Climate Implications for Watershed Management and Drainage Issues

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CES/AES/ABE
Past-President - American Association State Climatologists

MITCHELL MUNICIPAL AIRPORT SD

En Español

Snow

30°F

-1°C

Humidity	92%
Wind Speed	N 15 mph
Barometer	30.21 in (1024.1 mb)
Dewpoint	28°F (-2°C)
Visibility	NA
Wind Chill	19°F (-7°C)

Last Update on 22 Apr 7:53 am CDT

Current conditions at

Mitchell Municipal Airport (KMHE)

Lat: 43.77 Lon: -98.04 Elev: 1302ft.

More Local Wx | 3 Day History | Mobile Weather

Share |

TODAY	TONIGHT	TUESDAY	TUESDAY NIGHT	WEDNESDAY	WEDNESDAY NIGHT	THURSDAY	THURSDAY NIGHT	FRIDAY
100%	30%			40%	10%			
Heavy Snow	Chance Snow	Mostly Sunny	Partly Cloudy	Chance Showers	Slight Chc Showers	Mostly Sunny	Partly Cloudy	Mostly Sunny
High: 32 °F	Low: 19 °F	High: 37 °F	Low: 24 °F	High: 45 °F	Low: 26 °F	High: 55 °F	Low: 36 °F	High: 65 °F

HAZARDOUS WEATHER CONDITIONS

Winter Weather Advisory Hazardous Weather Outlook

7-DAY FORECAST

Today Snow. The snow could be heavy at times. High near 32. North wind around 15 mph, with gusts as high as 25 mph. Chance of precipitation is 100%. Total daytime snow accumulation of around 5 inches.

Tonight A chance of snow, mainly before 7pm. Cloudy, then gradually becoming partly cloudy, with a low

NWS Sioux Falls, SD

Point Forecast:	Mitchell Municipal Airport SD 43.76°N 98.04°W (Elev. 1256 ft)
Last Update:	8:26 am CDT Apr 22, 2013
Forecast Valid:	9am CDT Apr 22, 2013-6pm CDT Apr 28, 2013

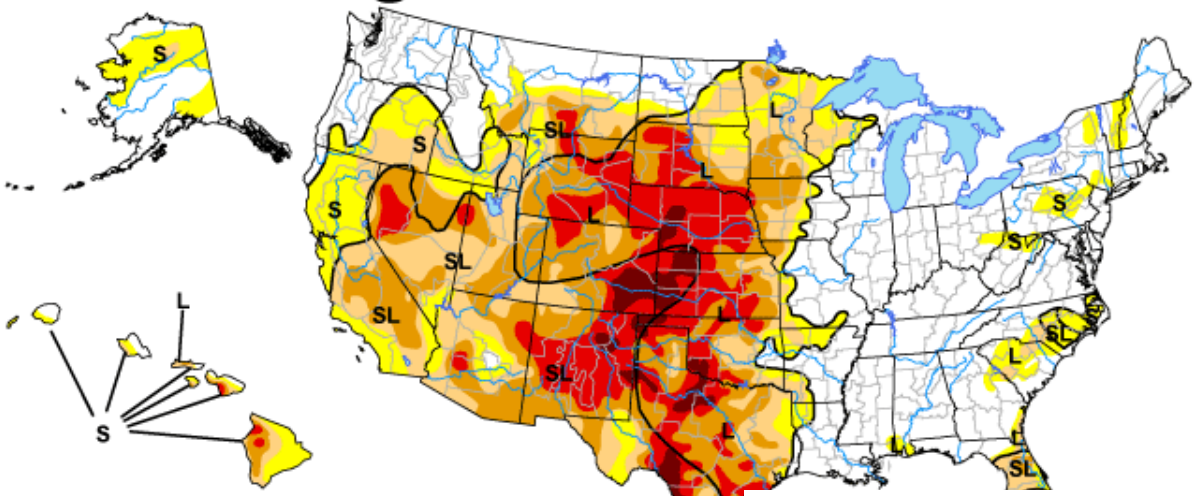
Forecast Discussion

KML XML

Click Map for Forecast Disclaimer

U.S. Drought Monitor

April 16, 2013
Valid 7 a.m. EDT



Intensity:
- D0 Abnormally Dry
- D1 Drought - Moderate
- D2 Drought - Severe
- D3 Drought - Extreme
- D4 Drought - Exceptional

Drought Impact Types:
- Delineates dominant impacts
- S = Short-Term, typically <6 months (e.g. agriculture, grasslands)
- L = Long-Term, typically >6 months (e.g. hydrology, ecology)

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

http://droughtmonitor.unl.edu/

USD

Rel
Autho

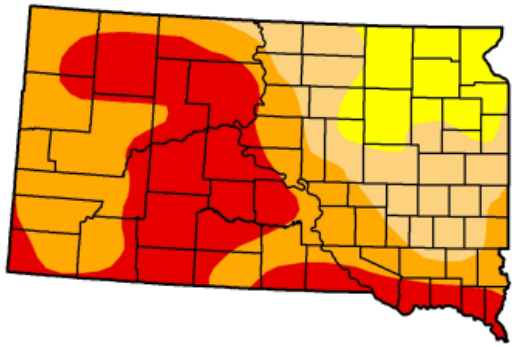
U.S. Drought Monitor

April 16, 2013
Valid 7 a.m. EST

South Dakota

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	0.00	100.00	87.71	69.08	32.92	0.00
Last Week (04/09/2013 map)	0.00	100.00	100.00	86.29	58.90	13.80
3 Months Ago (01/15/2013 map)	0.00	100.00	100.00	96.93	62.99	30.68
Start of Calendar Year (01/01/2013 map)	0.00	100.00	100.00	96.95	63.17	30.68
Start of Water Year (09/25/2012 map)	0.00	100.00	100.00	74.69	50.53	6.72
One Year Ago (04/10/2012 map)	12.33	87.67	41.14	2.45	0.00	0.00



Intensity:
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The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

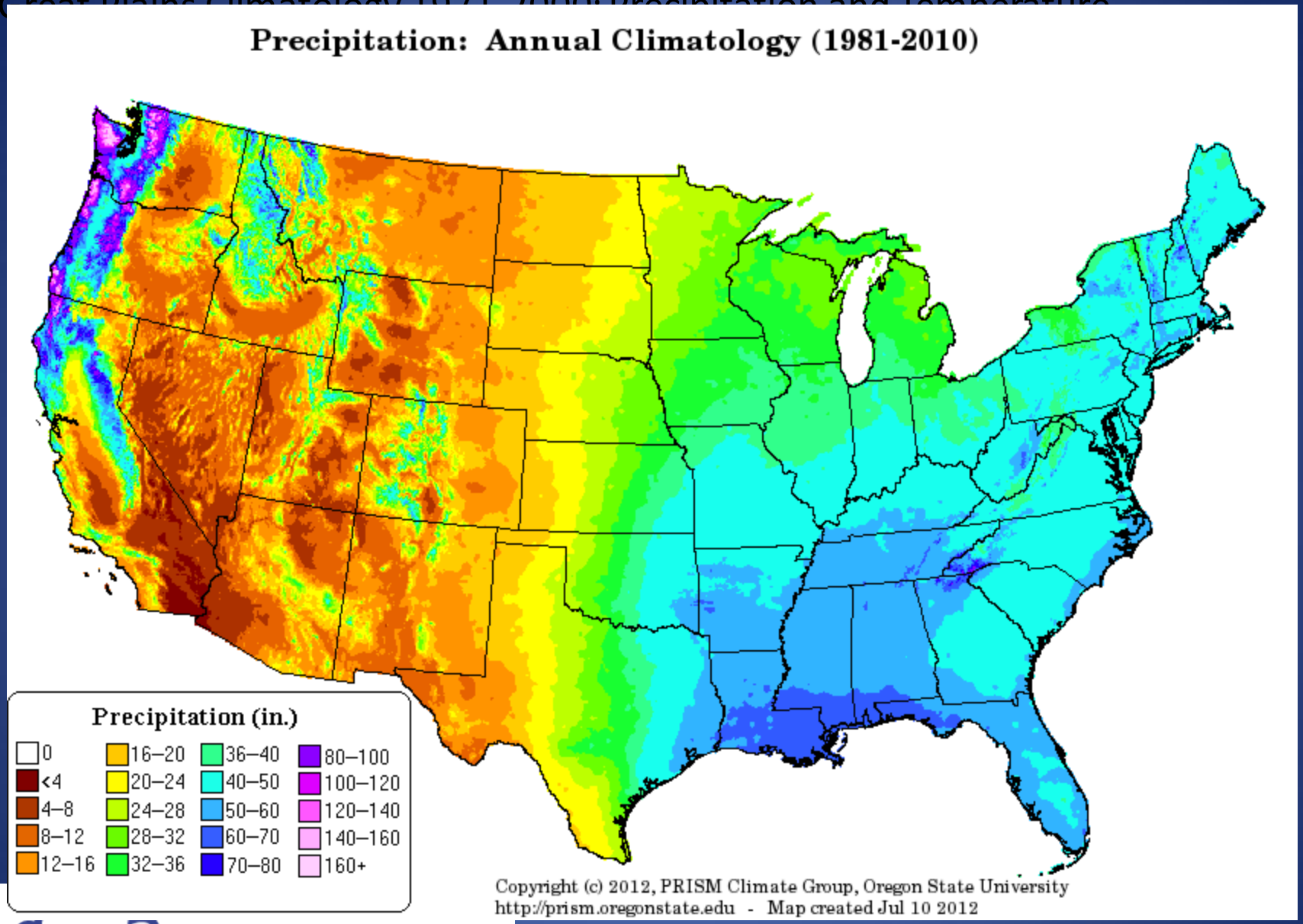
http://droughtmonitor.unl.edu

USDA National Drought Mitigation Center

Released Thursday, April 18, 2013
David Miskus, NOAA/NWS/NCEP/Climate Prediction Center

SOUTH DAKOTA Climate and Weather

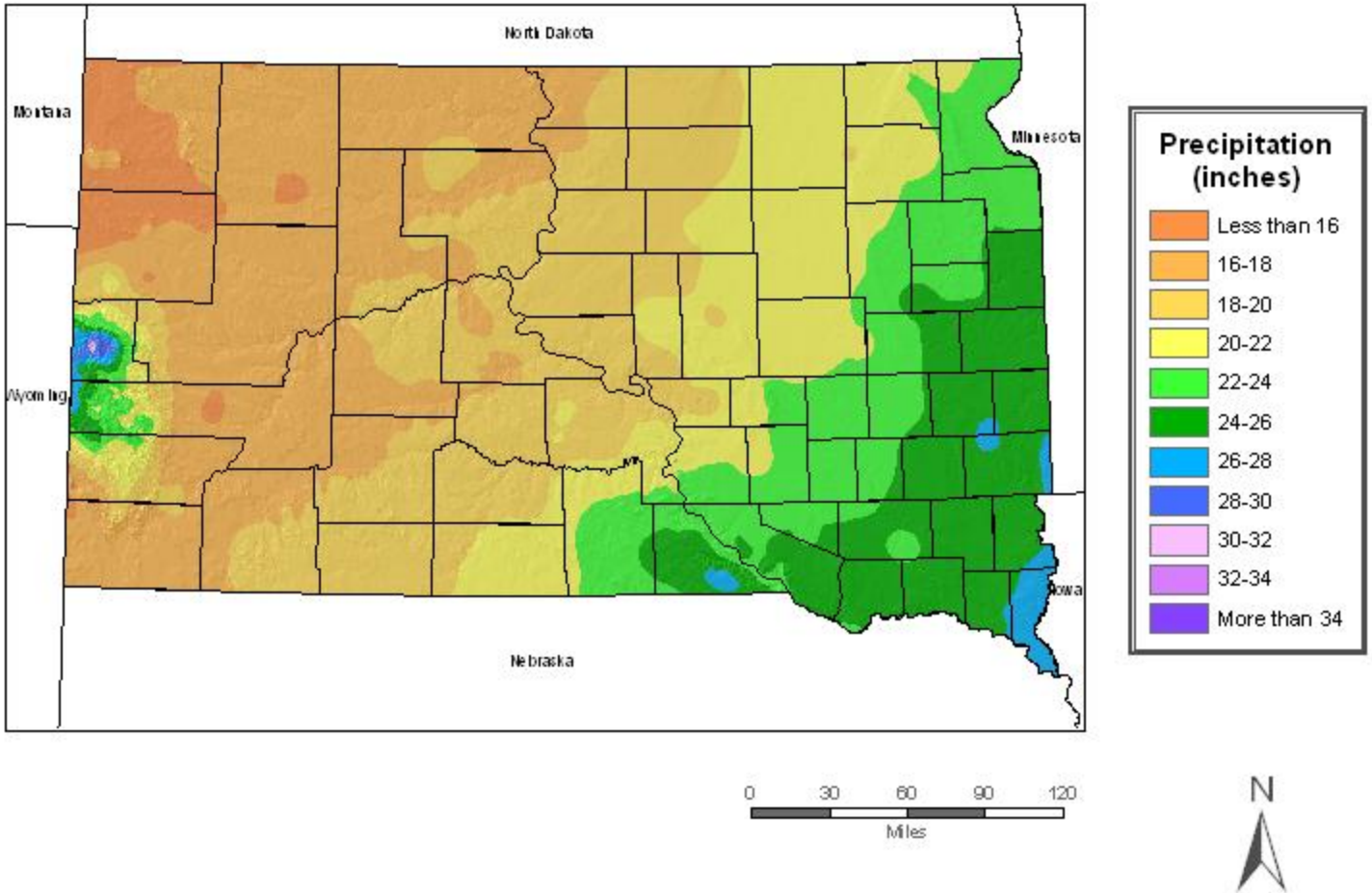
Great Plains Climatology 1971-2000: Precipitation and Temperature



SOUTH DAKOTA Climate and Weather

Source: Great Plains Region chapter of 2003 US National Assessment

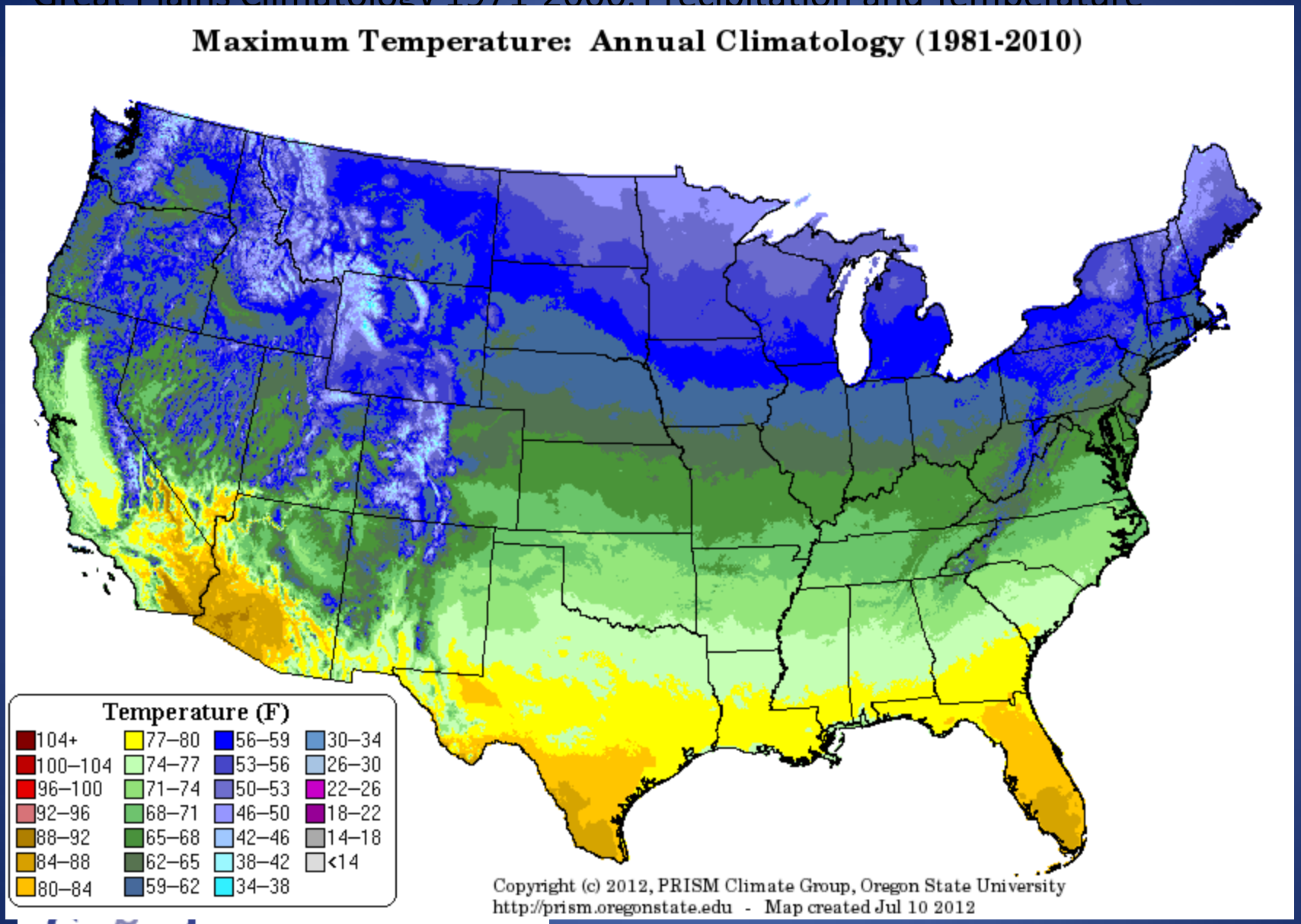
Average Annual Precipitation, 1971-2000
South Dakota



Map copyright (c) 2006 by the PRISM Group and
Oregon Climate Service, Oregon State University.

