A Presentation of the

December 2, 2008

IOWA STATE UNIVERSITY
University Extension

UNIVERSITY OF MINNESOTA
EXTENSION

MN-IA 9th Annual Drainage Forum

Dec 2, 2008

Climate Trends and Observations

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St Paul, MN

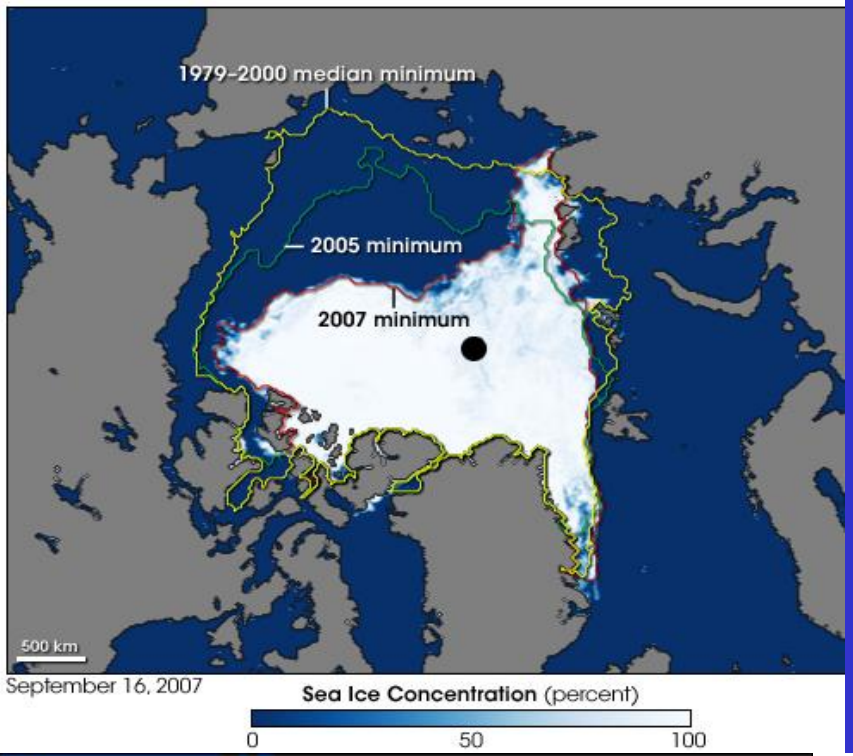
Big Picture Climate Trends Synopsis Points of Agreement (IPCC-2007)

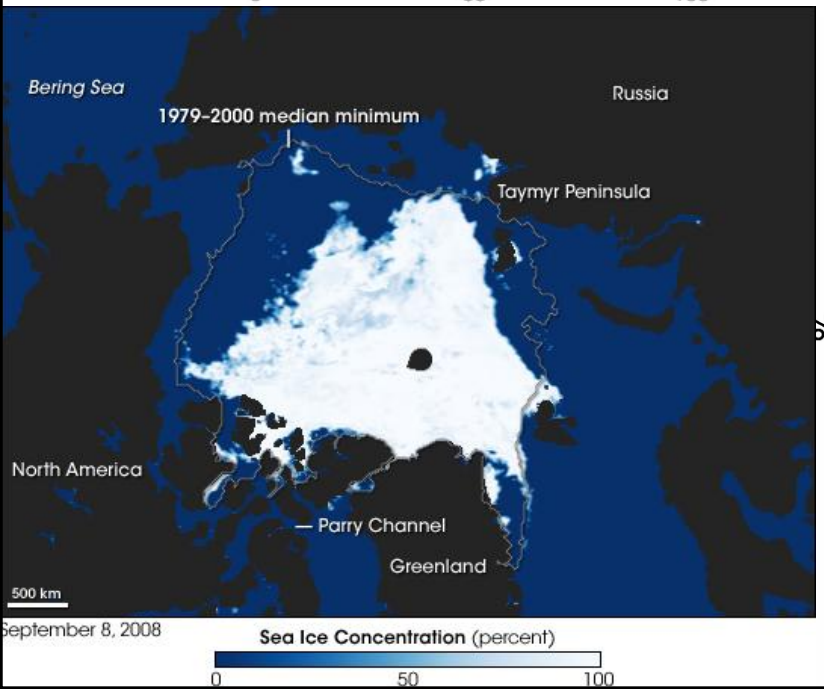
- **N. Hemisphere Bias**
- **Latitude Bias**
- **Seasonal Disparity**
- **Minimum Temperature Weighted**
- **Amplification of Hydrologic Cycle**
- **Highly Complex Water Vapor Signal**
- **Attribution Dilemma**

