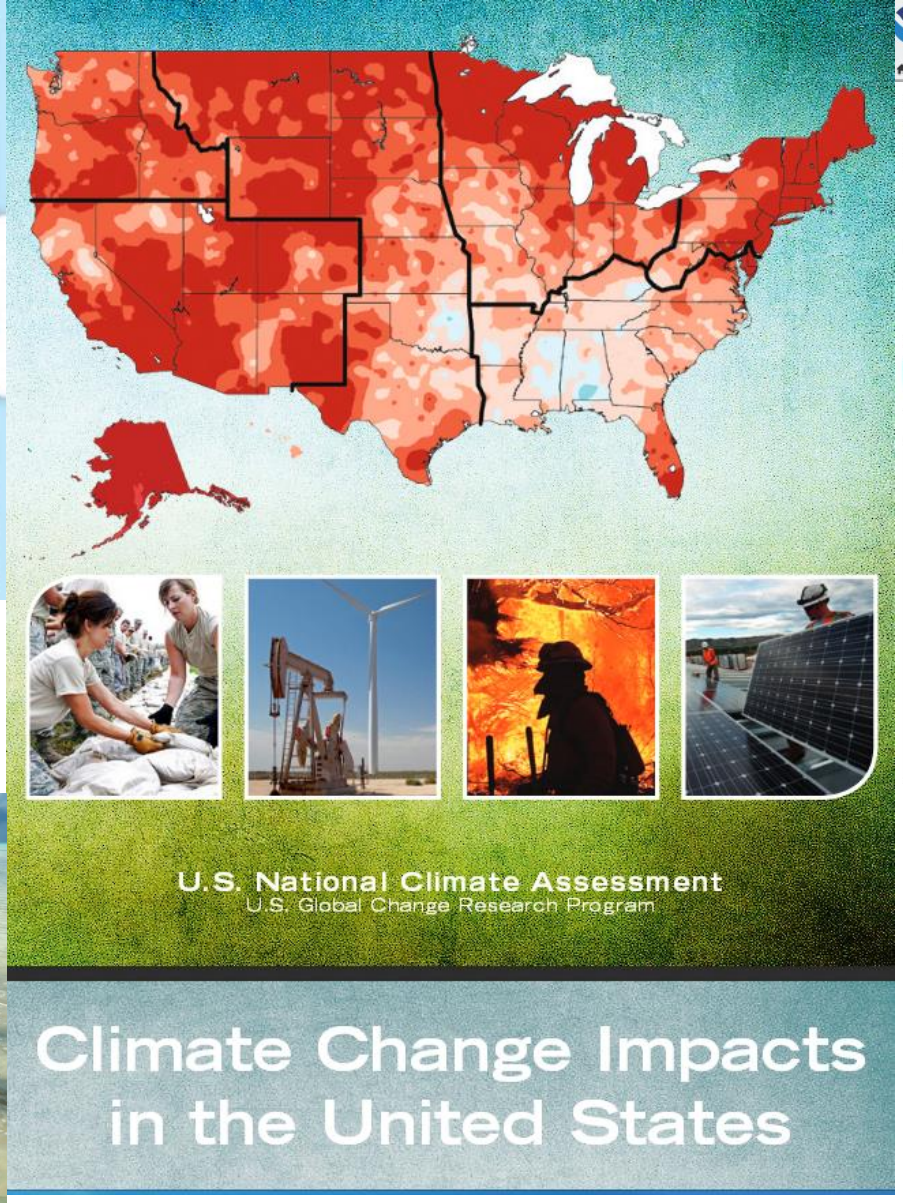
6” of snowfall at Cook, MN
May 14, 1974



Minnesota weather and climate history



IPCC 5th Assessment



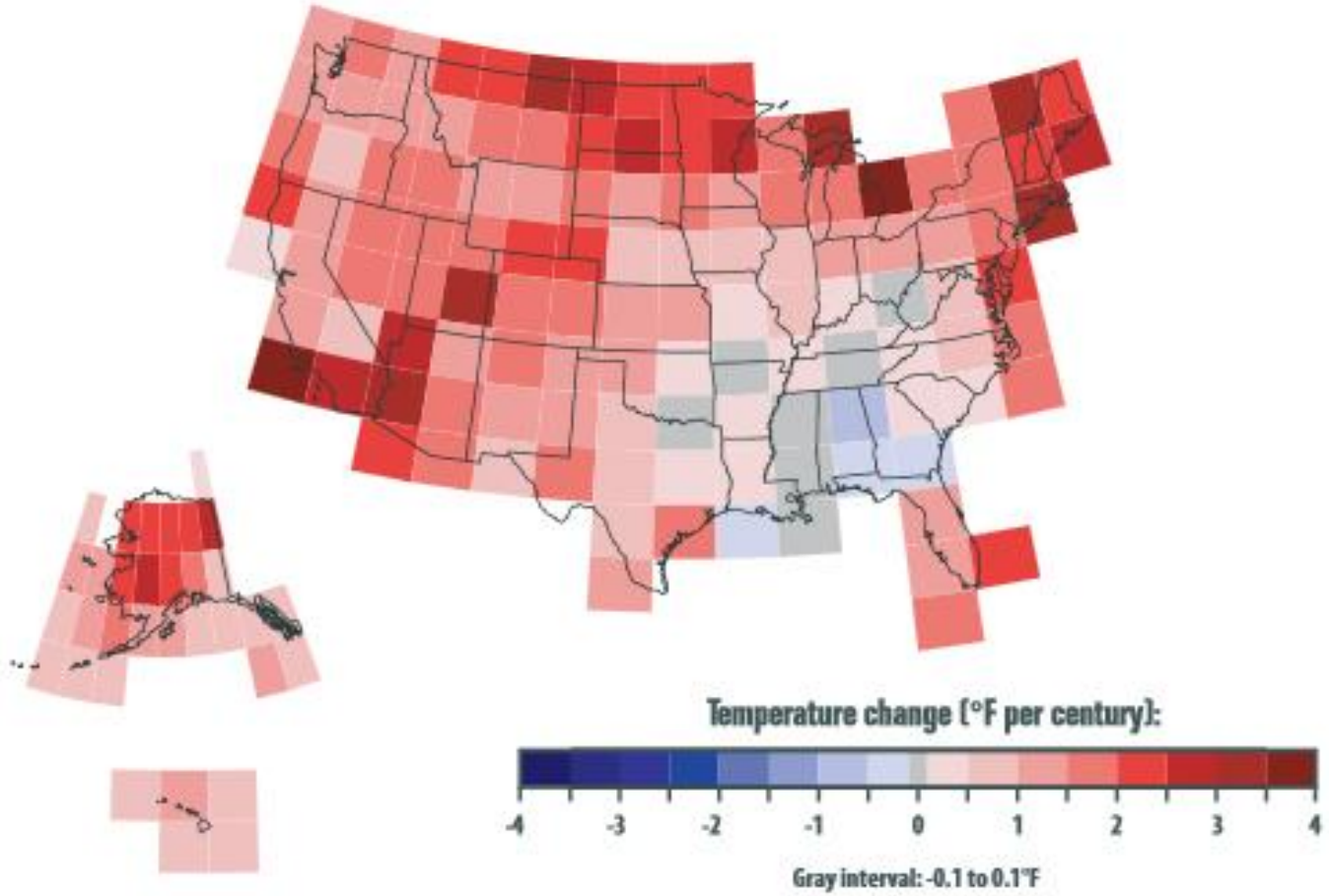
National Climate Assessment 2014

NOAA Climate Monitoring and Global and National Assessment Divisions

Information Resources Used

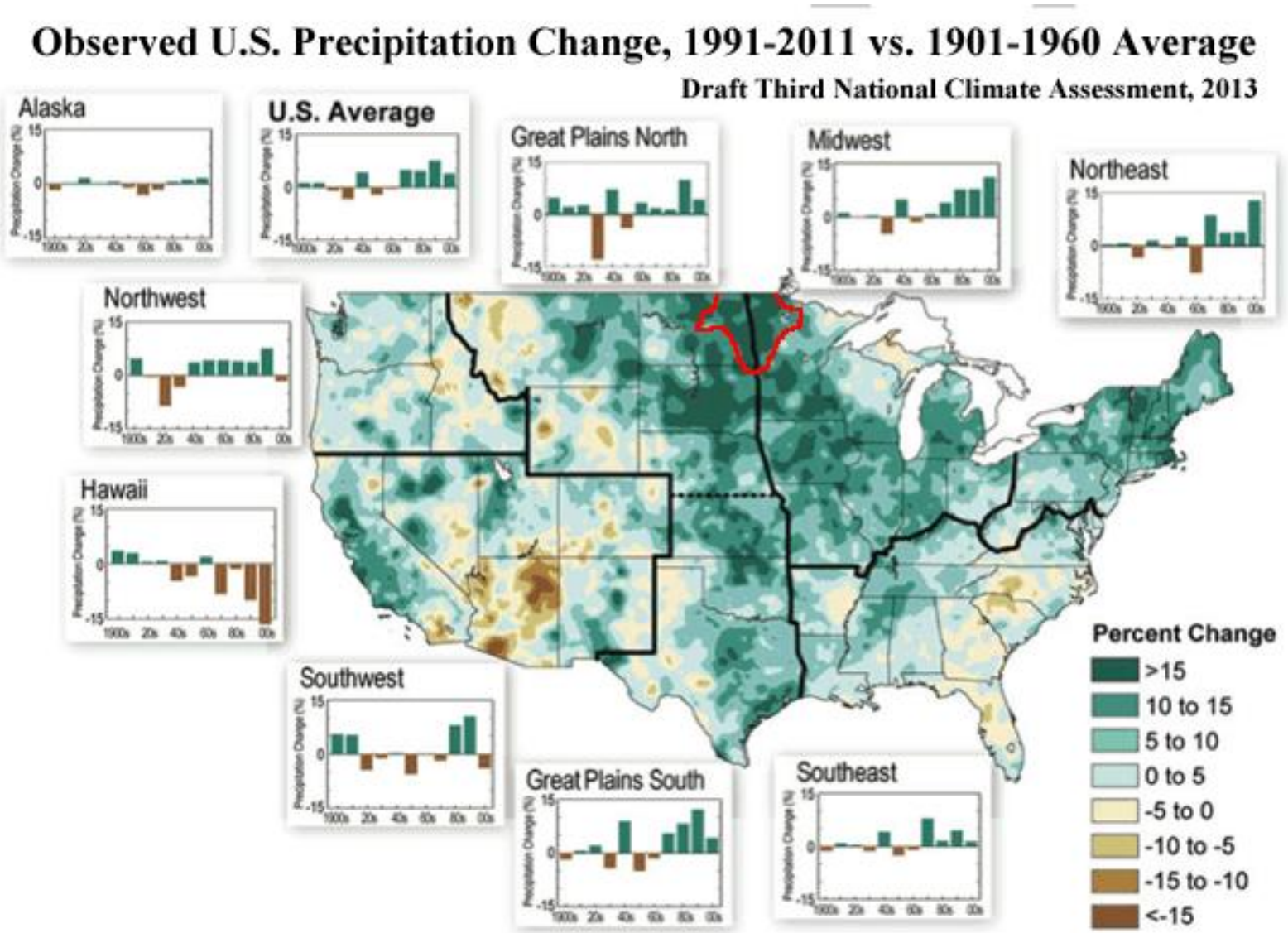
Figure 3. Rate of Temperature Change in the United States, 1901–2008

This figure shows how average air temperatures have changed in different parts of the United States since the early 20th century (since 1901 for the lower 48 states, 1905 for Hawaii, and 1918 for Alaska).