Older normals – but gives you the distribution over SD.

Great Plains Climatology 1971-2000: Precipitation and Temperature



SOUTH DAKOTA Climate and Weather

Source: Great Plains Region chapter of 2003 US National Assessment

TRENDS - PRECIPITATION

SOUTH DAKOTA
Climate and Weather

Climate data

- Measurements from National Weather Service Cooperative Observer Program
- Data since the late 1800s.
- More types of precipitation observation now (automated and volunteer manual)
- Official is still NWS can

SOUTH DAKOTA Climate and Weather

Climate data

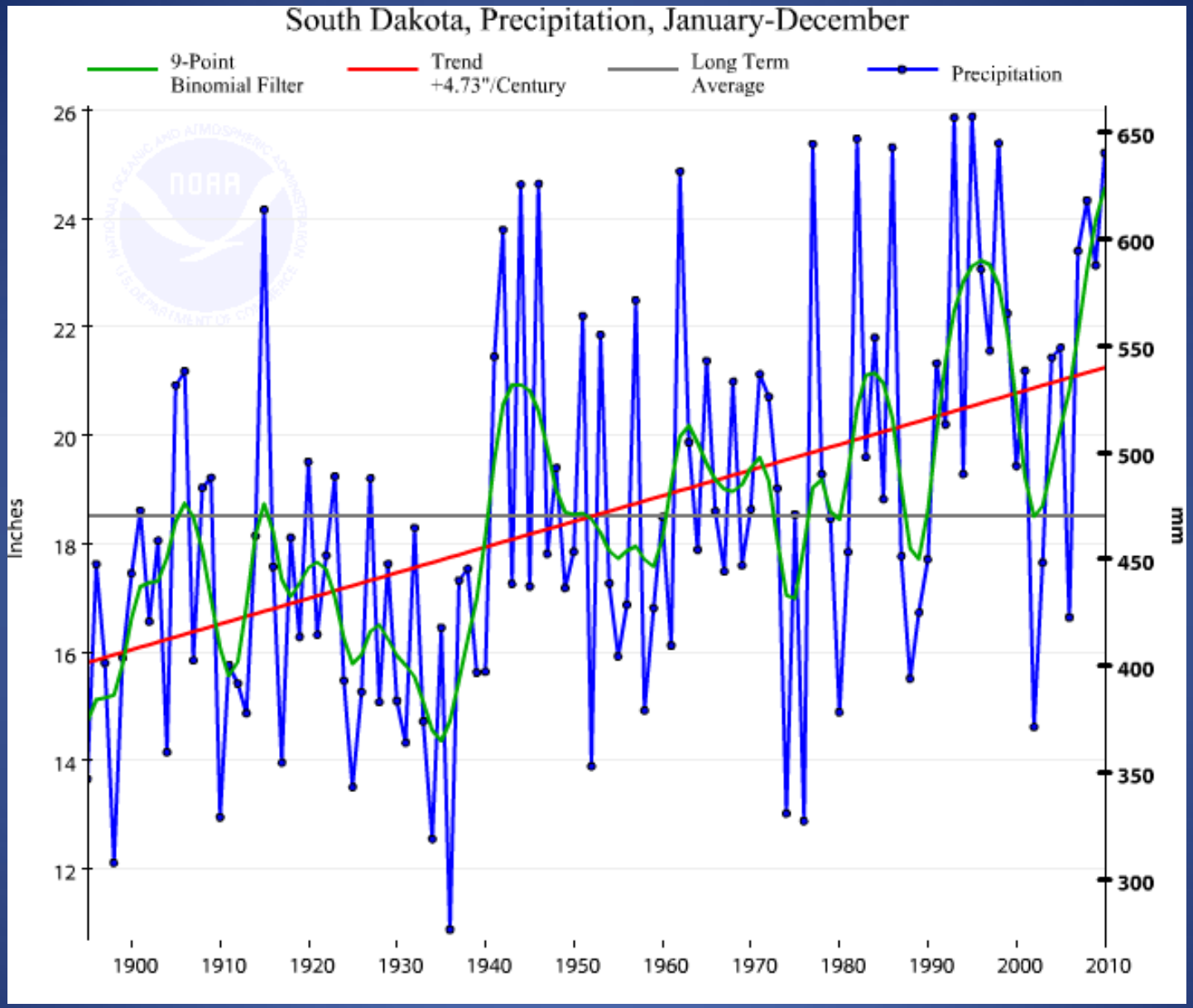
- Overall precipitation increasing since the 1930s
- Irregular trend
- Time of year a large component – different times of year
- More occurring in heavier rain events

SOUTH DAKOTA
Climate and Weather

Climate data

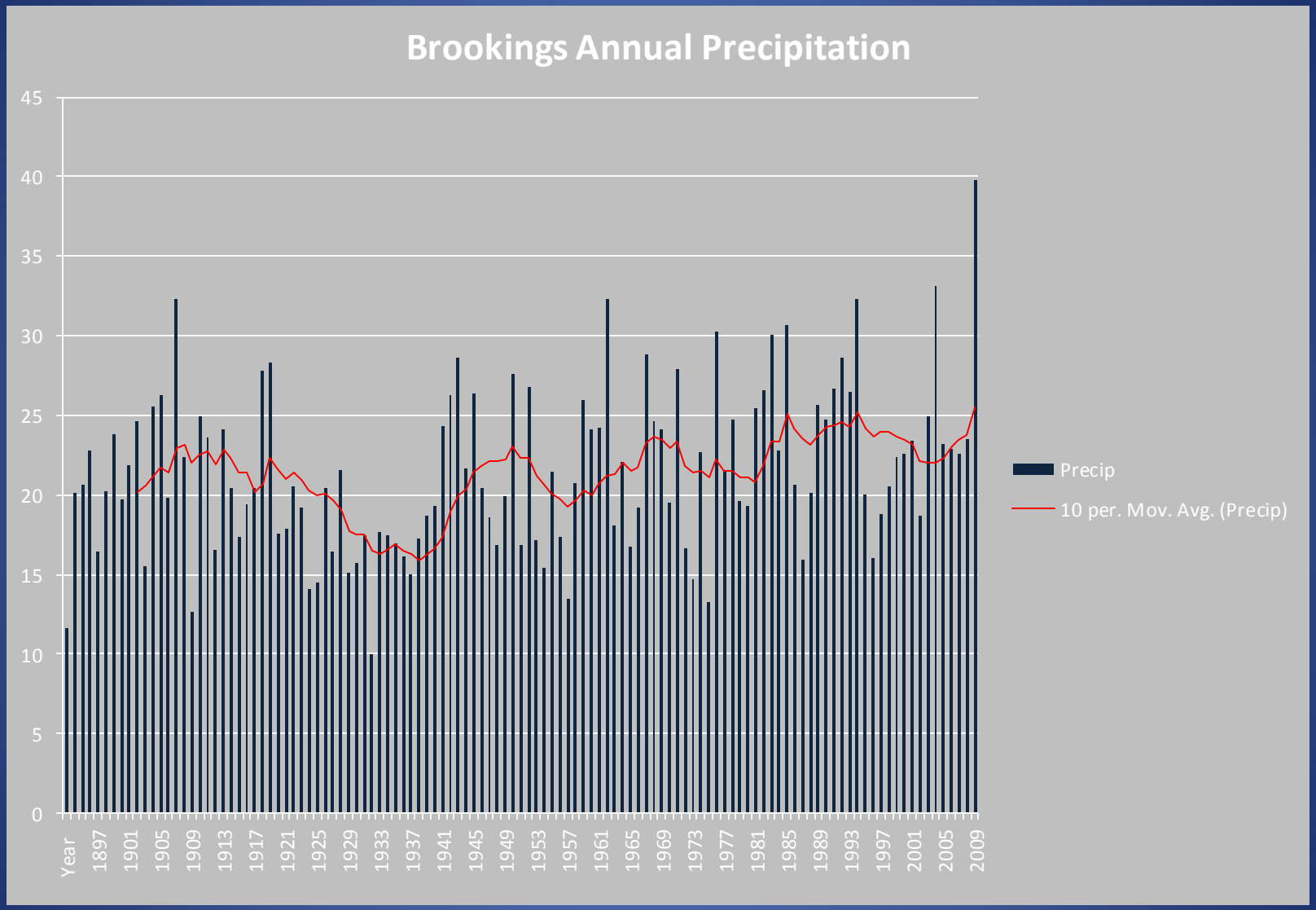
- Climate division data sets and statewide data
- Averages of stations in the entity
- Overcomes missing data
- Not as local

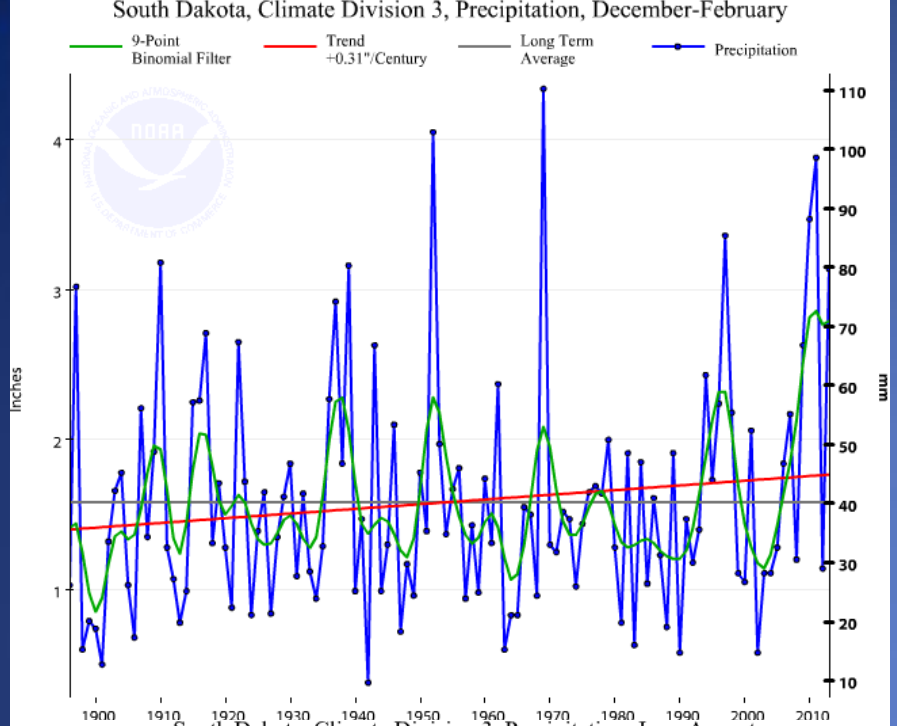
SOUTH DAKOTA
Climate and Weather

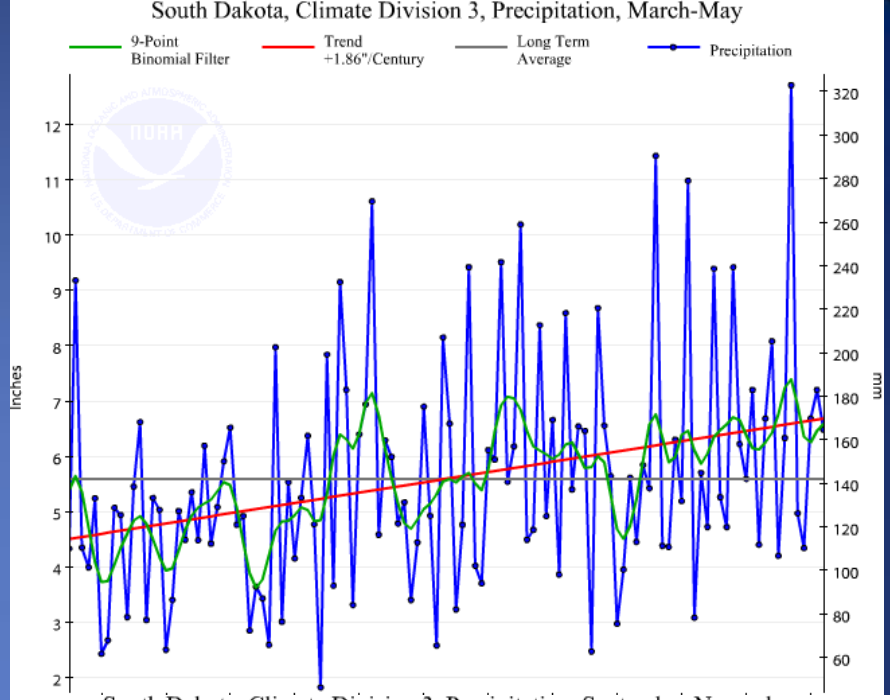


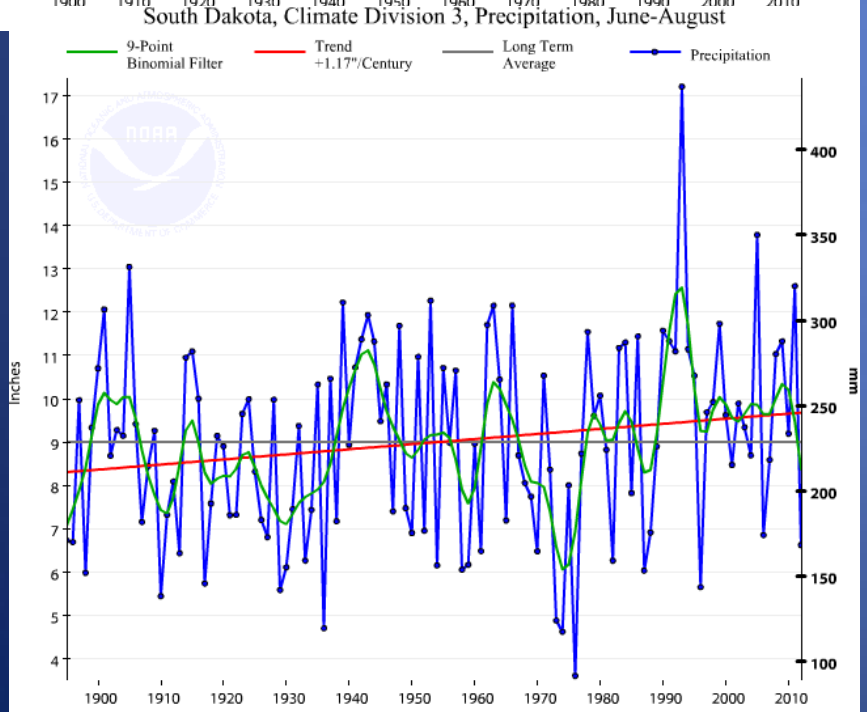
SOUTH DAKOTA Climate and Weather

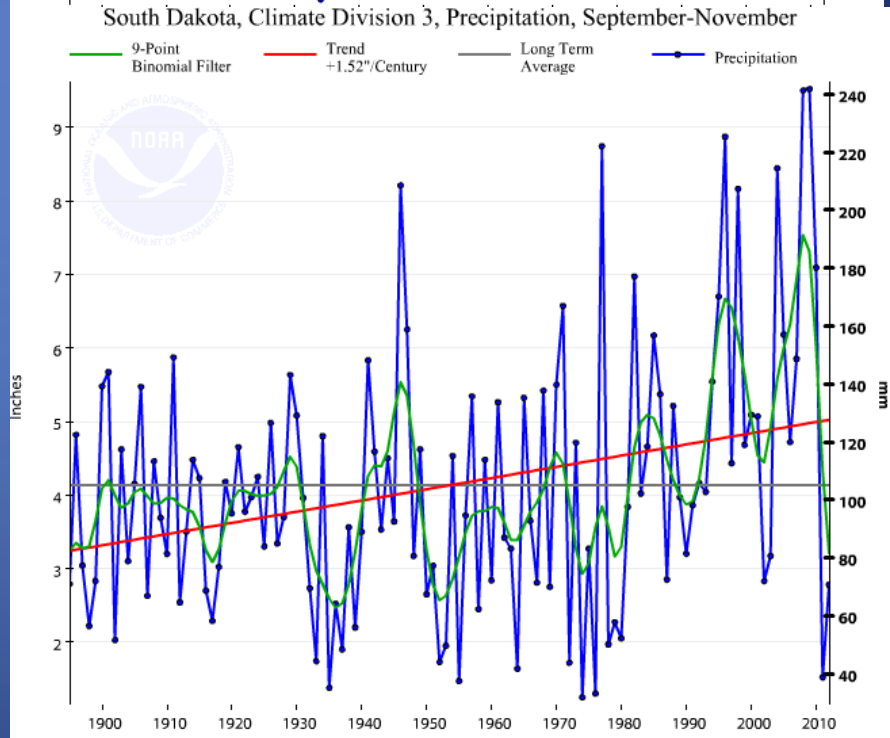
http://www.ncdc.noaa.gov/temp-and-precip/time-series/index.php?