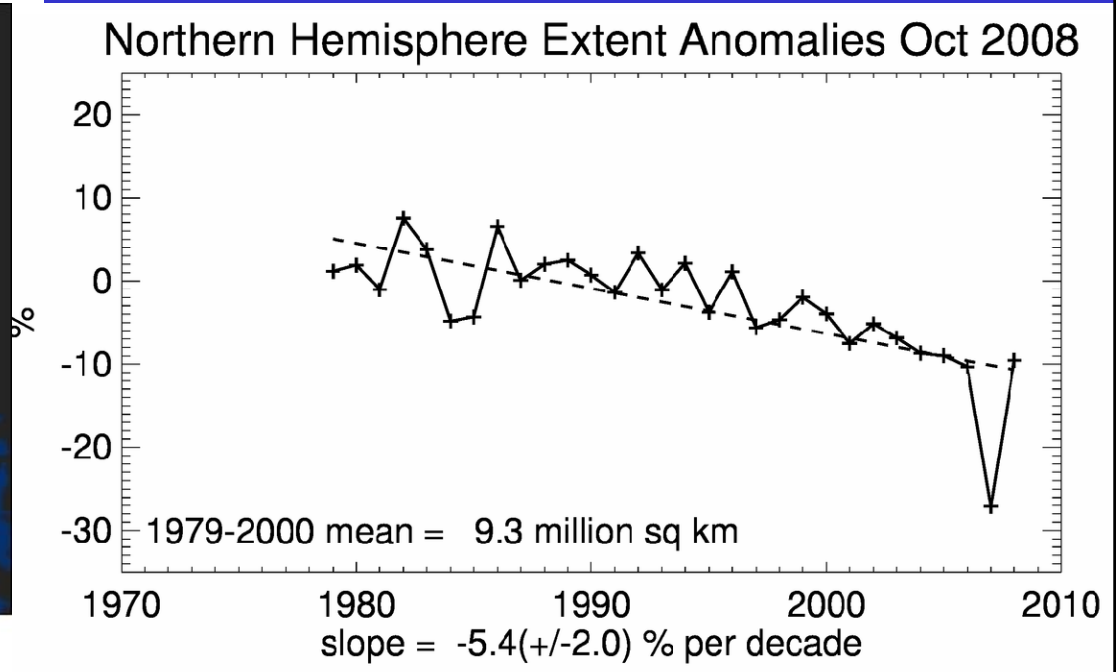
Shocking News in Sep 2007

Loss in NH polar ice to new record low

NH polar sea ice show continued decline in 2008, 2nd lowest





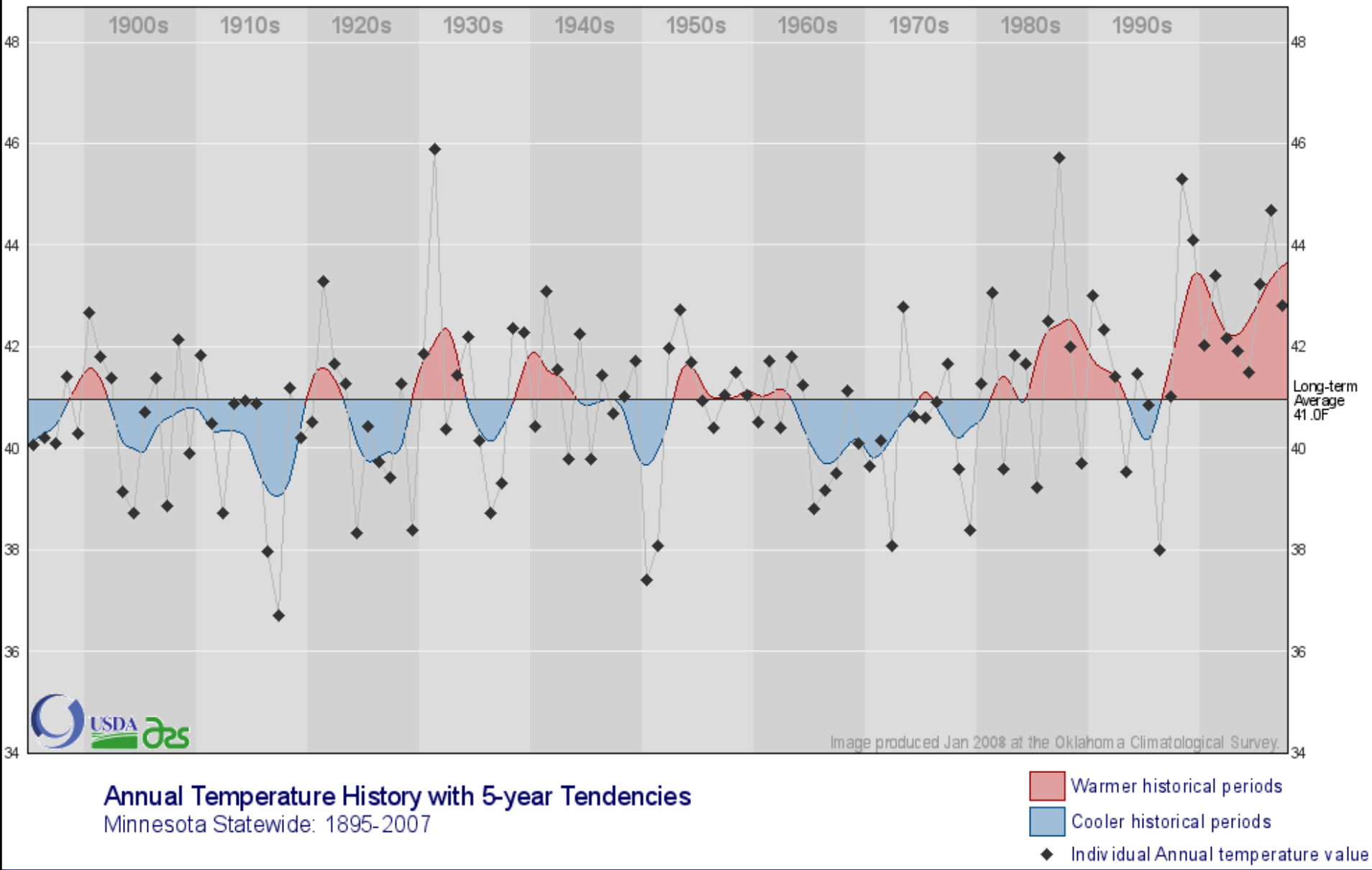


RECENT SIGNIFICANT CLIMATE TRENDS IN THE WESTERN GREAT LAKES

- *TEMPERATURE*: SEASONALITY AND WEIGHTED MINIMUM TEMPERATURE CONTRIBUTIONS

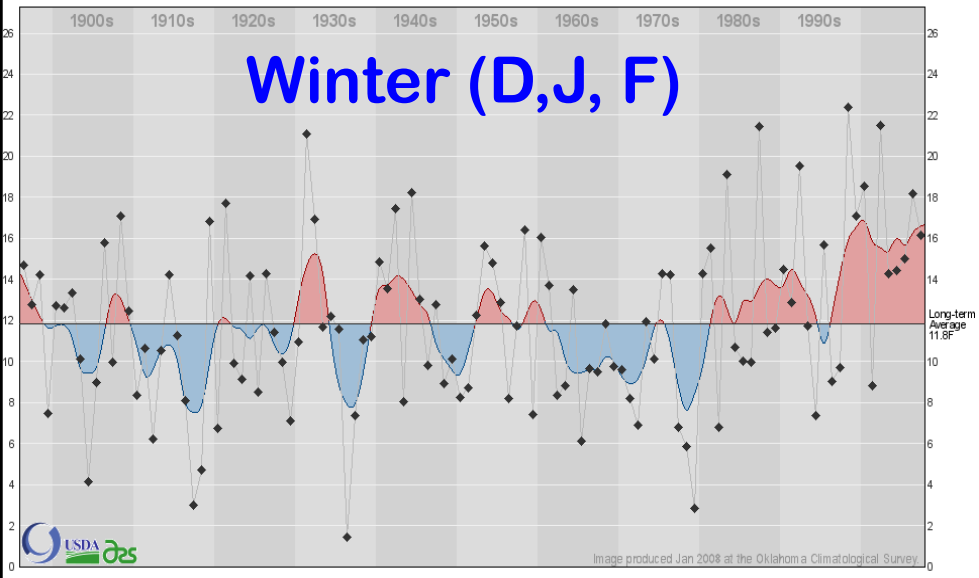
- *DEWPOINTS*: YIELDING WARMER SUMMERS AND MITIGATING EVAPORATION RATES

- *MOISTURE*: AMPLIFIED PRECIPITATION VARIABILITY, THUNDERSTORM CONTRIBUTION



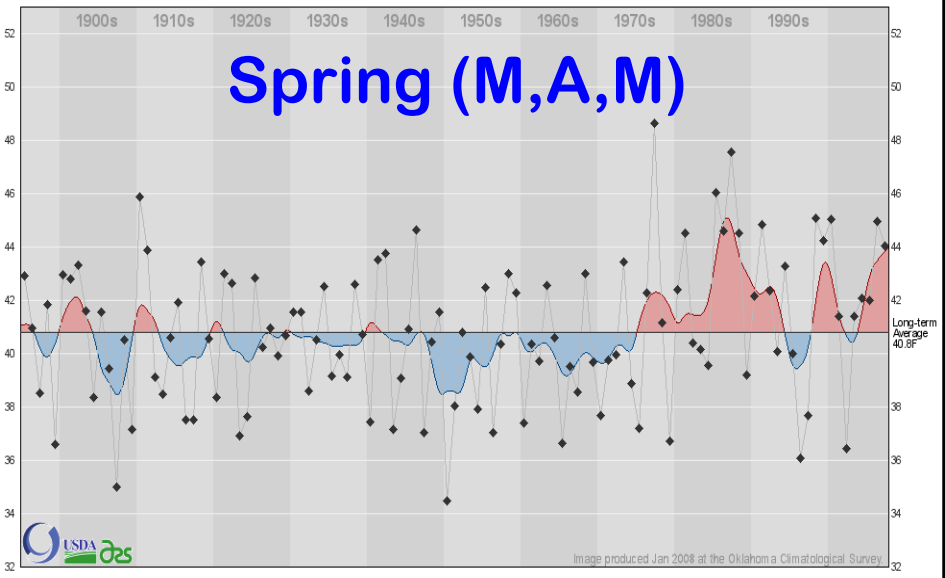
Statewide Annual Temperature History

Seasonal Temperature Trends in MN



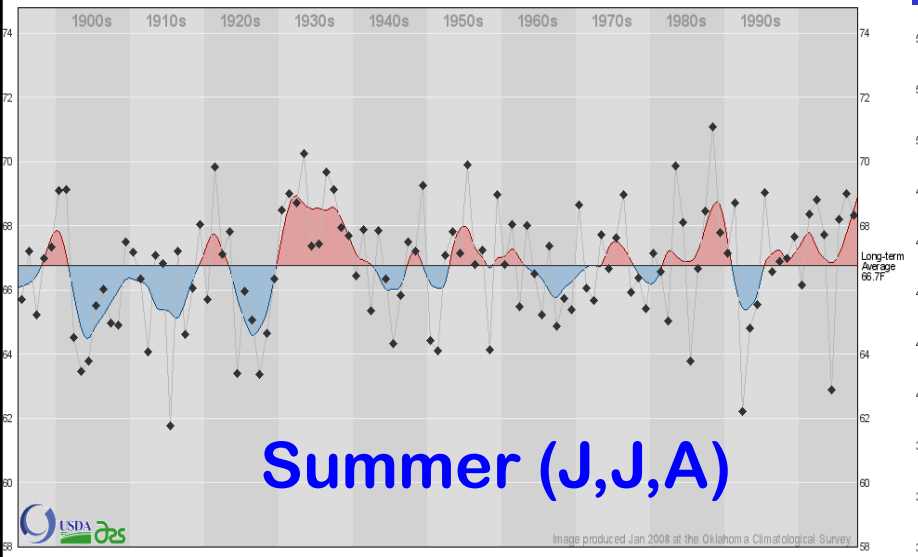
Winter Temperature History with 5-year Tendencies
Minnesota Statewide: 1896-2007

Warmer historical periods
Cooler historical periods
Individual Winter temperature valu



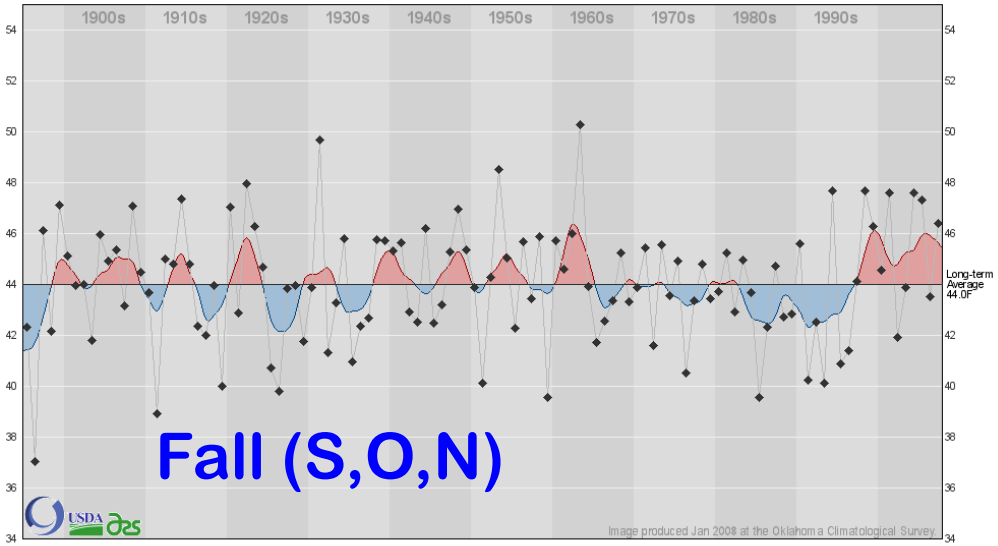
Spring Temperature History with 5-year Tendencies
Minnesota Statewide: 1895-2007

Warmer historical periods
Cooler historical periods
Individual Spring temperature value



Summer Temperature History with 5-year Tendencies
Minnesota Statewide: 1895-2007

Warmer historical periods
Cooler historical periods
Individual Summer temperature valu



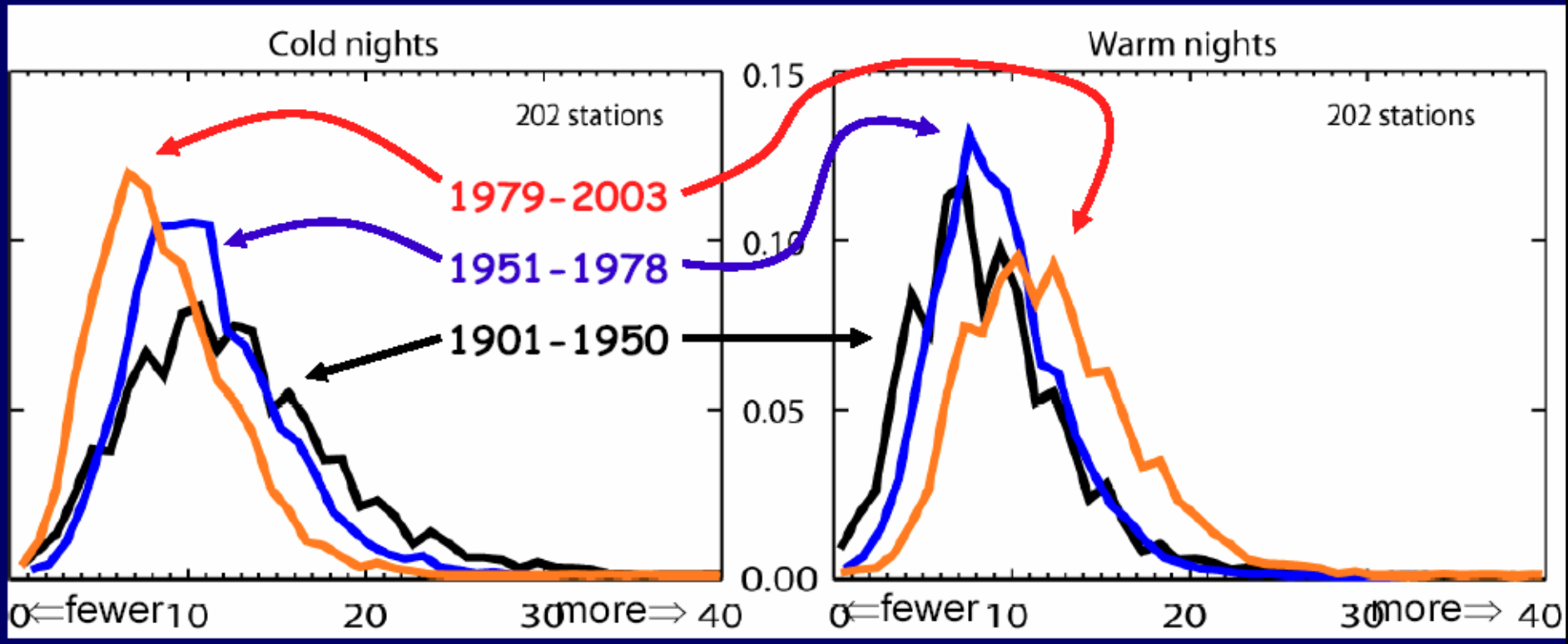
Autumn Temperature History with 5-year Tendencies
Minnesota Statewide: 1895-2007

Warmer historical periods
Cooler historical periods
Individual Autumn temperature value

Historical ranking and distribution of mean daily temperature over the past eleven winters (Nov-Mar) in MN

Winter	Mean Temp (F)	Ranking (since 1895)
1997-1998	24.2	109th
1998-1999	23.0	106th
1999-2000	26.0	113th
2000-2001	15.8	28th
2001-2002	25.0	112th
2002-2003	19.3	73rd
2003-2004	20.3	86th
2004-2005	21.2	95th
2005-2006	23.2	108th
2006-2007	22.2	103rd
2007-2008	16.7	40th

Warm nights are increasing; cold nights decreasing



Frequency of occurrence of cold or warm temperatures for 202 global stations for 3 time periods:
1901 to 1950 (black), 1951 to 1978 (blue) and 1979 to 2003 (red).

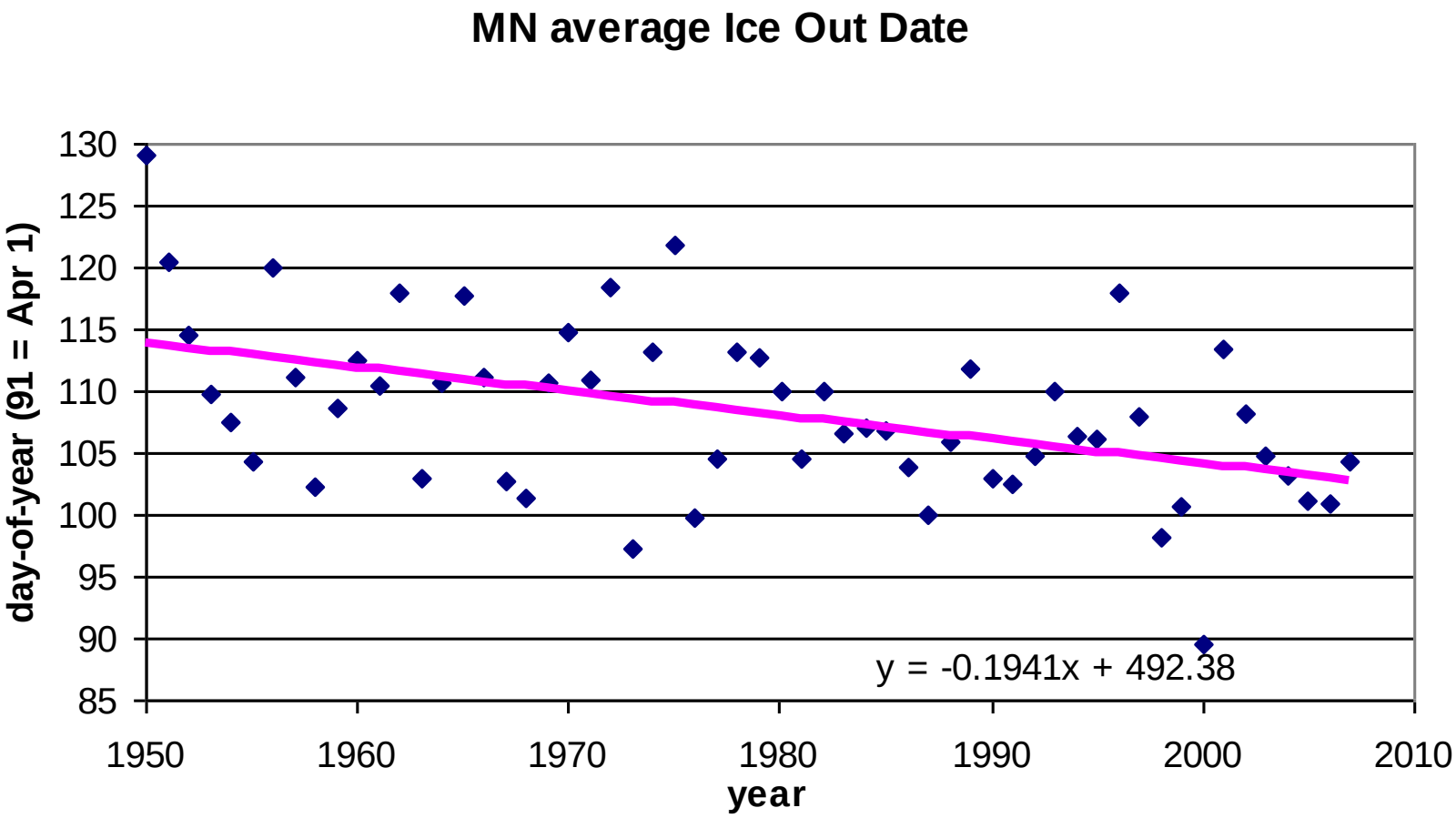
Warming is weighted towards minimum temperature change

Trends in average winter minimum temperatures Rochester, MN

Period of Record	Ave Min Temp in Deg. F
1951 - 1980	Jan 1.9
1961 - 1990	Jan 2.7
1971 - 2000	Jan 3.7
1951 - 1980	Feb 7.6
1961 - 1990	Feb 8.1
1971 - 2000	Feb 10.6
1951 - 1980	Mar 19.2
1961 - 1990	Mar 21.3
1971 - 2000	Mar 22.6