Data source: NOAA, 2009*

Disparity in the pace of climate change and the response to it



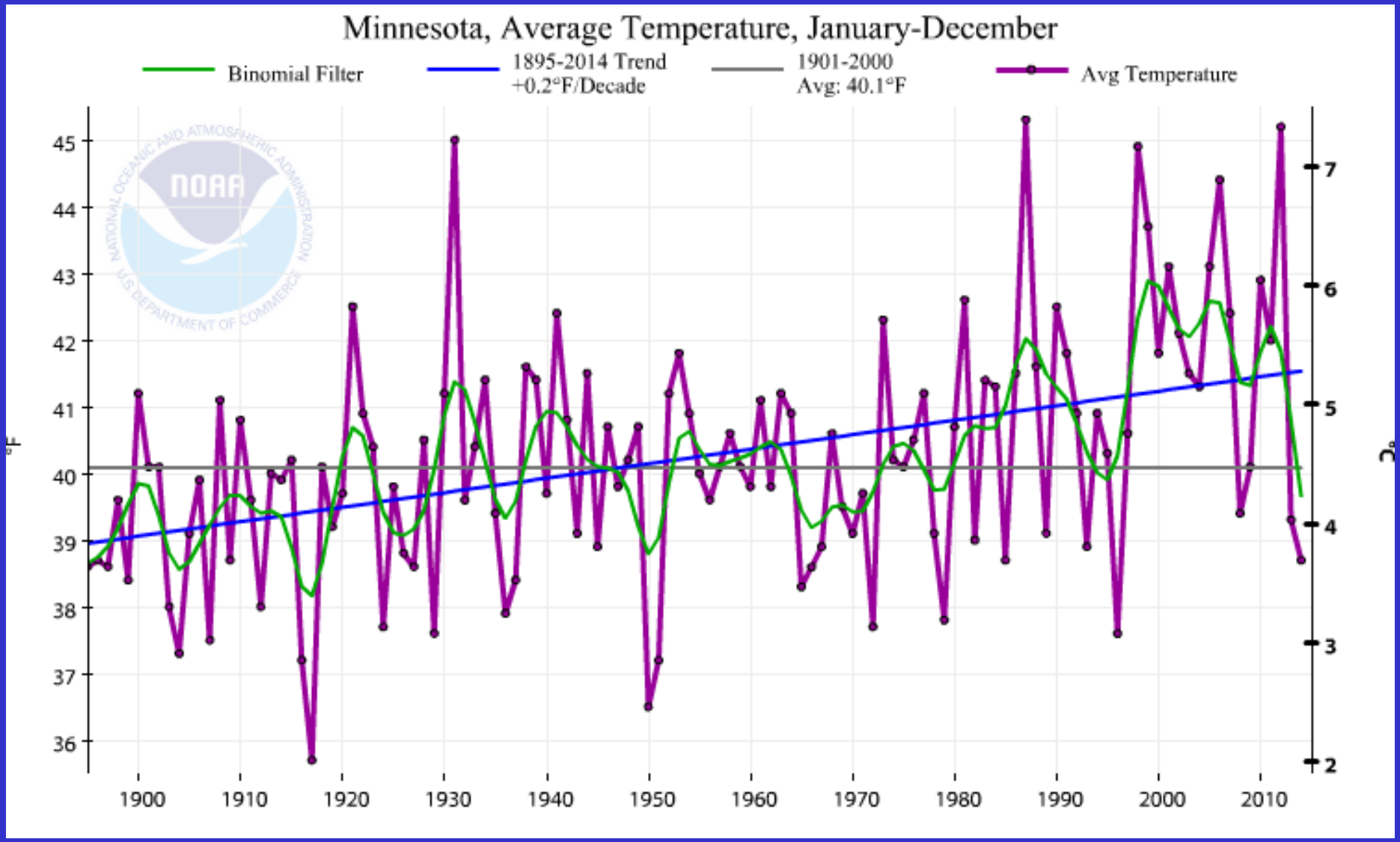
Geographic Disparity in Precipitation Change-IPCC 2013

RECENT SIGNIFICANT CLIMATE TRENDS IN MINNESOTA AND THE WESTERN GREAT LAKES

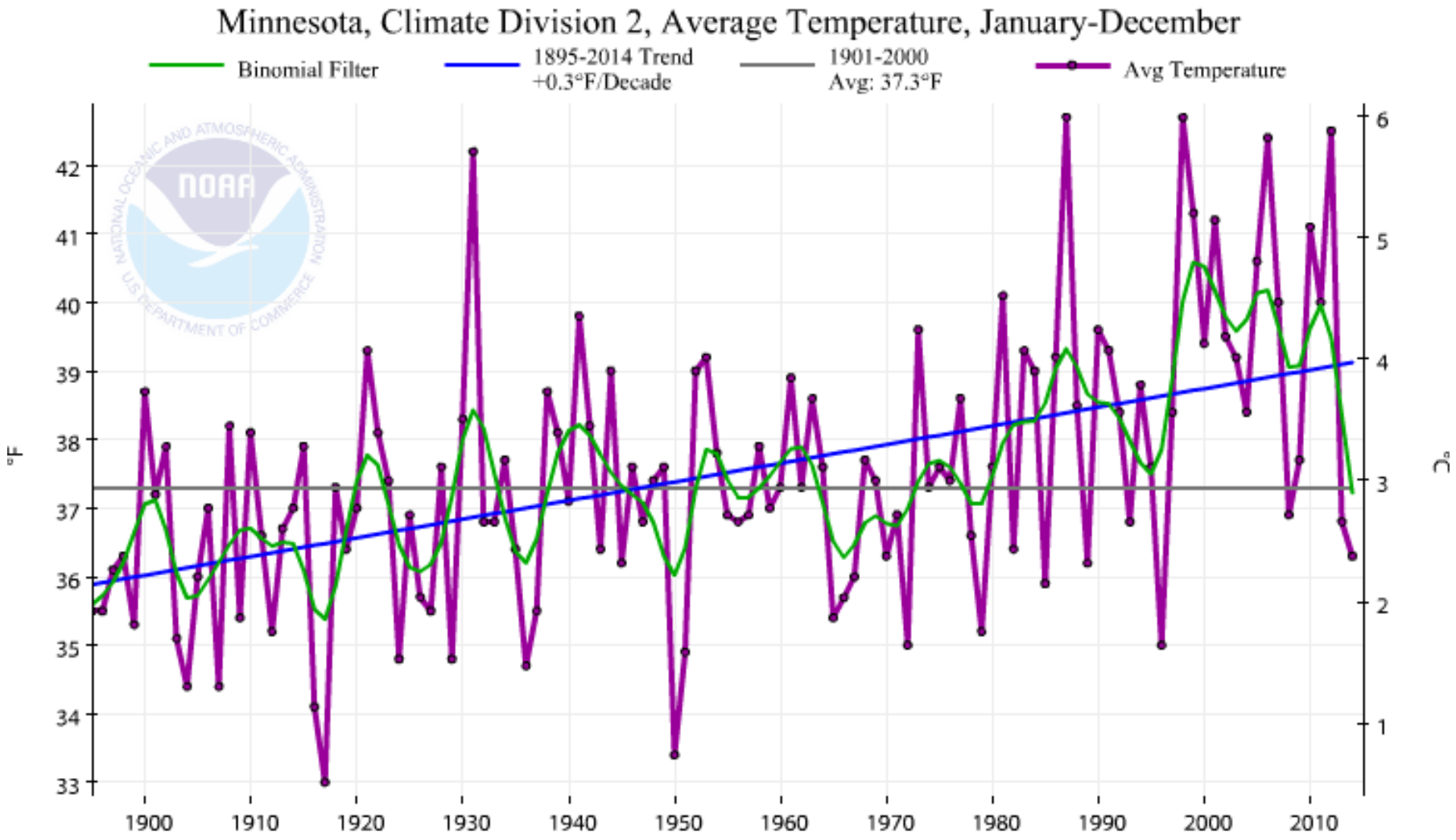
- *TEMPERATURE*: WARM WINTERS AND HIGHER MINIMUM TEMPERATURES

- *DEWPOINTS*: GREATER FREQUENCY OF TROPICAL-LIKE ATMOSPHERIC WATER VAPOR

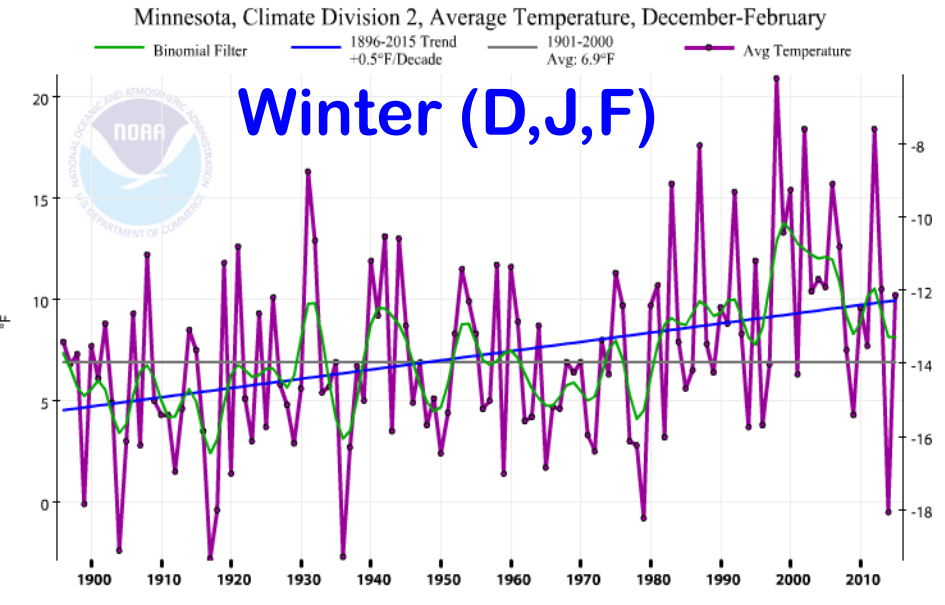
- *MOISTURE*: AMPLIFIED PRECIPITATION SIGNAL, THUNDERSTORM CONTRIBUTION

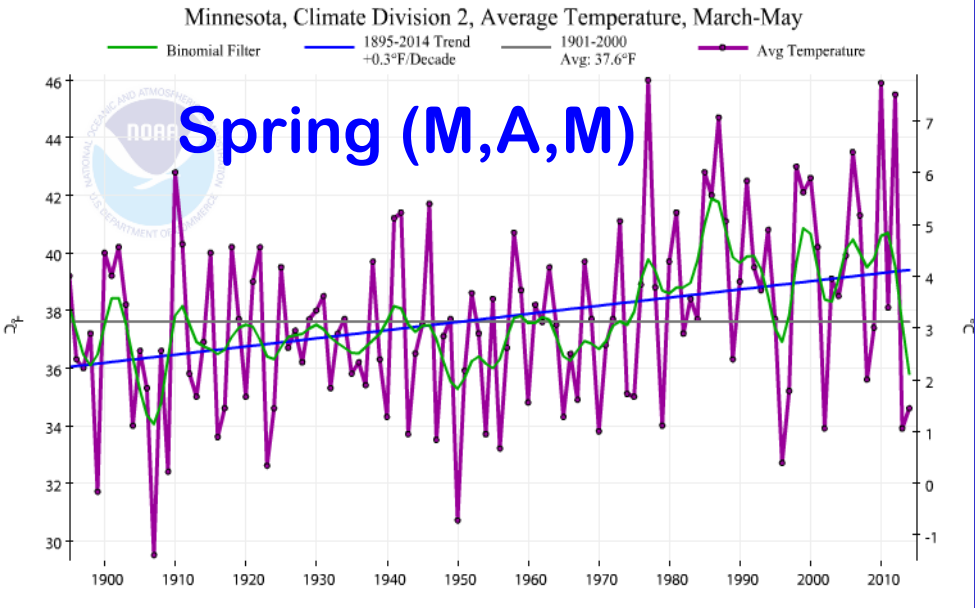


Temp trend is upward (about 2°F per century) and more frequently near historical warmth

