Observed Climate Change in the Twin Cities

Daniel Brown, Research Associate, GLISA

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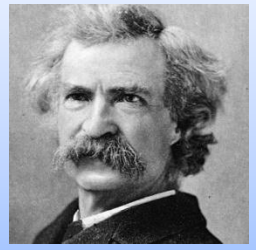
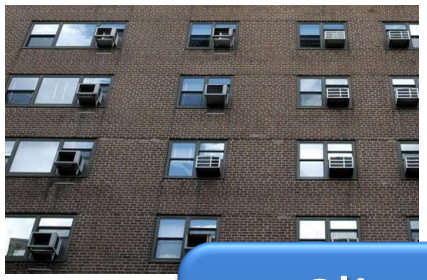
GREAT LAKES INTEGRATED SCIENCES + ASSESSMENTS

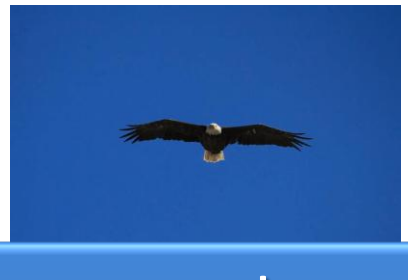
Why Care About Climate Change?

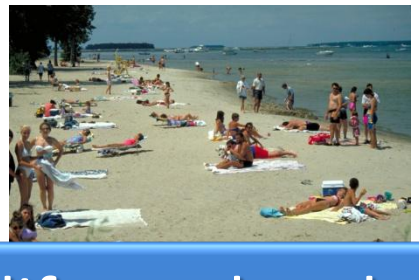


"Everybody talks about the weather, but nobody does anything about it."

—Mark Twain, 1897







Climate regulates life on the planet.
Climate determines how we live.

Photo credits: michigan.org, MSU, Daniel Brown, Wikipedia.org, ahajokes.com

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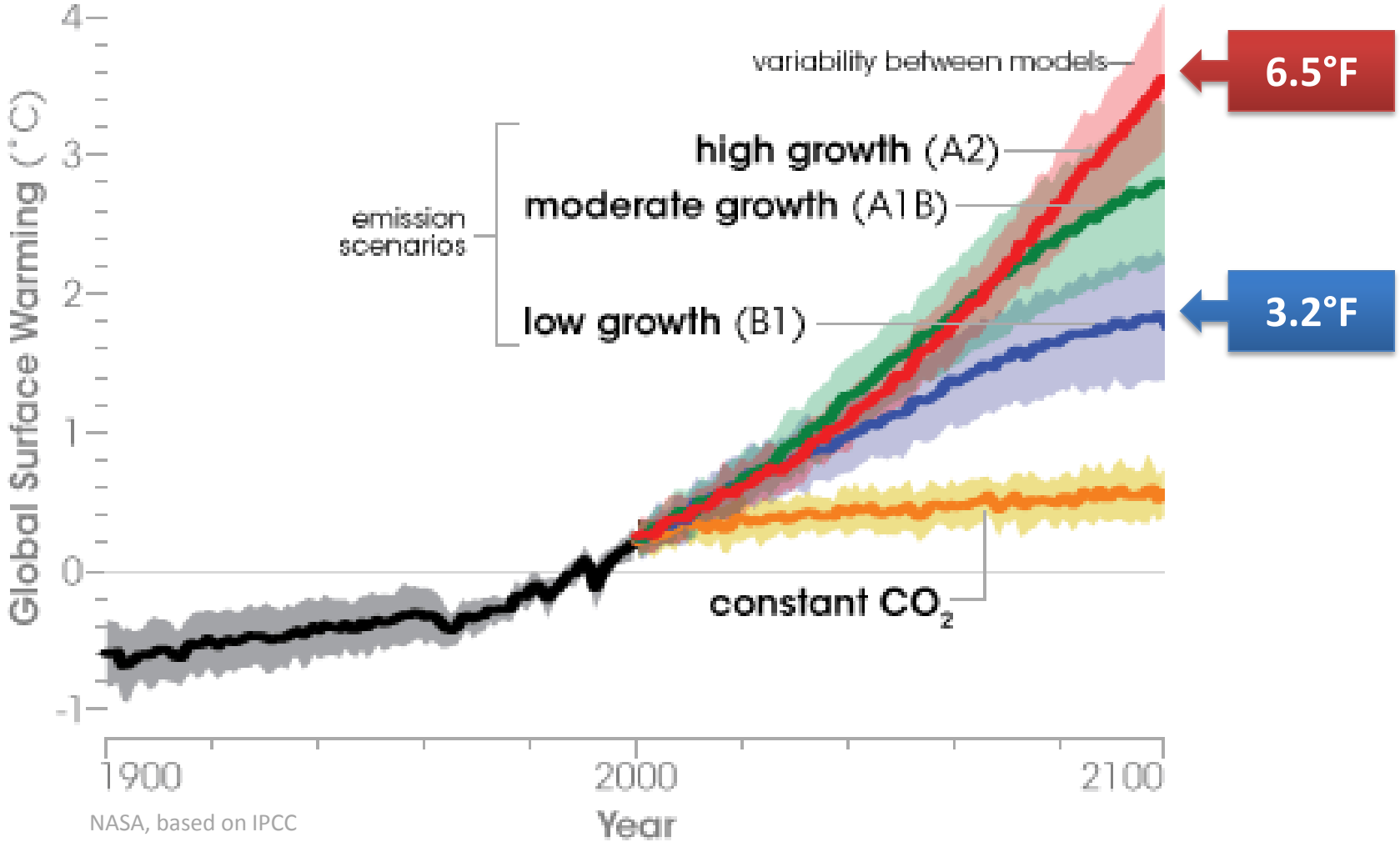
Observed and Projected Global Temperature



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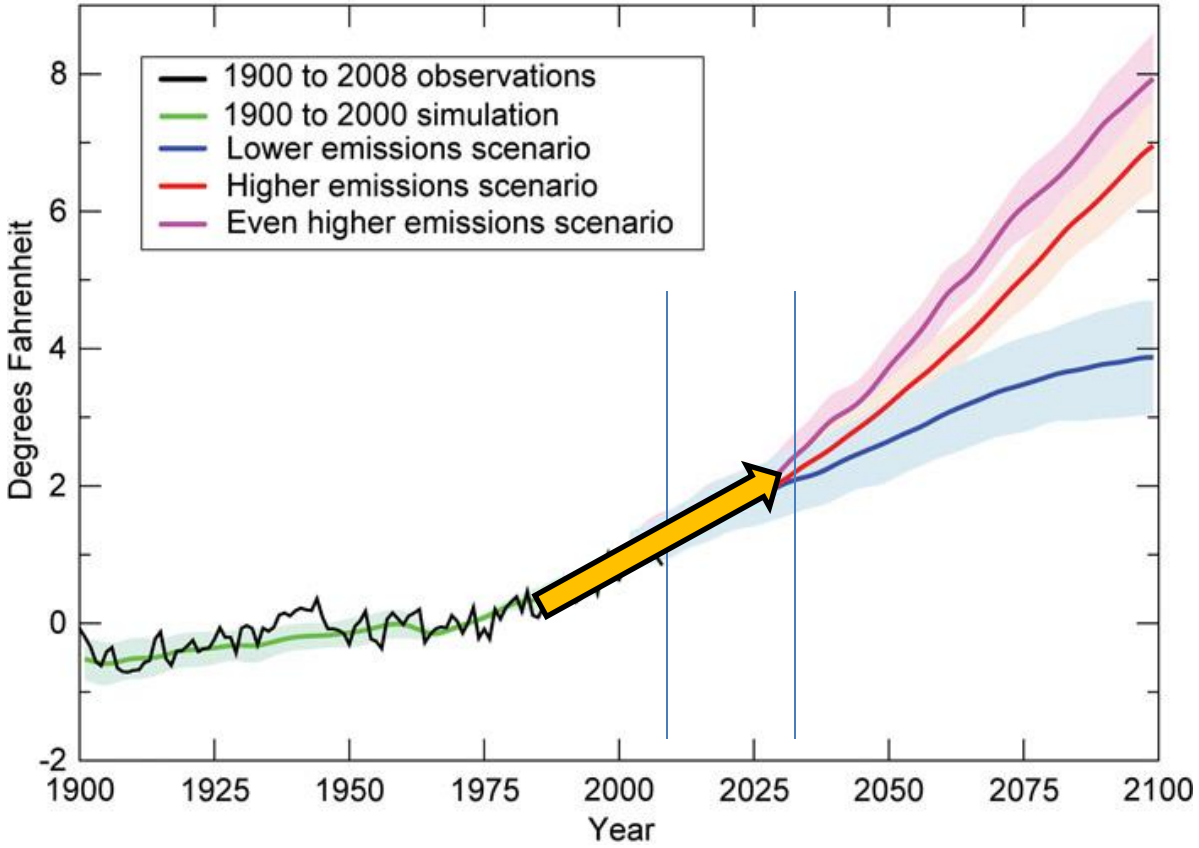
Historical Climate and Future Adaptation



- Future climate projections may not diverge significantly until the mid-21st century.
- Using recent historical trends and long-term future projections, adaptation trajectories for the near future can be better informed.

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Global Trends and Regional Trends

Global trends are more certain than regional trends.

Natural variability plays a larger role at the regional scale.

Local changes in land use can alter the severity of climate change impacts.

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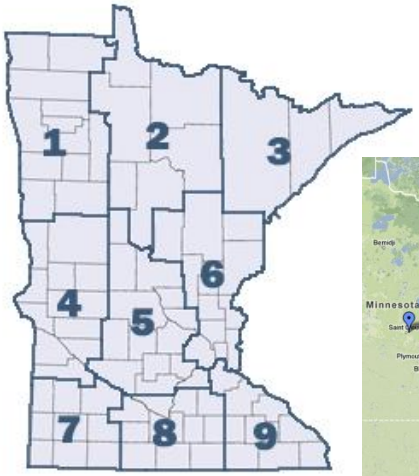
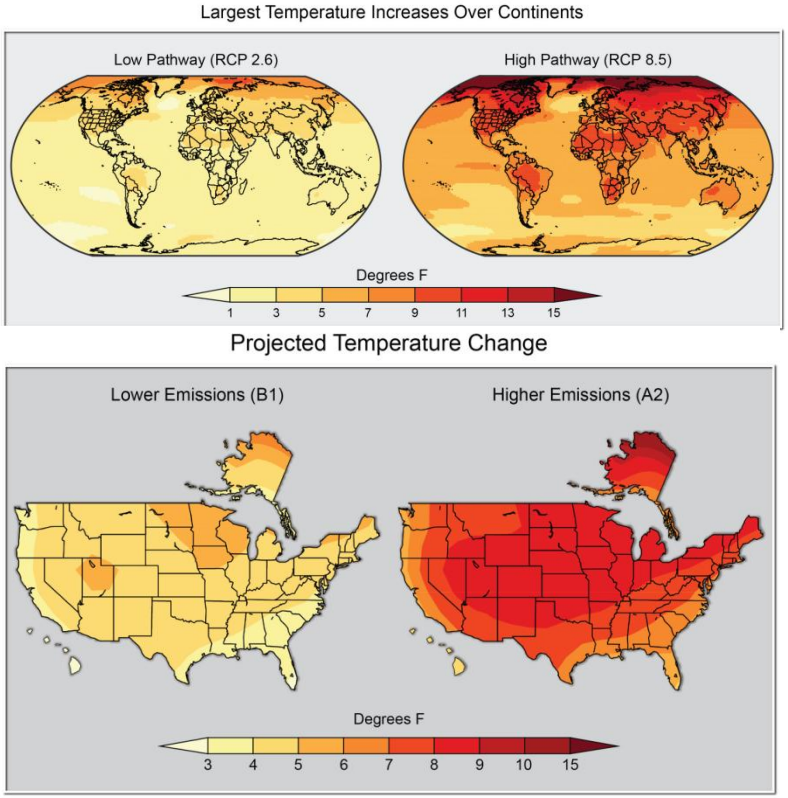
Scale and Uncertainty

More precise mapping or more spatially specific data can be useful but doesn't necessarily reduce uncertainty.





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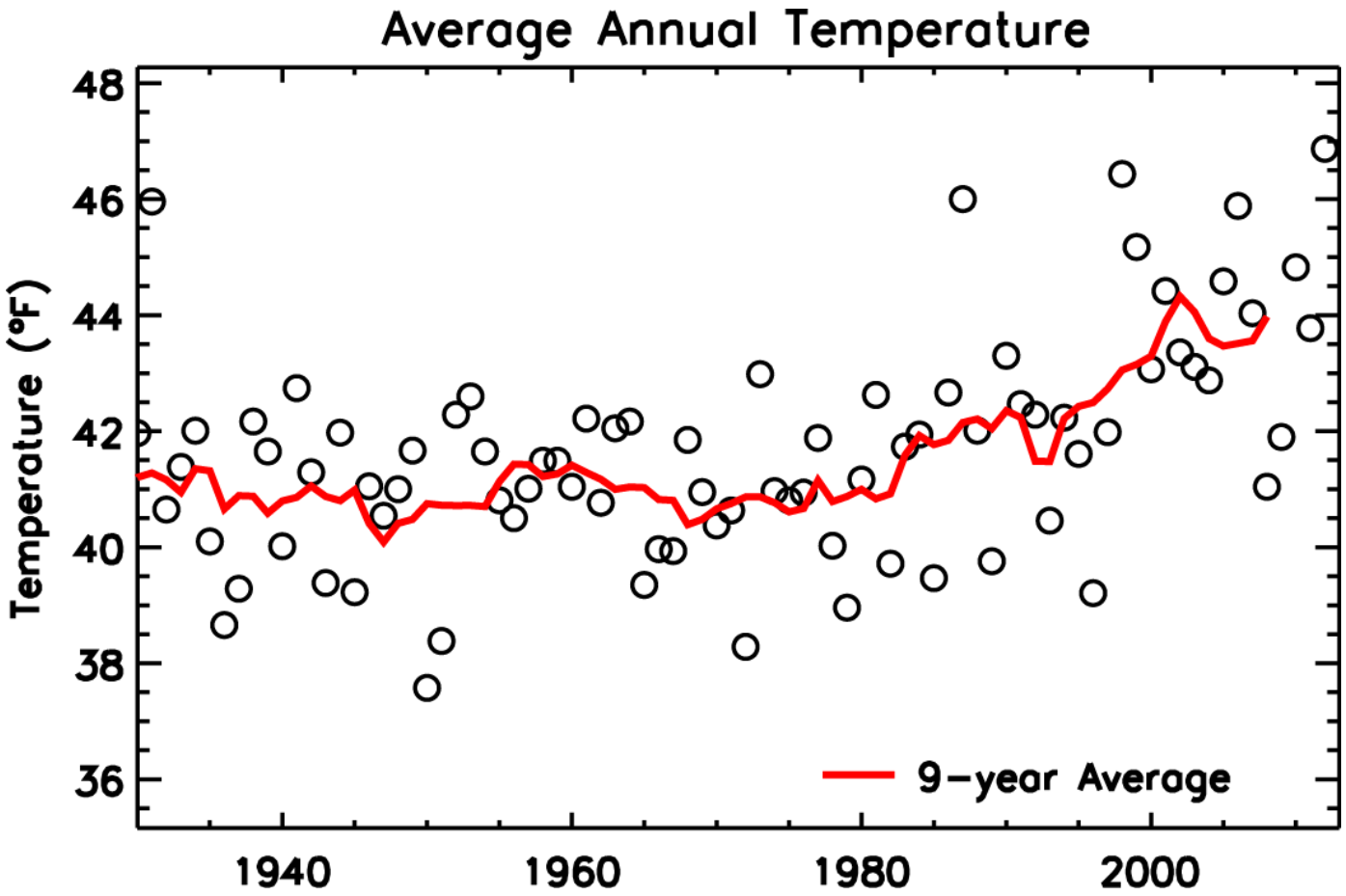
Observed East Central Minnesota Temperature