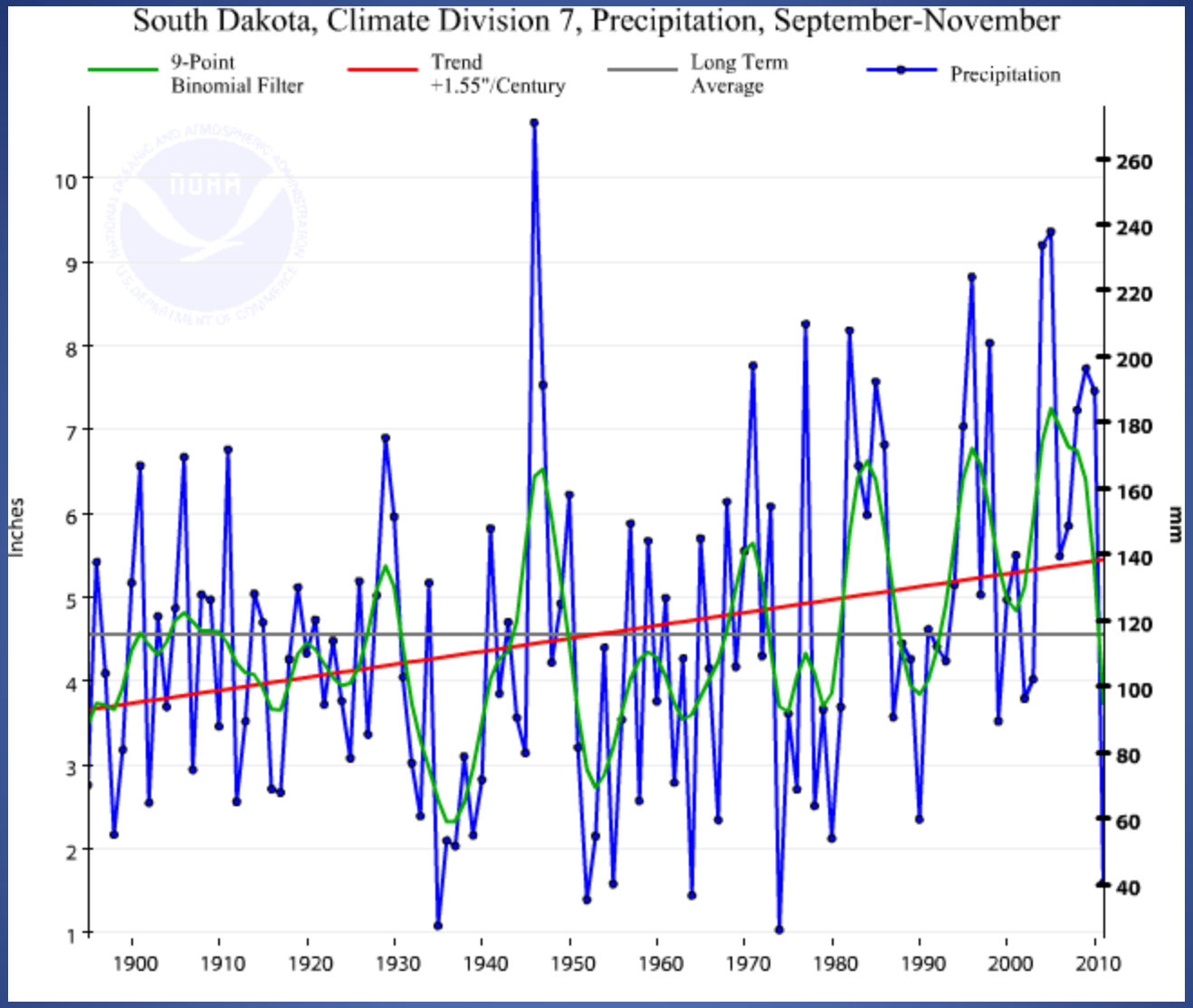

Brookings Annual Precipitation
45
40
35
30
25
20
15
10
5
0
Year
1897
1901
1905
1909
1913
1917
1921
1925
1929
1933
1937
1941
1945
1949
1953
1957
1961
1965
1969
1973
1977
1981
1985
1989
1993
1997
2001
2005
2009
Precip
10 per. Mov. Avg. (Precip)


South Dakota, Climate Division 3, Precipitation, December-February
9-Point Binomial Filter
Trend +0.31"/Century
Long Term Average
Precipitation
Inches
mm


South Dakota, Climate Division 3, Precipitation, March-May
9-Point Binomial Filter
Trend +1.86"/Century
Long Term Average
Precipitation
Inches
mm

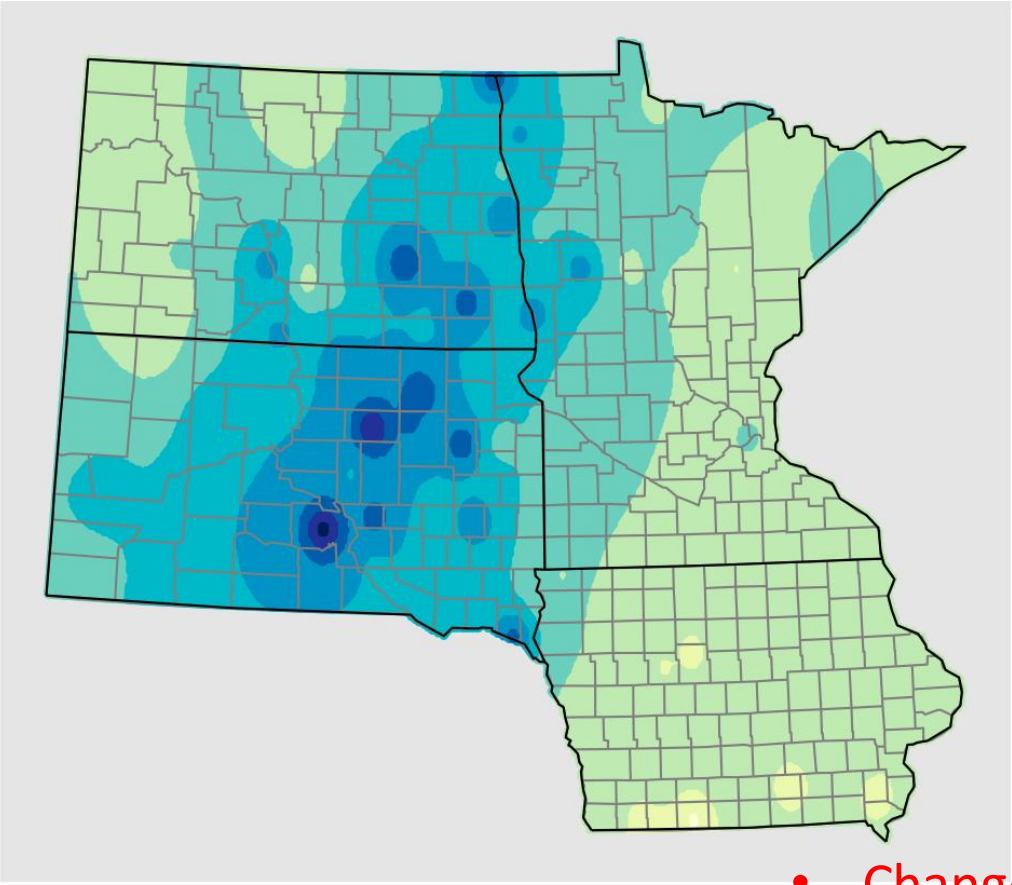

South Dakota, Climate Division 3, Precipitation, June-August
9-Point Binomial Filter
Trend +1.17"/Century
Long Term Average
Precipitation
Inches
mm

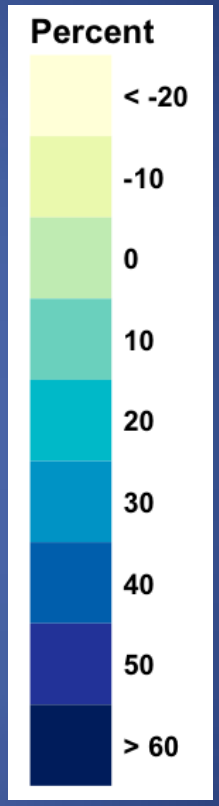

South Dakota, Climate Division 3, Precipitation, September-November
9-Point Binomial Filter
Trend +1.52"/Century
Long Term Average
Precipitation
Inches
mm



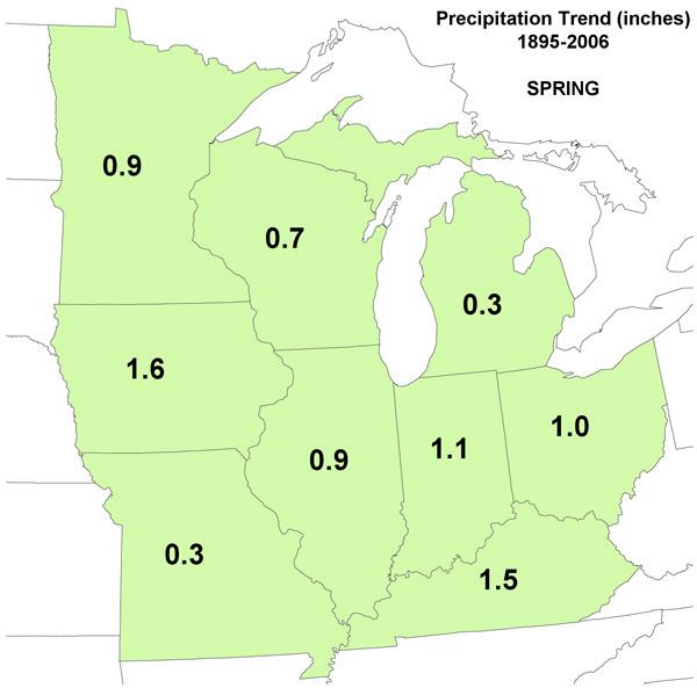
SOUTH DAKOTA Climate and Weather

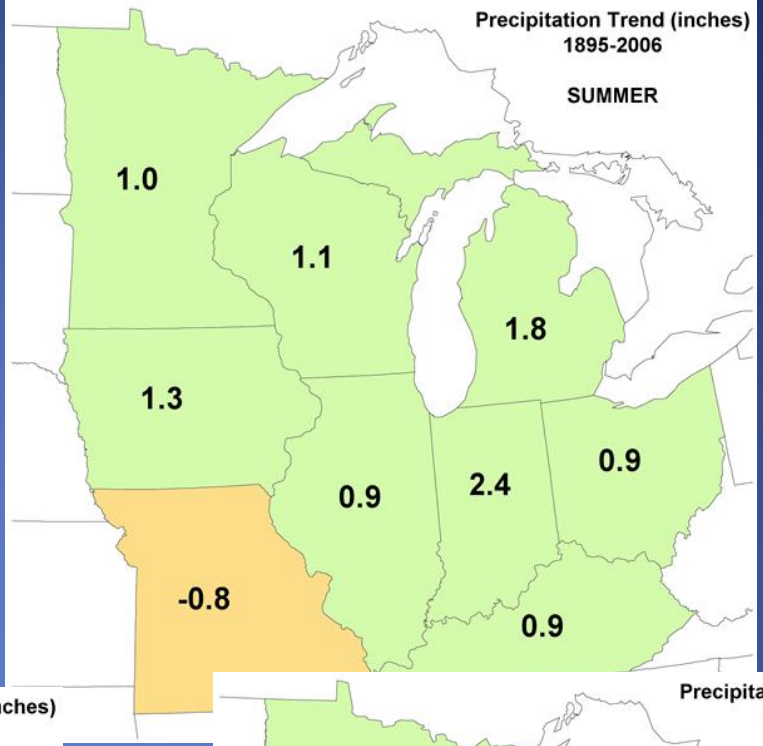
Large increases in fall precip. across the eastern Dakotas

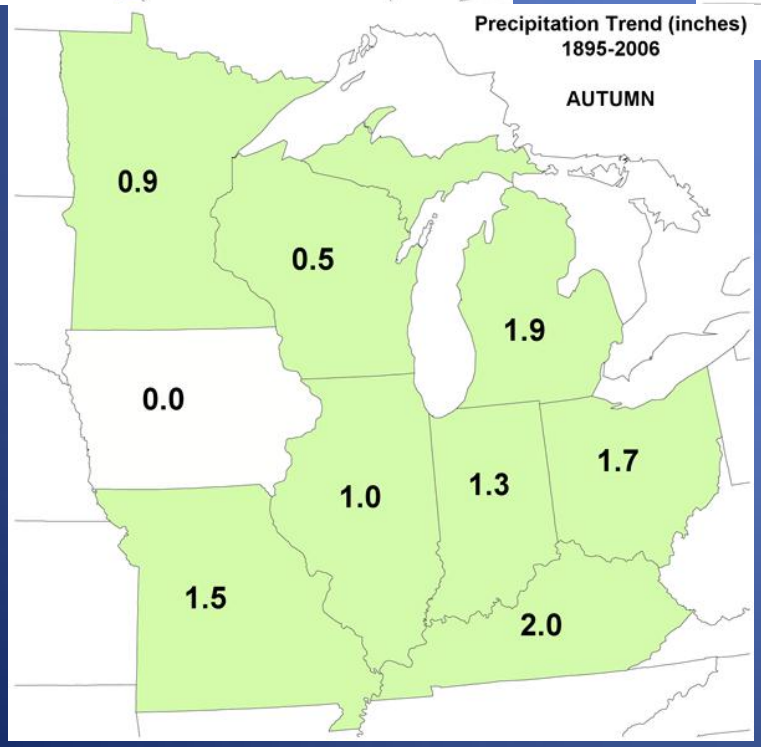


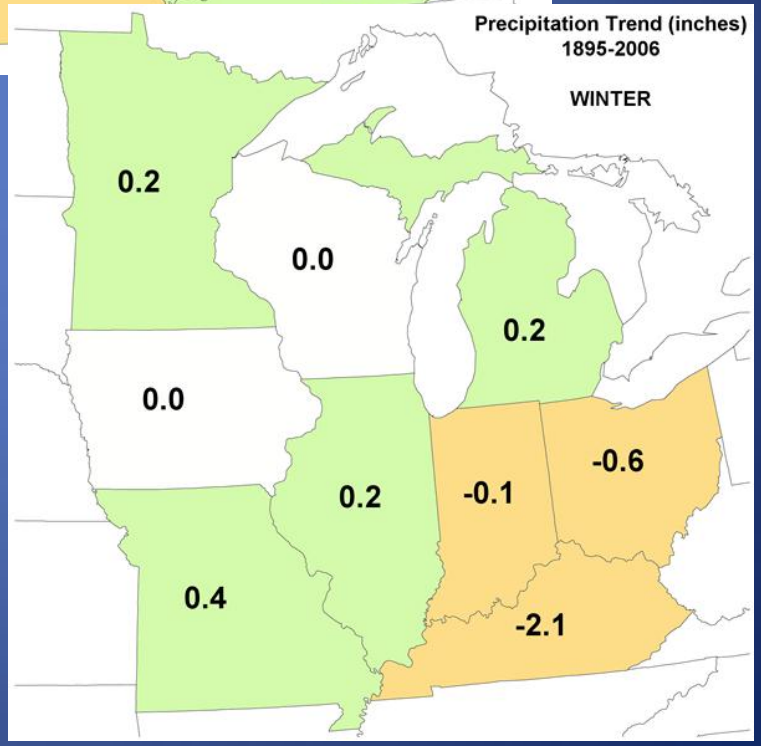


- Change in fall (SON) precipitation (%)
- 1991-2009 as compared to 1961-1990

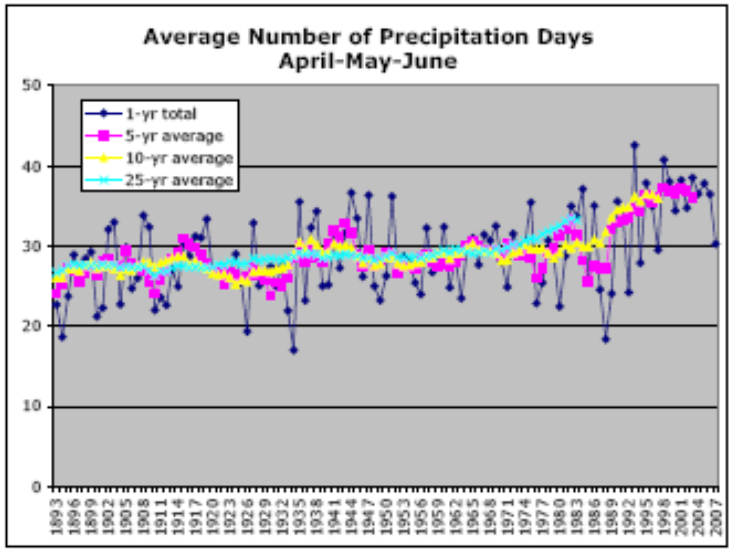

Precipitation Trend (inches)
1895-2006
SPRING
0.9
0.7
0.3
1.6
0.9
1.1
1.0
0.3
1.5