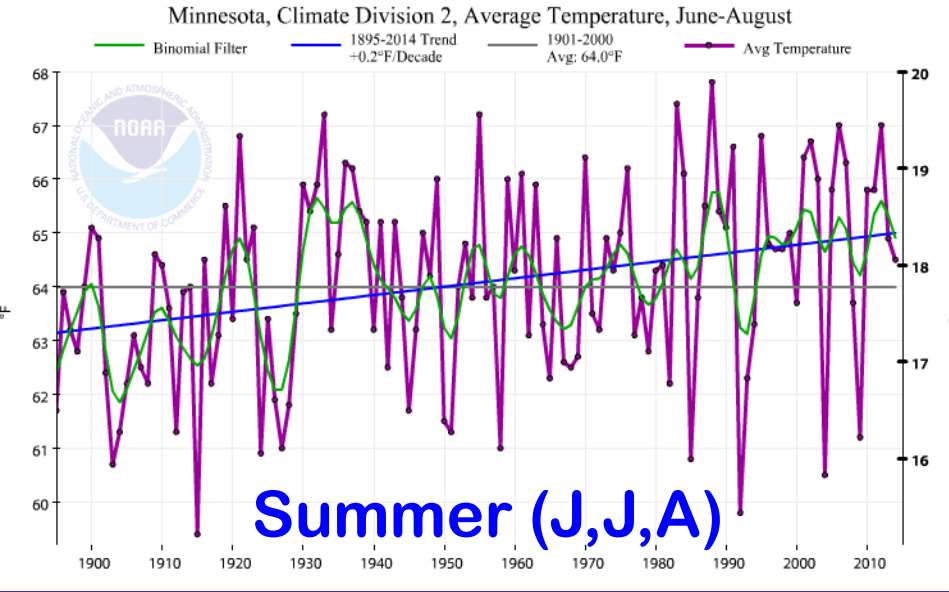


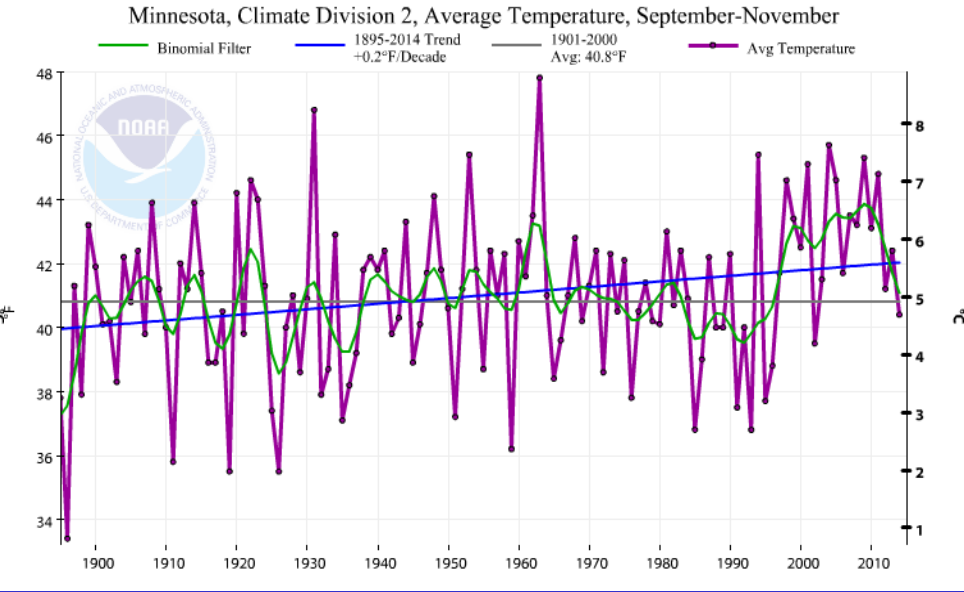
North Central Minnesota Trend in Mean Annual Temperature
Upward by 3°F per century





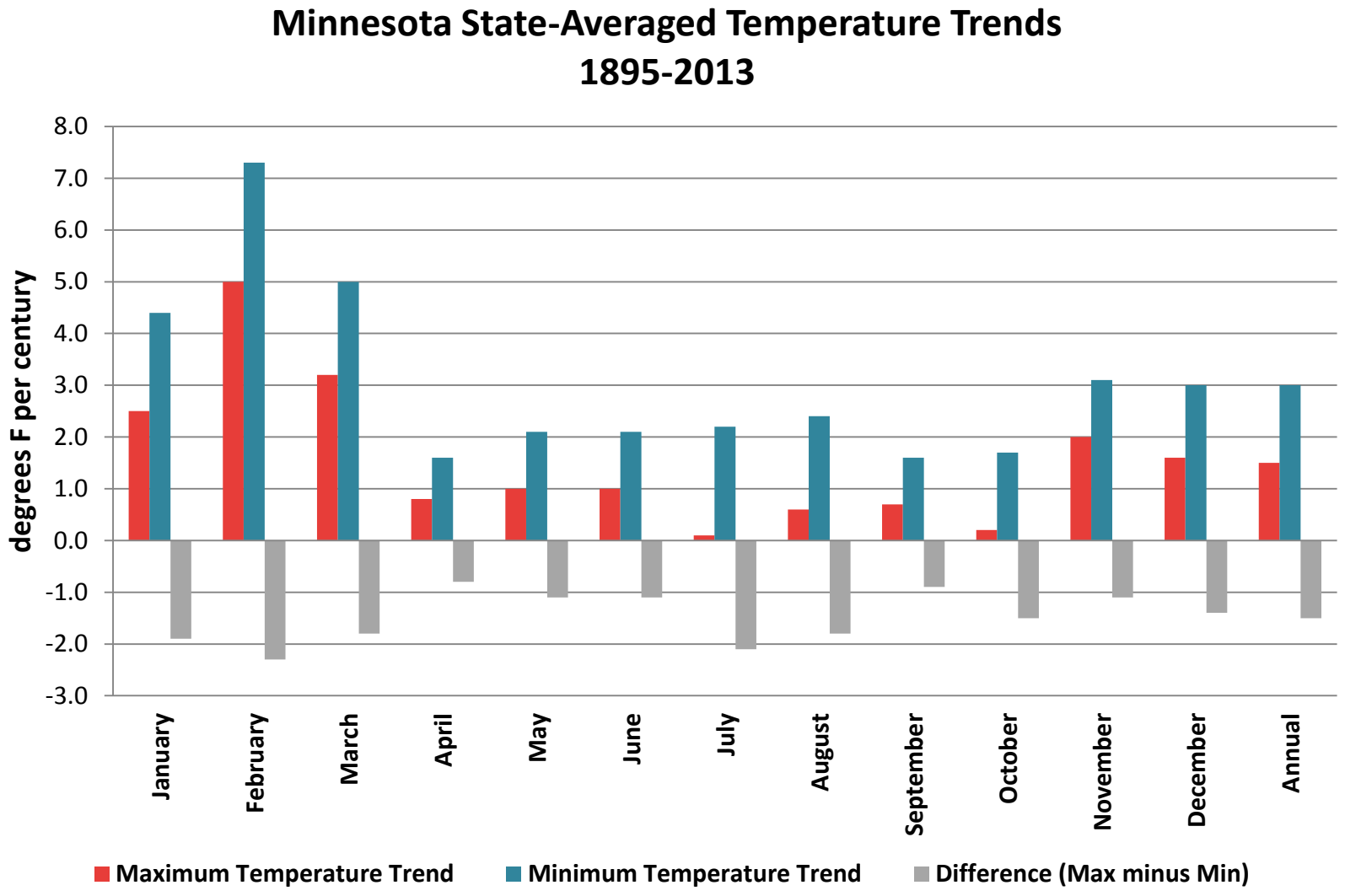
Seasonal Temperature Trends NC- MN Annual Temperatures





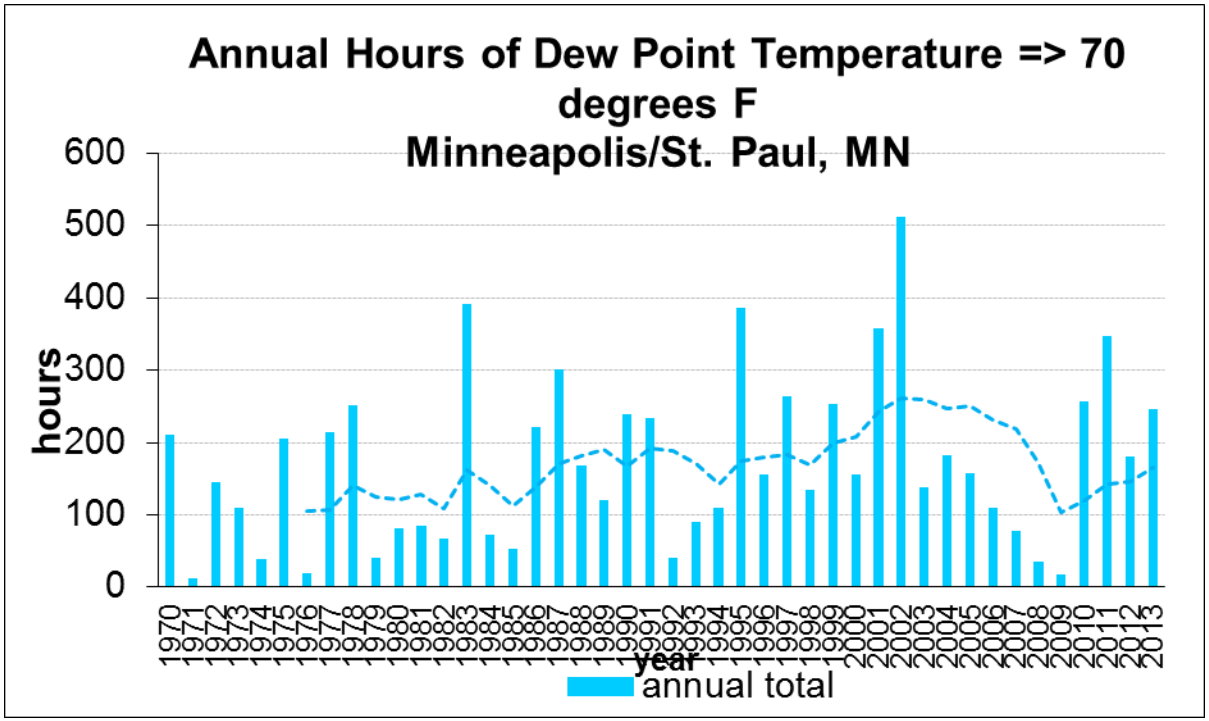
Trends in mean monthly temperatures at Grand Rapids, MN 1971-2000 normals vs 1981-2010 normals (F)