Changes in Mean Temperature (°F) from 1951-1980 to 1981-2010	
Annual	**1.8**
Winter	3.4
Spring	2.2
Summer	0.9
Fall	0.6

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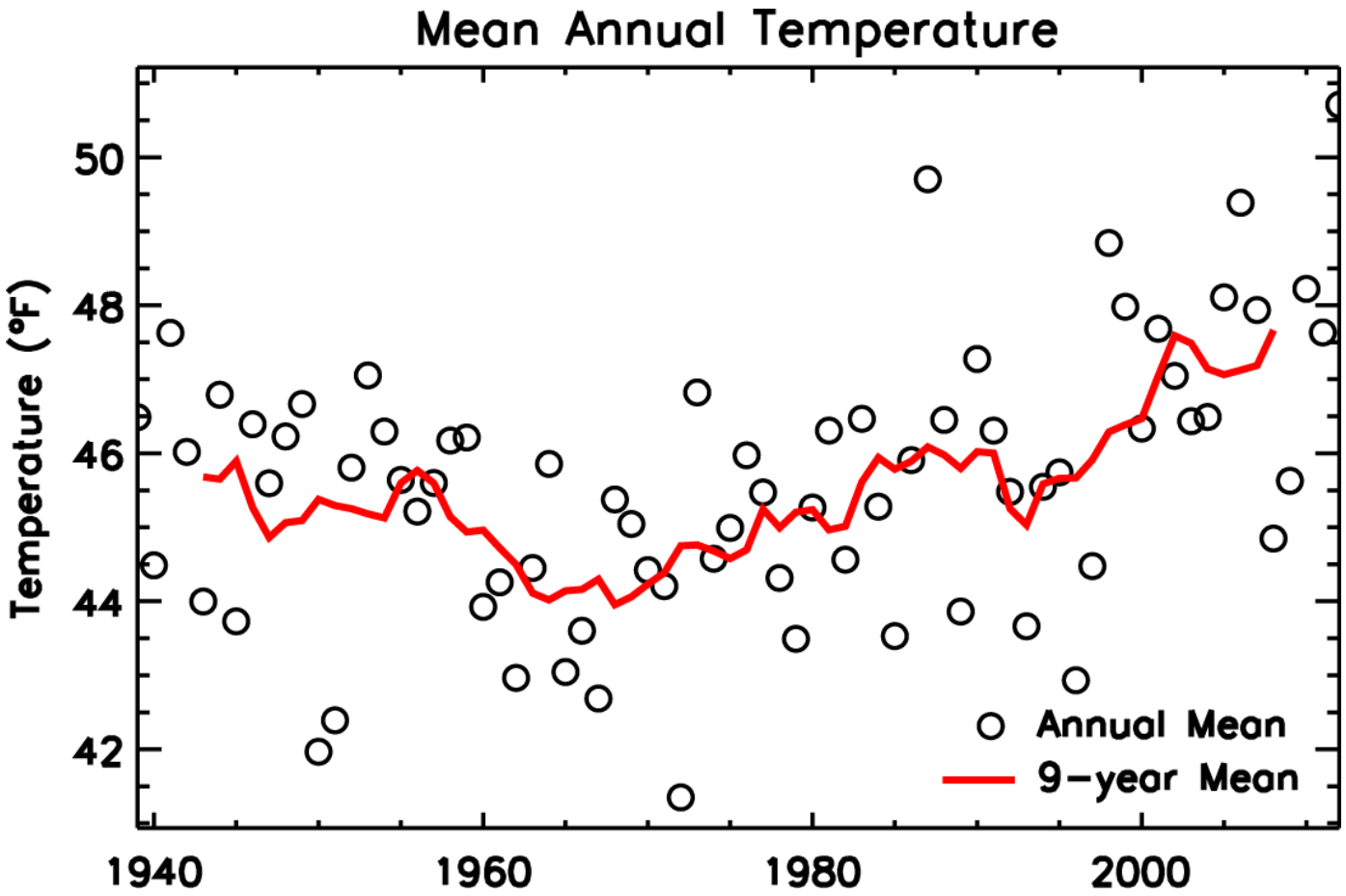
Observed Twin Cities Temperature



Changes in Mean Temperature (°F) from 1951-1980 to 1981-2010	
Annual	**1.5**
Winter	3.1
Spring	2.0
Summer	0.6
Fall	0.4

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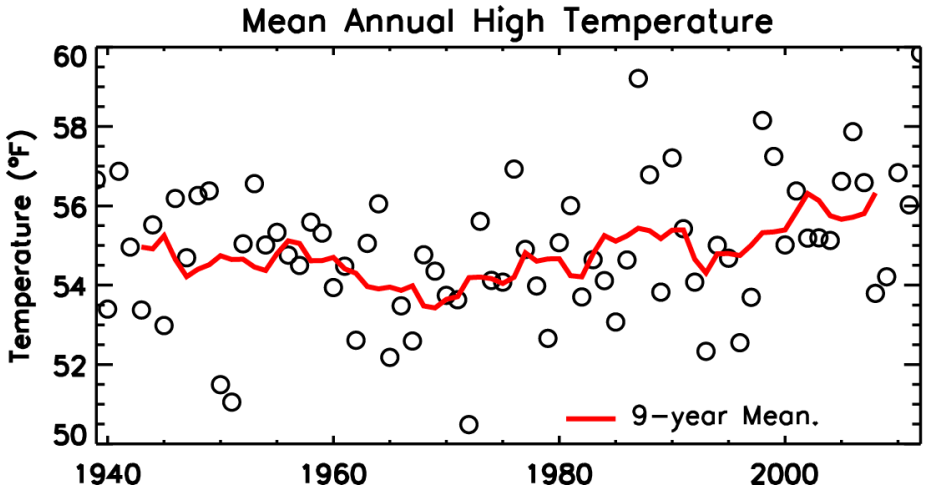
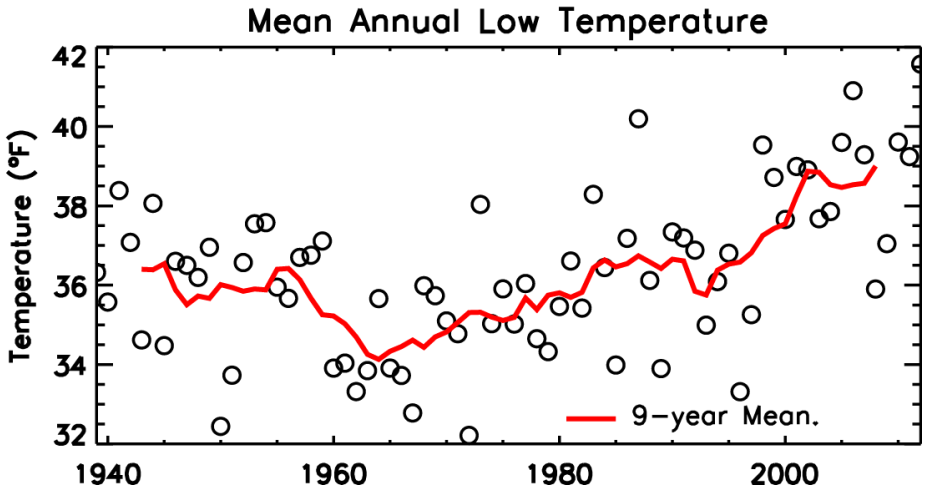
Observed Twin Cities High and Low Temperatures





Annual Average Low Temperatures increased at twice the rate of High Temperatures from 1951-1980 to 1981-2010.

Change in Mean Annual High Temperature from 1951-1980 (°F)	1.04°F
Change in Mean Annual Low Temperature from 1951-1980 (°F)	2.02°F

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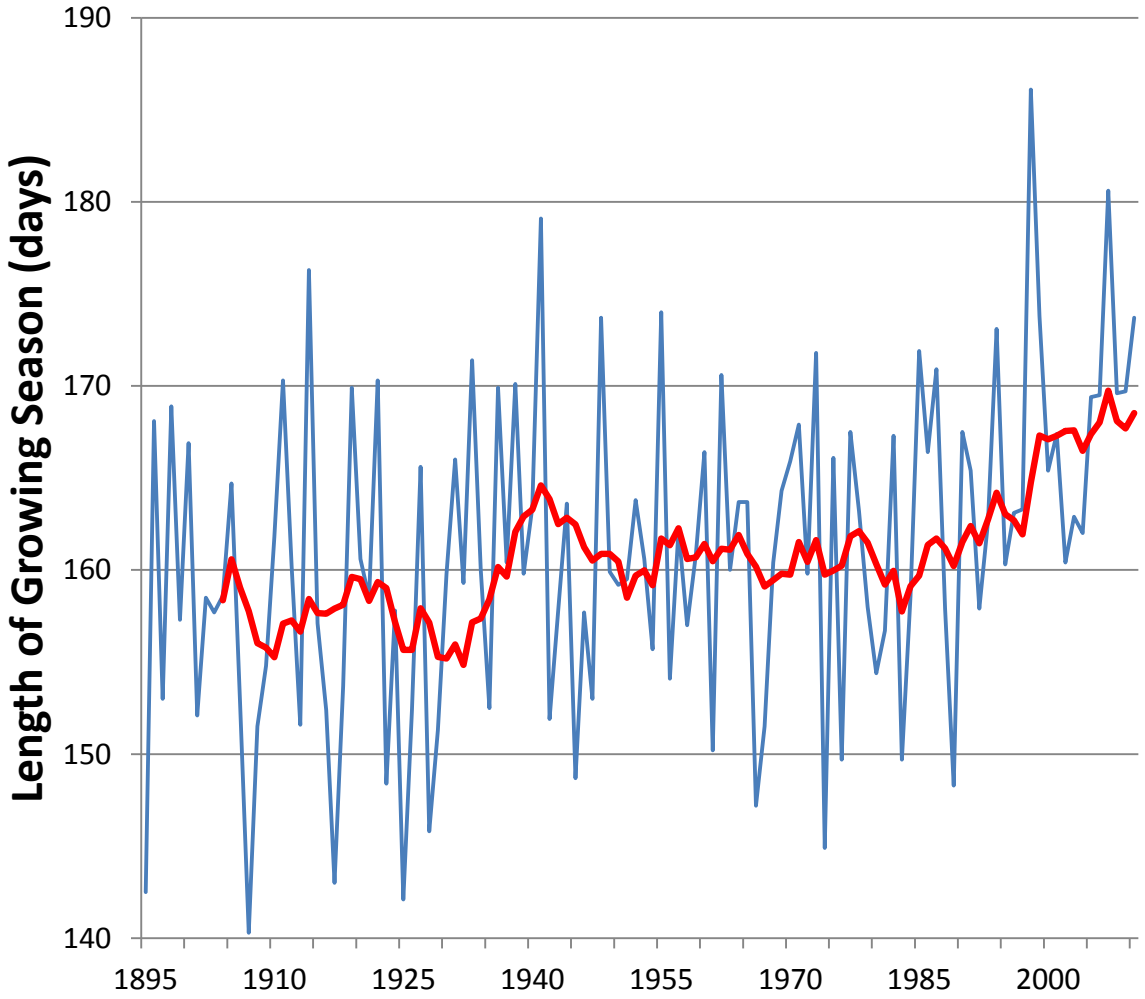
Longer Midwestern Growing Season



Growing season longer by ~1-2 weeks

Earlier last winter frost in spring

Date of first winter frost is often unchanged

Based on data from the National Climatic Data Center for the cooperative observer network and updated from Kunkel et al. (2004)

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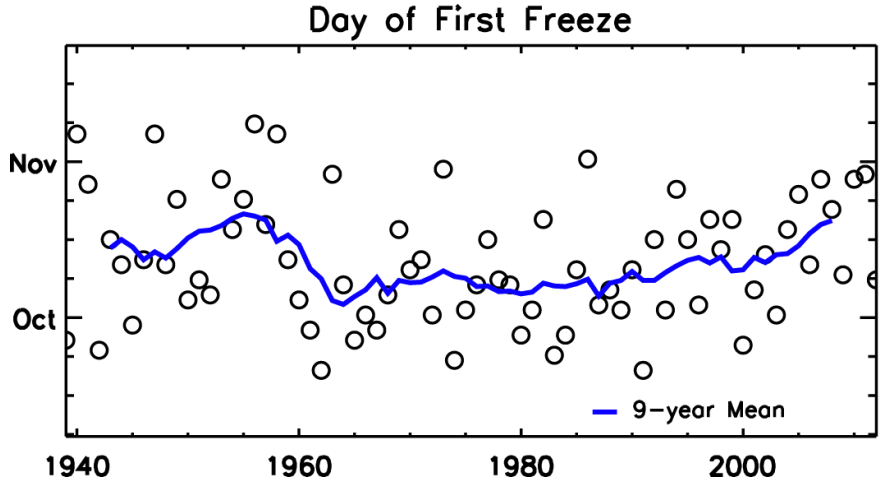
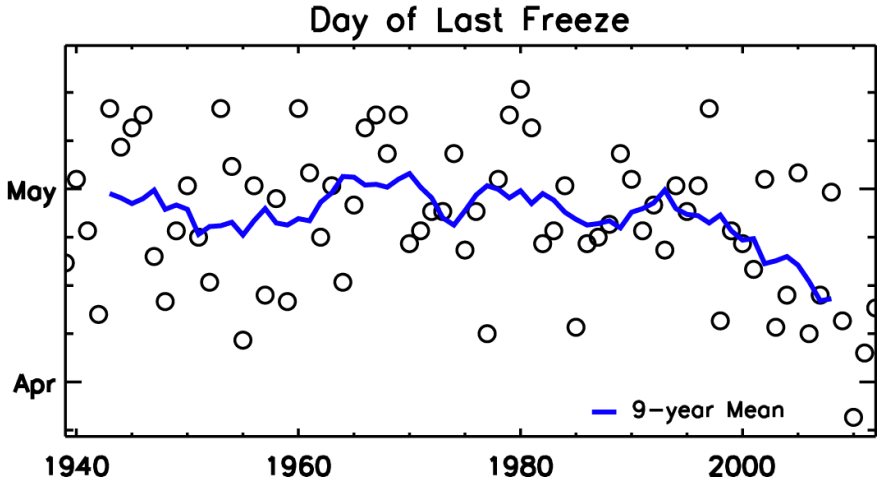
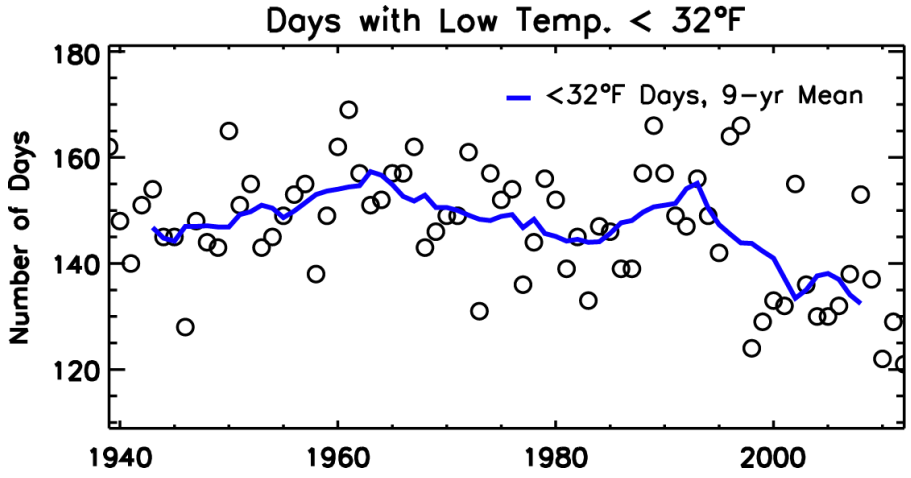
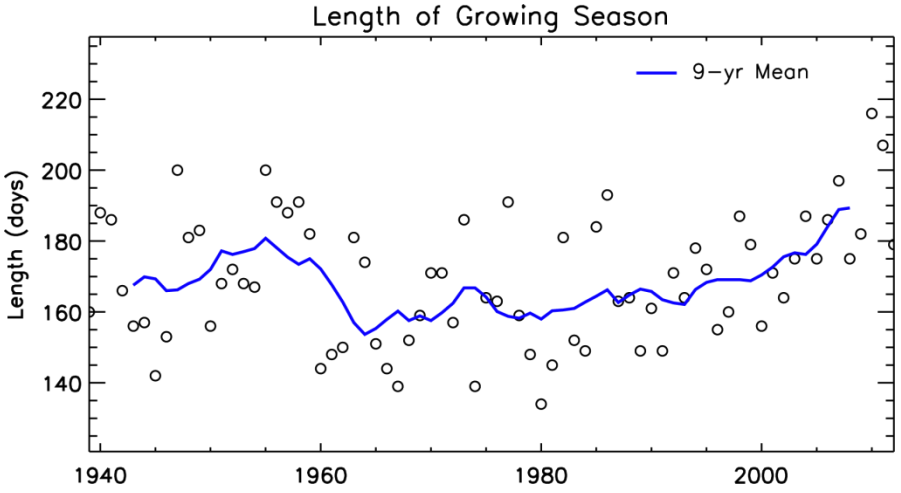
Observed Twin Cities Growing Season and Freezing Days