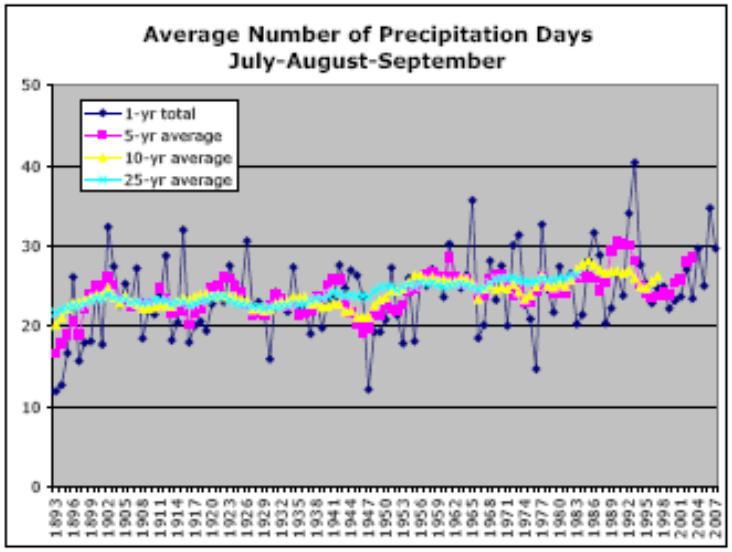

Precipitation Trend (inches)
1895-2006
SUMMER
1.0
1.1
1.8
1.3
0.9
2.4
0.9
-0.8
0.9

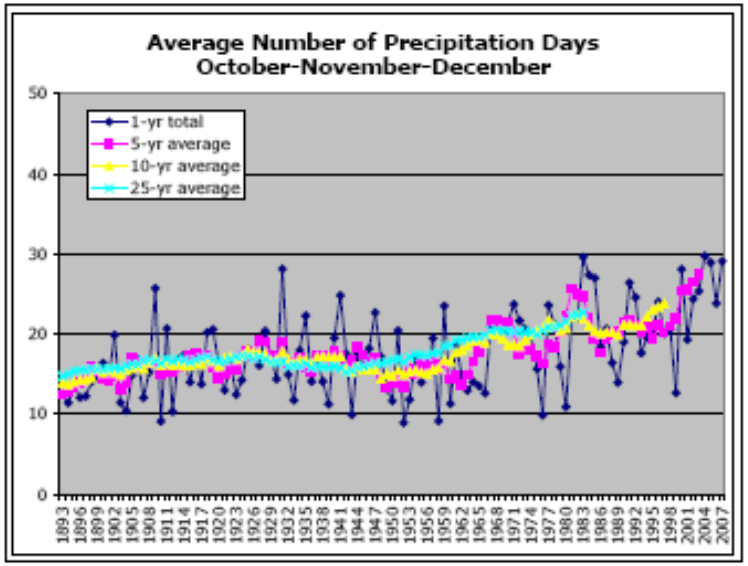

Precipitation Trend (inches)
1895-2006
AUTUMN
0.9
0.5
1.9
0.0
1.0
1.3
1.7
1.5
2.0

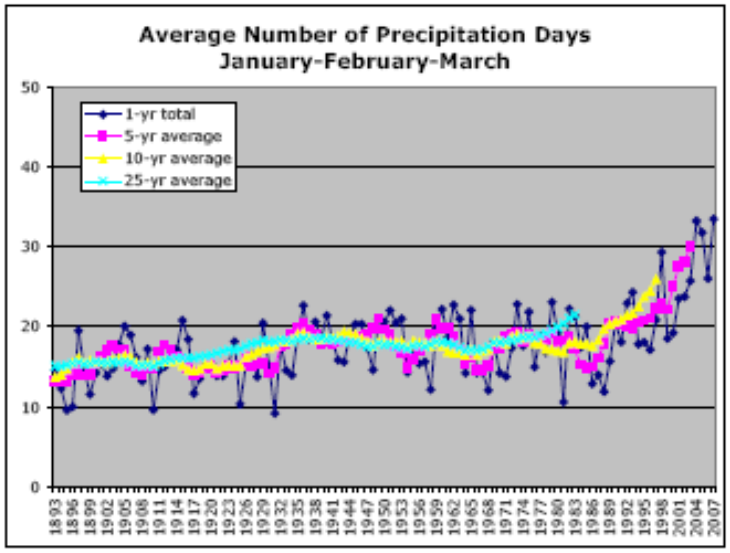

Precipitation Trend (inches)
1895-2006
WINTER
0.2
0.0
0.2
0.0
0.2
-0.1
-0.6
0.4
-2.1

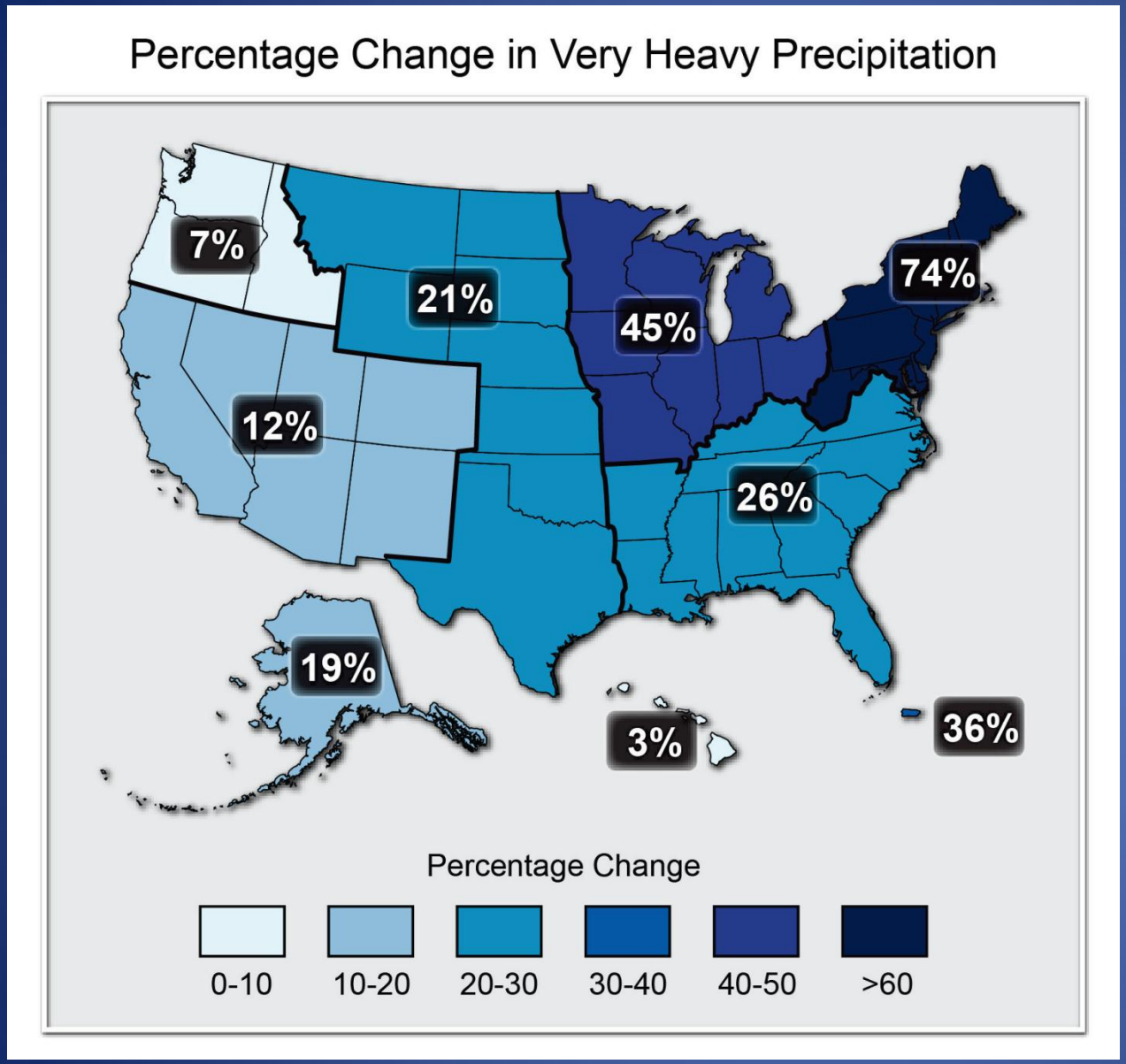
Iowa precipitation days



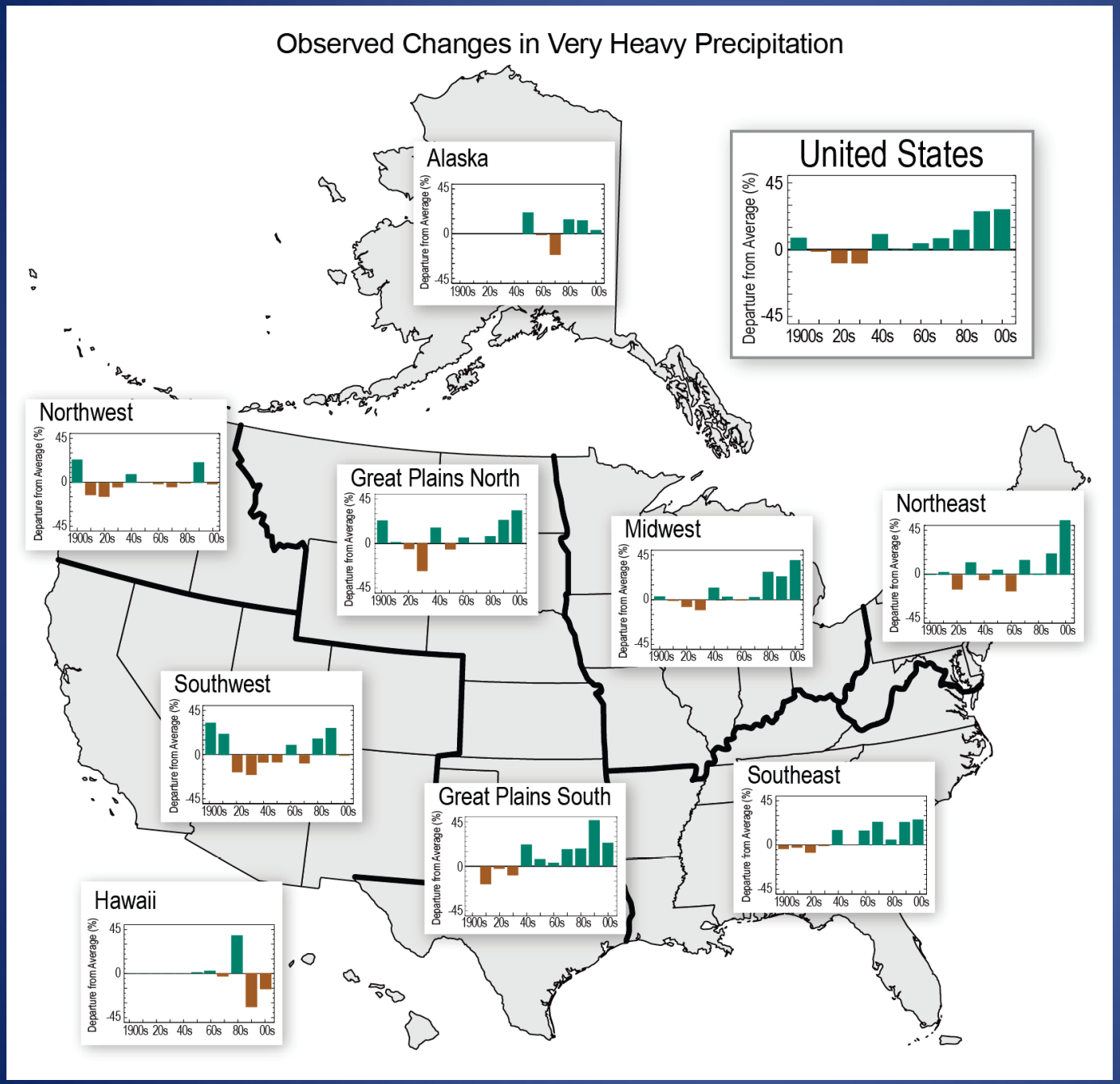








Caption: The map shows percent increases in the amount of precipitation falling 3 in *very heavy events (defined as the heaviest 1% of all daily events) from 1958 to 4 2011 for each region. There are clear trends toward a greater amount of very 5 heavy precipitation for the nation as a whole, and particularly in the Northeast and 6 Midwest. (Figure source: updated from (Karl et al. 2009) with data from NCDC)*



Caption: Percent changes in the annual amount of precipitation falling in *very 3 heavy events, defined as the heaviest 1% of all daily events from 1901 to 2011 for 4 each region. The far right bar is for 2001-2011. In recent decades there have been 5 increases everywhere, except for the Southwest, Northwest, and Hawaii, with the 6 largest increases in the Northeast, Great Plains, Midwest, and Southeast. Changes 7 are compared to the 1901-1960 average for all regions except Alaska and Hawaii, 8 which are relative to the 1951-1980 average. (Figure source: NOAA NCDC / 9 CICS-NC)*

Issues

- Overall increases
- Time of year – more off season precip
- Intensity – more in large events