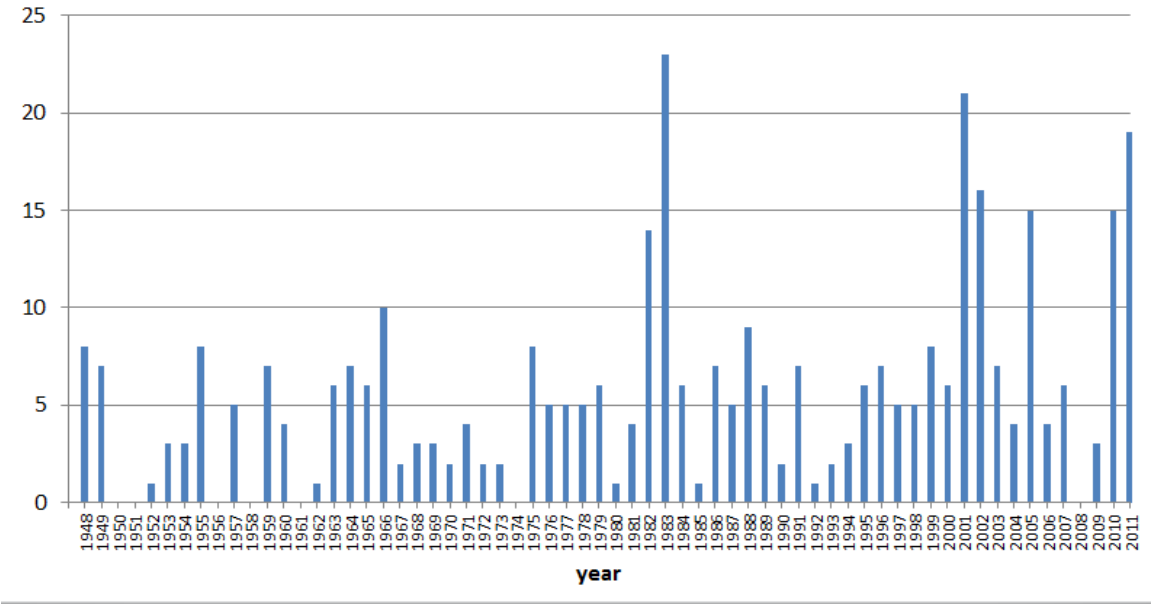
Month	Min Change	Max Change	Mean Change
January	+1.6	+2.4	+2.0
February	+0.1	+0.5	+0.3
March	+1.1	+0.8	+1.0
April	+1.3	+0.6	+0.9
May	+0.7	-0.8	-0.1
June	+1.2	-0.3	+0.4
July	+1.1	+0.4	+0.7
August	+1.7	+0.7	+1.2
September	+1.8	+1.3	+1.5
October	-0.1	-0.2	-0.1
November	+1.2	+1.7	+1.5
December	+1.3	+1.3	+1.3


Minnesota State-Averaged Temperature Trends
1895-2013
degrees F per century
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
-2.0
-3.0
January
February
March
April
May
June
July
August
September
October
November
December
Annual
Maximum Temperature Trend
Minimum Temperature Trend
Difference (Max minus Min)

Trend in episodes of dewpoints of 70 F or higher

Latitude 45 degrees



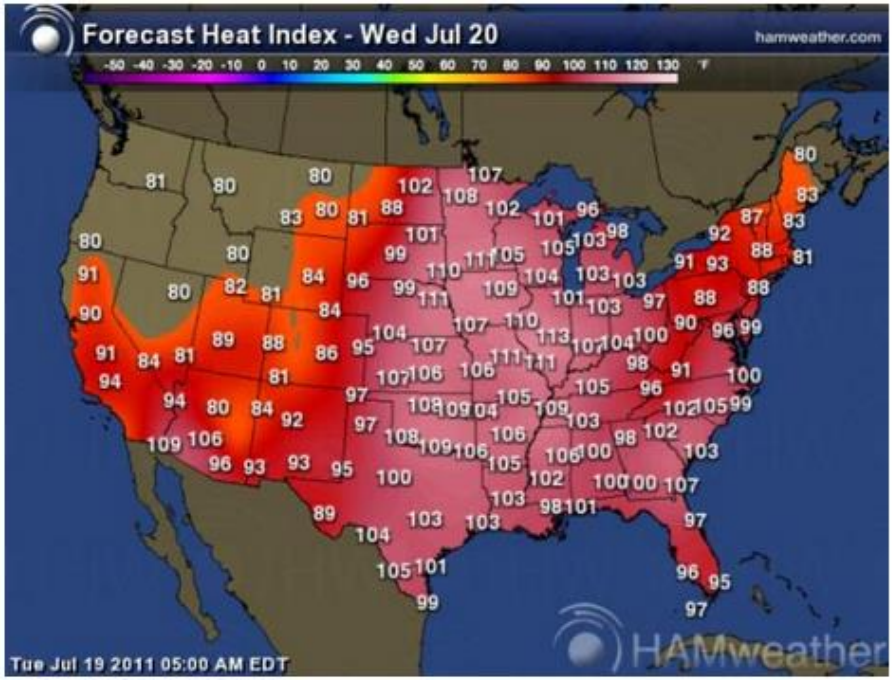


Hours with dewpoints of 70 degrees F or higher at Voyageurs National Park

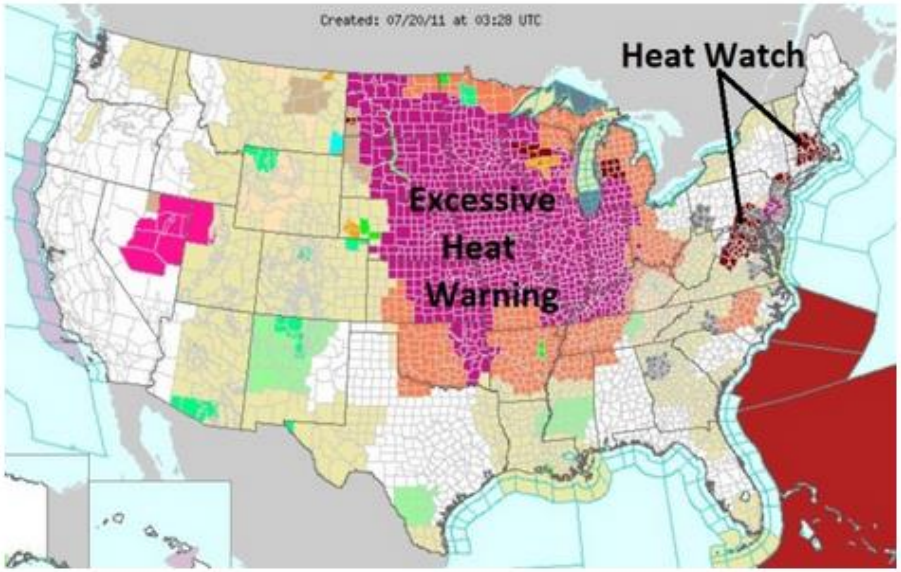
Latitude 48.5 degrees

Frequencies of tropical-like dew points (70 F or higher) and associated Heat Index values for the Twin Cities since 1945

Year	Hours with DP of 70 F or greater	Range of Heat Index Values (F)
1947	256	99 - 112
1949	303	98 - 112
1955	345	98 - 113
1957	243	98 - 112
1959	317	99 - 113
1960	259	98 - 112
1978	252	99 - 114
1983	392	102 - 110
1987	302	98 - 104
1995	387	98 - 116
1997	264	98 - 113
1999	254	98 - 116
2001	357	98 - 110
2002	512	98 - 109
2010	256	98 - 111
2011	347	98 - 118 (*134)
2013	248	99 - 105



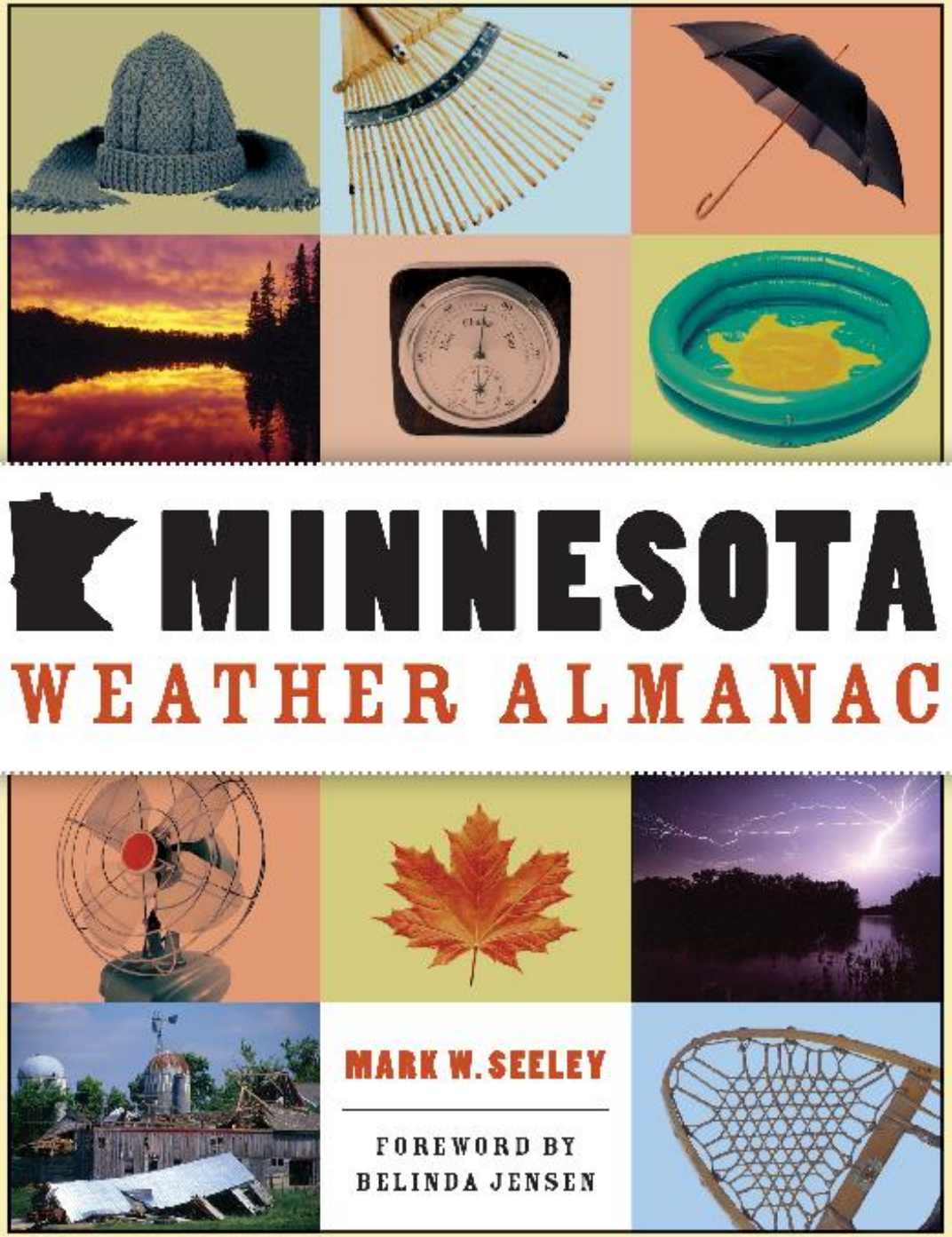
The Great Heatwave of '11. Heat indices will top 100 again today from the Great Plains eastward to the Great Lakes, Ohio Valley and southeastern USA, gripping the eastern 2/3rds of America.