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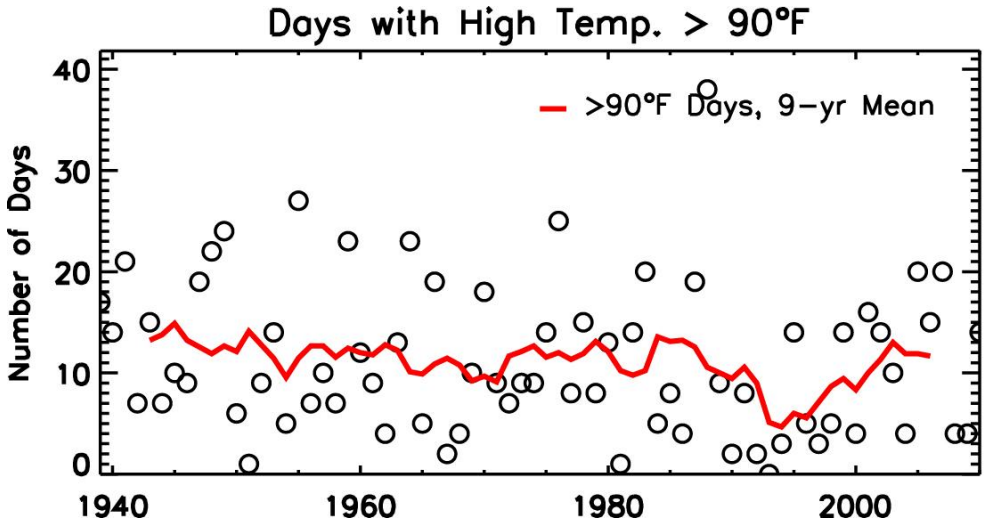
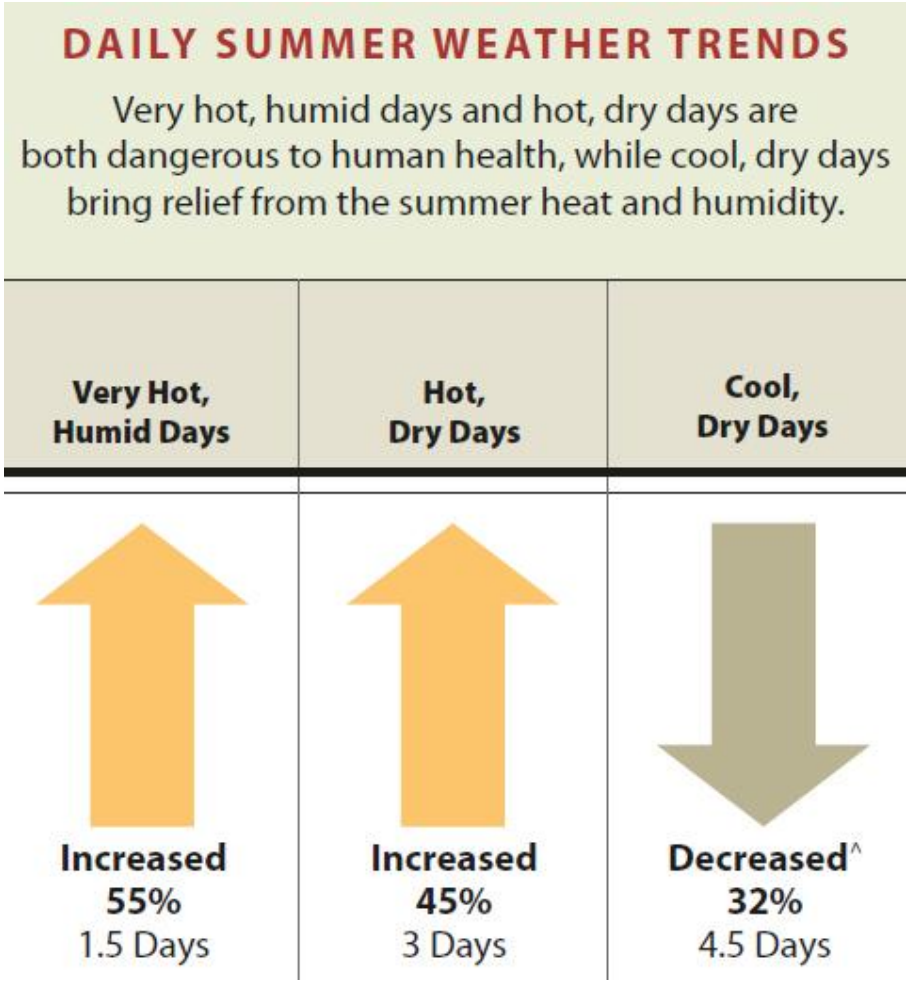
Observed Twin Cities Hot Days



The number of days exceeding 90°F has not significantly changed over the record.

The average number of cool, dry days per year has decreased.



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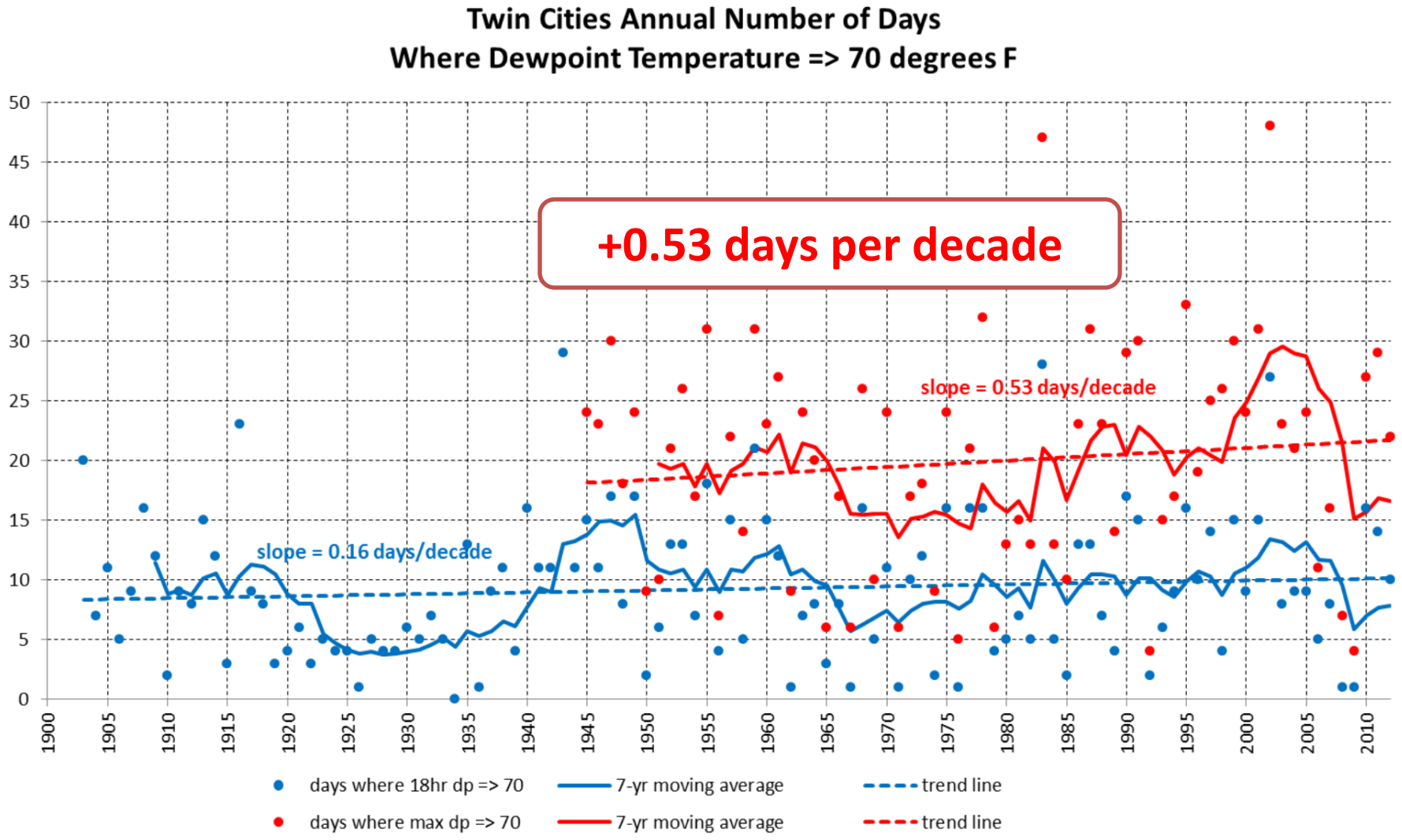
Twin Cities Dewpoint Temperatures



Mark Seeley, MN State Climatologist

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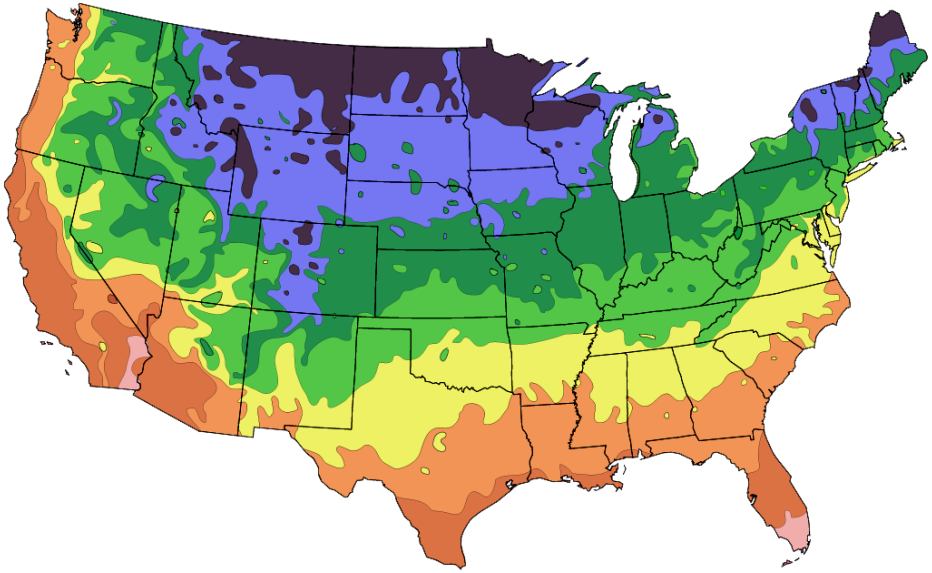
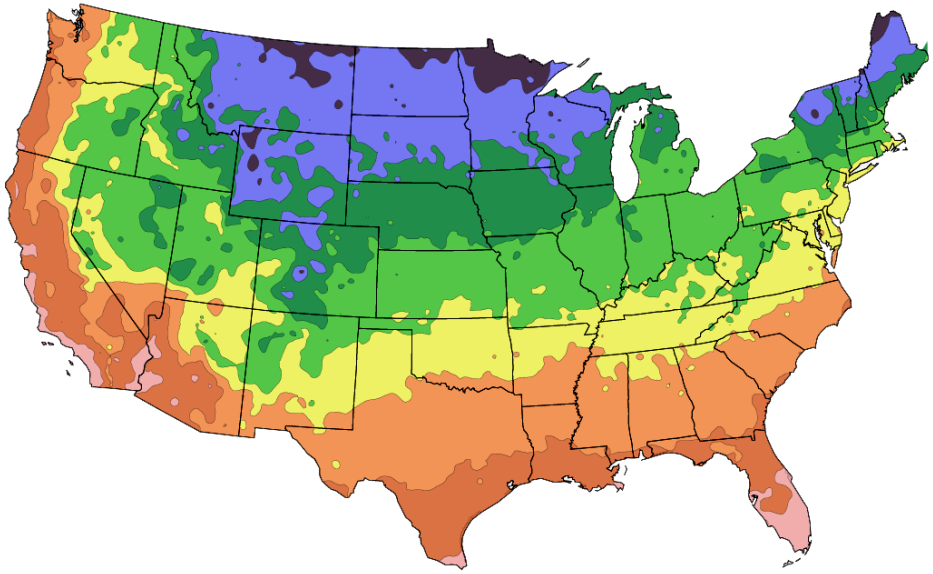
Shifting Plant Hardiness Zones

1990 Map



After USDA Plant Hardiness Zone Map, USDA Miscellaneous Publication No. 1475, Issued Januay 1990

2006 Map



National Arbor Day Foundation Plant Hardiness Zone Map published in 2006.