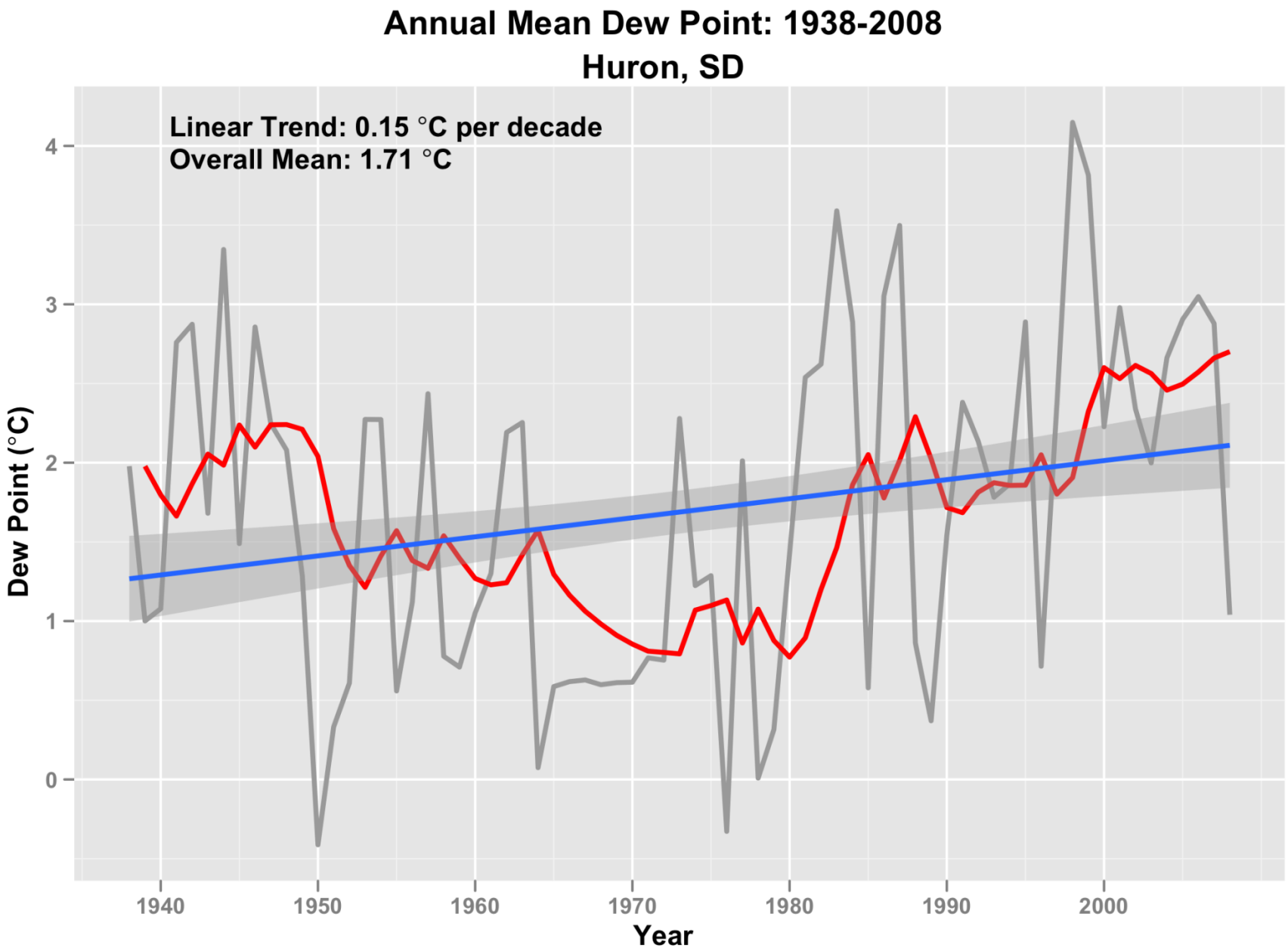
TRENDS – DEW POINT

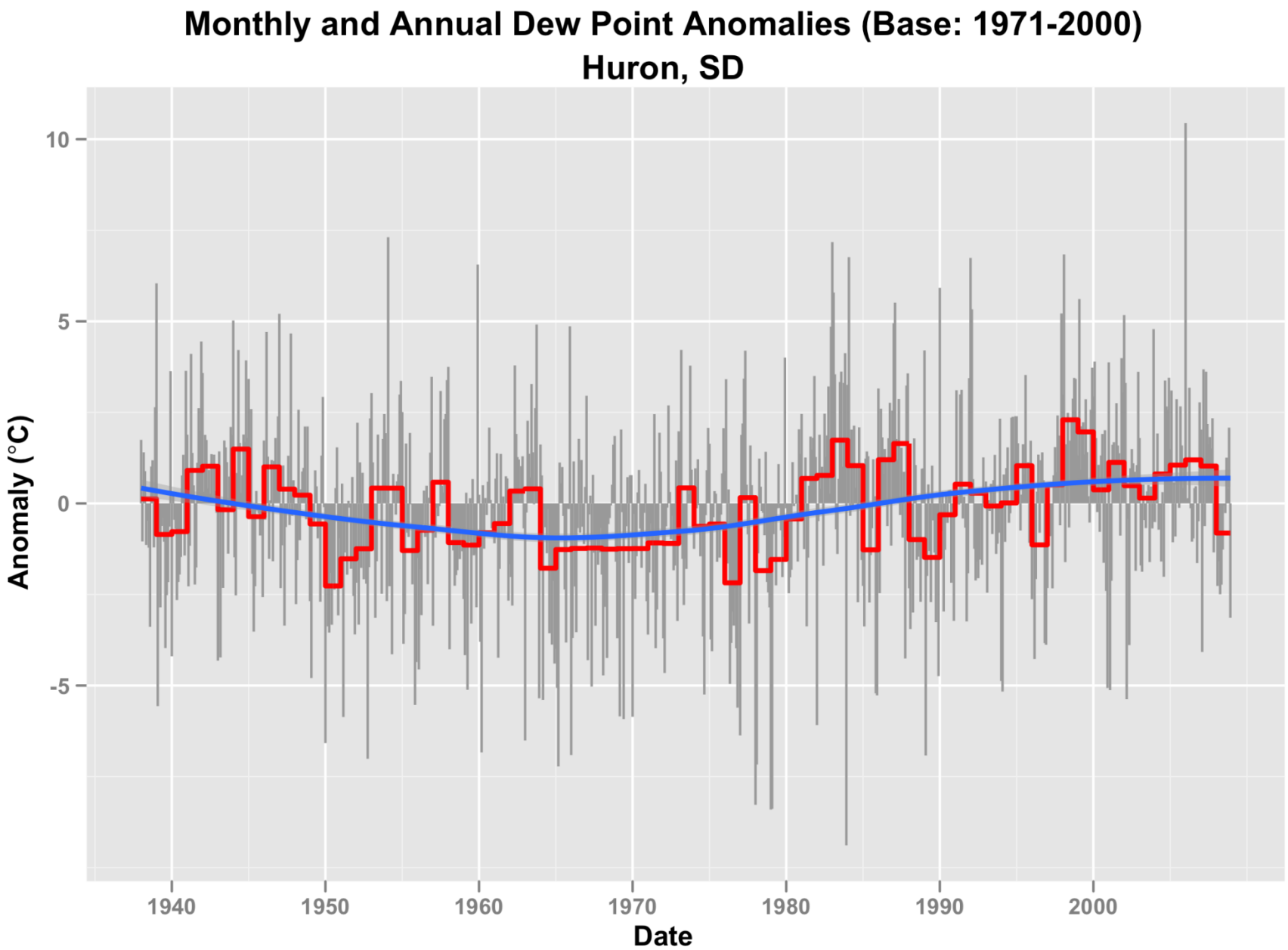
SOUTH DAKOTA
Climate and Weather

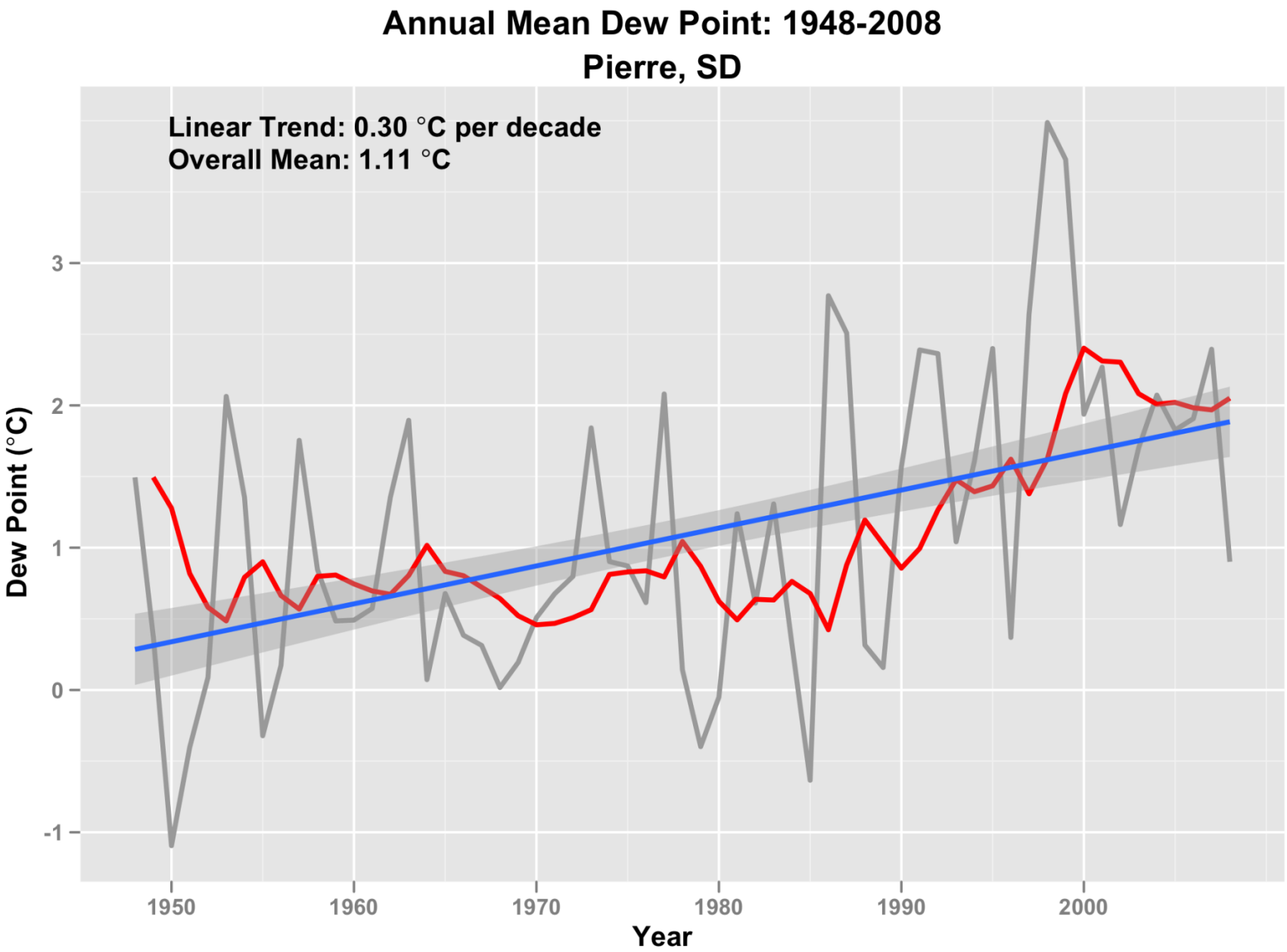
Dew Point

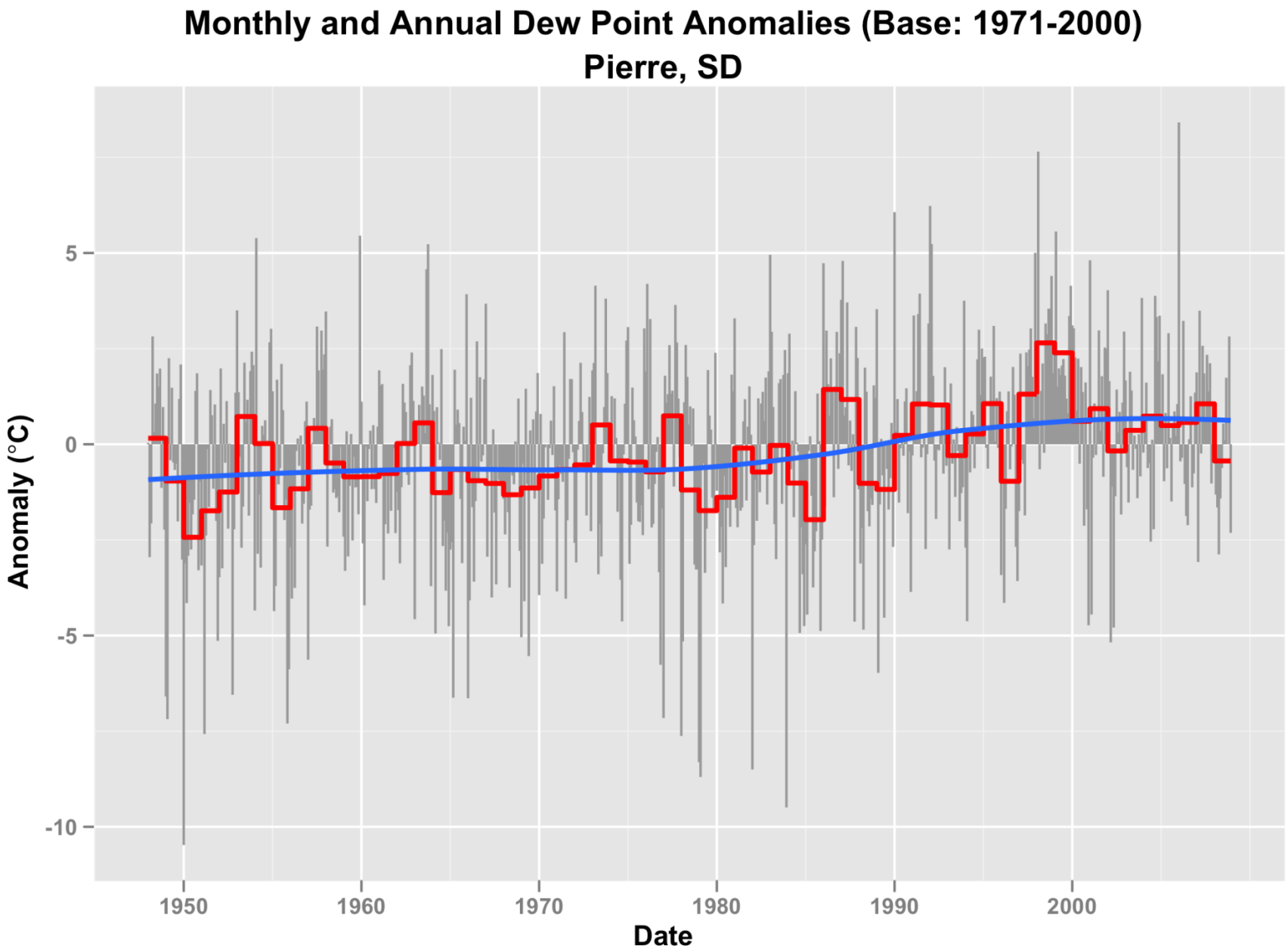
- Definition – temperature at which dew forms

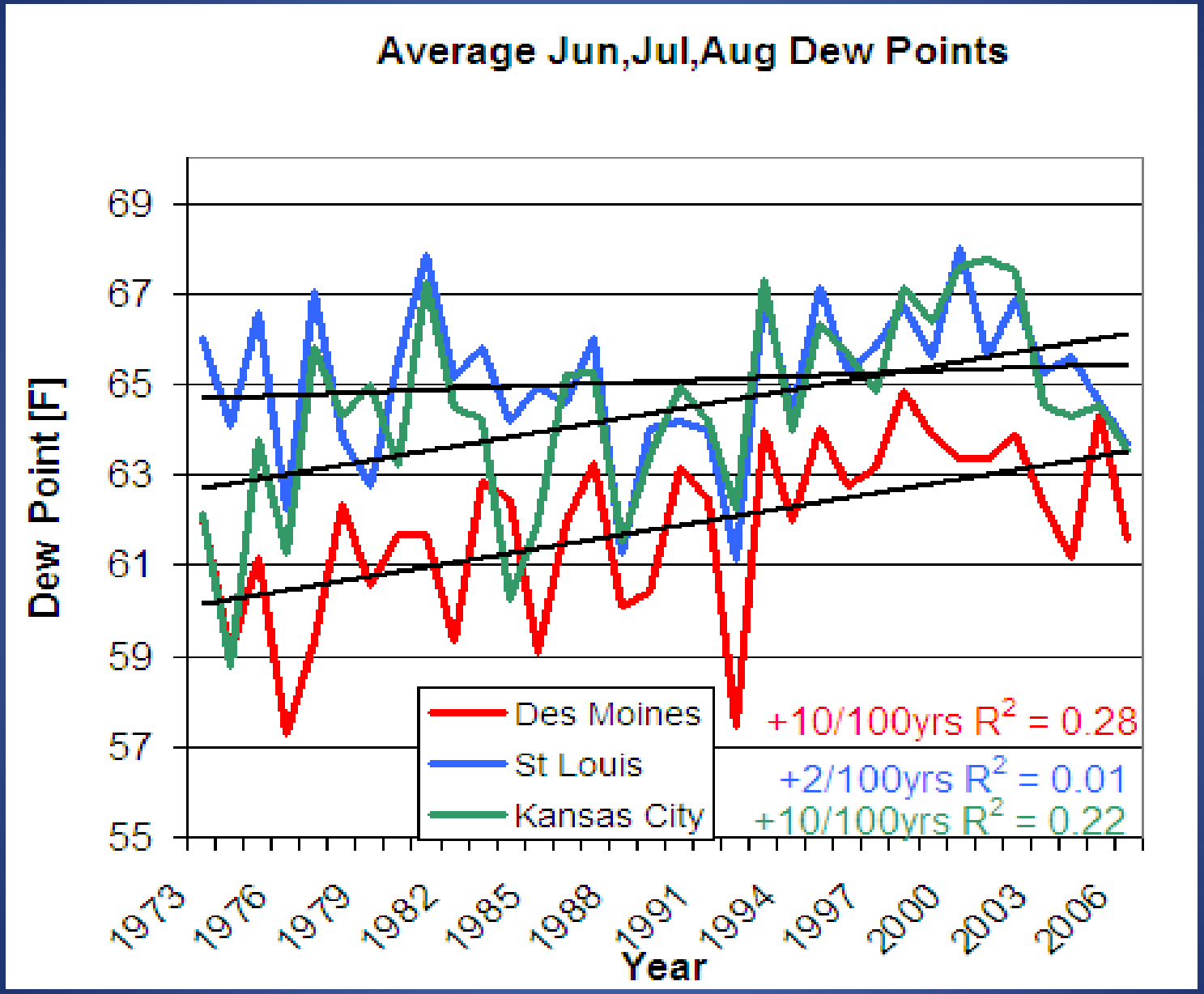
- Practical – higher dew point, more moisture in the atmosphere
- Consequence – reduced evaporation potential