July 19,20, 2011 Heat Wave

Heat Index:

99°F Thief River Falls
98°F – Bemidji
102°F-Grand Rapids
104°F Grand Forks
106°F Park Rapids
111°F Crookston
112°F Fergus Falls
116°F Hallock
117°F Fargo
123°F Pelican Rapids
134°F Moorhead

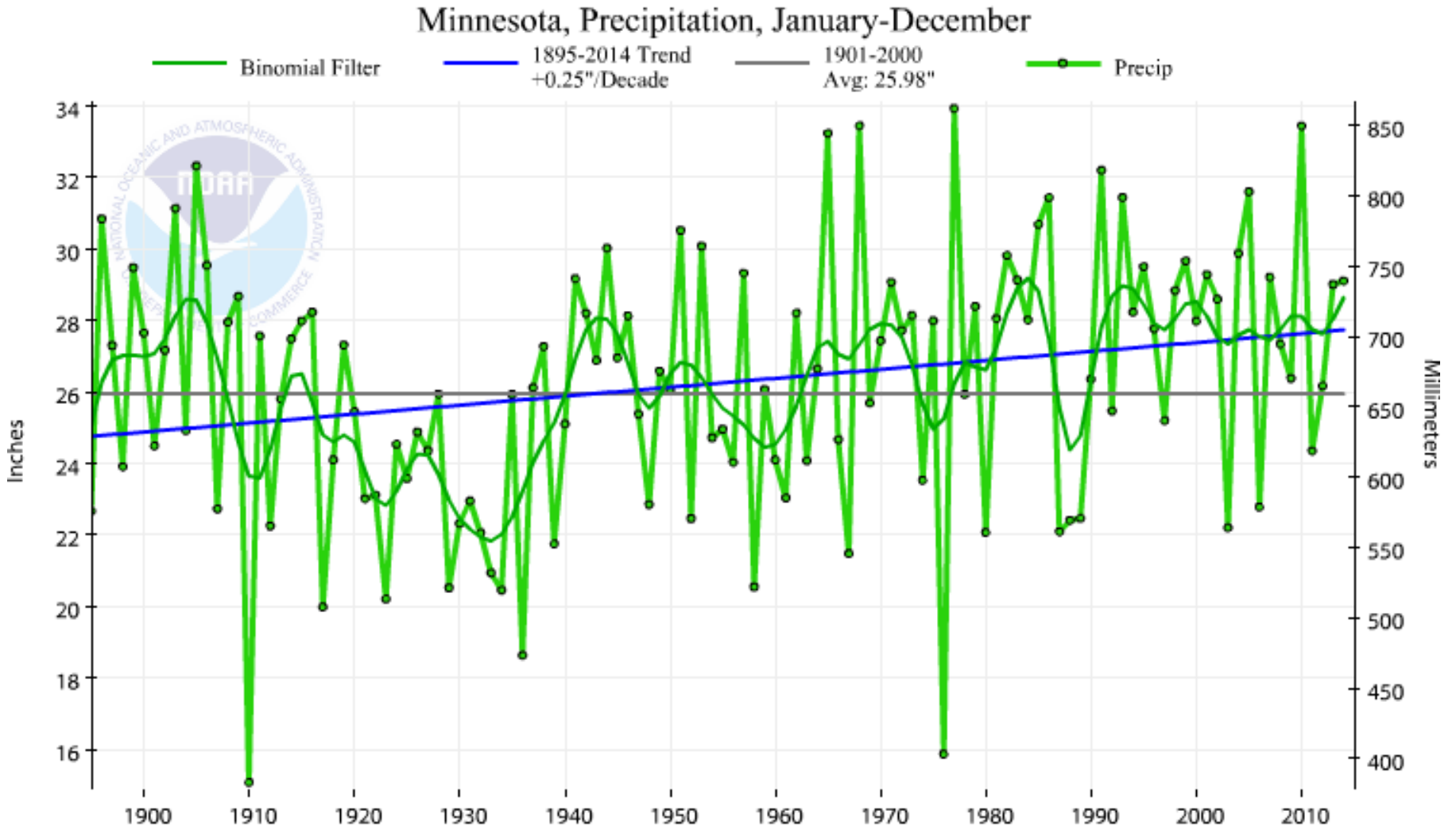


Historical Minnesota Heat Waves:

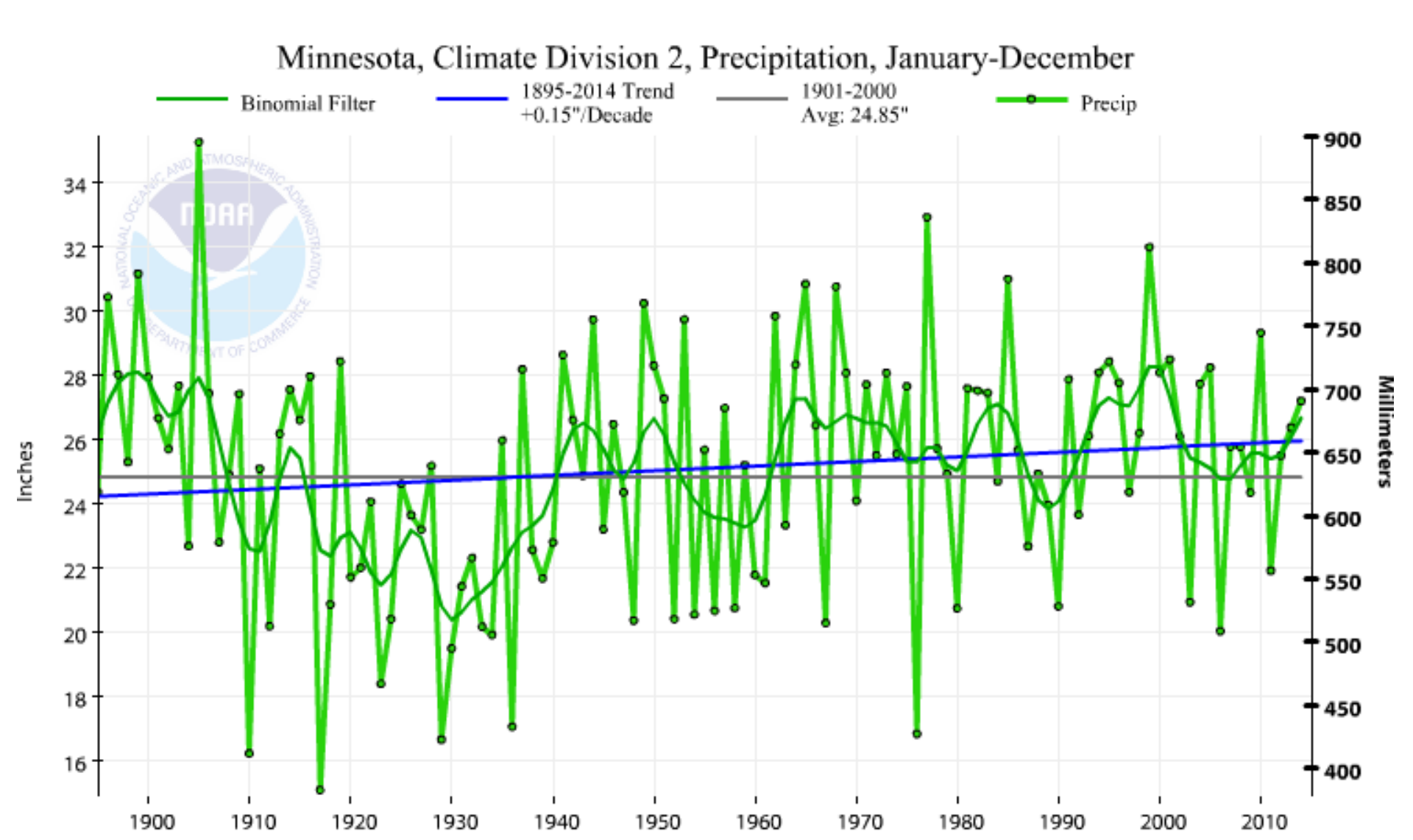
Red denotes dewpoint driven

1883, 1894, 1901, 1910, 1917, 1921, 1931, 1933, 1934, 1936, 1937, 1947, 1948, 1949, 1955, 1957, 1959, 1964, 1976, 1977, 1983, 1988, 1995,1999, 2001, 2005, 2006, 2007, 2010, 2011, 2012, 2013

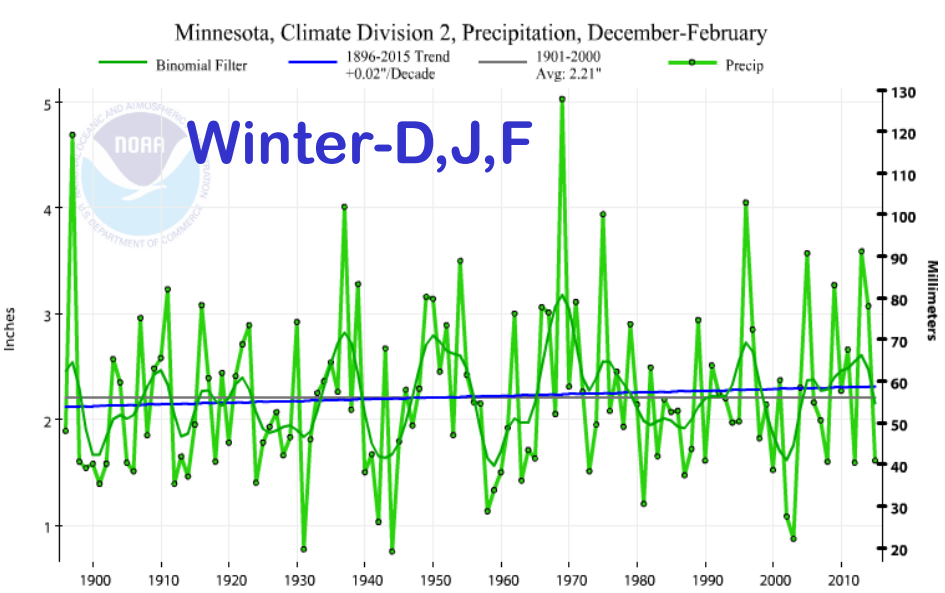
(pattern is episodic but increasing in frequency)