Zone

© 2006 by The National Arbor Day Foundation®

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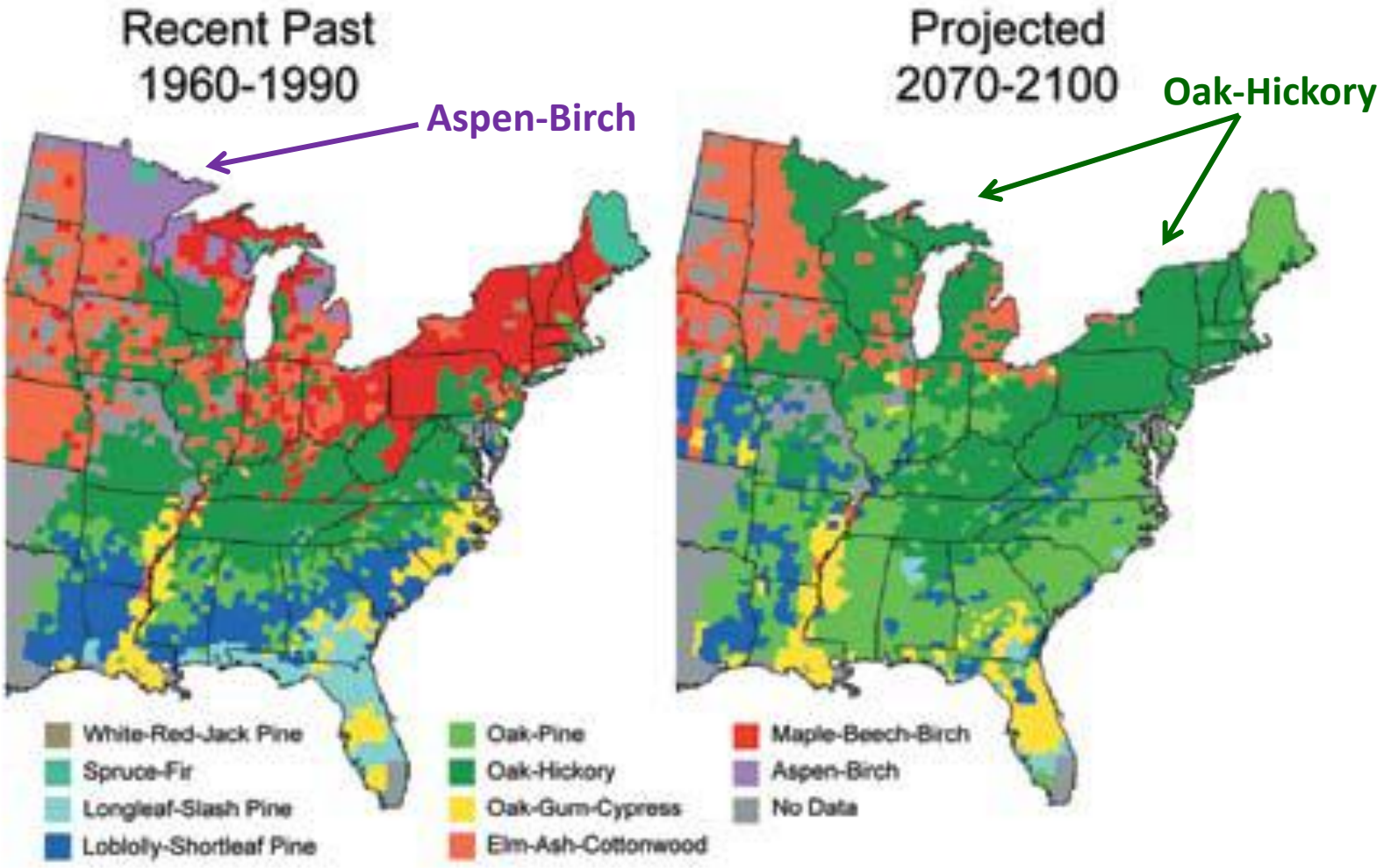
Projected Shifts in Forest Types



USGCRP (2009)

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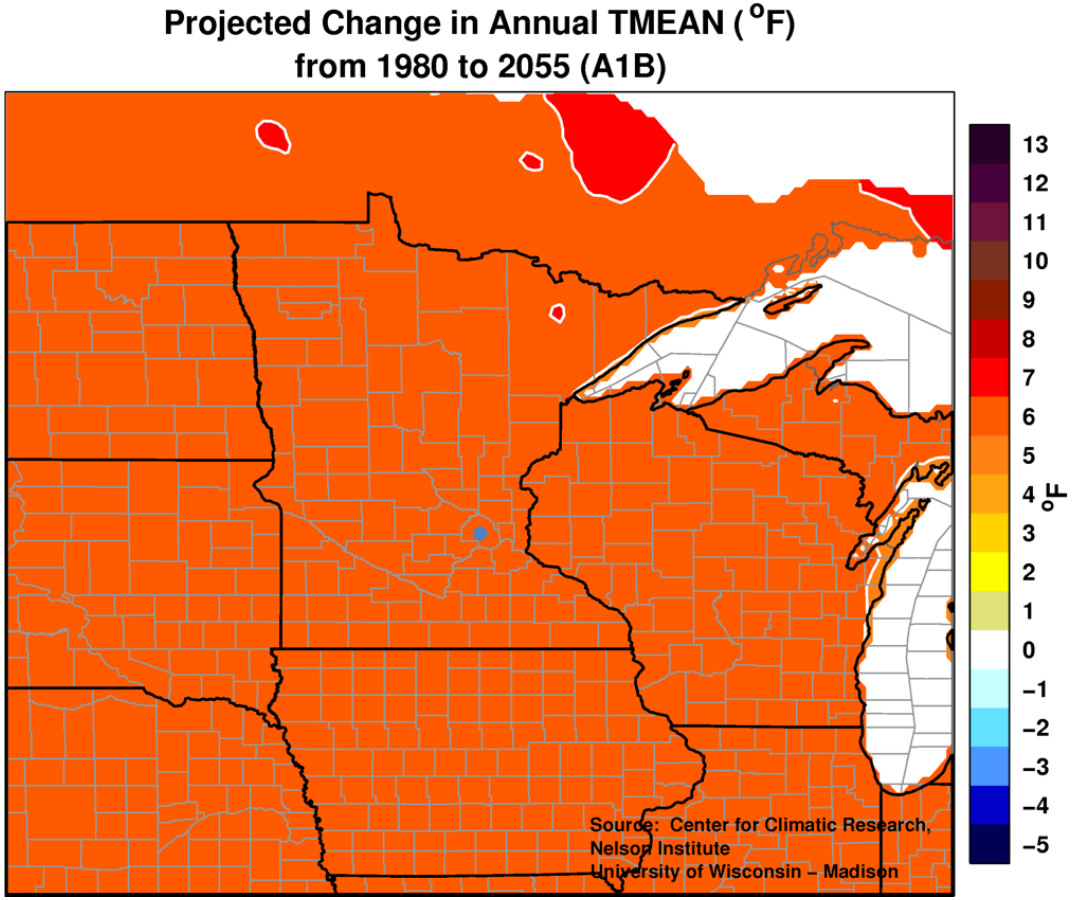
Projected Future Temperature



80% range: 3-9˚F

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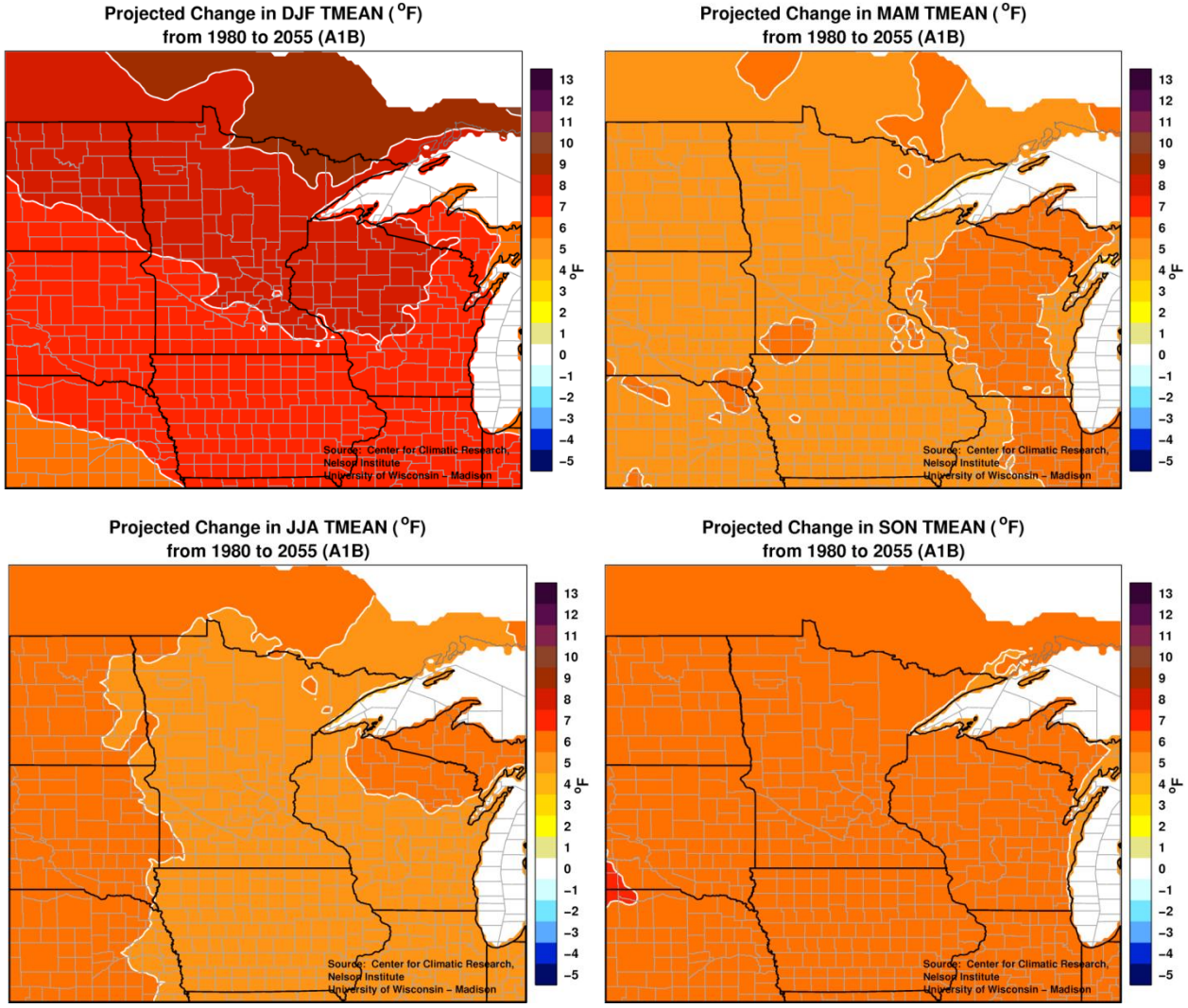
Projected Seasonal Temperatures



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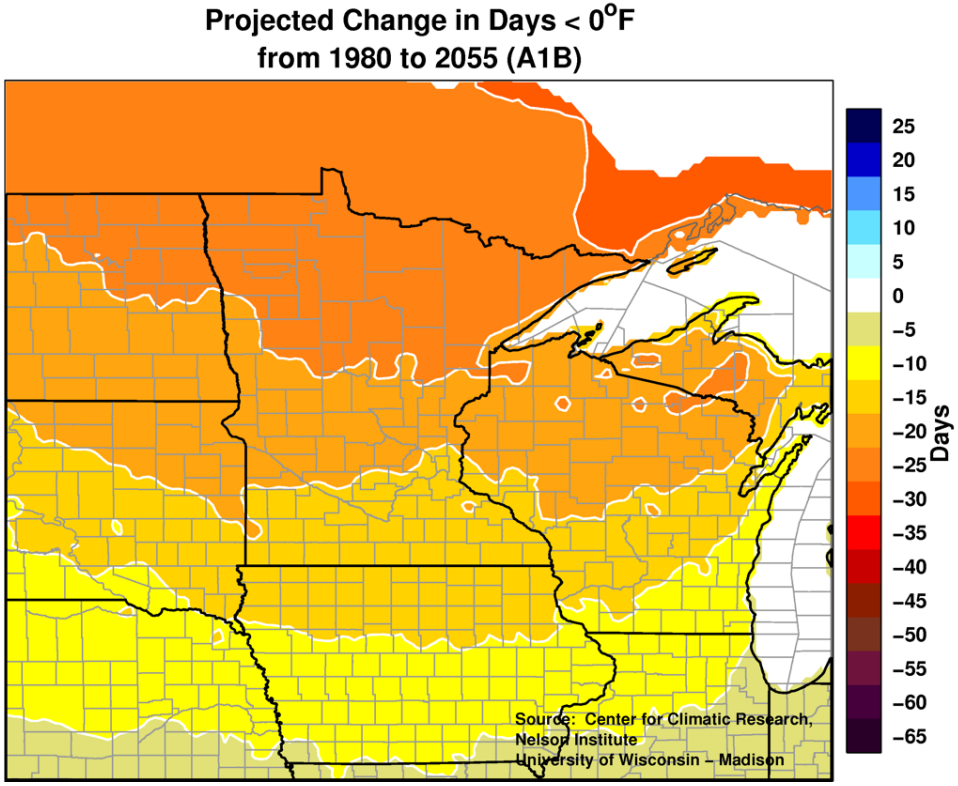
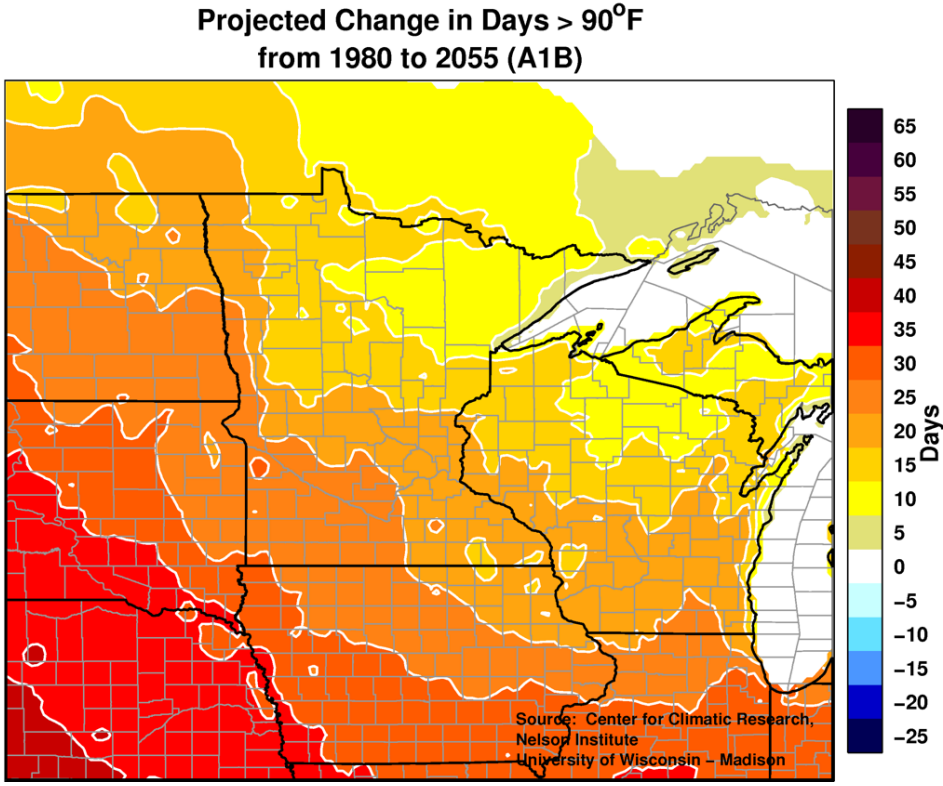
Fewer Cold Days, More Hot Days





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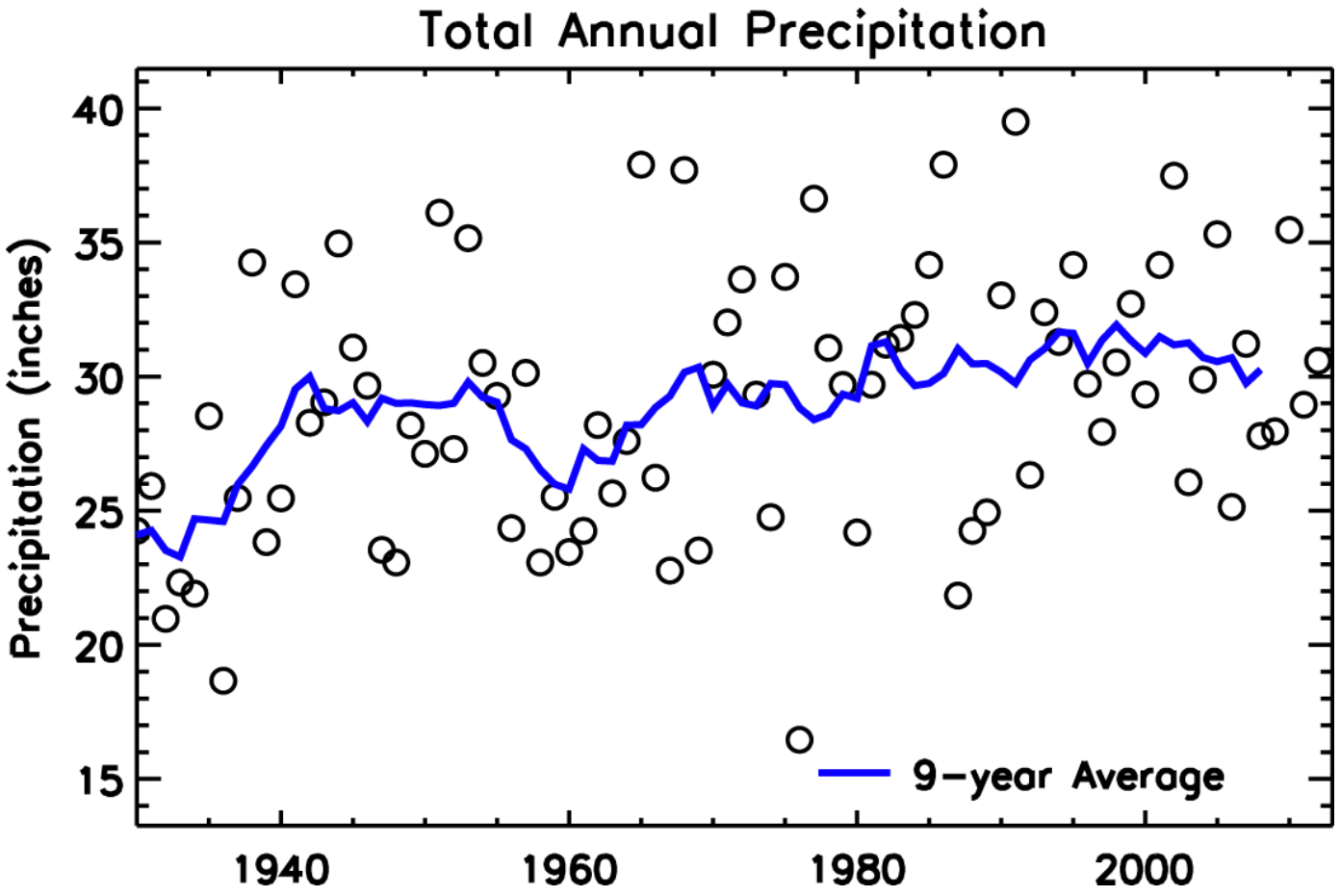
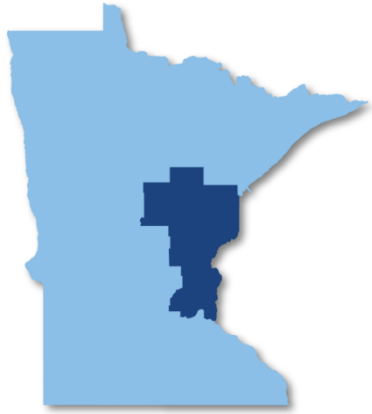
East Central Minnesota Precipitation