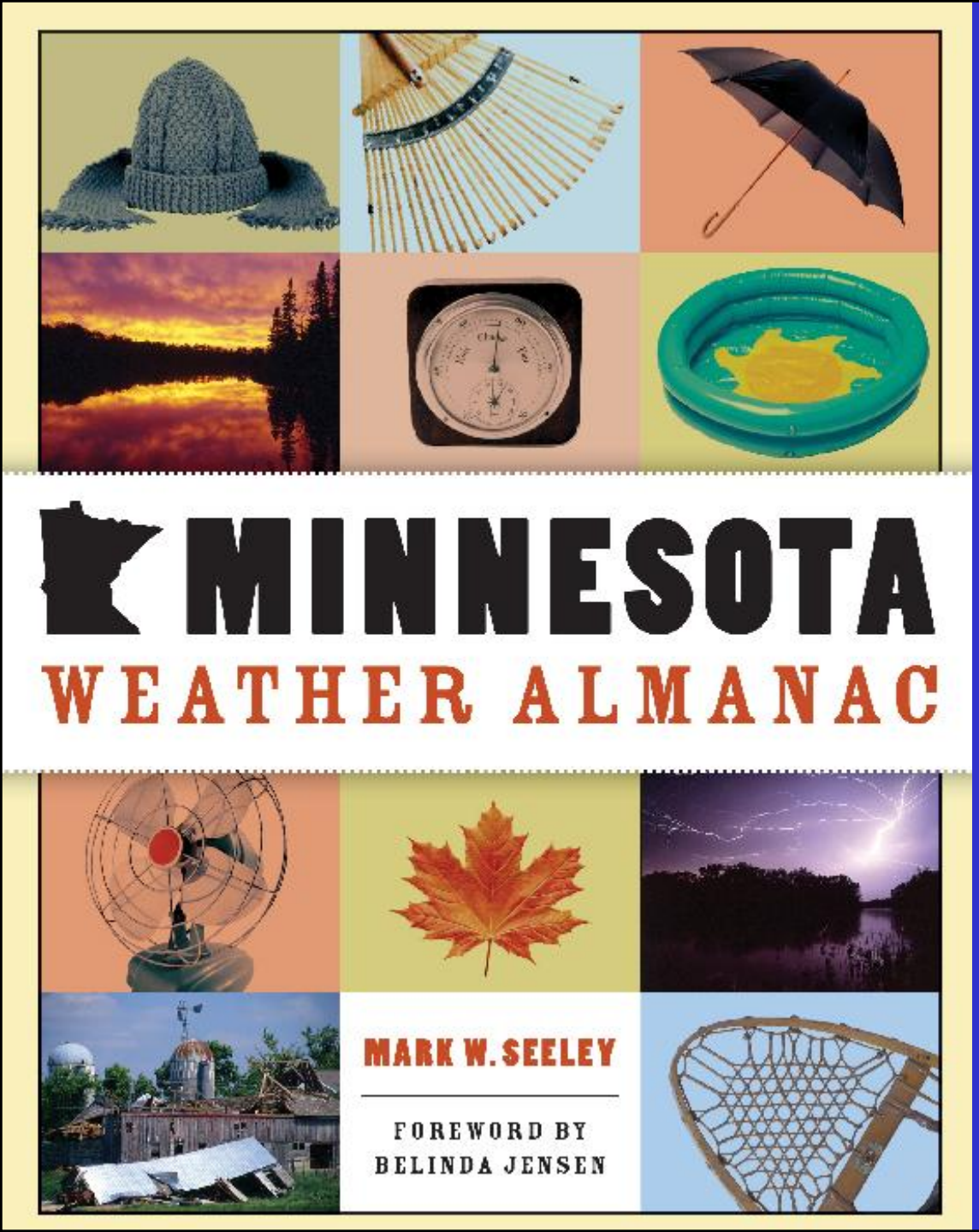
Possible Implications of Warm Winters and Higher Minimum Temperatures

- Change in depth and duration of soil and lake freezing
- More rapid breakdown of crop residues
- Later fall nitrogen applications
- Longer outdoor construction season, fewer adverse weather days
- Change in over winter survival rates of insect pests and plant diseases, and soil microbes
- Reduced energy use for heating
- Increased number of freeze/thaw cycles
- Change in animal migration, hibernation, and foraging
- Longer exposure times to mold and allergens



State Climatology Office, DNR Waters, 2007

Change in average ice out dates across MN



Most Striking 19th Century Winter Weather Stories:

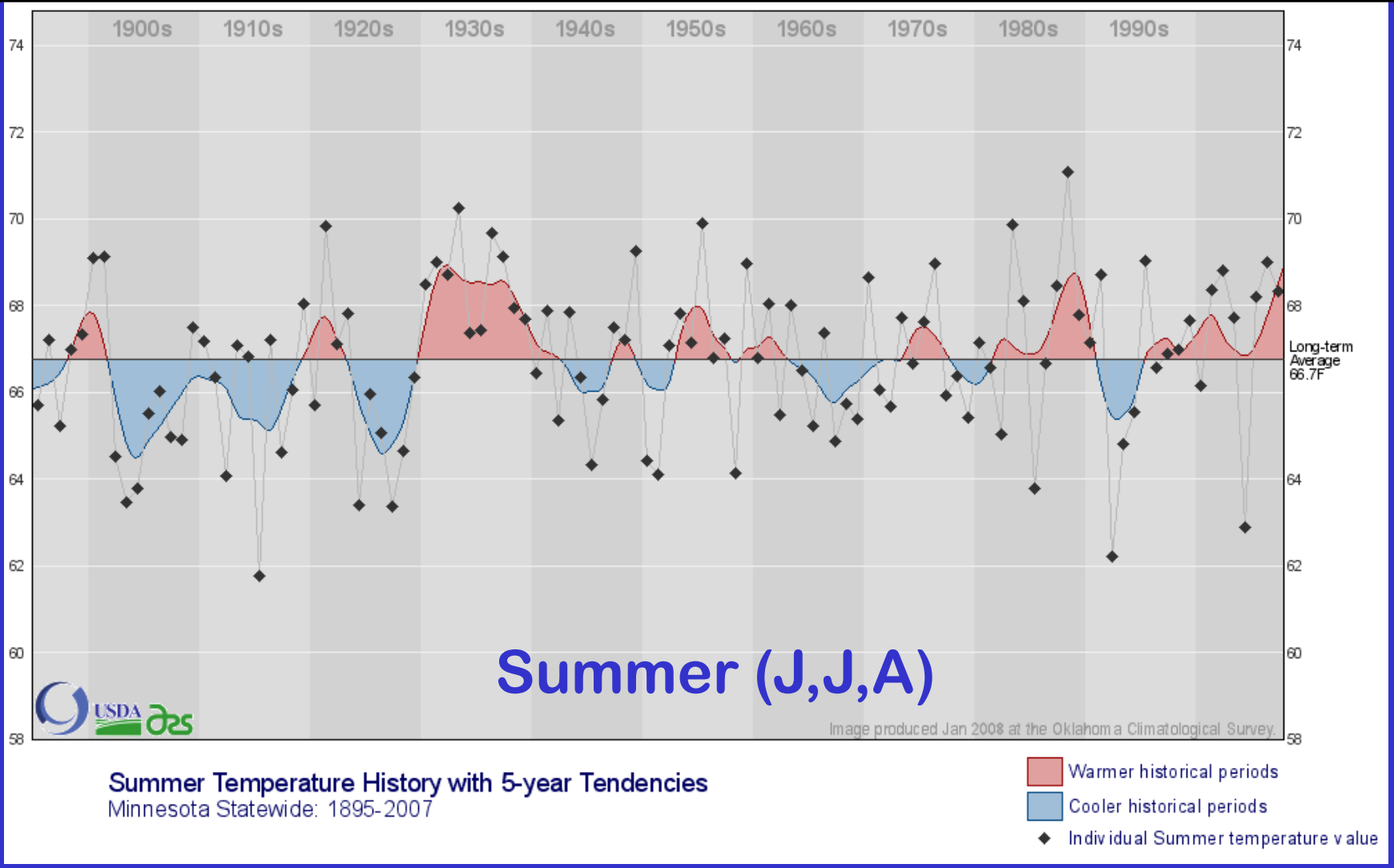
March 1843

Winter 1856-1857

Winter 1877-78

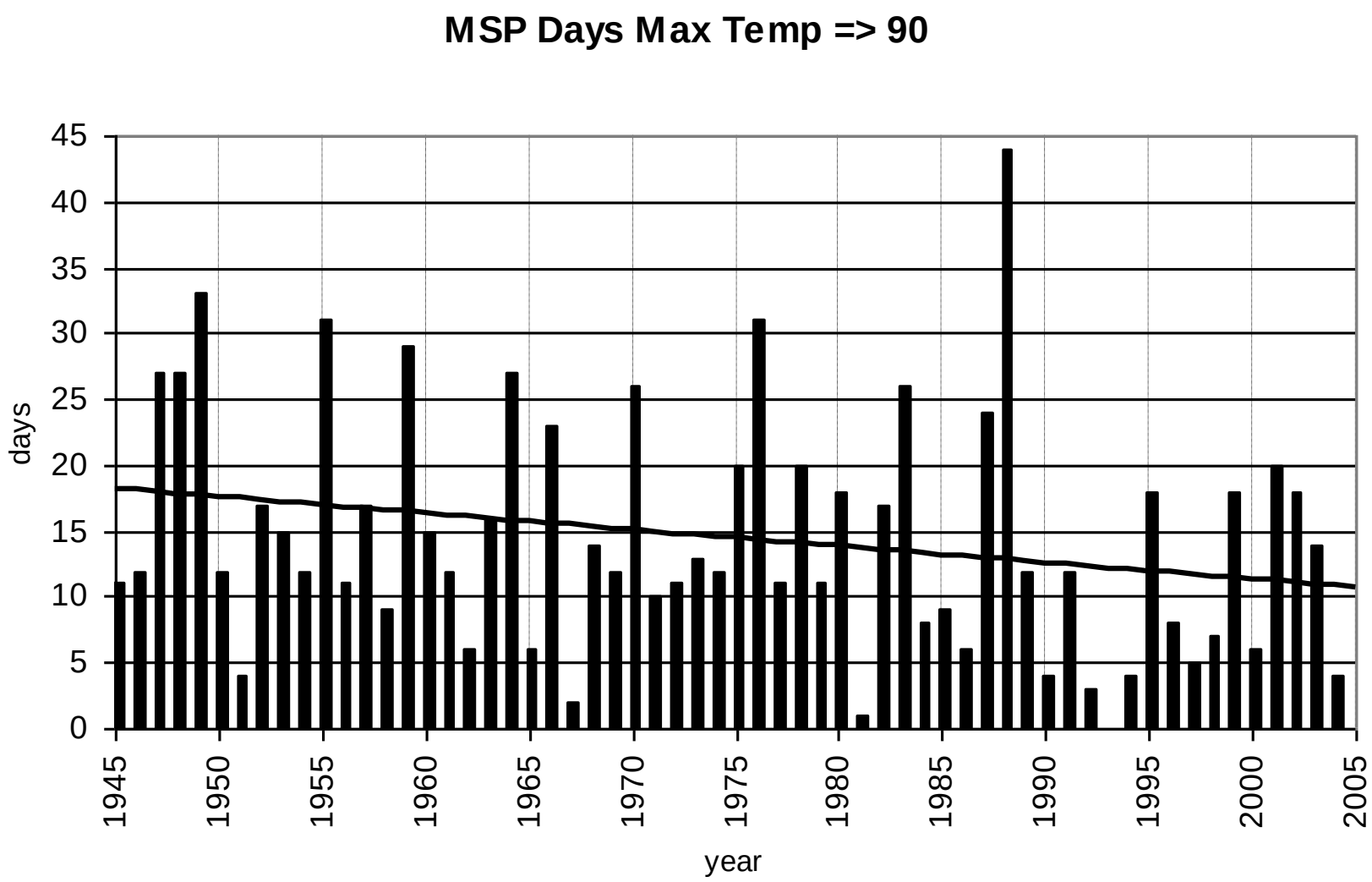
Christmas 1879

Winter 1880-81

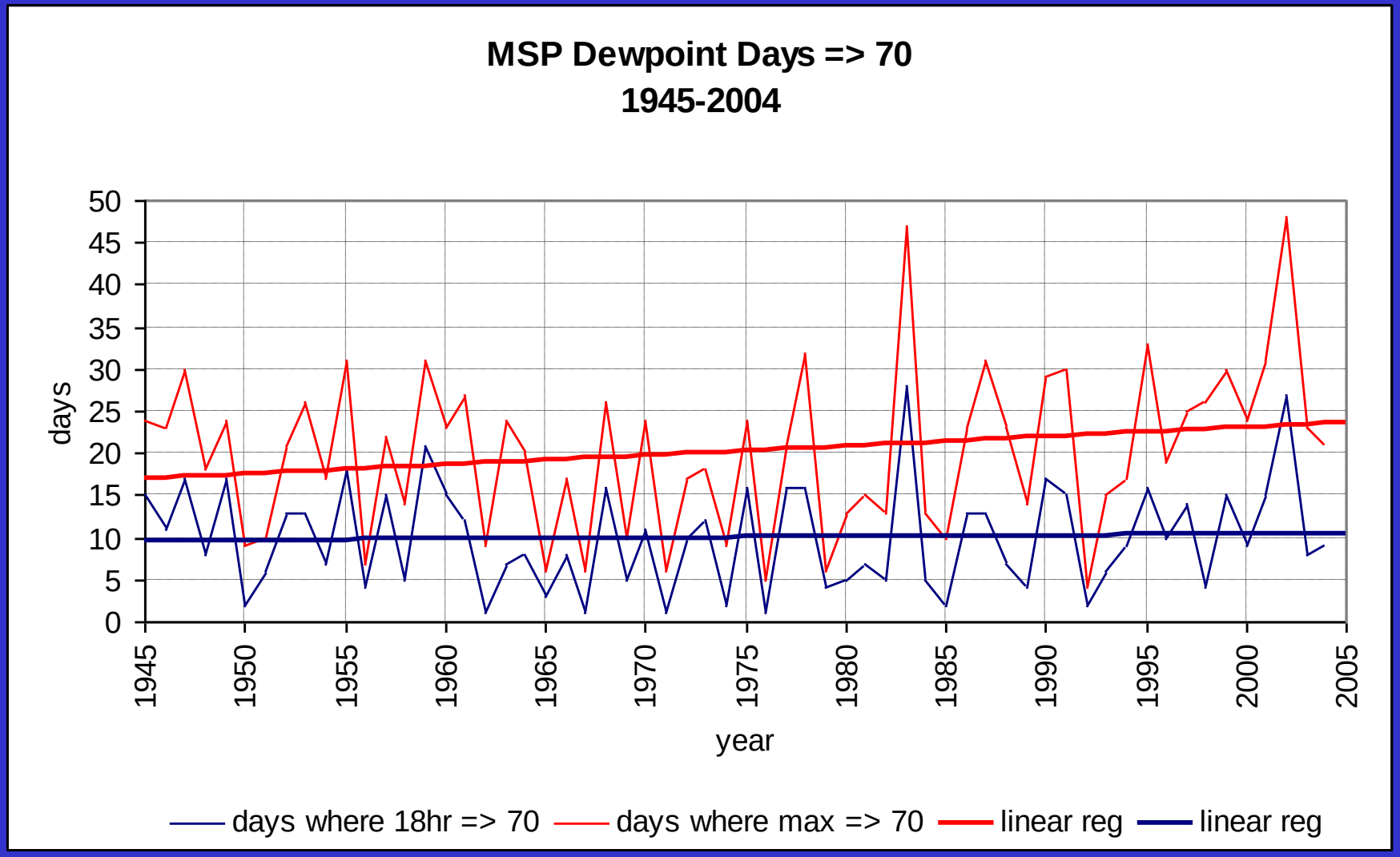


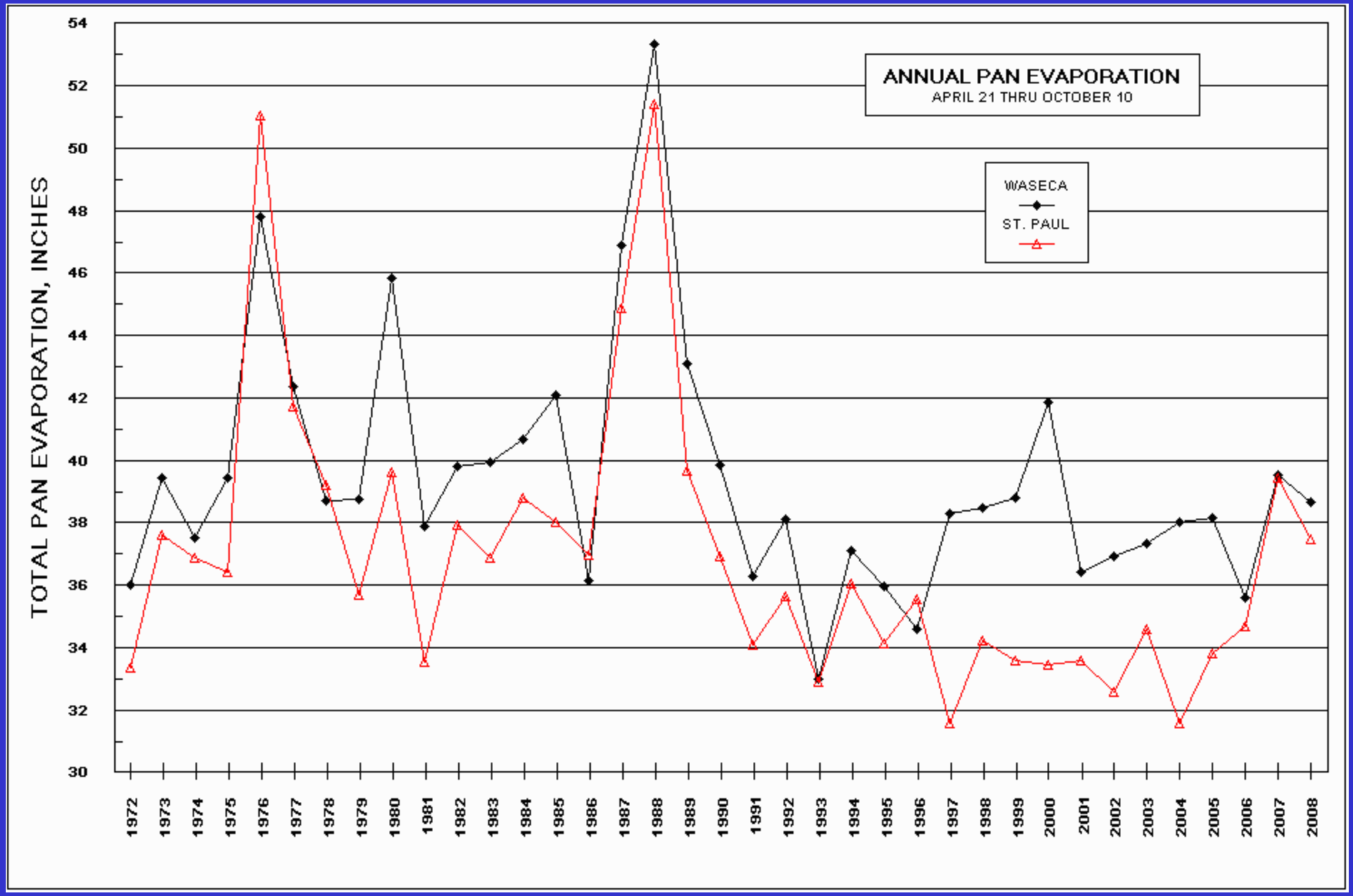
Recent summer mean temperature trend is warmer

Number of days with max temp of 90 F or higher



Trend in dewpoints of 70 F or higher in the Twin Cities




ANNUAL PAN EVAPORATION
APRIL 21 THRU OCTOBER 10
WASECA
ST. PAUL
TOTAL PAN EVAPORATION, INCHES
54
52
50
48
46
44
42
40
38
36
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1974
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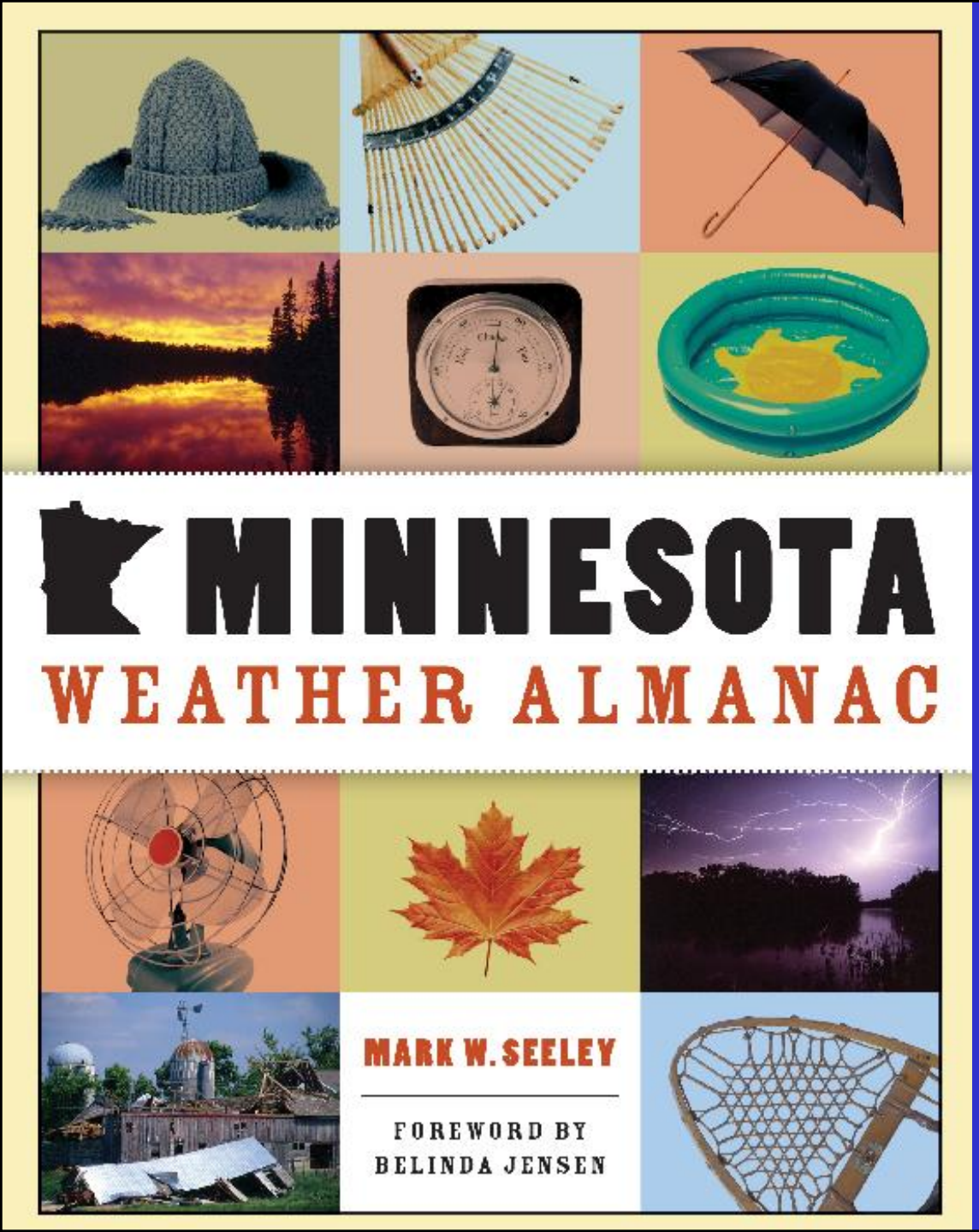
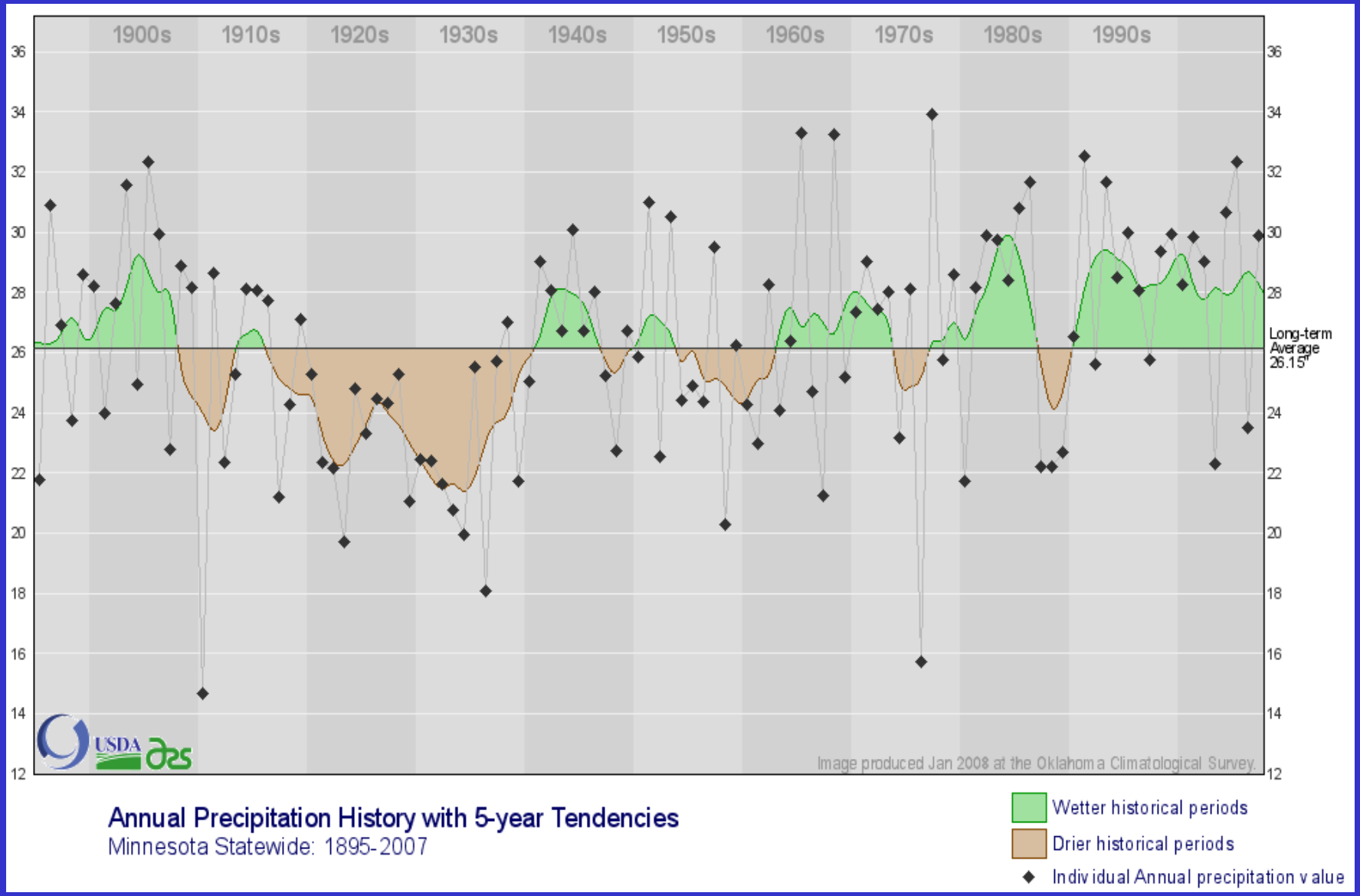