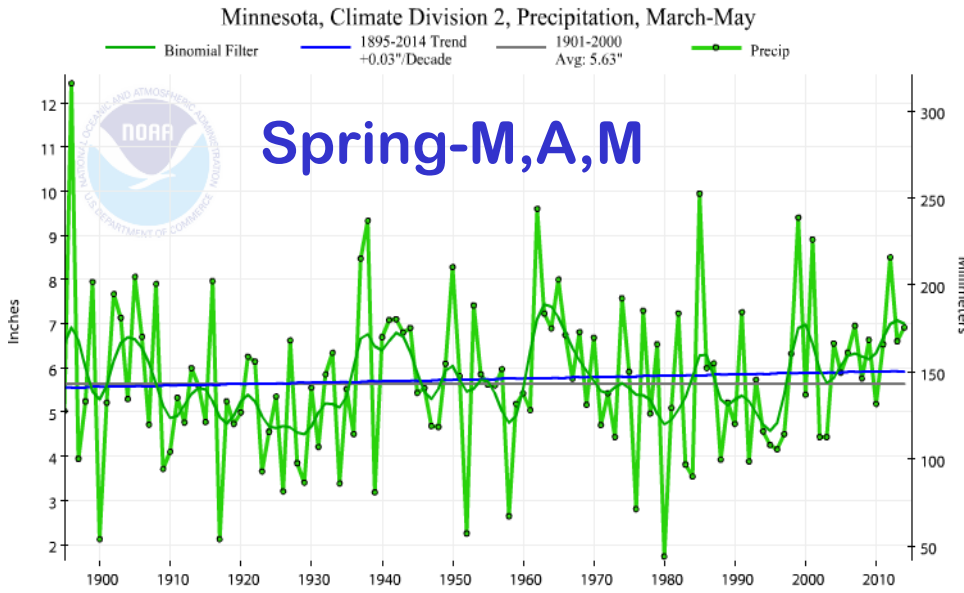


Annual precipitation trend in Minnesota
Upward by 2.50 inches per century

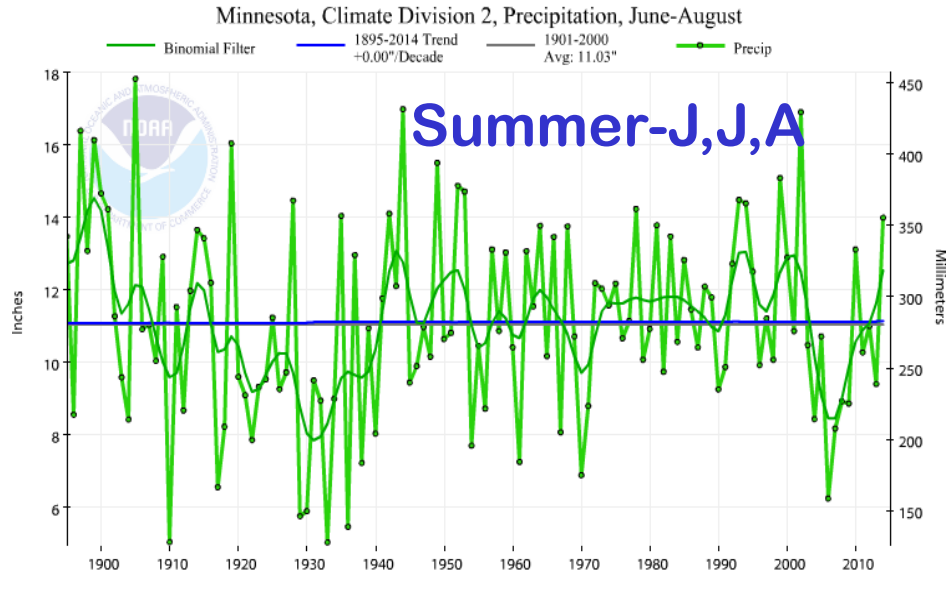


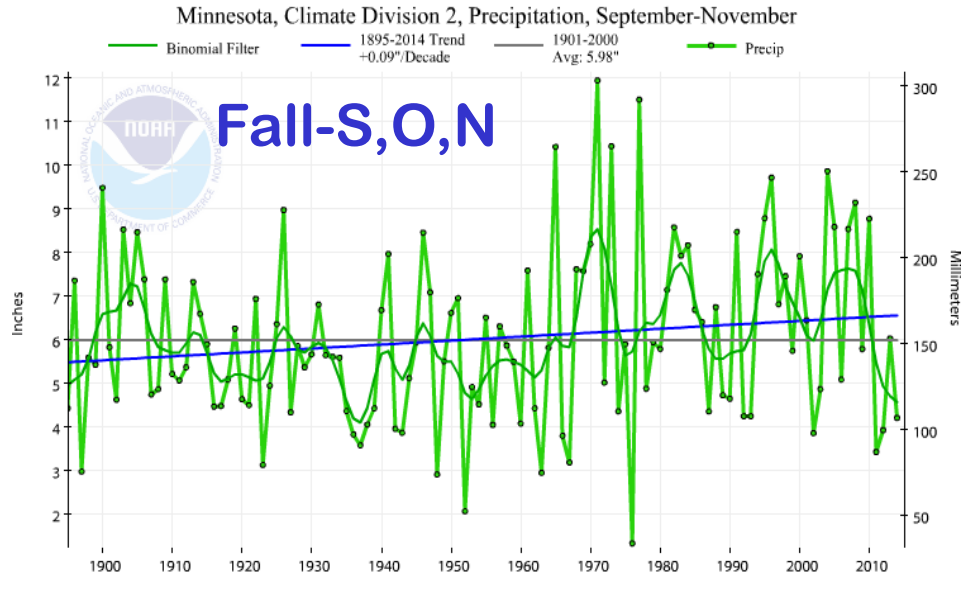
Annual precipitation trend in NC-Minnesota
Upward by 1.50 inches per century