Changes in Total Precipitation (%) from 1951-1980 to 1981-2010	
Annual	**7.5**
Winter	0.4
Spring	7.2
Summer	-1.6
Fall	27.3

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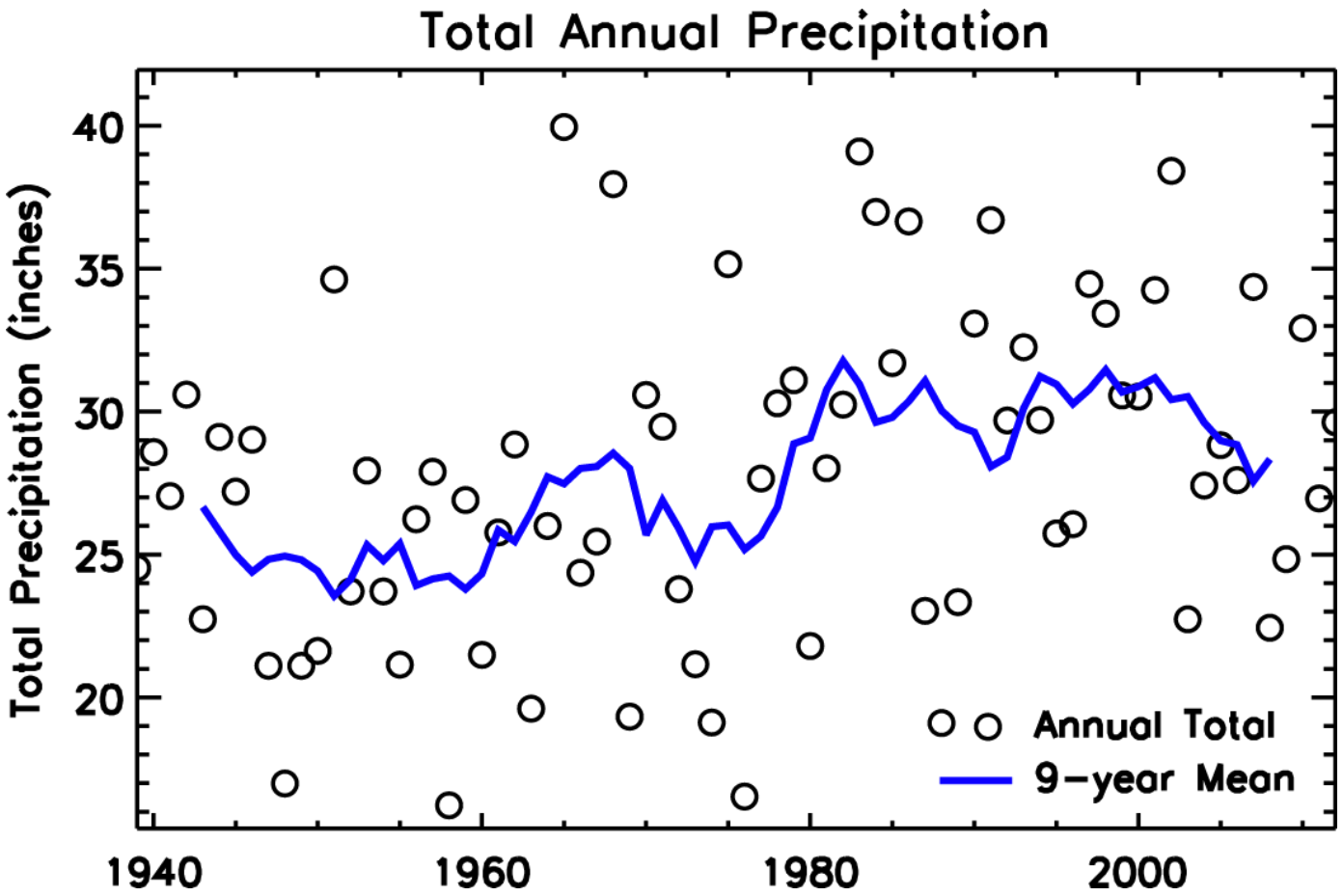
Observed Twin Cities Precipitation



Changes in Total Precipitation (%) from 1951-1980 to 1981-2010	
Annual	**15.4**
Winter	3.8
Spring	7.5
Summer	5.3
Fall	8.8

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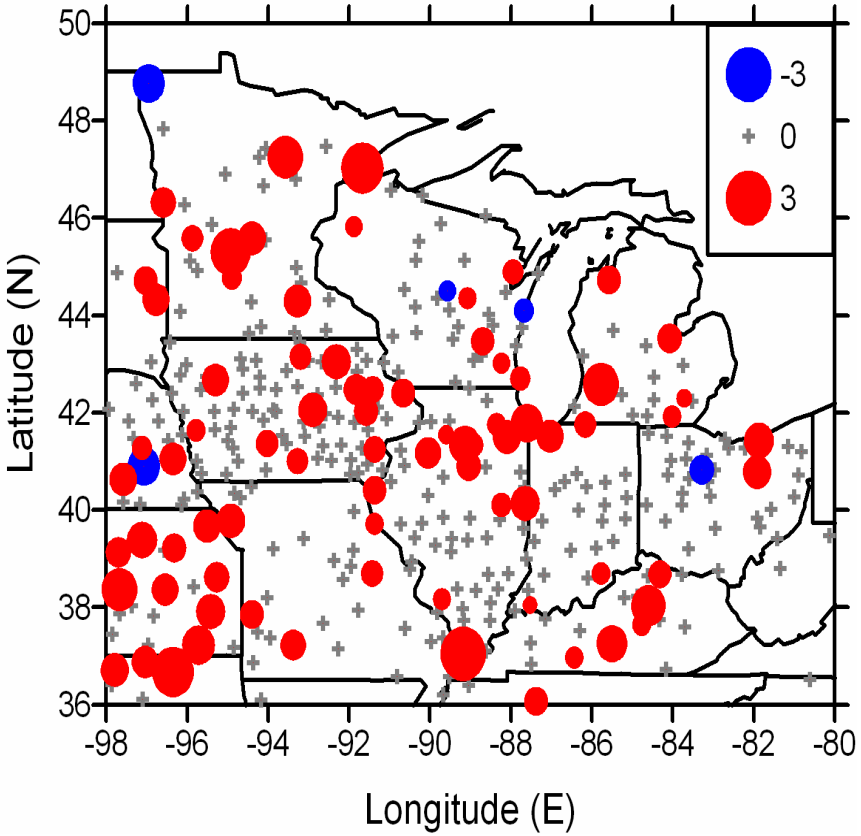
Observed Extreme Precipitation

Reproduced with permission from Kunkel at al. (1999) Journal of Climate



Trend in sum of the top-10 wettest days in a year (% per decade)
1901-2000

(Pryor et al., 2009)

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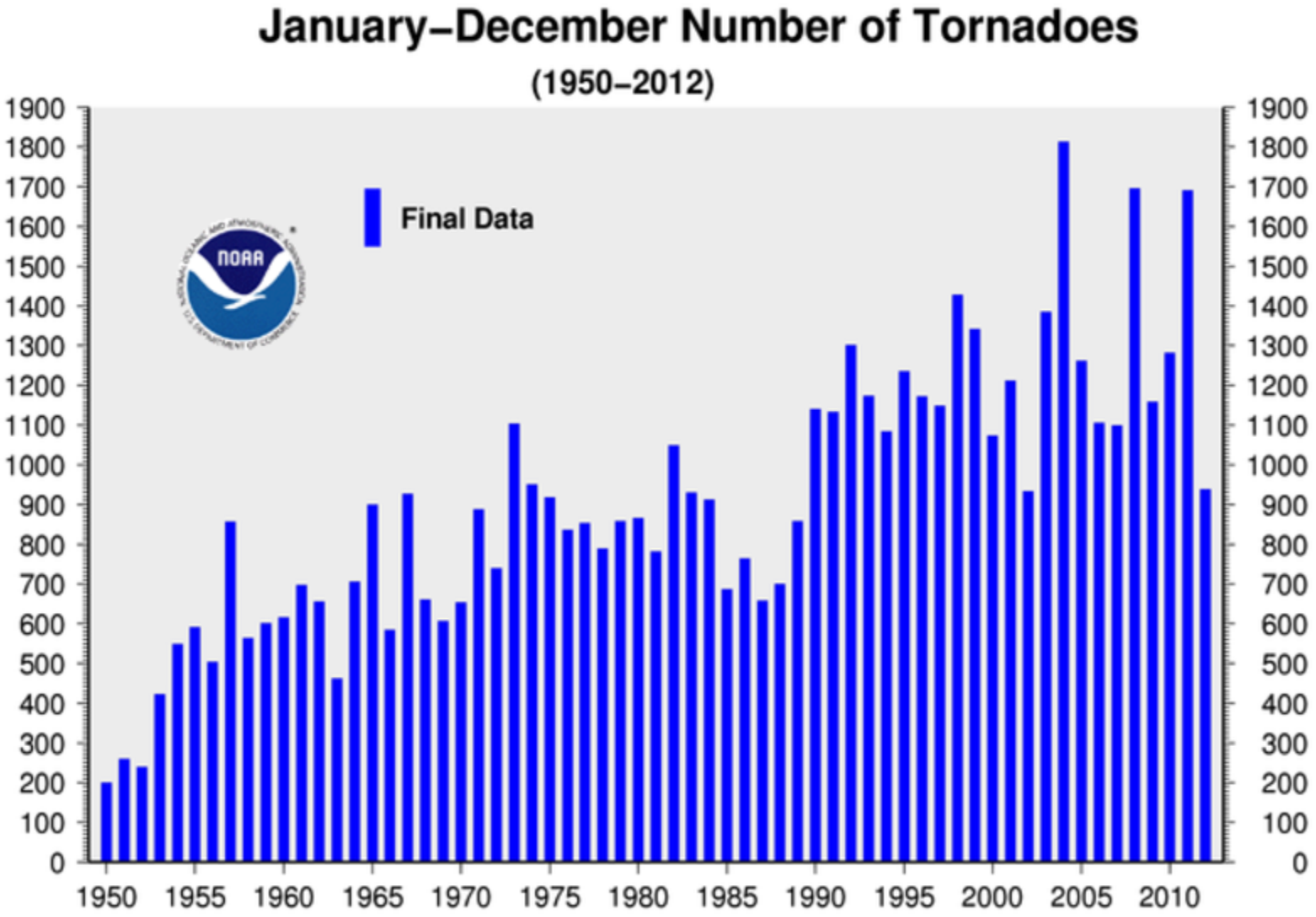
Total Confirmed Tornadoes in the U.S.



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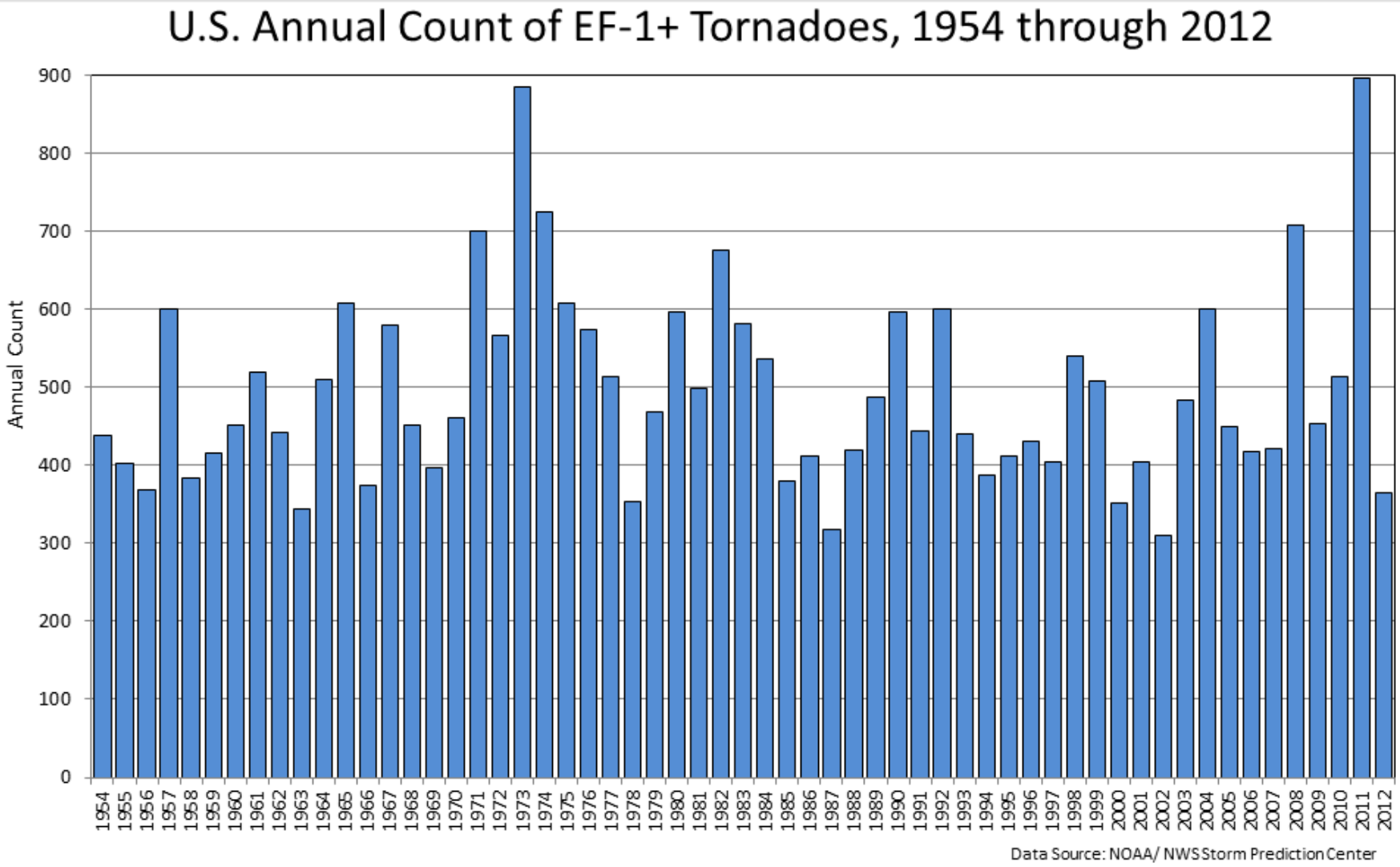
EF-1+ Tornadoes in the U.S.