Historic Minnesota Heat Waves:

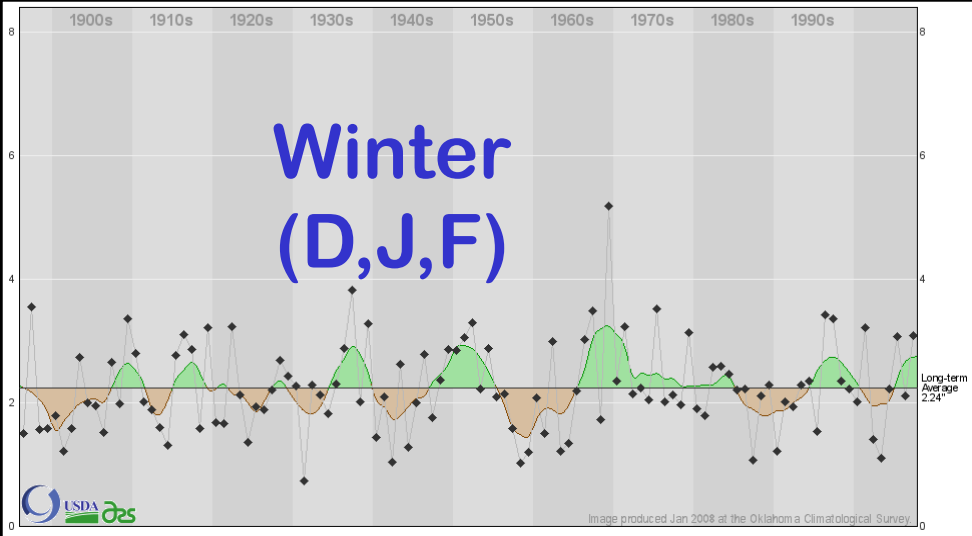
Red denotes dewpoint driven

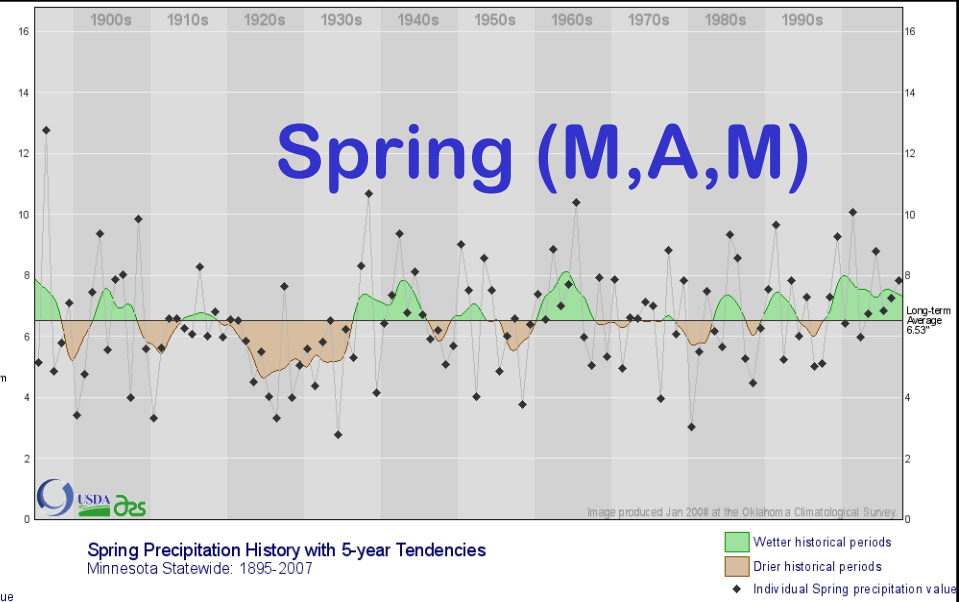
1883, 1894, 1901, 1910, 1917, 1921, 1931, 1933, 1934, 1936, 1937, 1947, 1948, 1949, 1955, 1957, 1959, 1964, 1976, 1977, 1983, 1988, 1995,1999, 2001, 2005, 2006, 2007

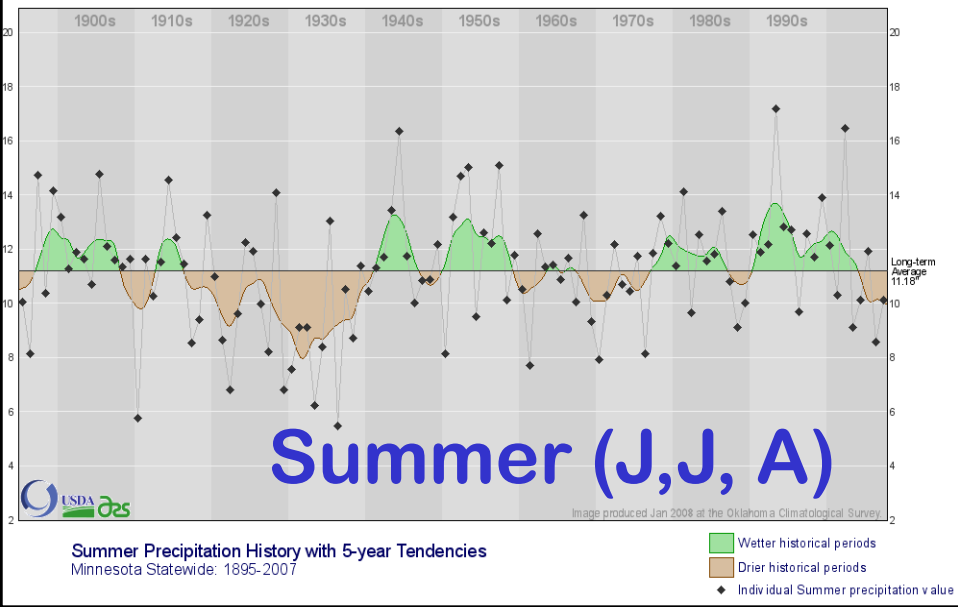


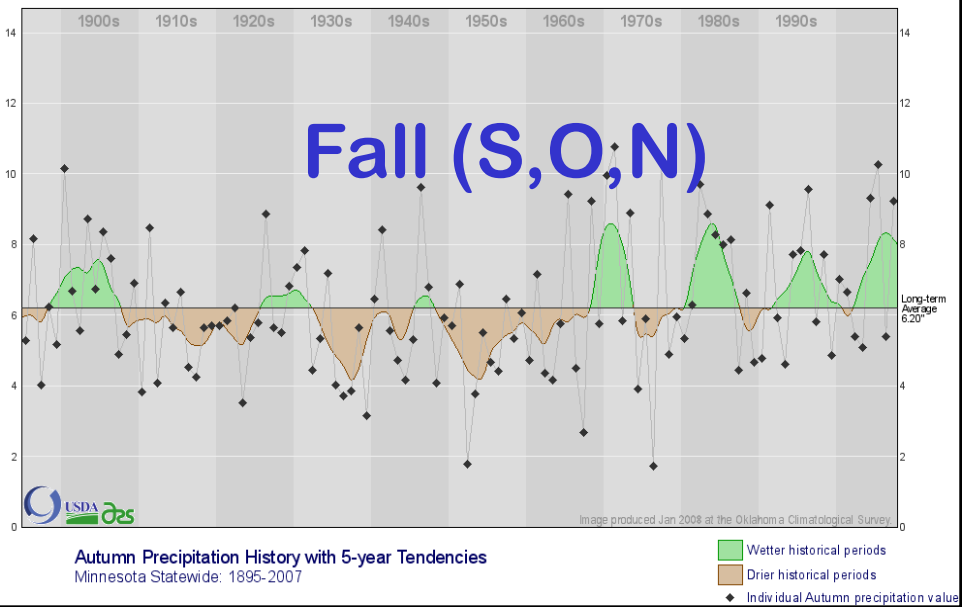
MN Annual Precipitation with 5-yr Tendencies

Seasonality in MN Precipitation Trends









Change in Annual Precipitation "Normals" at Waseca, MN

PERIOD	AMOUNT (IN.)
1921-1950	27.55″
1931-1960	27.82″
1941-1970	29.94″
1951-1980	30.62″
1961-1990	32.45″
1971-2000	34.69″
1978-2007	35.84″

30 percent increase
since 1921-1950 period

Change in Annual Precipitation Normals at Willmar, MN

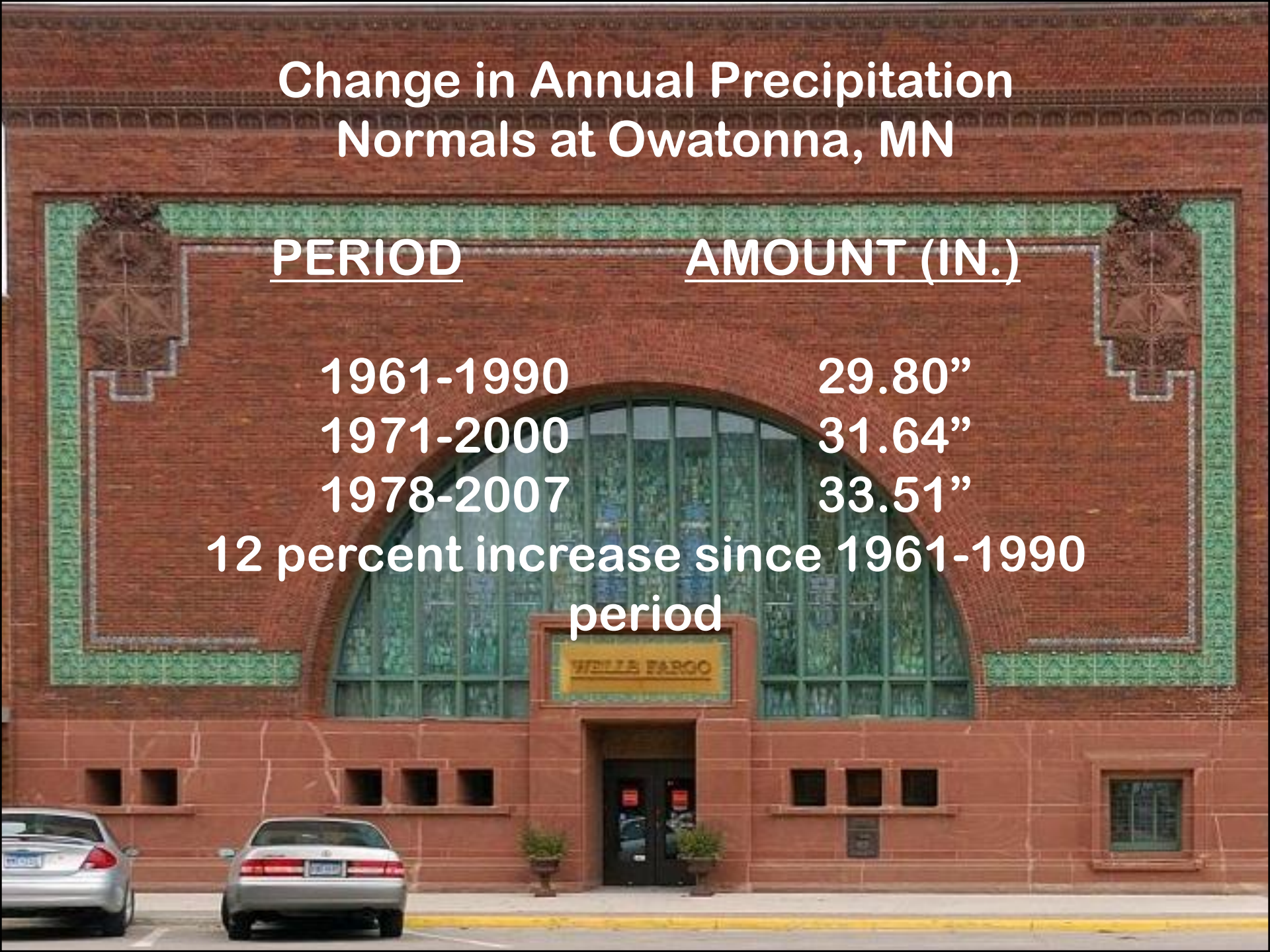
PERIOD	AMOUNT (IN.)
1921-1950	23.01”
1931-1960	24.47”
1941-1970	27.63”
1951-1980	27.71”
1961-1990	28.21”
1971-2000	28.23”
1978-2007	28.62”