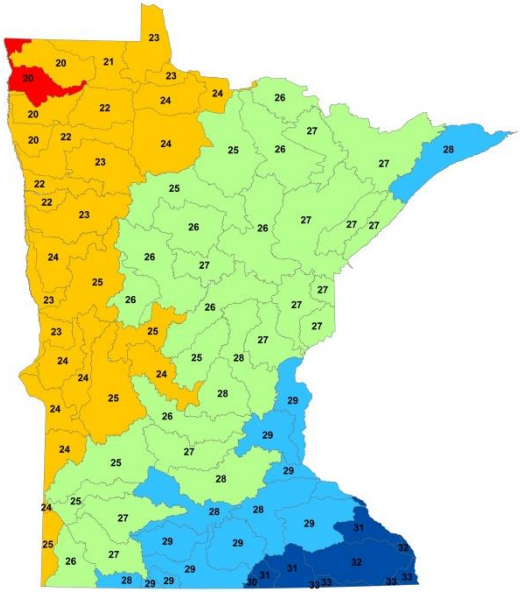


Seasonality in NC-MN Precipitation Trends

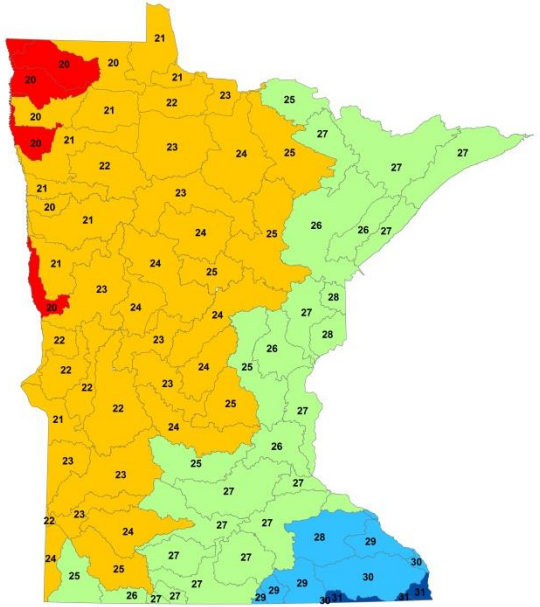




Average Annual PPT 1891-1920,



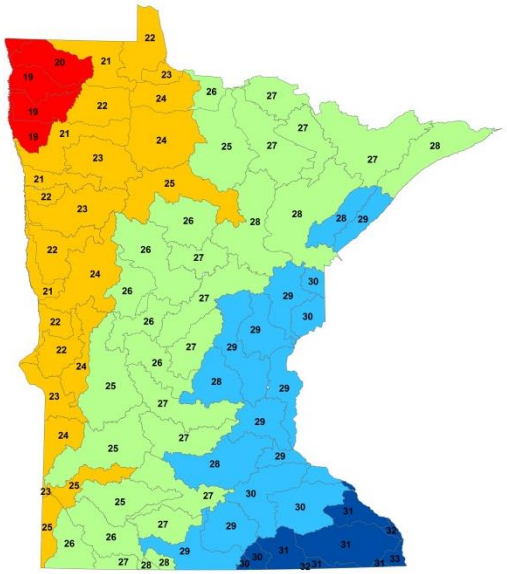
Average Annual PPT 1921-1950, in



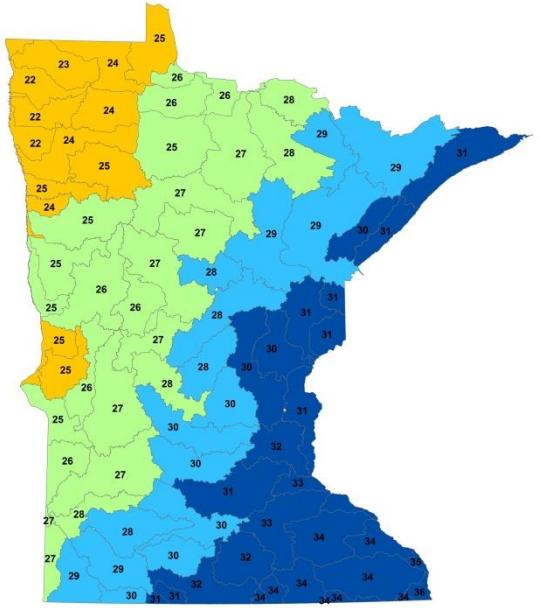
Avg. Annual PPT, in

- < 20
- 21 - 25
- 26 - 28
- 29 - 30
- > 30

Average Annual PPT 1951-1980, in



Average Annual PPT 1981-2010, in

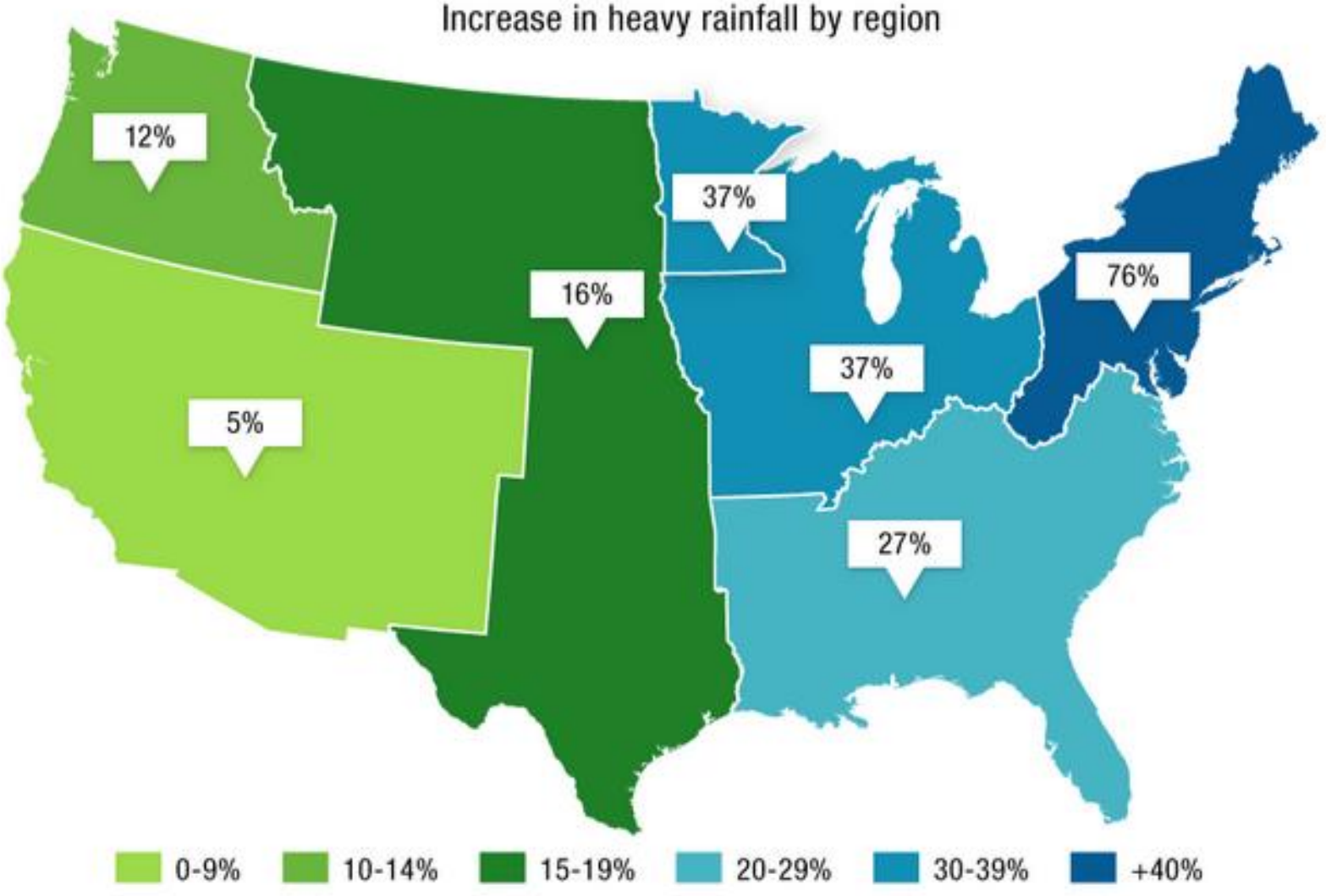


Change in Annual Precipitation Normal at Grand Rapids, MN

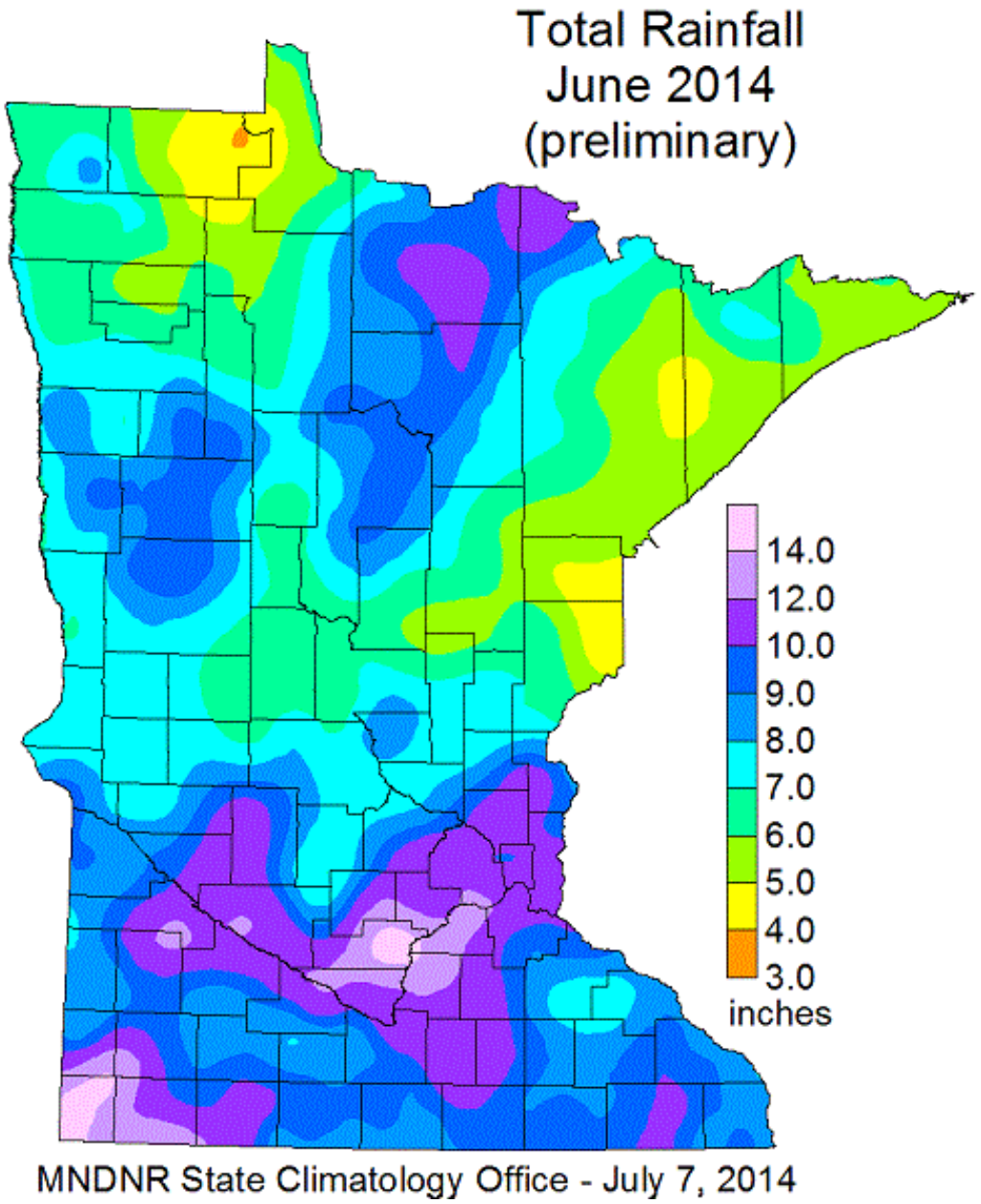
PERIOD	AMOUNT (IN.)
1921-1950	23.75”
1931-1960	25.57”
1941-1970	26.56”
1951-1980	26.36”
1961-1990	27.54”
1971-2000	28.78”
1981-2010	28.93”

22 percent increase since 1921-1950

Extremes 14.62” in 1929, 38.00” in 1977

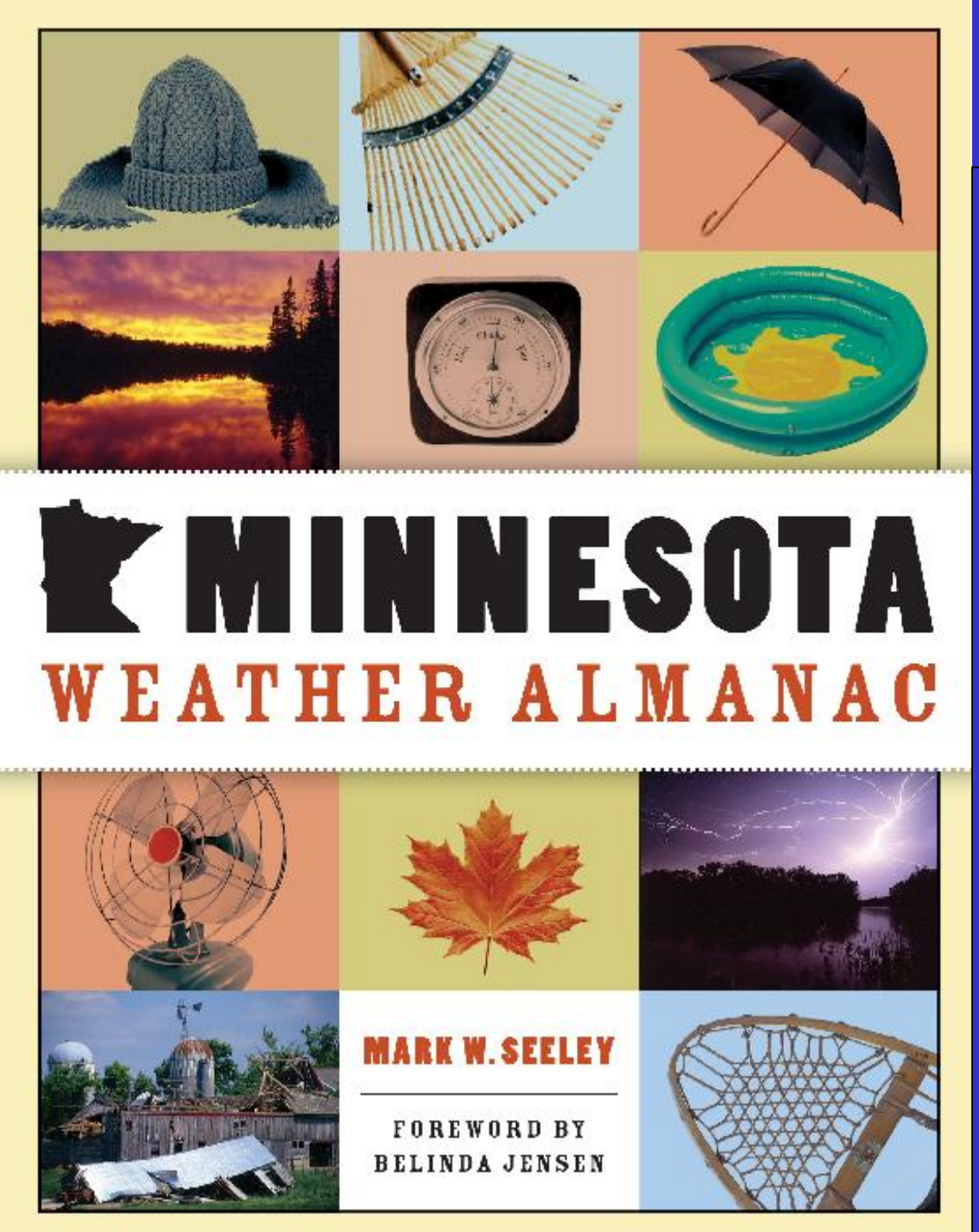


Source: National Climate Assessment, National Climatic Data Center



June 2014
Wettest month in history
on a statewide basis

Hawley 10.95”
International Falls 10.24”
Kabetogama 11.93”
Granite Falls 10.99”
Belle Plaine 15.16”
Glencoe 14.61”
MSP 11.36”
Luverne 13.84”
Redwood Falls 14.24”
Waseca 12.93”
Rushford 12.76”



Historic Droughts

(Associated fires)