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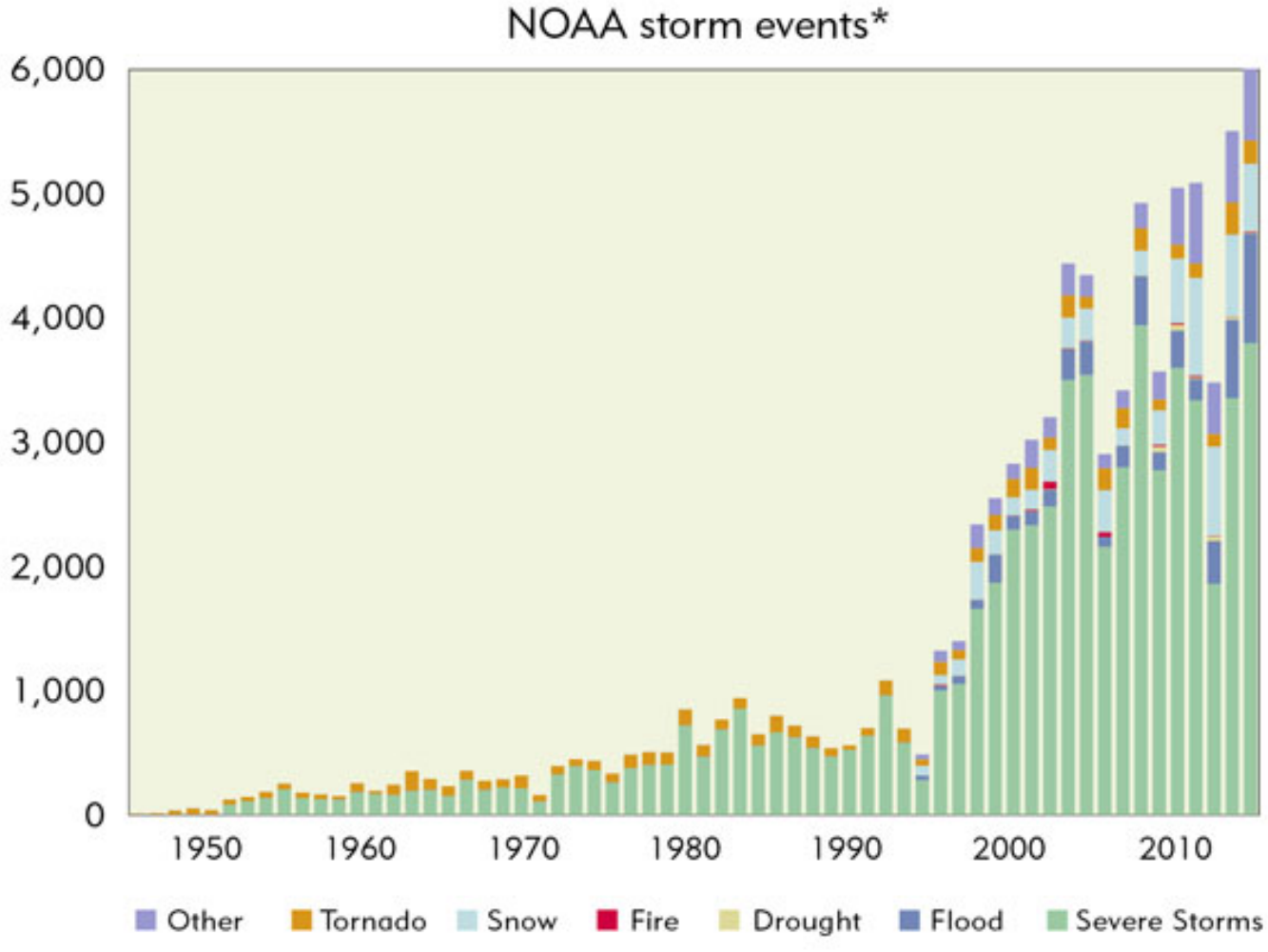
Number of NOAA Storm Events

Disasters in Montana, N. Dakota, S. Dakota, Minnesota, Northern WI, Michigan Western U.P.



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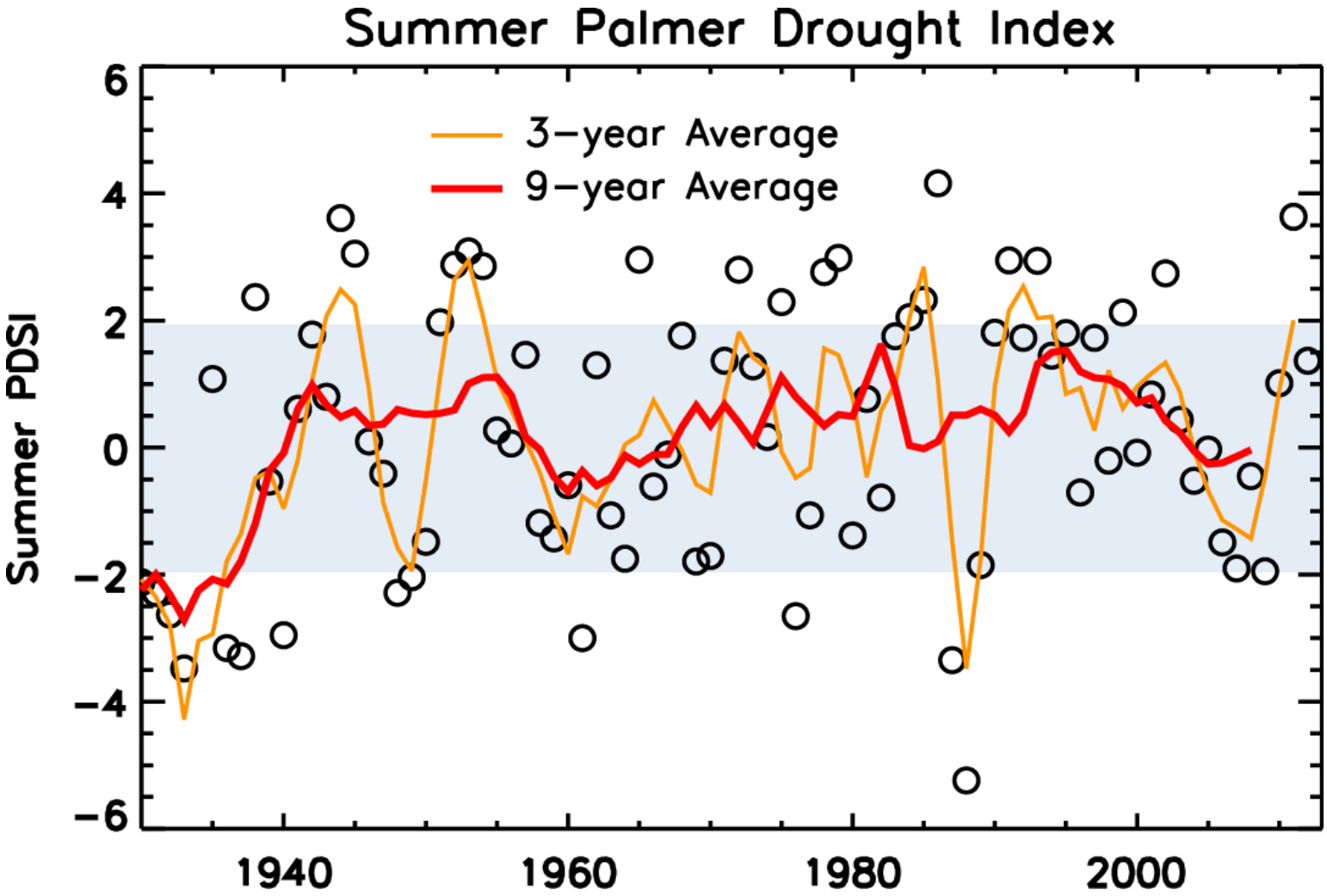
Observed East Central Minnesota Drought Index



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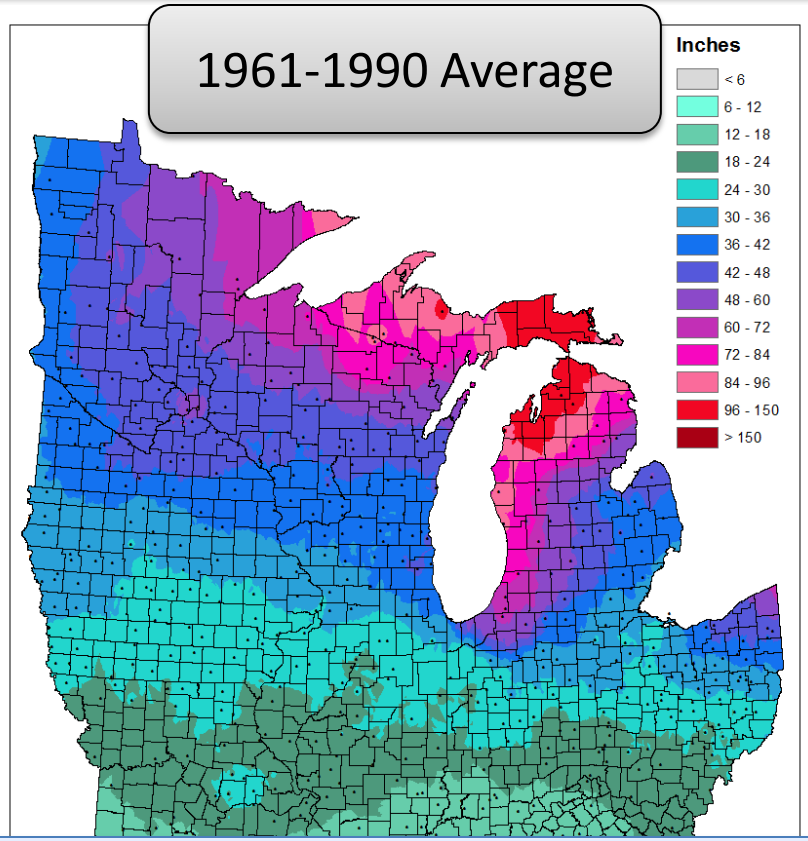
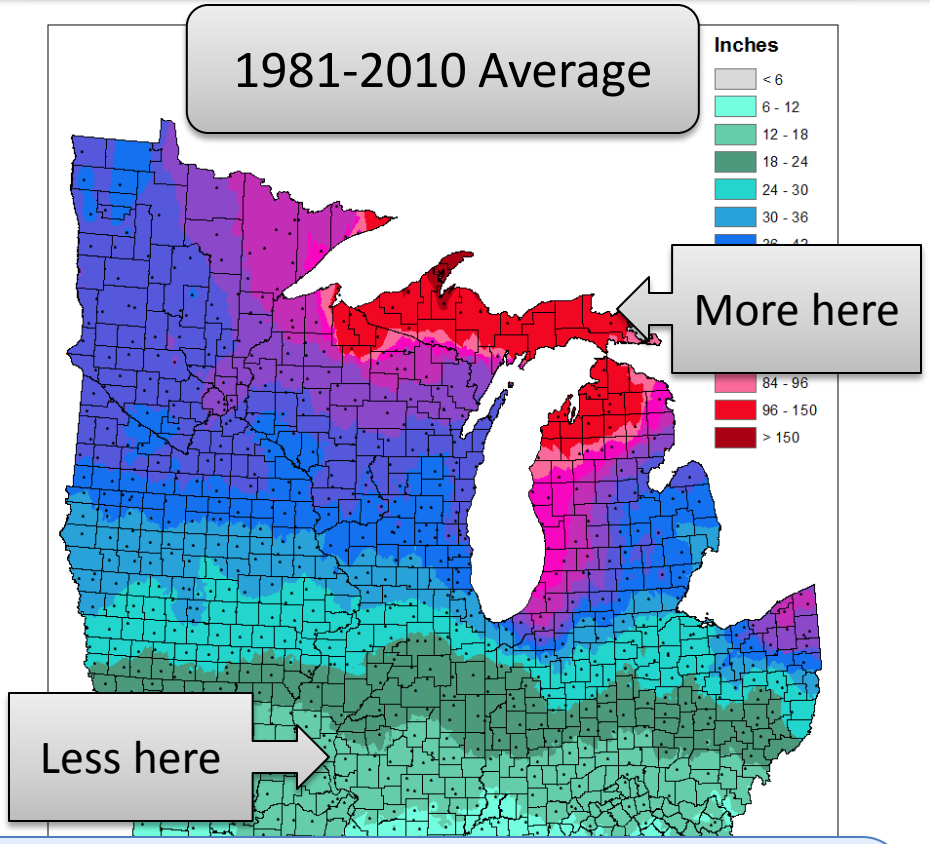
Observed Snowfall





Snowfall has generally increased across the Northern Midwest, remained stable in the central latitudes, and has decreased in the southern areas.

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Potential Changes in Winter Precipitation Type

- Projected changes in the frequency or severity of winter precipitation types are very uncertain
- More precipitation may fall as rain or freezing rain instead of snow
- Reduced snow accumulation with warmer surface temperatures

Photo credits:, NASA, weather.com

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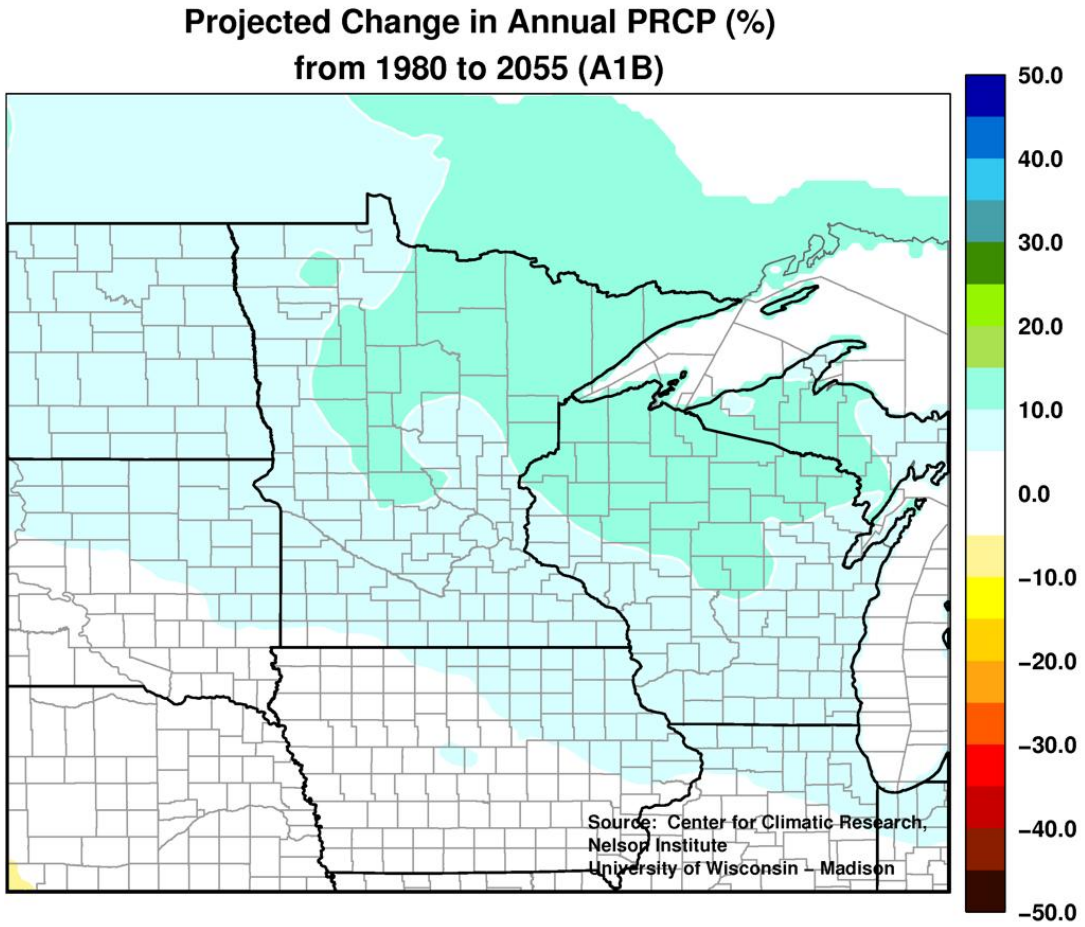
Projected Precipitation