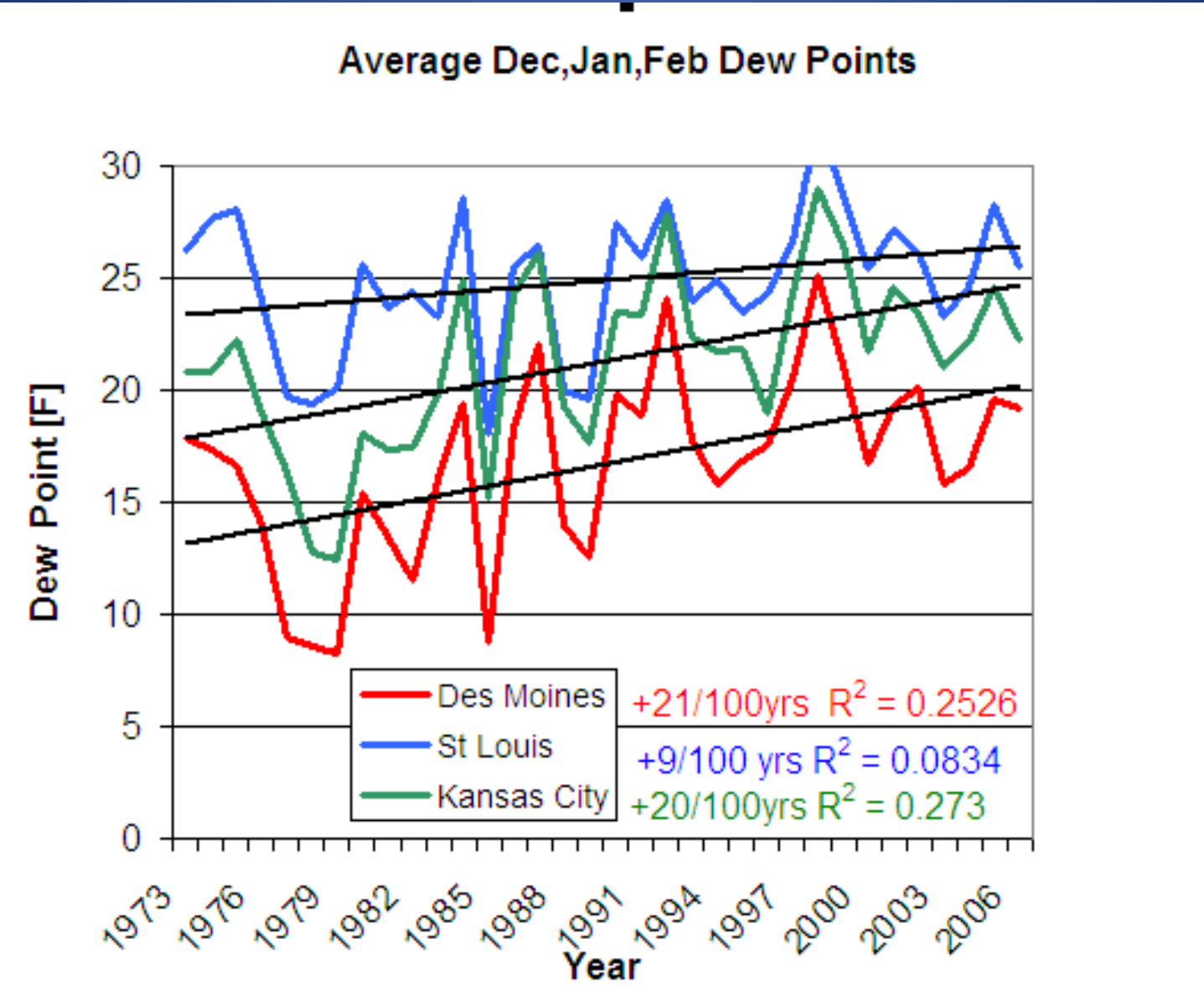

Annual Mean Dew Point: 1938-2008
Huron, SD
Linear Trend: 0.15 °C per decade
Overall Mean: 1.71 °C
Dew Point (°C)
4
3
2
1
0
1940
1950
1960
1970
1980
1990
2000
Year


Monthly and Annual Dew Point Anomalies (Base: 1971-2000)
Huron, SD
Anomaly (°C)
10
5
0
-5
1940
1950
1960
1970
1980
1990
2000
Date


Annual Mean Dew Point: 1948-2008
Pierre, SD
Linear Trend: 0.30 °C per decade
Overall Mean: 1.11 °C
Dew Point (°C)
3
2
1
0
-1
1950
1960
1970
1980
1990
2000
Year


Monthly and Annual Dew Point Anomalies (Base: 1971-2000)
Pierre, SD
Anomaly (°C)
5
0
-5
-10
1950
1960
1970
1980
1990
2000
Date


Average Jun,Jul,Aug Dew Points
Dew Point [F]
69
67
65
63
61
59
57
55
1973
1976
1979
1982
1985
1988
1991
1994
1997
2000
2003
2006
Year
Des Moines
St Louis
Kansas City
+10/100yrs R2 = 0.28
+2/100yrs R2 = 0.01
+10/100yrs R2 = 0.22


Average Dec,Jan,Feb Dew Points
Dew Point [F]
30
25
20
15
10
5
0
1973
1976
1979
1982
1985
1988
1991
1994
1997
2000
2003
2006
Year
Des Moines
St Louis
Kansas City
+21/100yrs R2 = 0.2526
+9/100 yrs R2 = 0.0834
+20/100yrs R2 = 0.273

Most stations showed a significant increasing trend in dew point

Station	Period	Trend (° C/10 yrs)	Kendall's τ	S	Adj. p-value
Aberdeen	1965–2008	0.34	0.130	1532	0.0030
Ellsworth AFB	1959–2008	0.29	0.138	2096	0.0045
Huron	1959–2008	0.32	0.138	2101	0.0017
Pierre	1959–2008	0.33	0.155	2361	0.0003
Rapid City	1959–2008	0.31	0.148	2250	0.0006
Sioux Falls	1973–2008	0.29	0.096	752	0.0514
Watertown	1973–2008	0.14	0.046	360	0.3038

TEMPERATURE

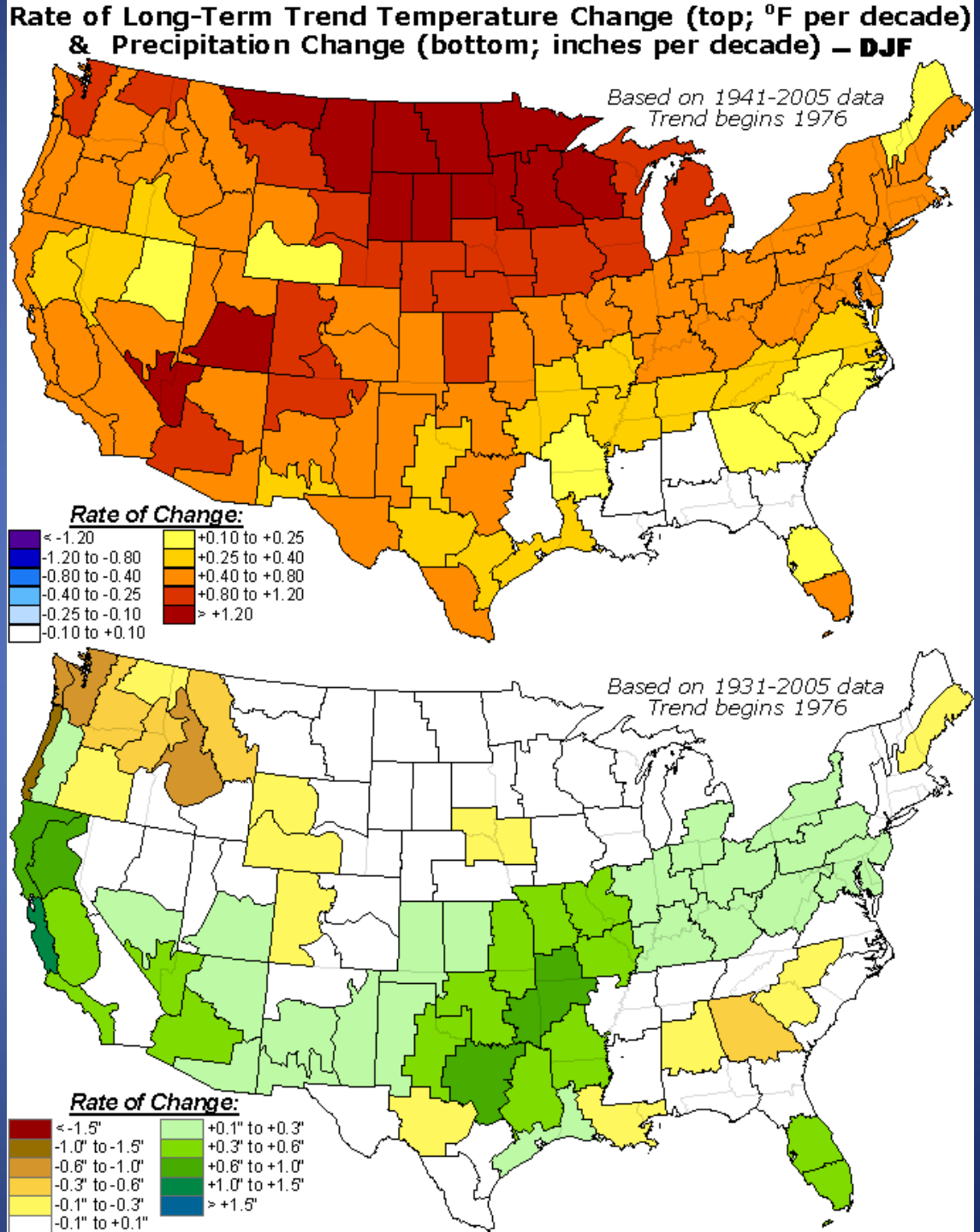
SOUTH DAKOTA
Climate and Weather

Climate data

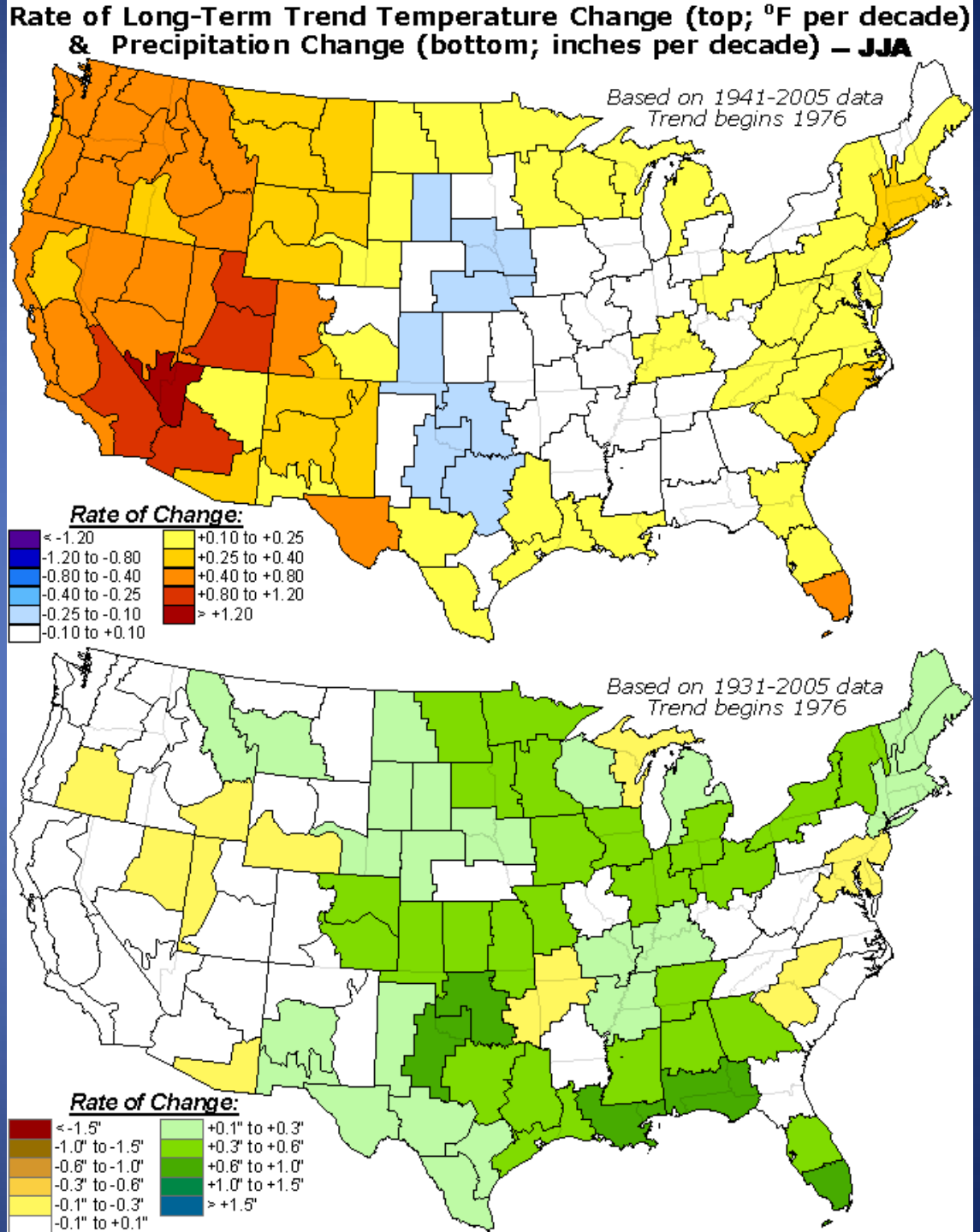
- Measurements from National Weather Service Cooperative Observer Program
- Data since the late 1800s.
- NWS still official data