24 percent increase since 1921-1950 period

Change in Annual Precipitation Normals at Owatonna, MN

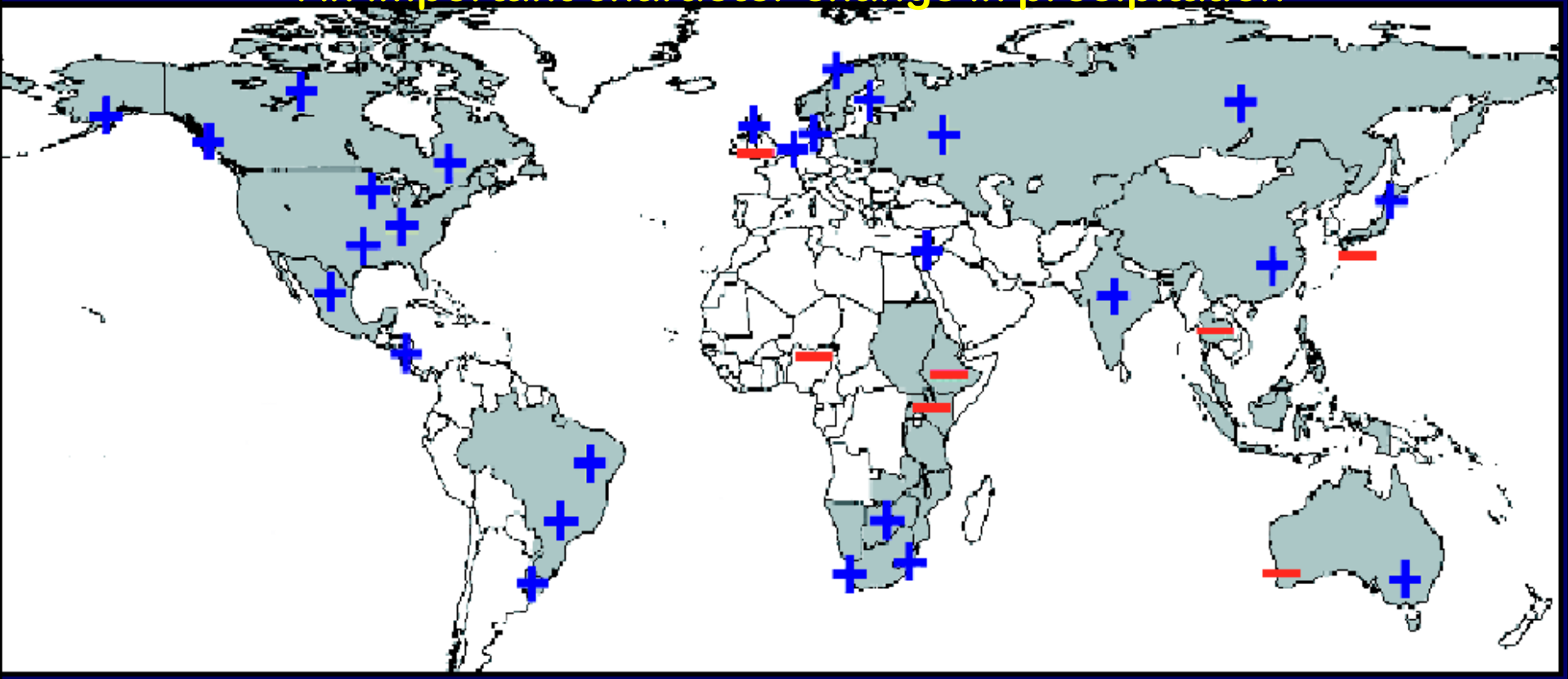
PERIOD	AMOUNT (IN.)
1961-1990	29.80”
1971-2000	31.64”
1978-2007	33.51”

12 percent increase since 1961-1990 period



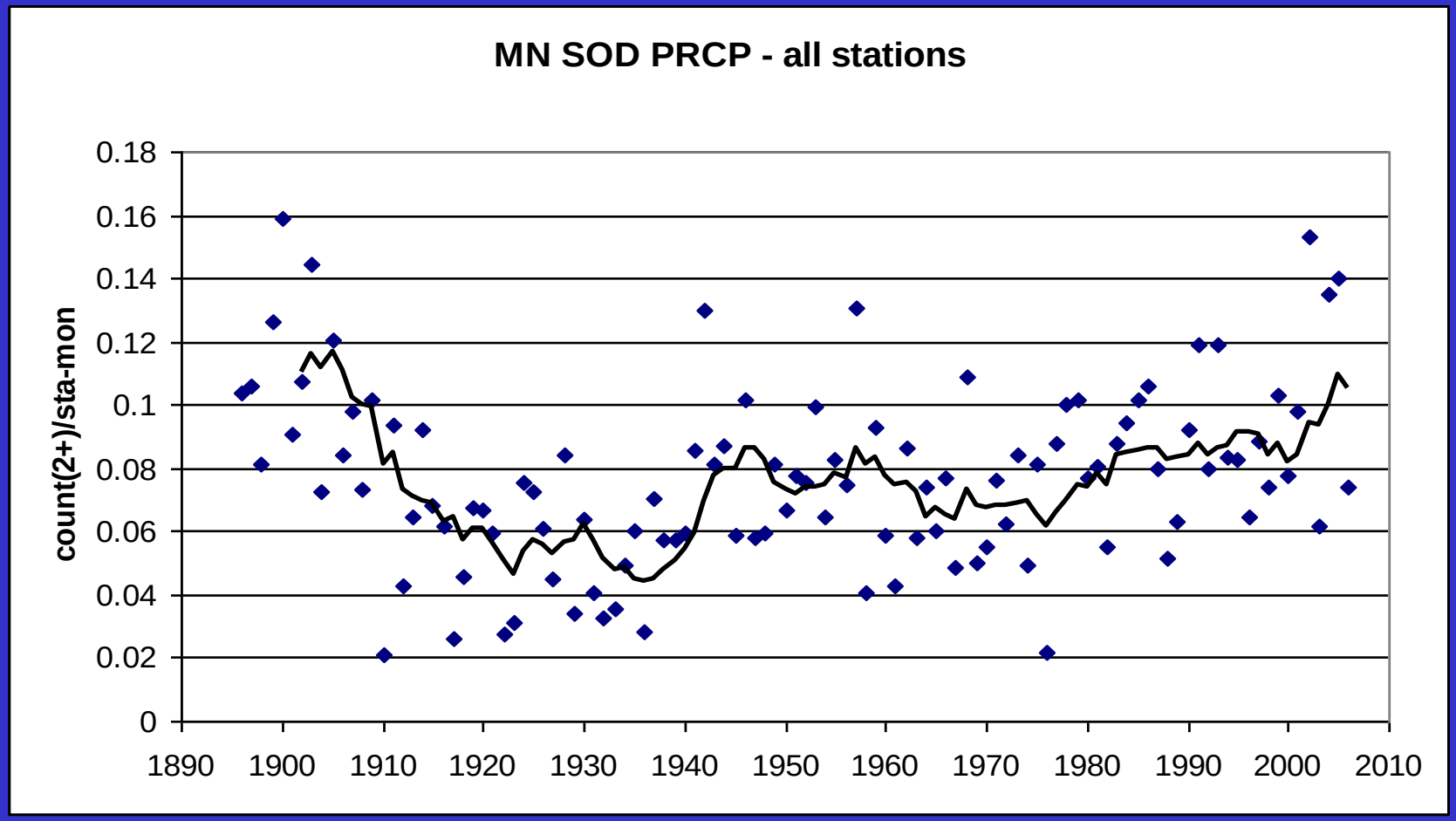
Proportion of heavy rainfalls: increasing in most land areas

An important character change in precipitation



Regions of disproportionate changes in heavy (95th) and very heavy (99th) precipitation

From IPCC 4th Assessment 2007



Overall temporal trend in rainfalls of 2” or greater in Minnesota

Historical recurrence interval of 2 inch rains in MN is once per year.

Observed 2 inch rainfalls for the period 1991 – 2008 (most recent 18 years) and maximum single day value for MN communities:

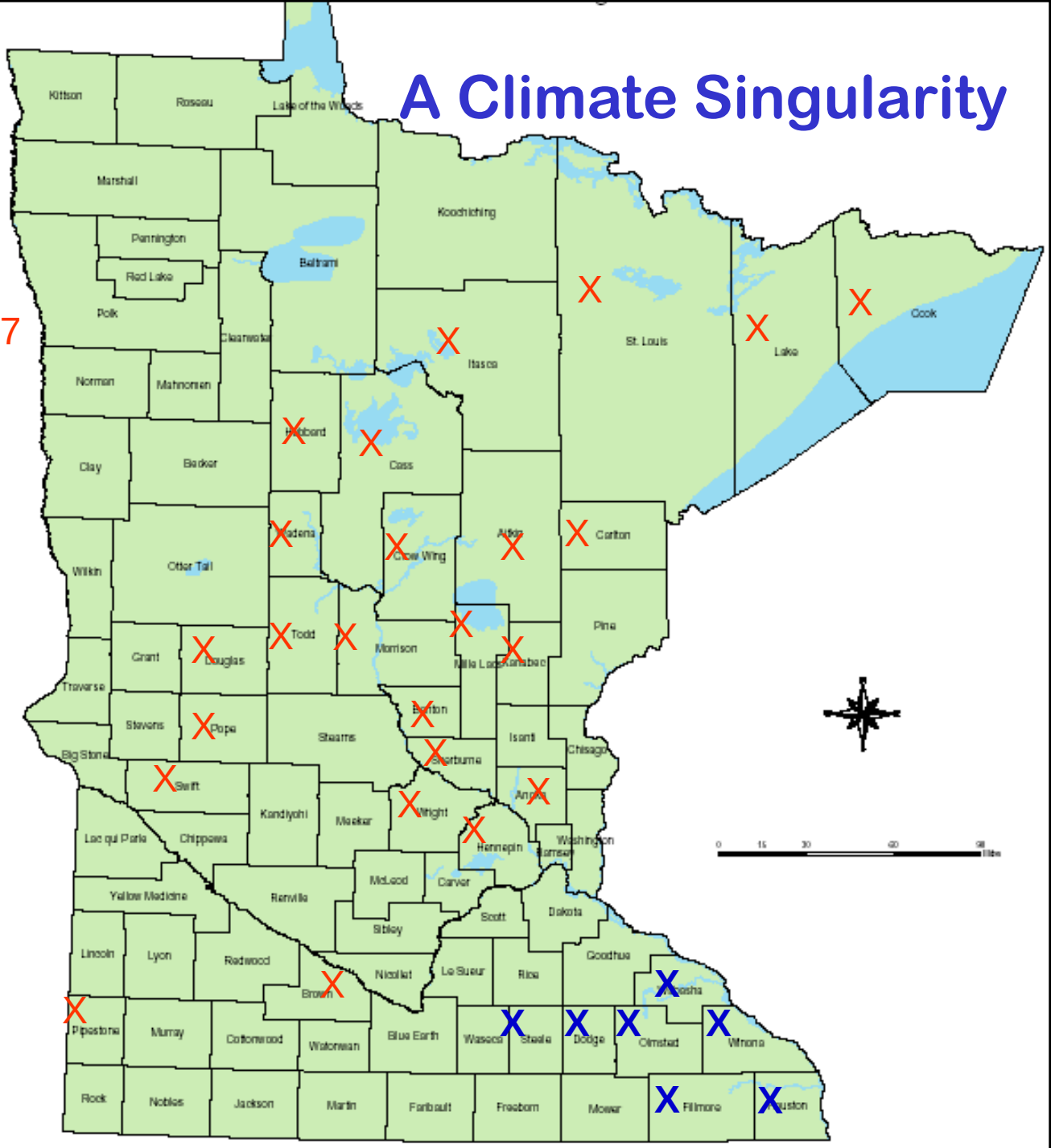
Location	No. 2 in. rains	Maximum Value (date)
Zumbrota	30	6.46 (6/27/98)
Albert Lea	30	7.50 (6/15/78)
Preston	31	6.60 (7/21/51)
Red Wing	27	7.78 (7/1/78)
Lake City	35	5.60 (5/28/70)
Waseca	31	5.40 (8/31/62)
Winnebago	36	8.64 (9/25/2005)
Bricelyn	30	9.22 (9/14/2004)
Amboy	30	4.69 (8/19/2007)
Hokah	28	15.10 (8/19/2007)

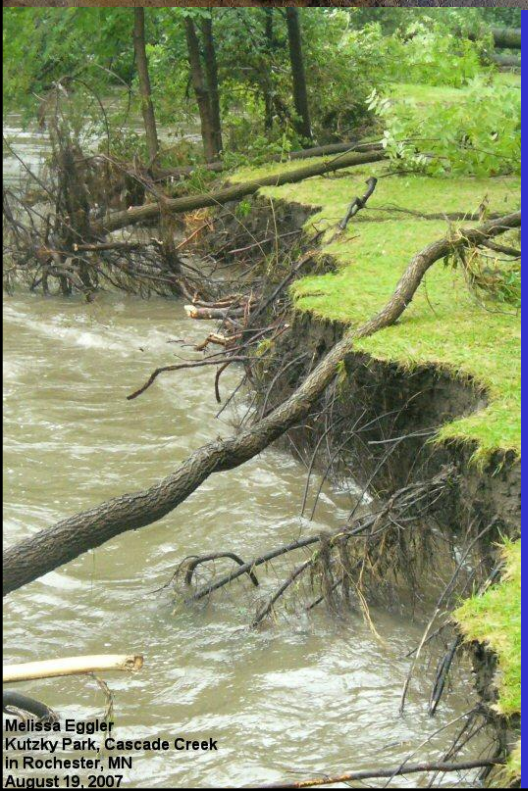
A Climate Singularity

X = 24 counties included in USDA drought disaster declaration of August 7, 2007

Note: adjacent 32 counties were also eligible for assistance

X= Counties included in federal flood disaster declaration of August 20, 2007 and eligible for FEMA assistance





Pictures of storm damage from NWS,

La Crosse, WI

Attributes of this storm:

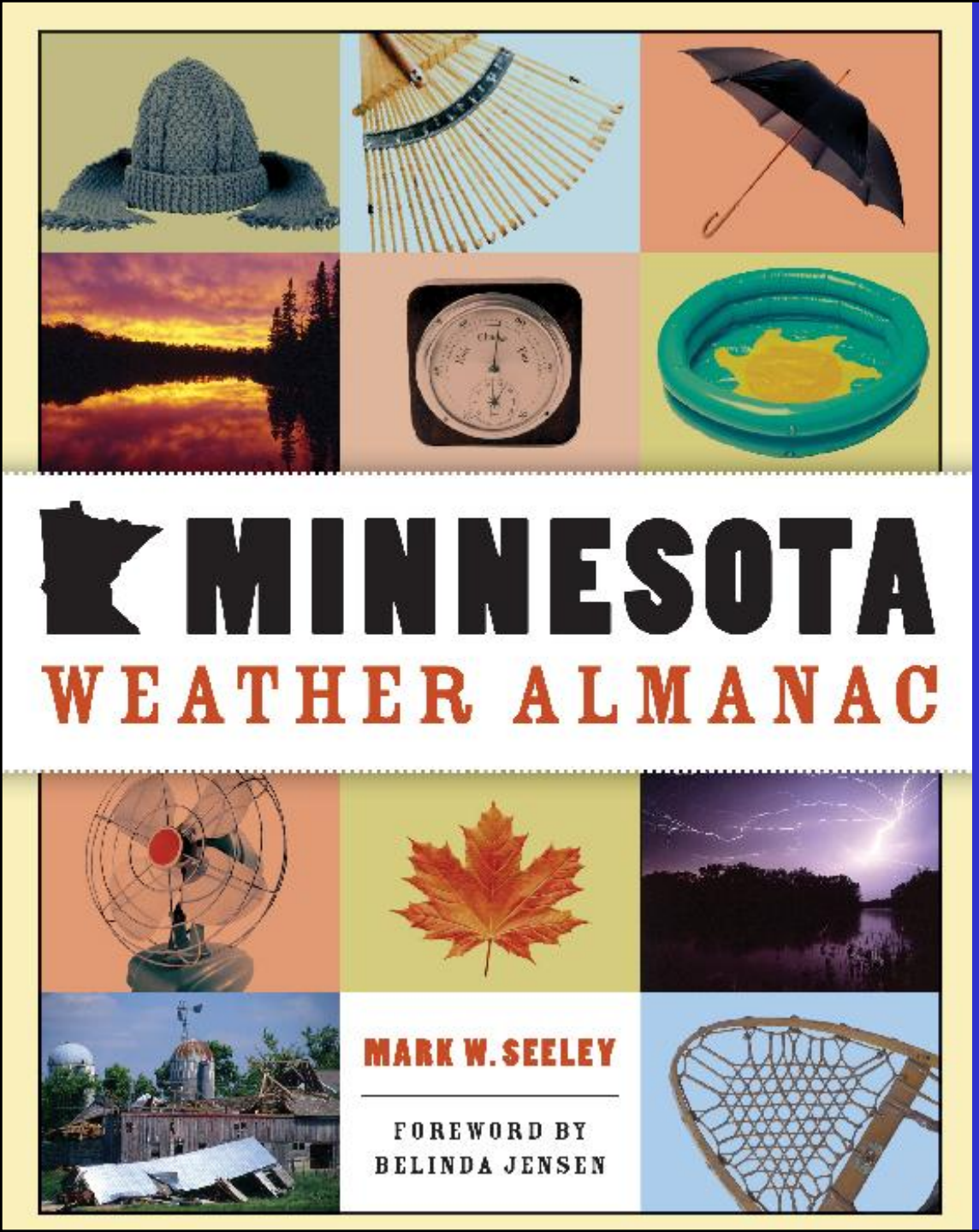
Observers in 28 counties reported 4” or more

Observers in 3 counties (Winona, Fillmore, Houston) reported 14” or more

Dewpoints 60-65 degrees F

Diffuse, weak jet stream

Rushford, MN - August 19, 2007
Image courtesy of Fillmore Co. Emergency Management



Most Striking 19th Century Flash Flood Weather Stories:

August 6-8, 1866

(Wisel Flood)

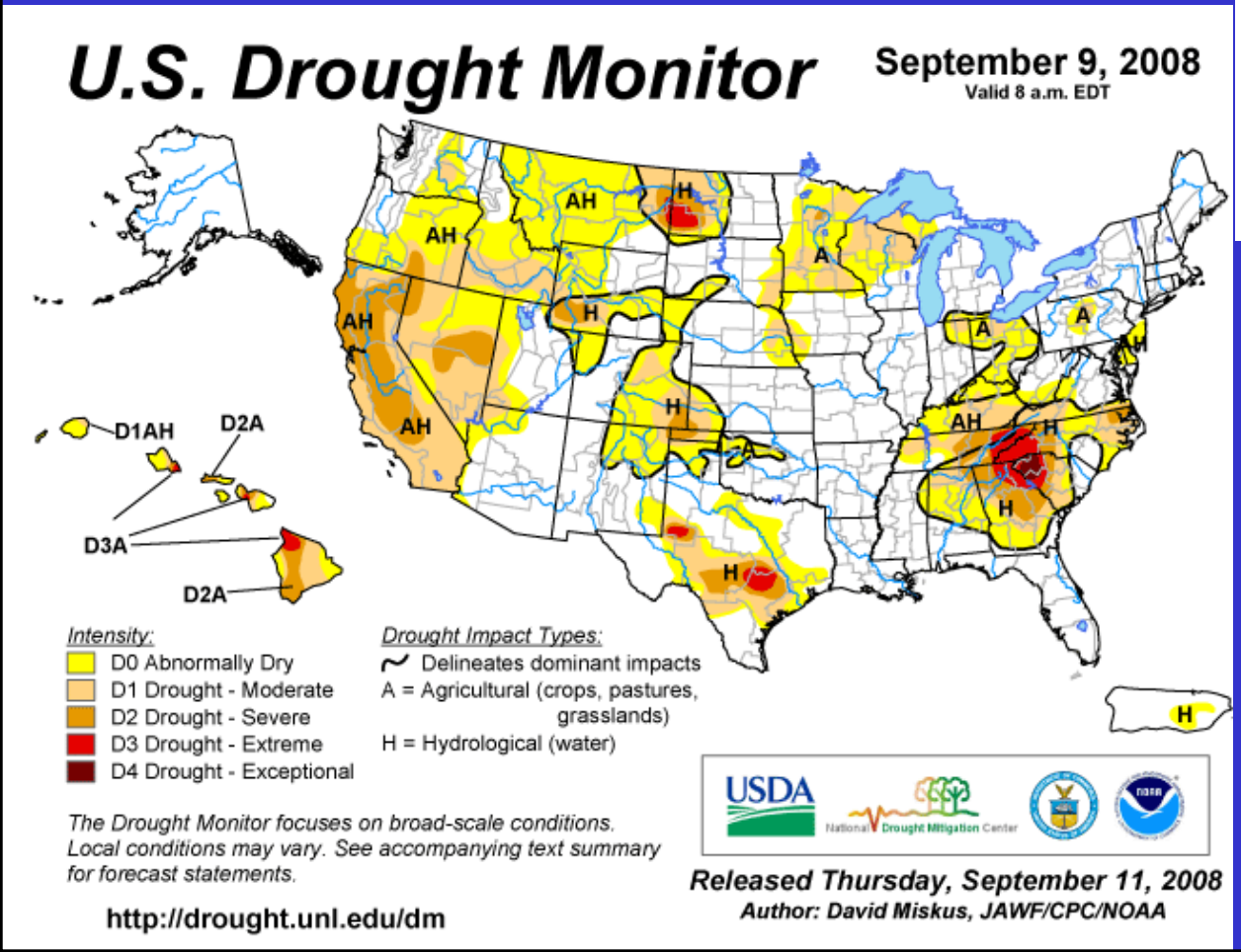
July 17-19, 1867

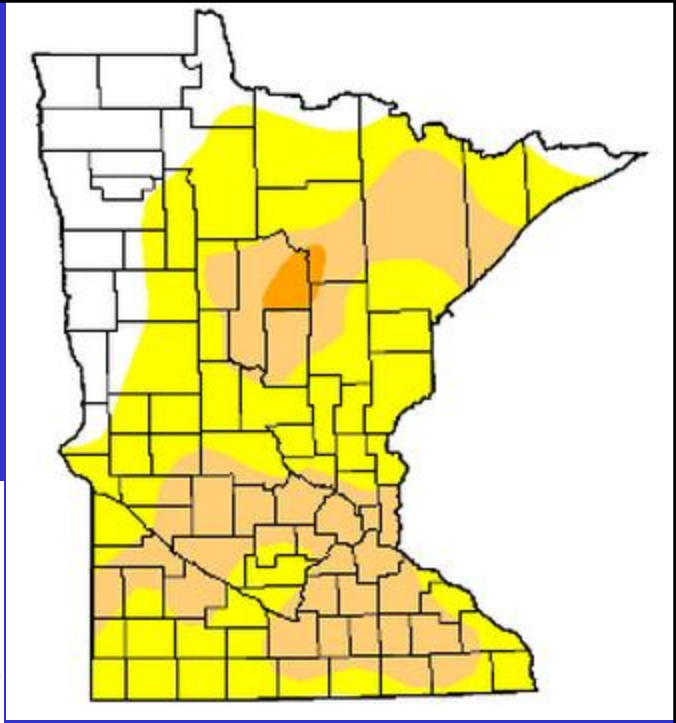
(Wright Flood)

June 12, 1899

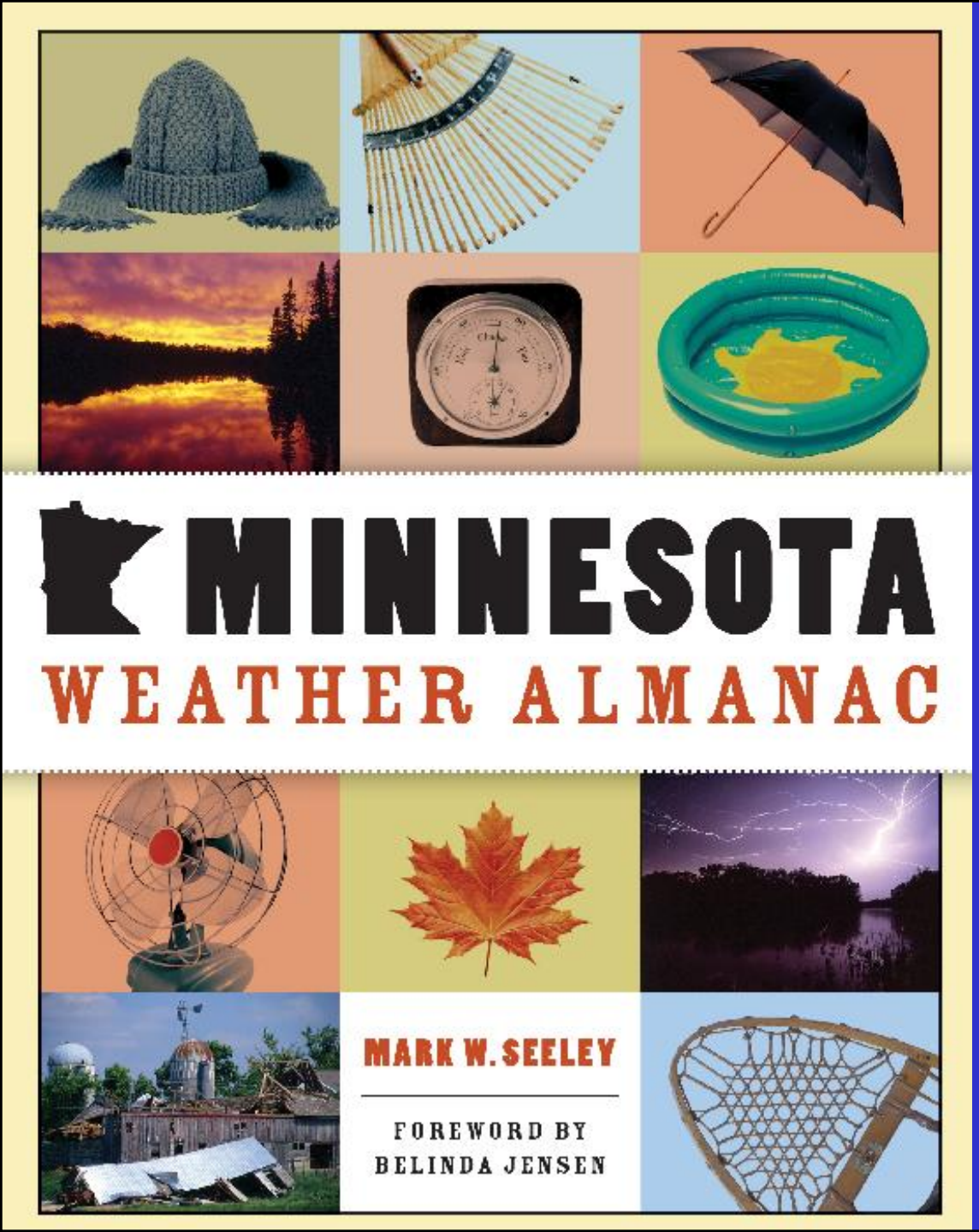
(New Richmond, WI Storm)