80% range: 1% - 13%

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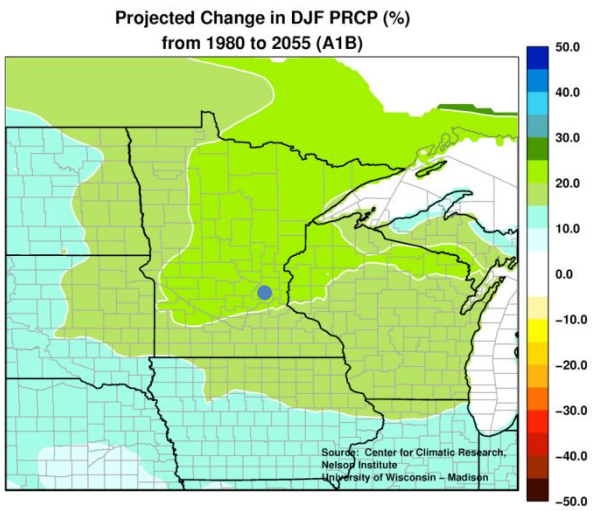
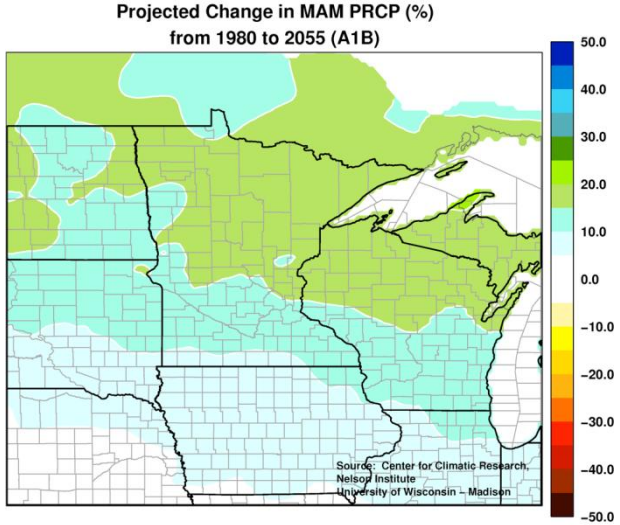
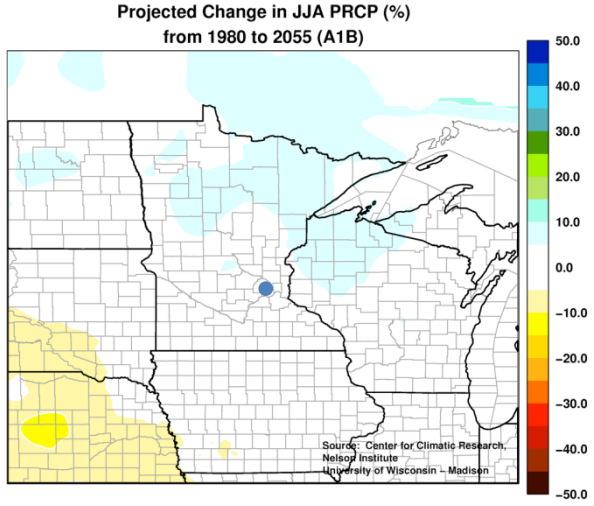
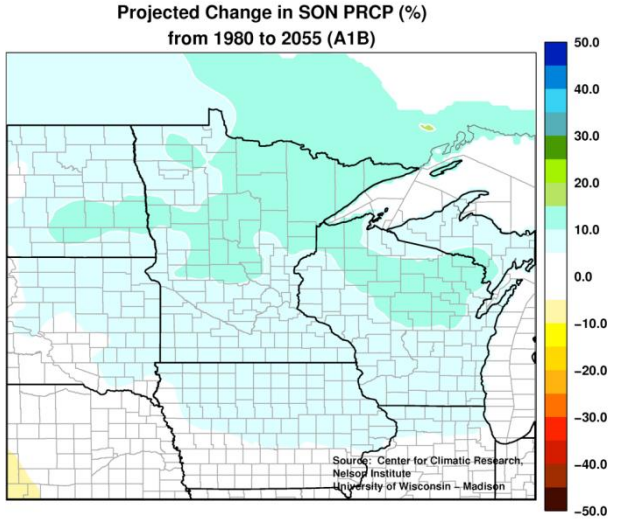
Projected Precipitation









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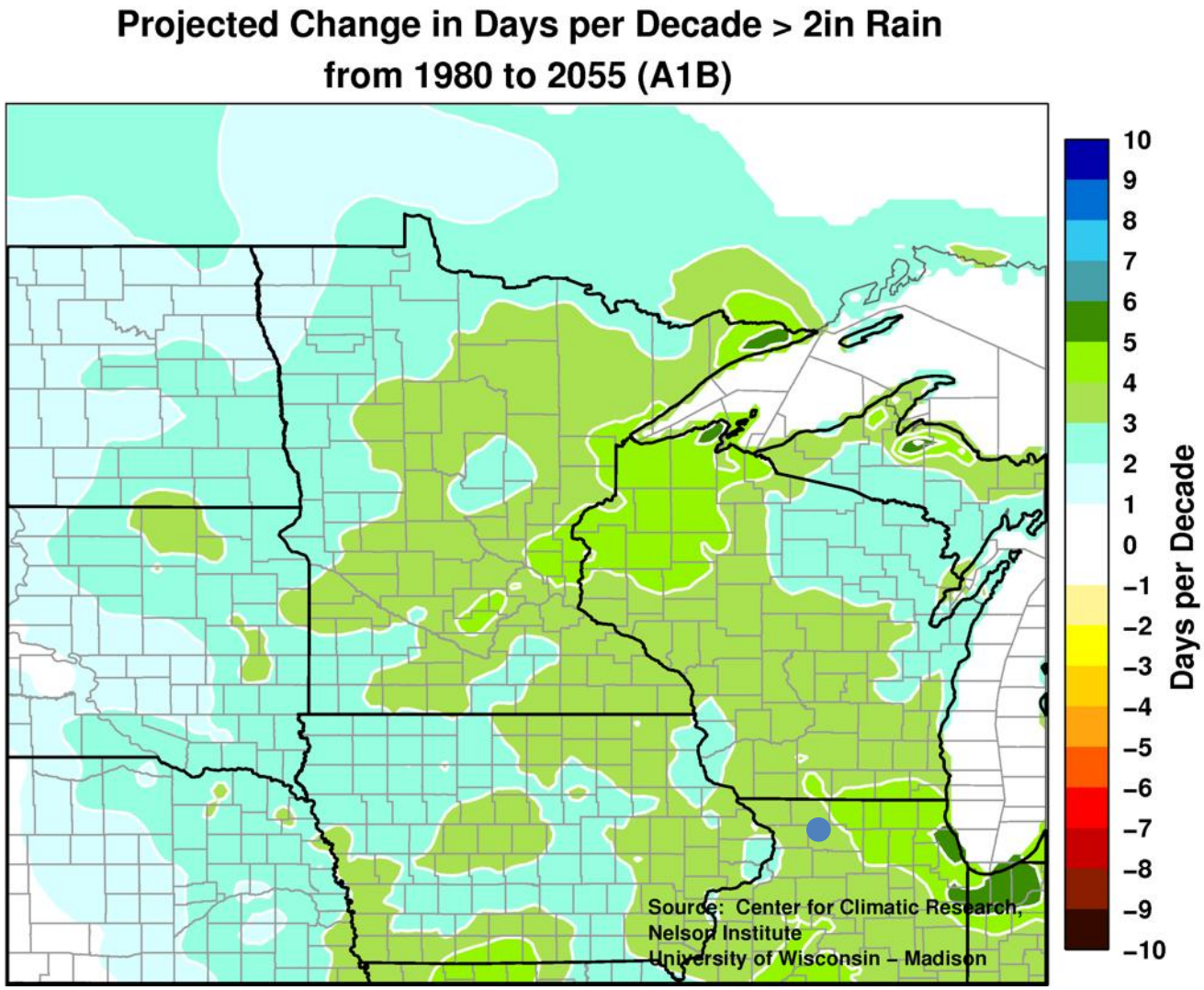
Projected Heavy Precipitation



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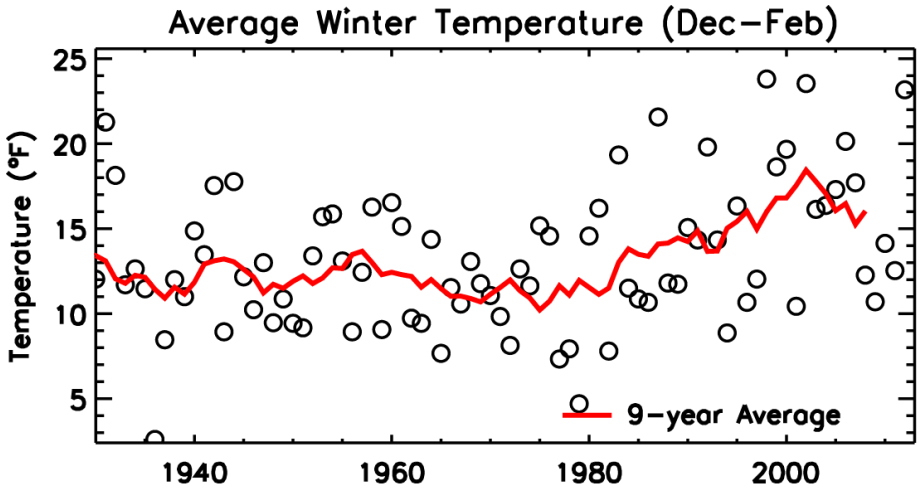
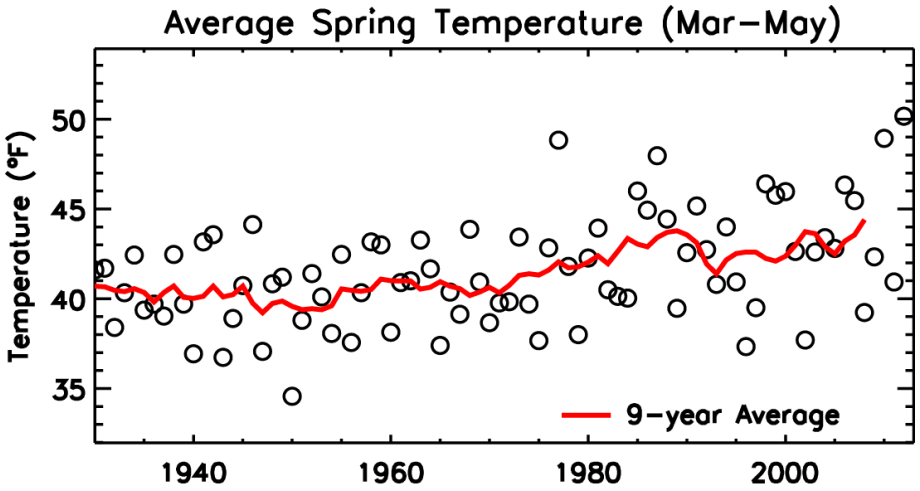
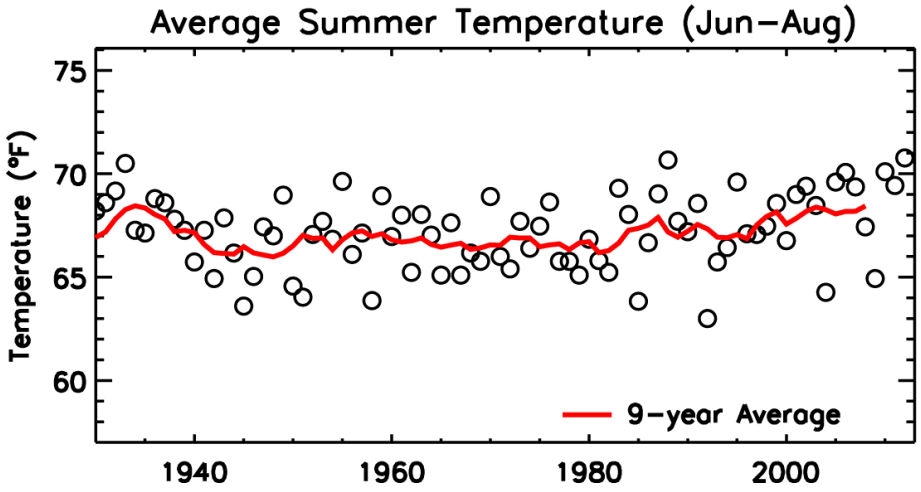
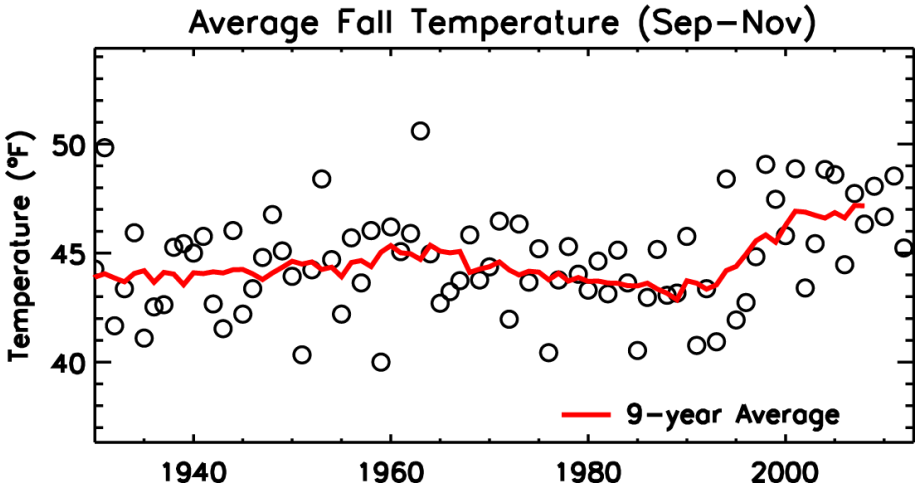
East Central Minnesota Temperature