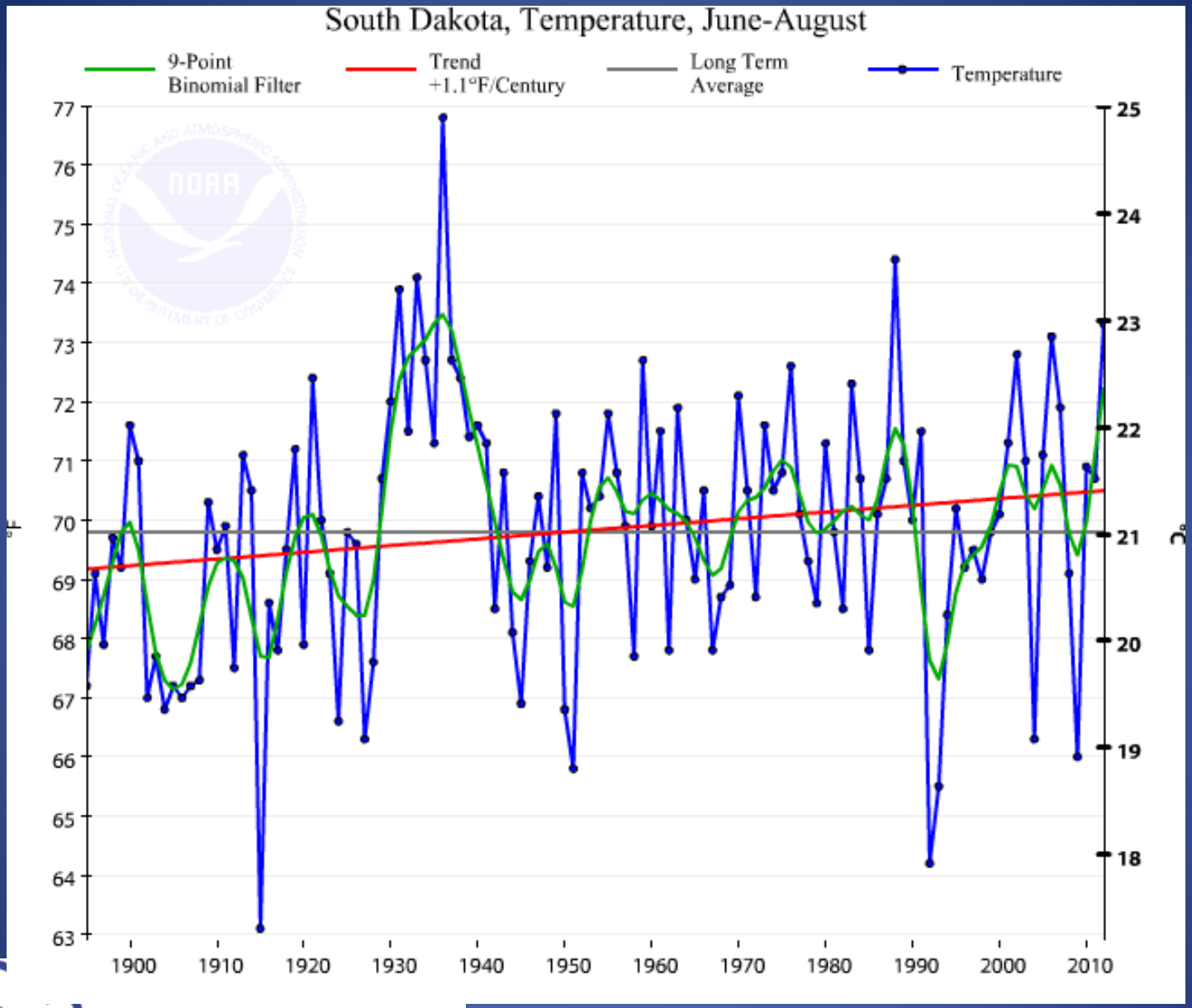
SOUTH DAKOTA Climate and Weather

Dec-Feb trends



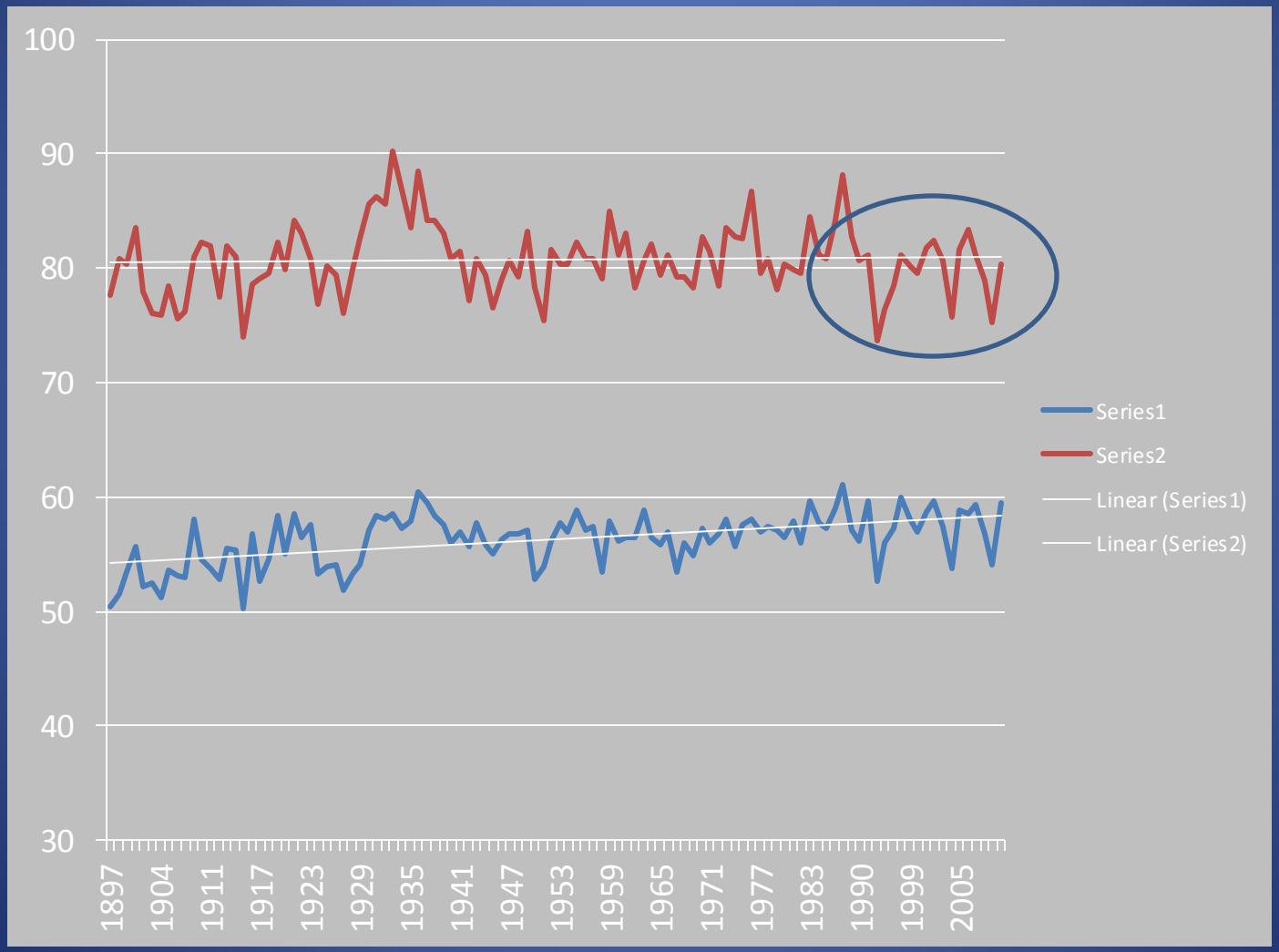
Jun. – Aug. trends



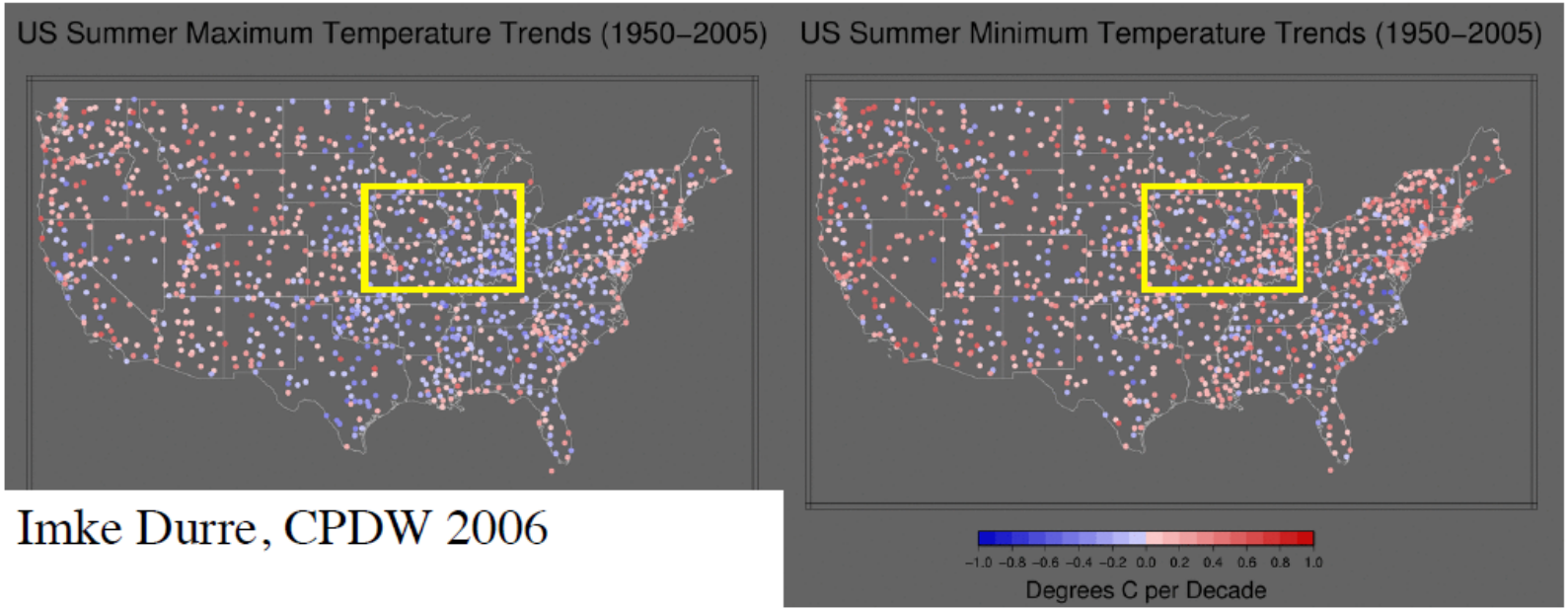


SOUTH DAKOTA Climate and Weather

Watertown summer temperatures 1897-2010



Maximum and Minimum Temperature Trends Offset Each Other



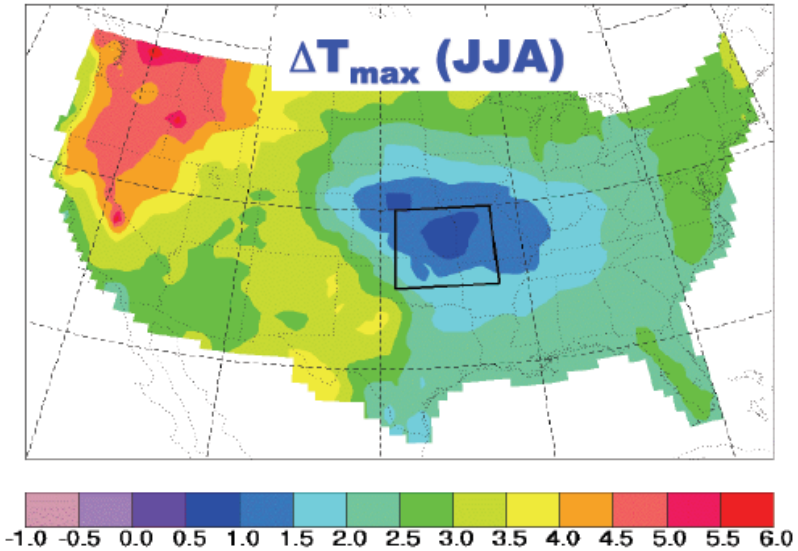
Imke Durre, CPDW 2006

An increase in minimum temperature and a decrease in maximum temperature results in little change in a verage temperature.

"Warming Hole"

Global models poorly simulate Midwest temperature trend (Kunkel et al 2006).

Regional model simulated Midwest trends and used to examine future change considering greenhouse gas increases alone.**



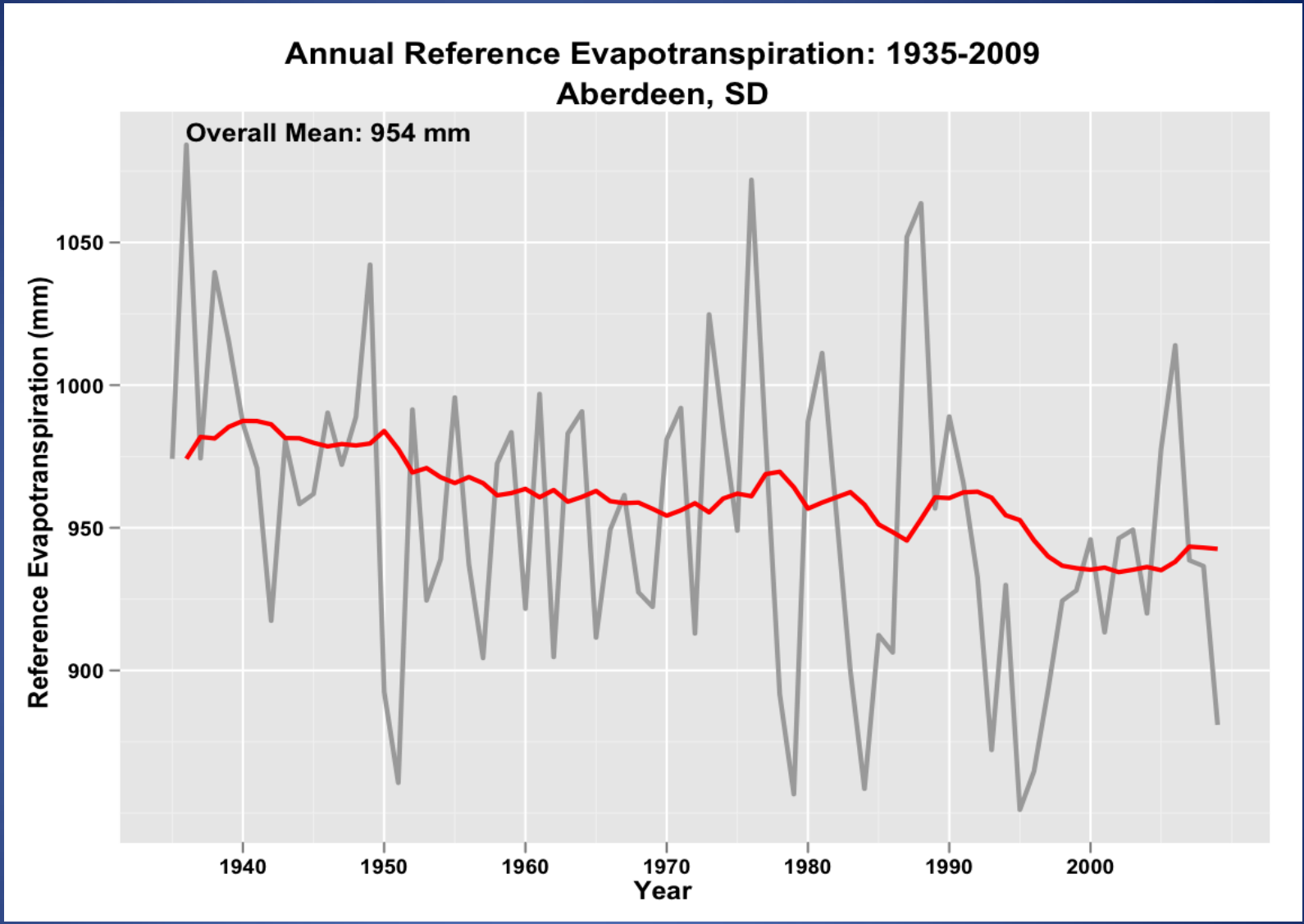
Conclusion: Lack of Midwest warming can be consistent with global warming mechanism.

**Pan, Z., R. W. Arritt, E. S. Takle, W. J. Gutowski, Jr., C. J. Anderson, and M. Segal, 2004: Altered hydrologic feedback in a warming climate introduces a "warming hole". Geophys. Res. Lett.31, L17109, doi: 10.1029/2004GL020528.

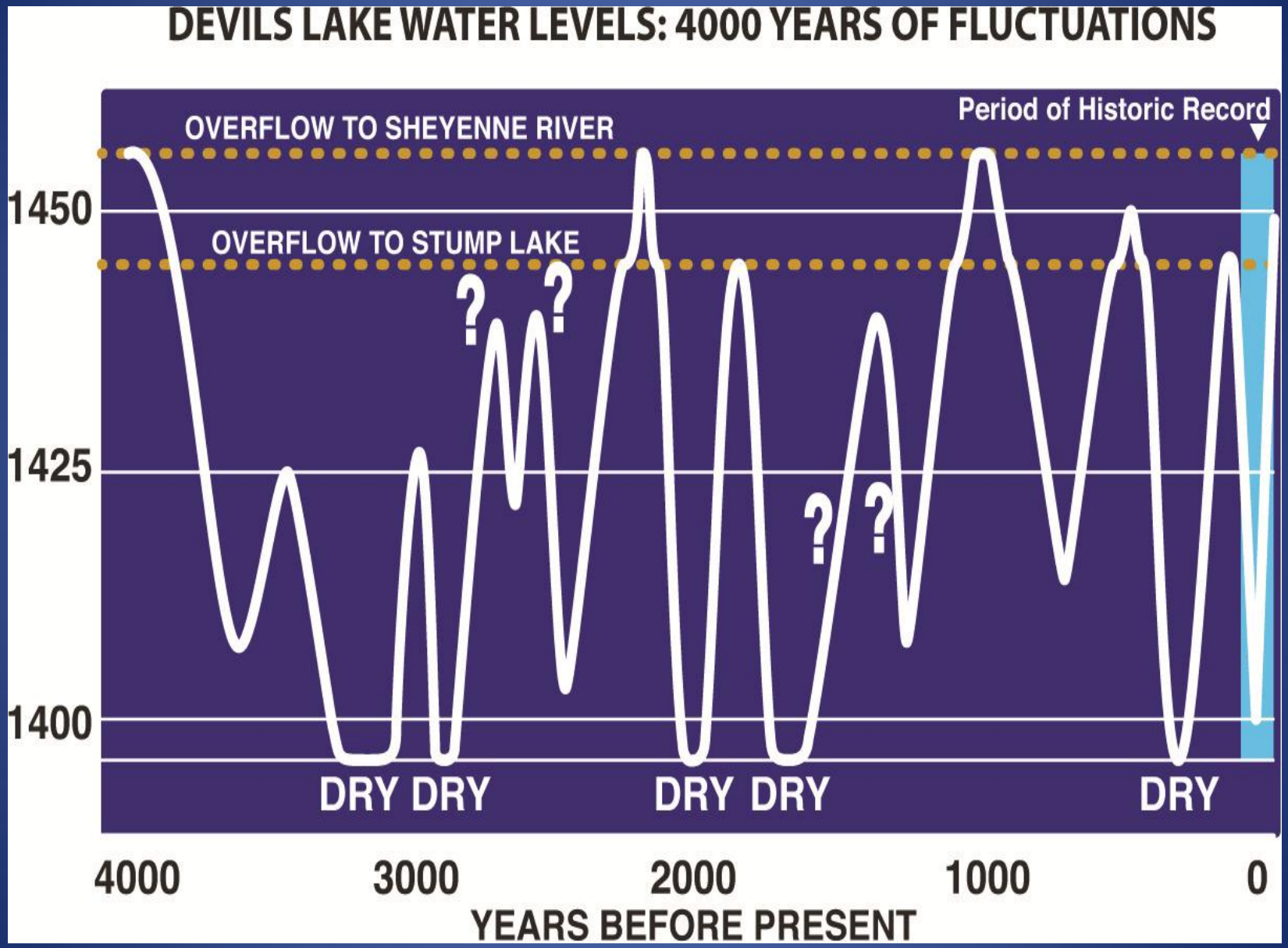
Impact – reduced high temps

- Cooler high temperatures reduces evaporative potential as well as crop water use.
- Thus, less water removed from surface.