Increased contribution from thunderstorms also means amplified dryness





Frequency and spatial context for drought may change



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,

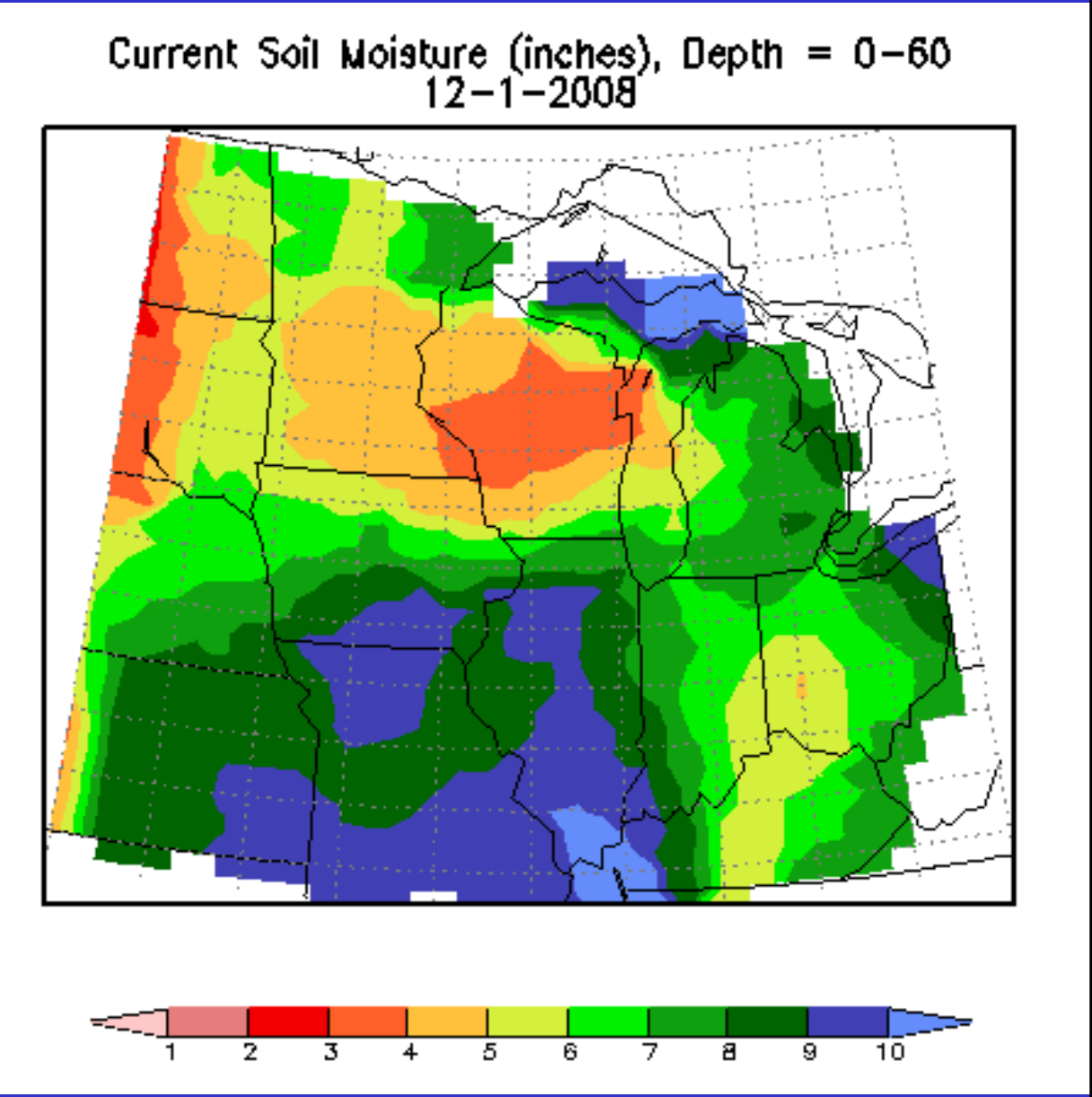
1987, 1988, 1997,
2005-2006-2007

Possible Implications of a Amplified Precipitation Variability

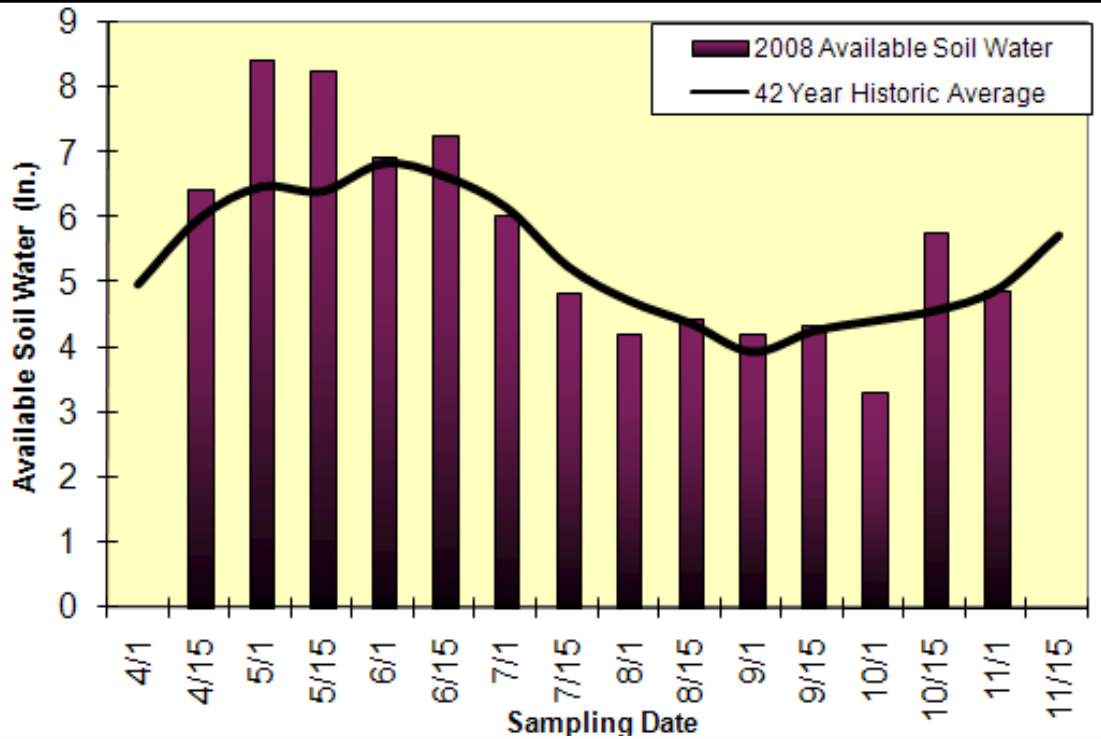
- Irrigation, drainage, runoff, sediment, and shoreline management
- Change in storm sewer runoff design
- Amplified hydrographs, lake level variation
- Change in fish stocking practice and fish populations
- Mitigation of soil erosion
- Increased variability of water borne diseases
- Mitigation of increased flooding potential
- Mitigation of blowing snow and management of roads and highways

What characteristic do these climate trends have in common?
WATER VAPOR!
The Ultimate Greenhouse Gas
And Feedback Mechanism
McIDAS
14 APR 05 - COMPOSITE - 20:15 UTC
SSEC

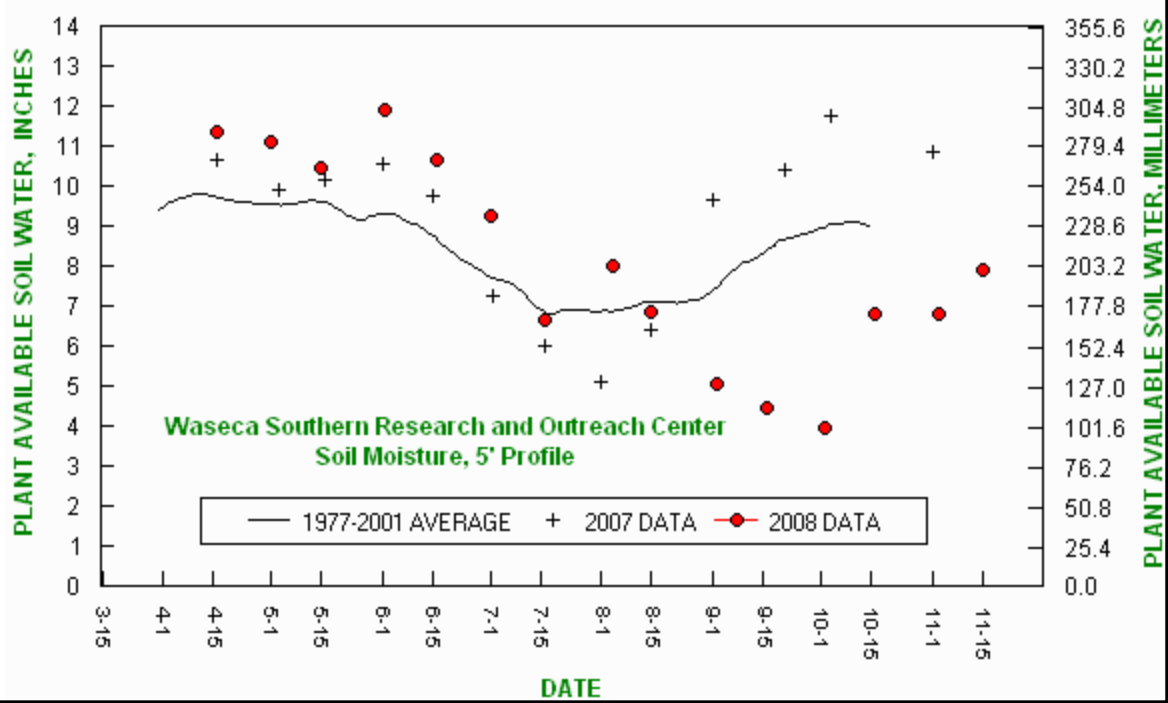
Regional soil moisture estimates (top 5 ft) from the Midwest Climate Center



Fall stored soil moisture at Lamberton, MN



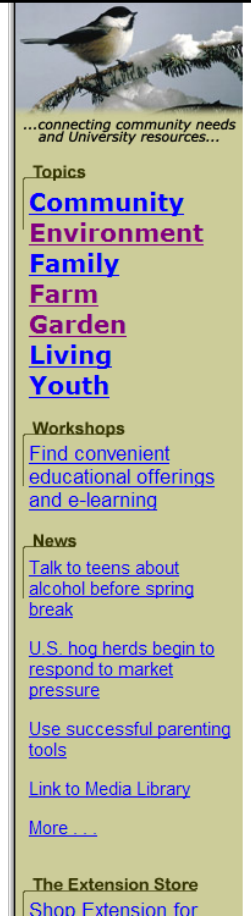
Fall stored soil moisture at Waseca, MN

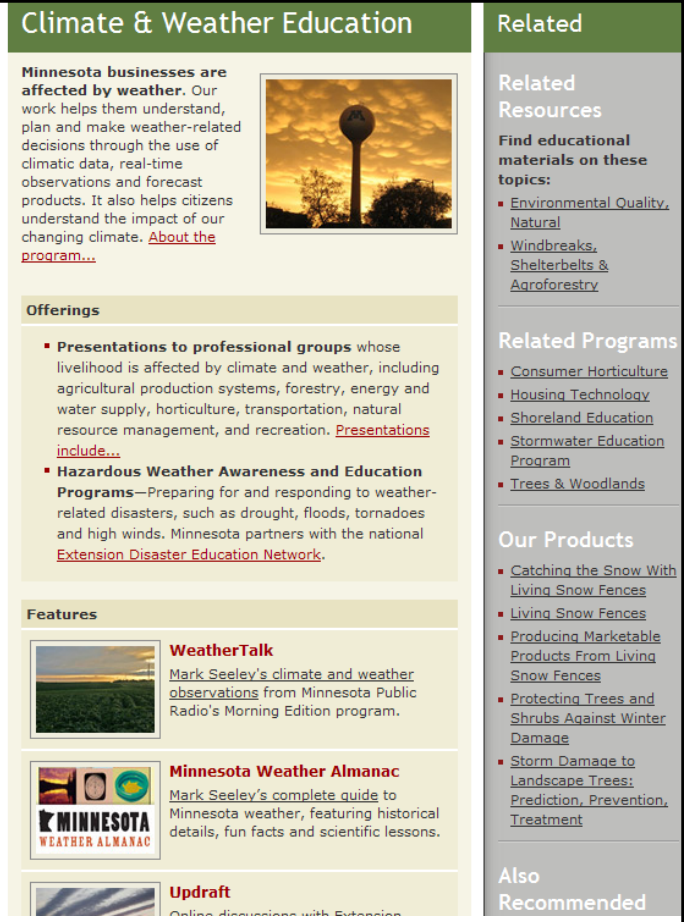


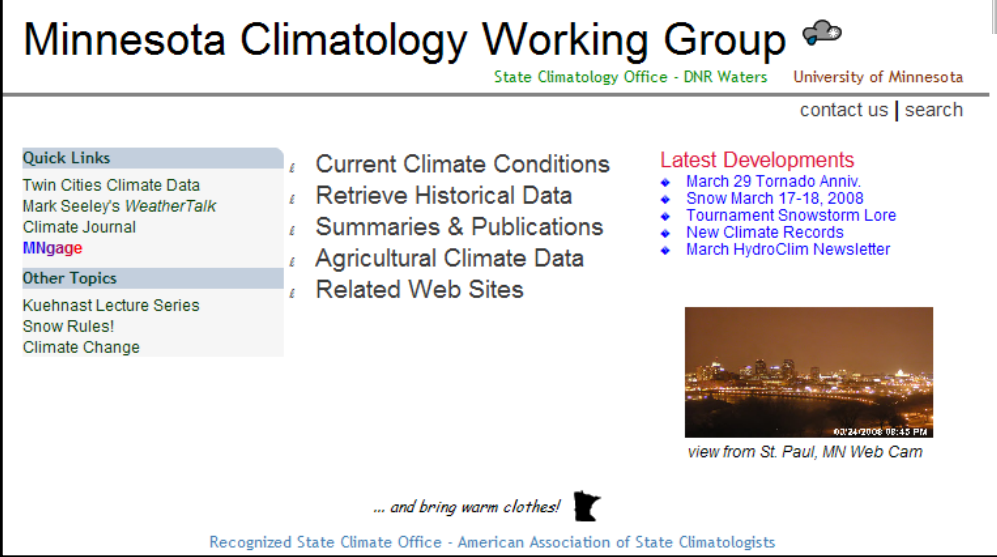
Web site resources for 2008 updates and summaries

www.extension.umn.edu/Climate/

www.climate.umn.edu







Information providers:

U of MN (CFANS,ROCs)

Extension

State Agencies

Federal Agencies