1829, 1852, 1856

1863-1864, 1871-1872

1894, 1896, 1900,

1910, 1918, 1921-1923

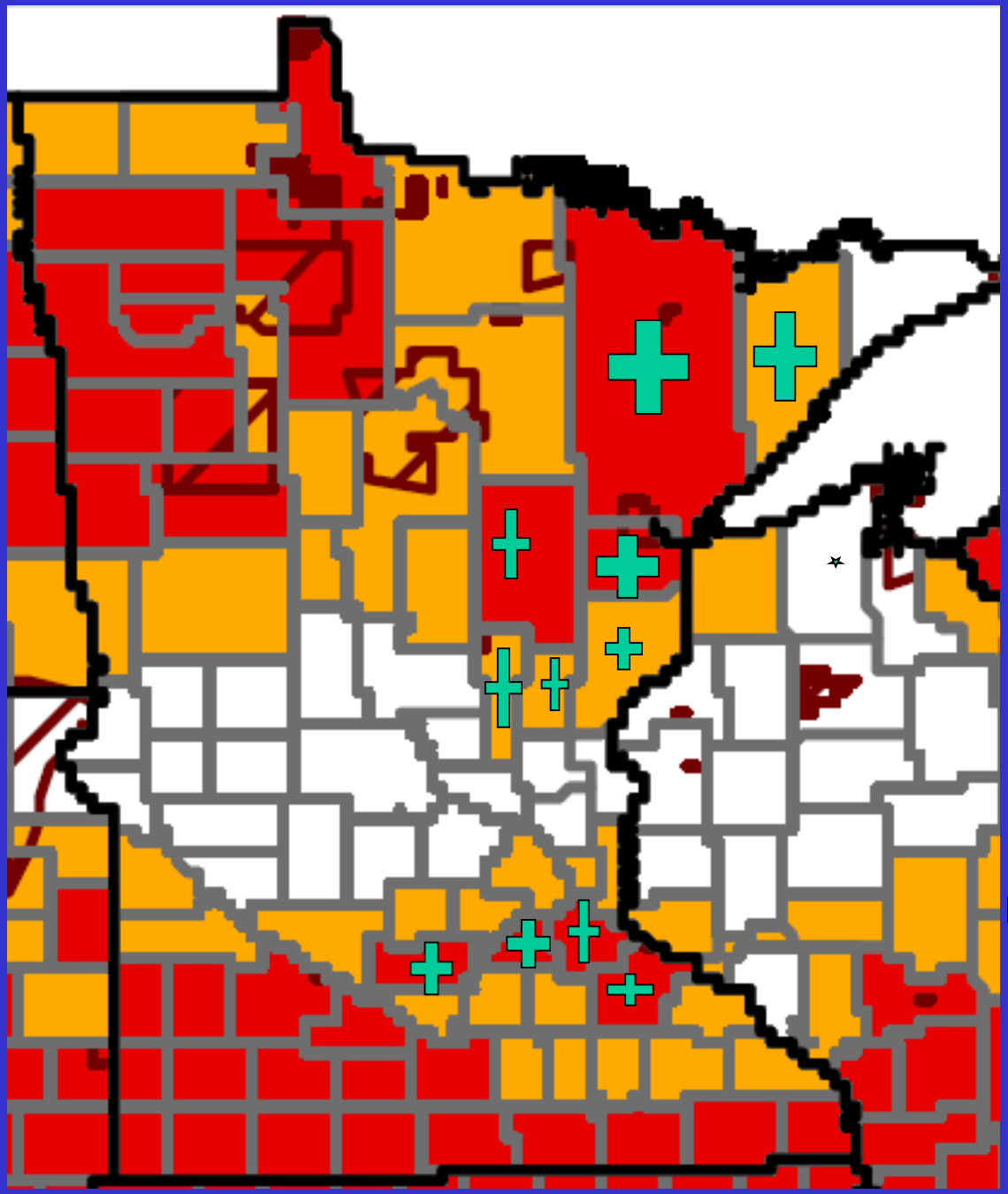
1926, 1929-1934,

1936-1939, 1948,

1954-1956, 1961,

1976, 1980, 1984,

1987, 1988, 1997, 2005-2006, 2007 2008 2009, 2010, 2011, 2012, 2013

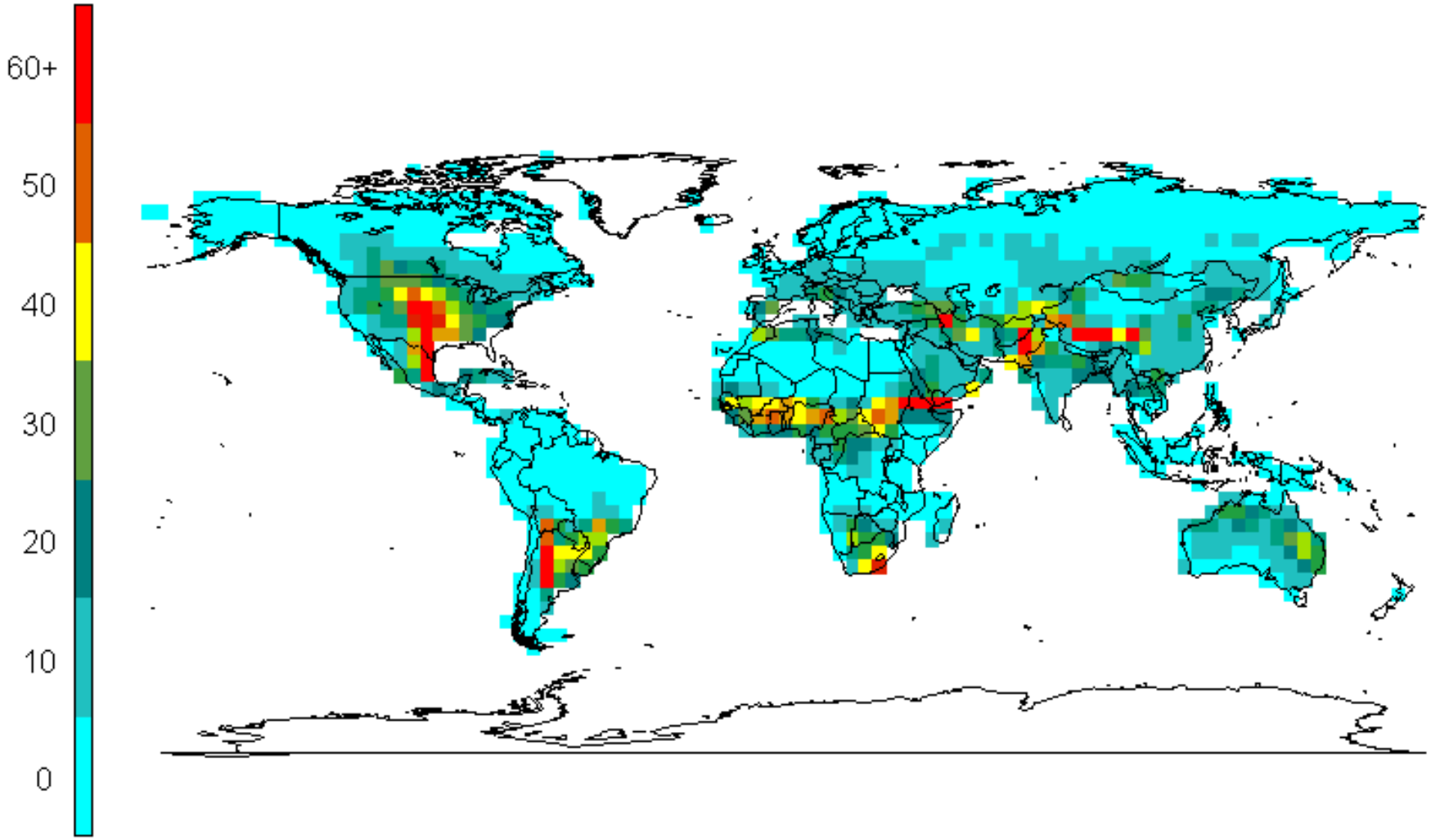


MN Counties designated for federal disaster assistance in 2012

All are associated with drought except those with

Which designates for flood or severe storm

Days per Year with Favorable Severe Parameters



from Brooks et al, NOAA-SSL, 2012

Observations – Minnesota Trends

Minnesota Mega-rain Events

August 6, 1866, Southern Minnesota
July 17-19 1867, Central Minnesota
July 20-22, 1909, Northern Minnesota
September 9-10, 1947 Iron Range
July 21-22, 1972, Grand Daddy Flash Flood
June 28-29, 1975, Northwest Minnesota
July 23-24, 1987, Twin Cities Superstorm
June 9-10, 2002, Northern Minnesota
September 14-15, 2004 Southern Minnesota
August 18-20, 2007, Southern Minnesota
September 22-23, 2010 Southern Minnesota
June 19-20, 2012, Northeast Minnesota

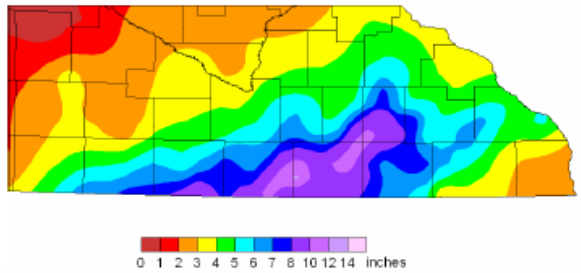
Defined as 6" or greater rains cover at least 1000 square miles and a peak amount of 8" or greater

Shift in Precipitation Recurrence Intervals

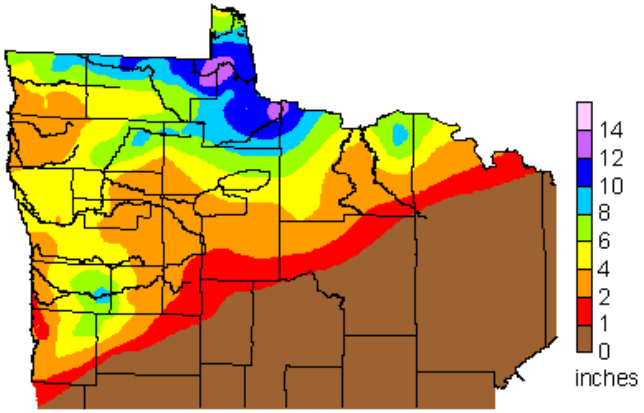
Mega Rains since 2002

'1000-yr (approx.) events' in Southern Minnesota in the last decade.

September 14-15, 2004

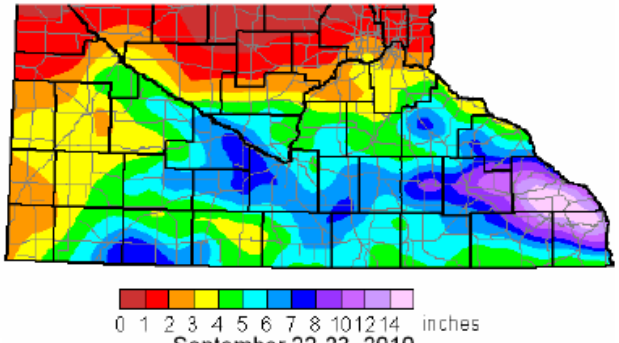


Rainfall Totals - June 9 and 10, 2002

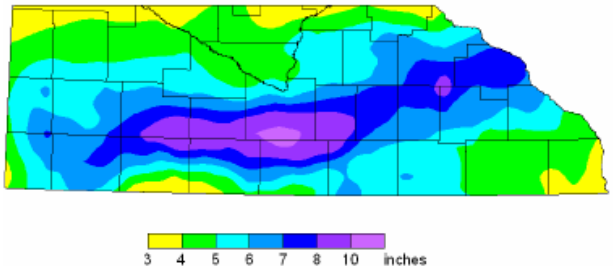


State Climatology Office - DNR Waters

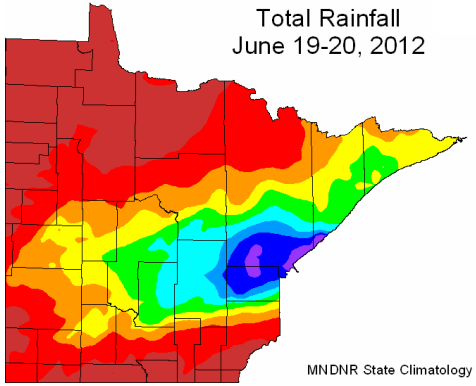
August 18 through August 20 (8:00 AM CDT), 2007



September 22-23, 2010



Total Rainfall
June 19-20, 2012



A 'by-eye' estimate of the total area covered by 10" of rain over the 7 years of 2004-2010 appears to be near 1400 sq. mi. or about 200 sq. mi per year. Given that the area of the southern 3 layers of counties looks to be approximately 20000 sq. mi. the areal fraction of the southern three counties covered by 10" per year appears to be approximately 1/100; i.e. at the rate of coverage for the last 7 years an area equal to the whole southern three county area could be covered in about 100 years.

©State Climatology Office, DNR-Eco/Waters, September 2010

2010 Minnesota Tornadoes

48 on June 17, 2010

OPERATIONAL EF SCALE	
EF Number	3 Second Gust (mph)
0	65-85
1	86-110
2	111-135
3	136-165
4	166-200
5	Over 200

Tornado Enhanced Fujita Intensity Rating

- = EF4 (4)
- = EF3 (4)
- = EF2 (8)
- = EF1 (31)
- = EF0 (66)

Total = 113

First ever EF-5 Tornado in Canada, (Elie, Manitoba) June 22, 2007

First 4 inch thunderstorm rainfall Churchill, Manitoba, Aug 24, 2010

Located at nearly 59 degrees N. latitude, Churchill, Manitoba reported their first ever 4.12 inch thunderstorm rainfall on August 24, 2010! Previous record was 2.45 inches.

Consequences Observed and Associated with Climate Change in Minnesota and the western Great Lakes

Adjustments to storm sewer systems, irrigation, drainage, runoff, sediment, and shoreline management

Adjustments in public health (Heat Waves, allergy season)

Modified fisheries management

Mitigation of flooding potential

Longer growing season, shift in Plant Hardiness Zones

Change in biological organisms (pathogens, pests, microbes)

Change in animal migration, hibernation, and foraging

Change in frequency and magnitude of insured losses

Change in drought and fire weather frequencies

Increased use of air conditioning

Amplified variability of watershed volume flows

Our state climate database indicates that many attributes of our environment are changing……some changes are evident in the measurement of averages, variability, and extremes…….and further these changes are having observable consequences. It is clearly poor judgment to ignore this!

www.cloudappreciationsociety.org