- Biggest impact of this in the Bitter Lake area
  - Only way to remove water is evaporate

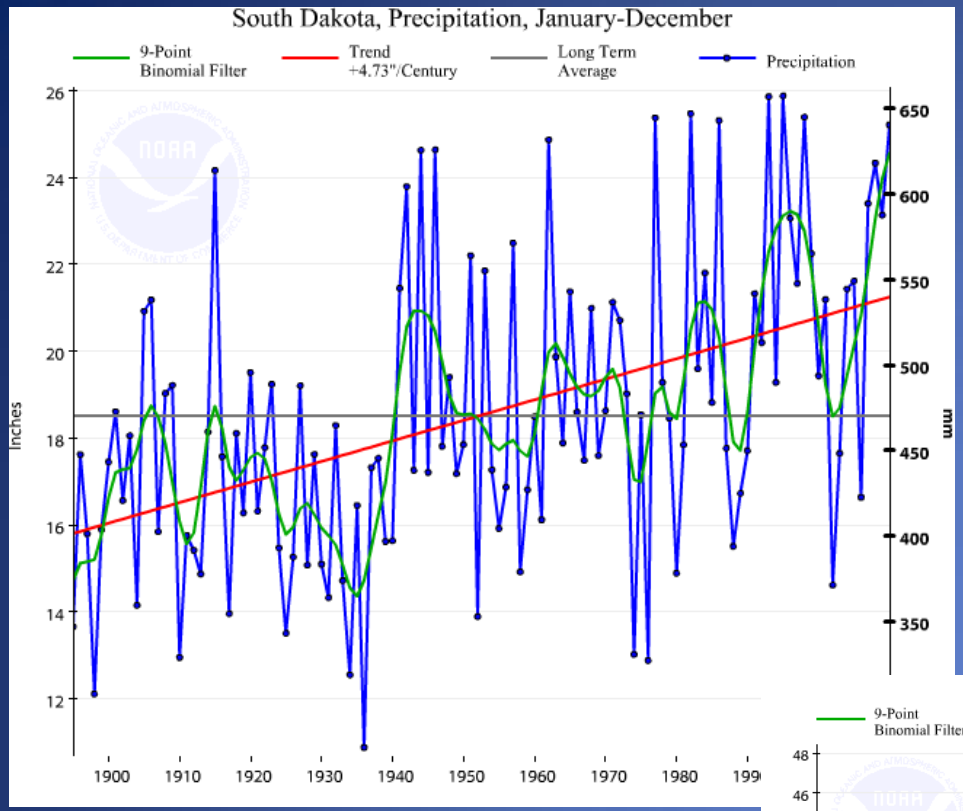


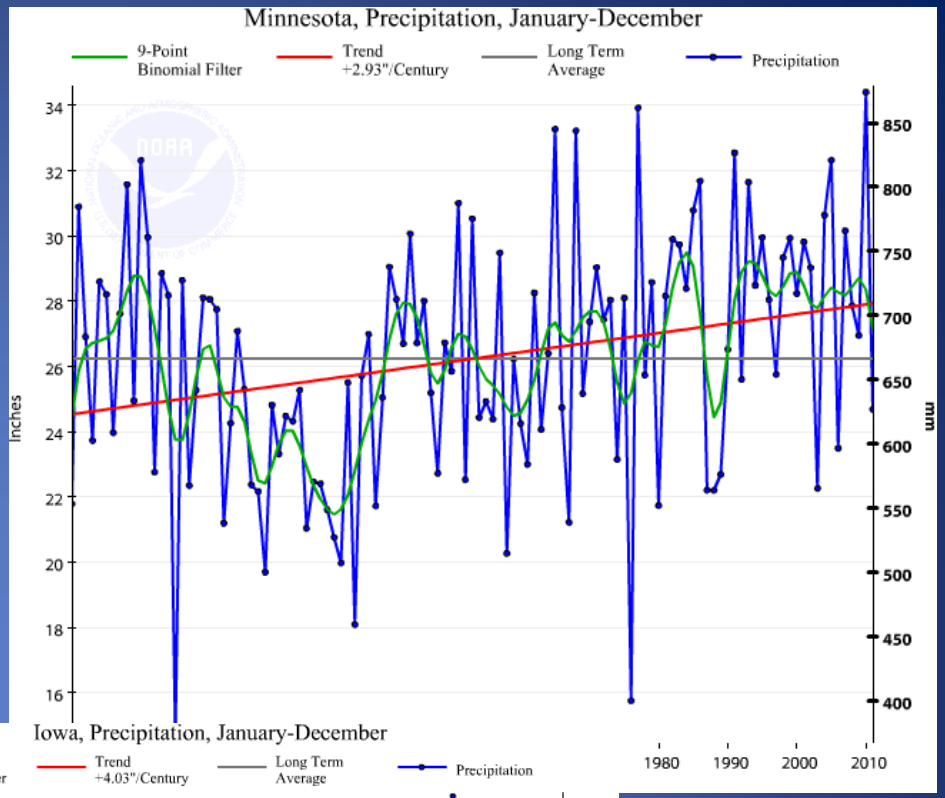
ET – Evapotranspiration, a combination of surface evaporation and transpiration from a crop
Calculated based on temperature index

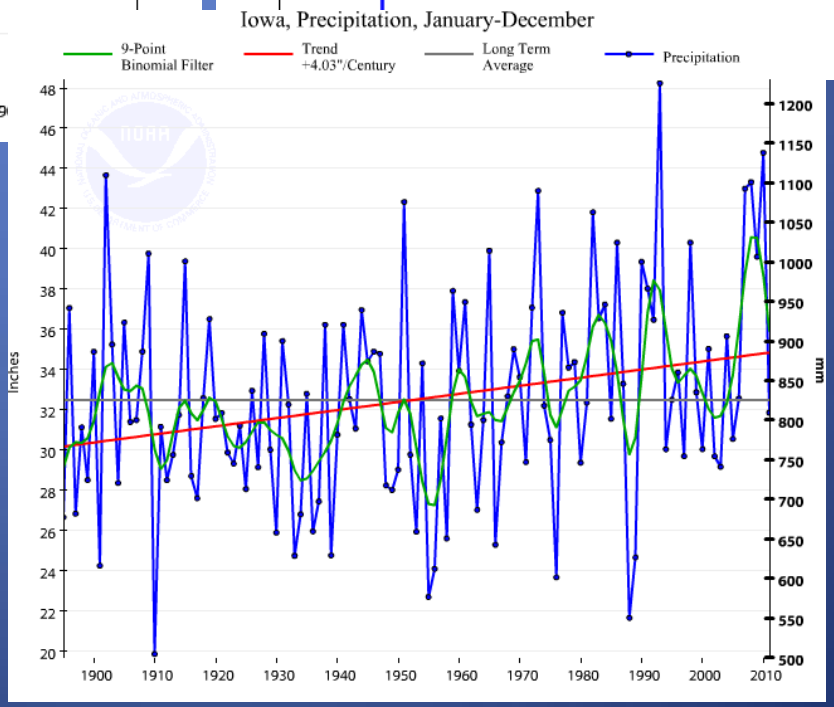

DEVILS LAKE WATER LEVELS: 4000 YEARS OF FLUCTUATIONS
Period of Historic Record
OVERFLOW TO SHEYENNE RIVER
OVERFLOW TO STUMP LAKE
1450
1425
1400
?
?
?
?
DRY DRY
DRY DRY
DRY
4000
3000
2000
1000
0
YEARS BEFORE PRESENT

VARIABILITY

SOUTH DAKOTA
Climate and Weather





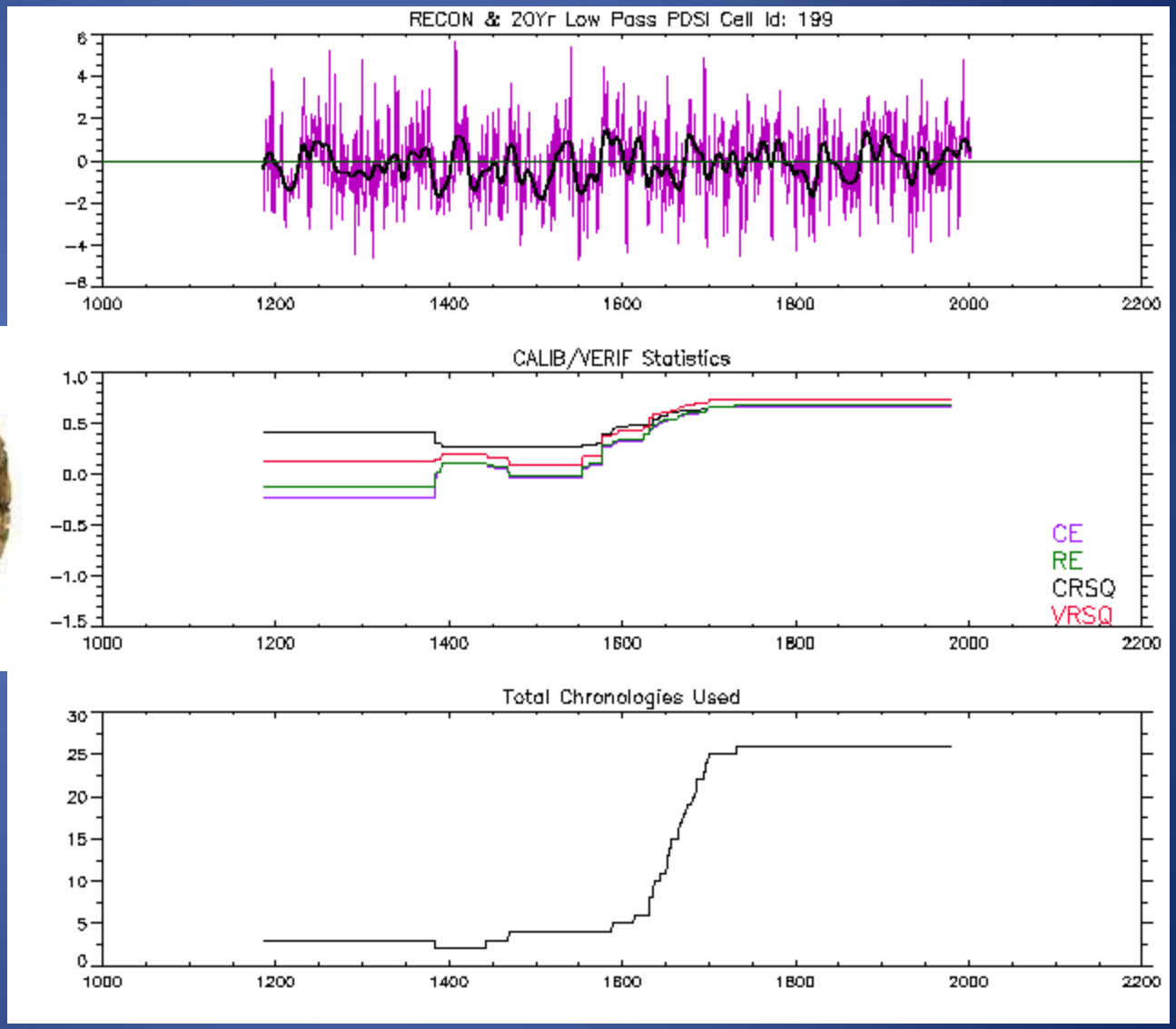


SOUTH DAKOTA Climate and Weather

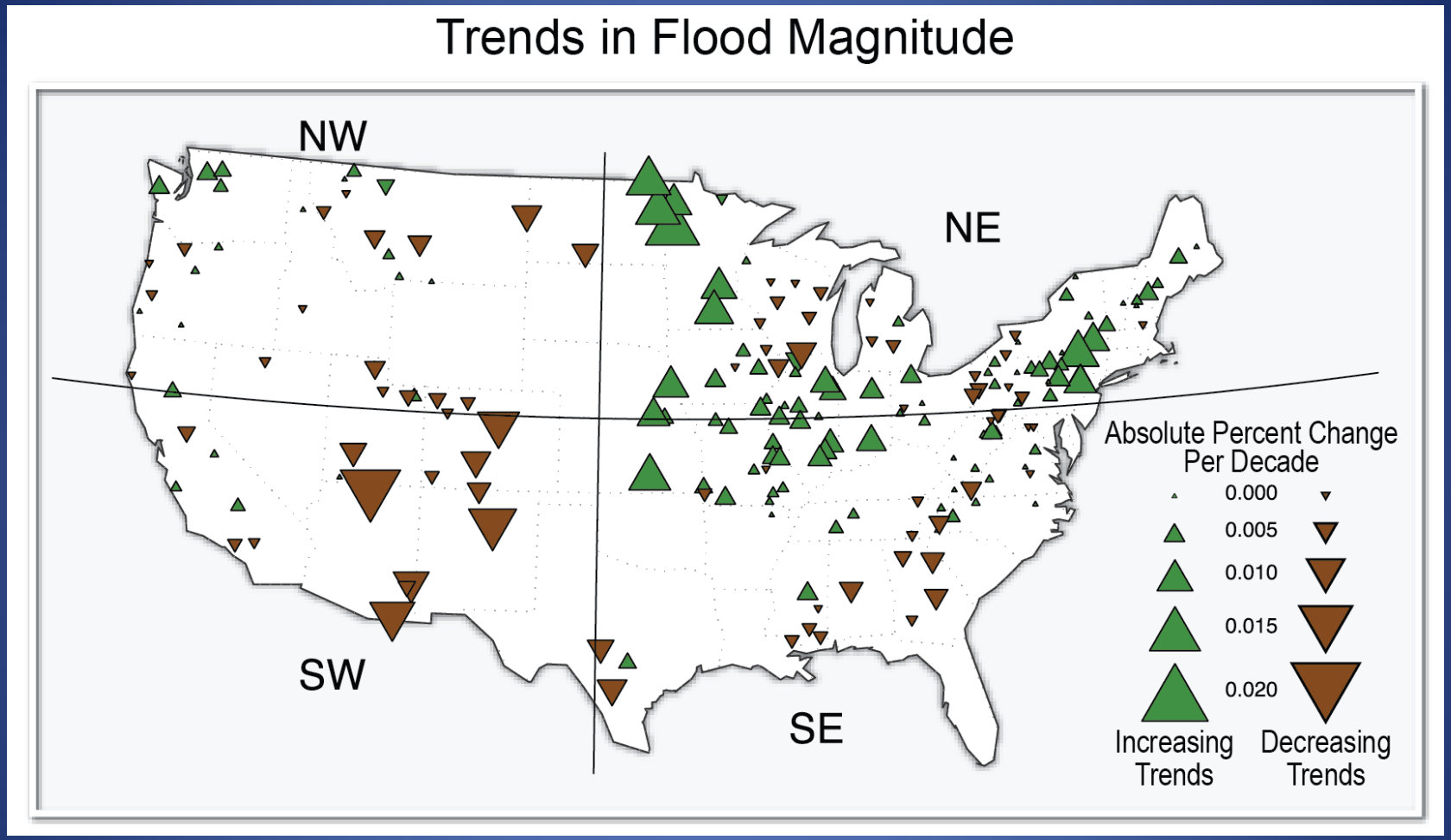
Records of wetness

- Instrumented – best
- Proxies – longer, but not as accurate
  - Tree rings
  - Lake cores (salinity)

Tree ring reconstructions



http://www.ncdc.noaa.gov/paleo/newpdsi.html



Caption: Trend magnitude (triangle size) and direction (green = increasing trend, 3 brown = decreasing trend) of annual flood magnitude from the 1920s through 4 2008. (Source: Hirsch and Ryberg 2012).

Summary

- More precipitation overall – especially fall
- More heavy precipitation events
- Increasing dew point
- General warming (more winter – less summer)
- Decreased evap-ET

SOUTH DAKOTA
Climate and Weather

Needs

- Monitoring of all parts of water cycle
  - Soil moisture
  - Precip
  - RH/Dew point
- Others?

SOUTH DAKOTA
Climate and Weather

Comments/Questions/Complaints?

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