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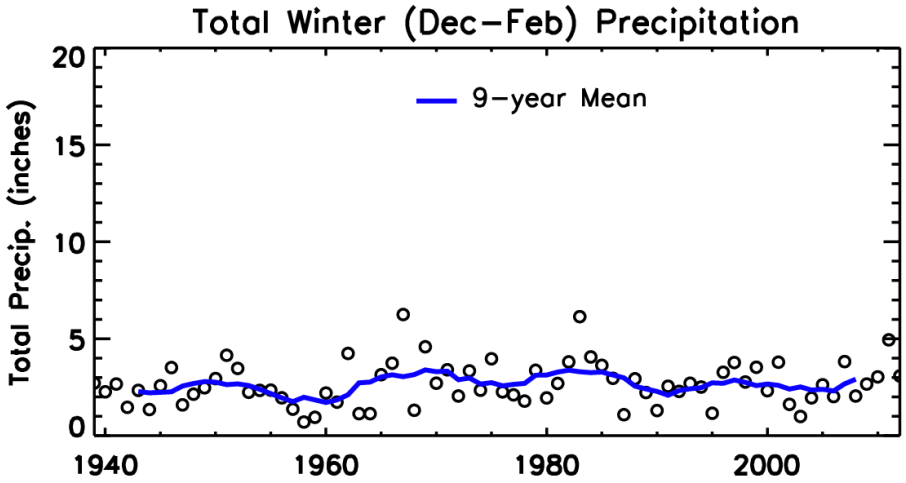
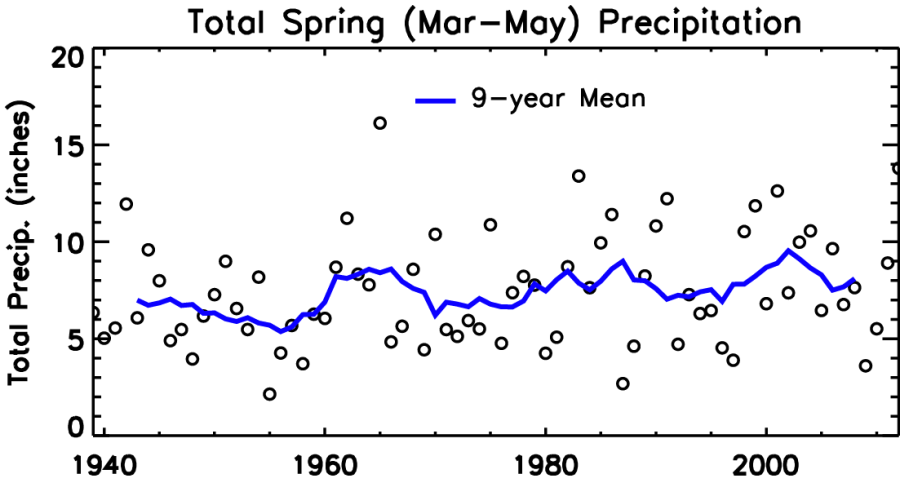
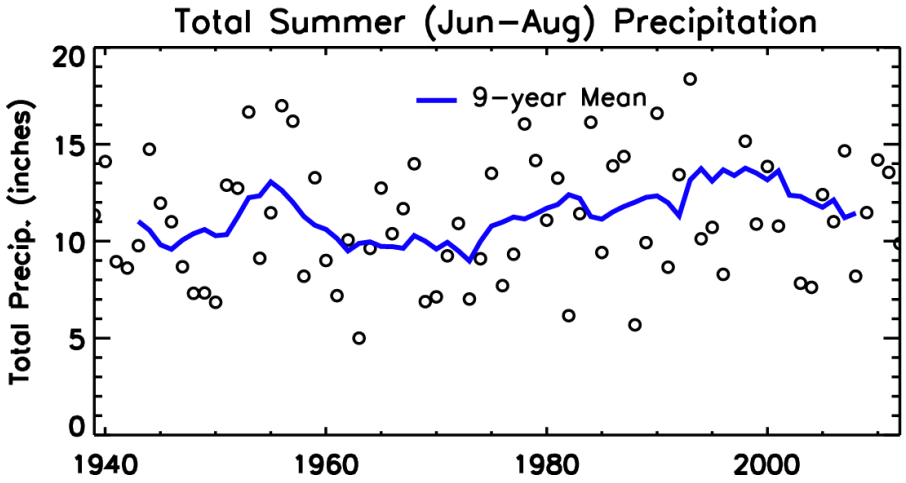
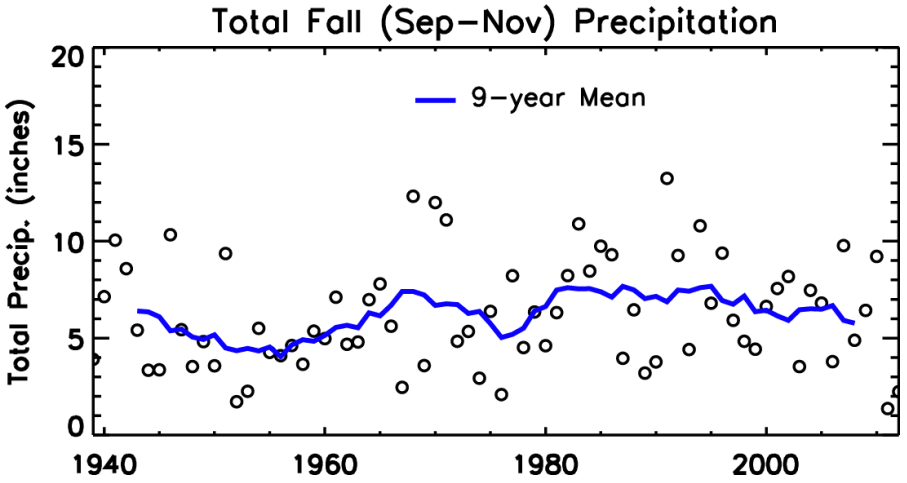
Twin Cities Seasonal Precipitation









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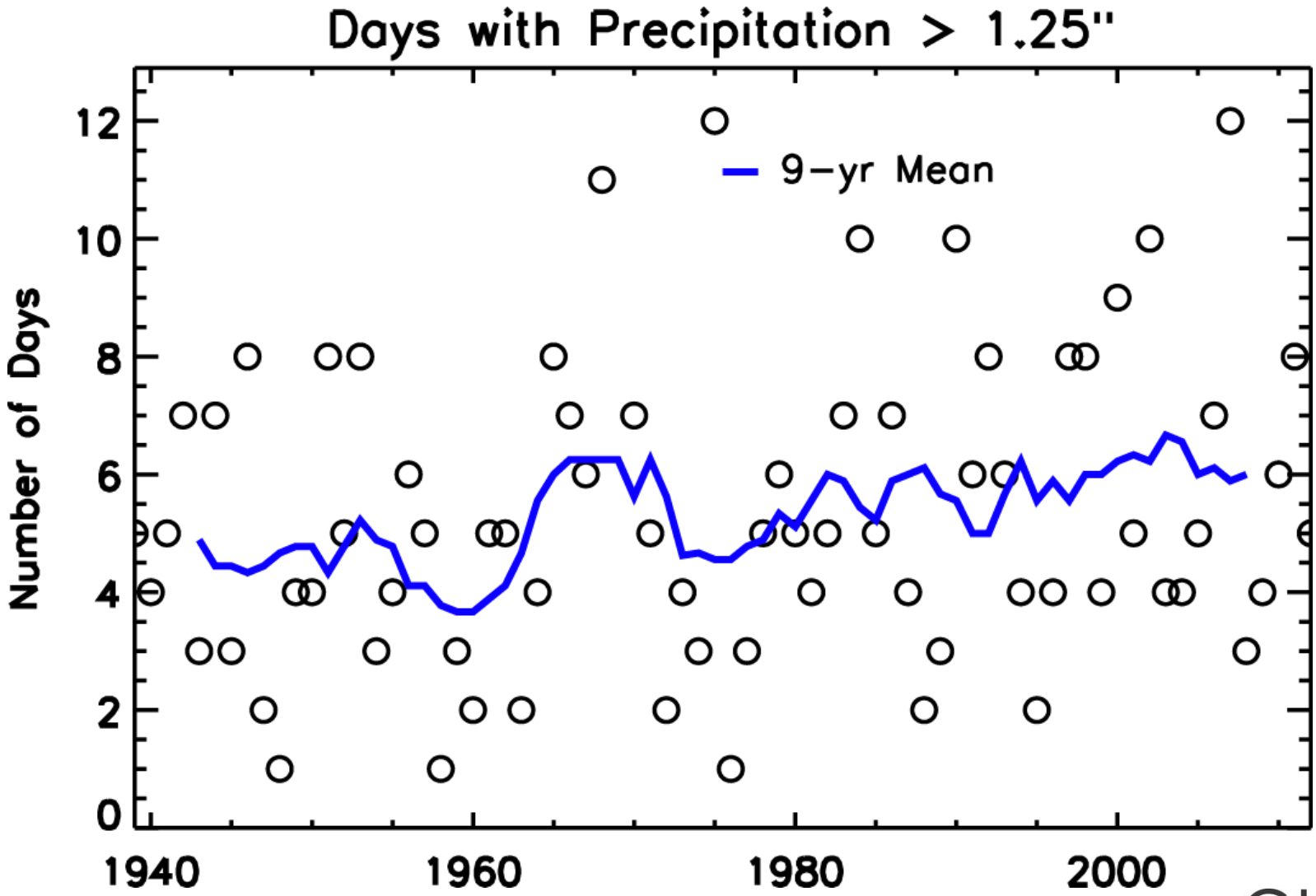
Twin Cities Heavy Precipitation



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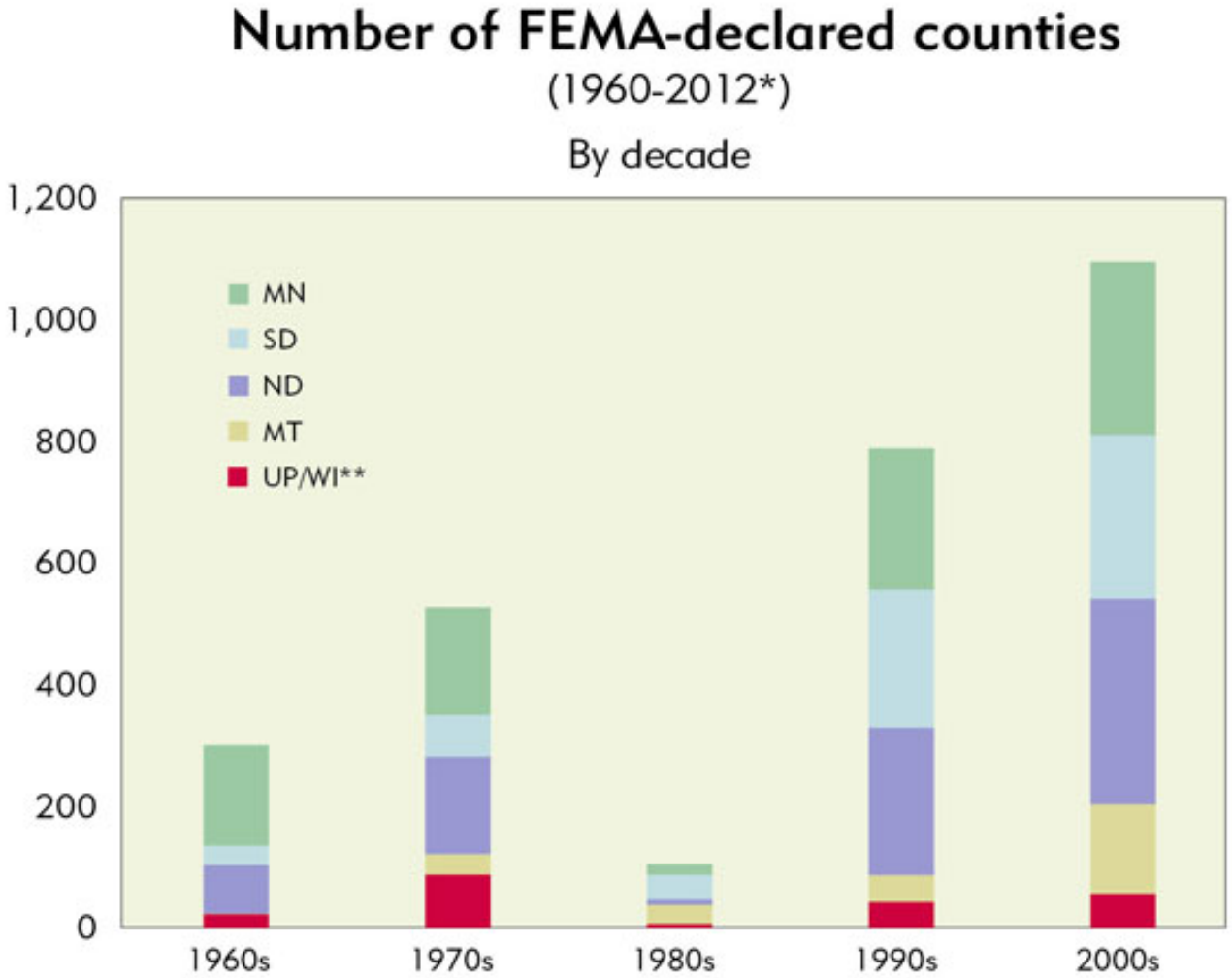
Number of FEMA-declared Counties



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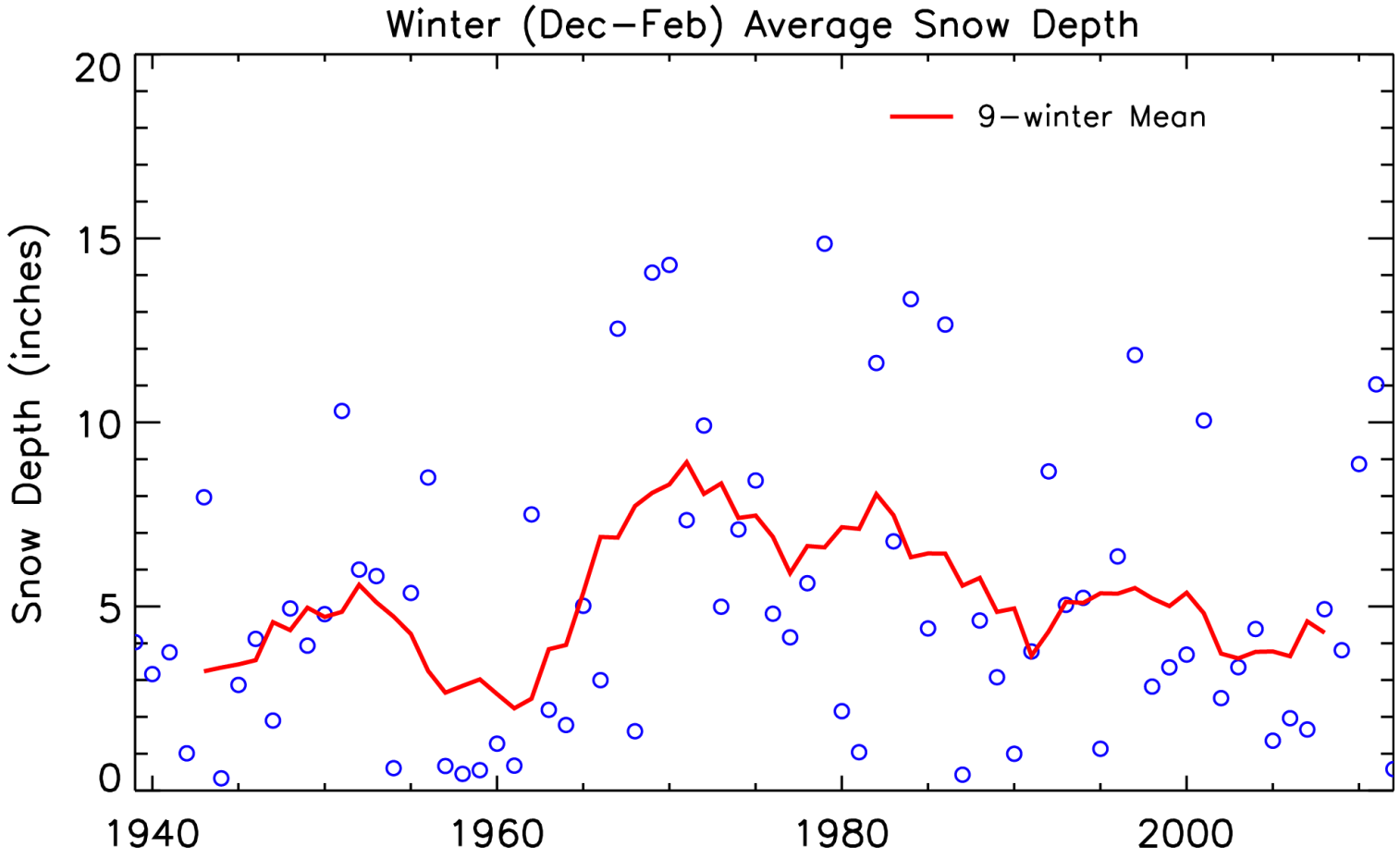
Twin Cities Winter Snow Depth



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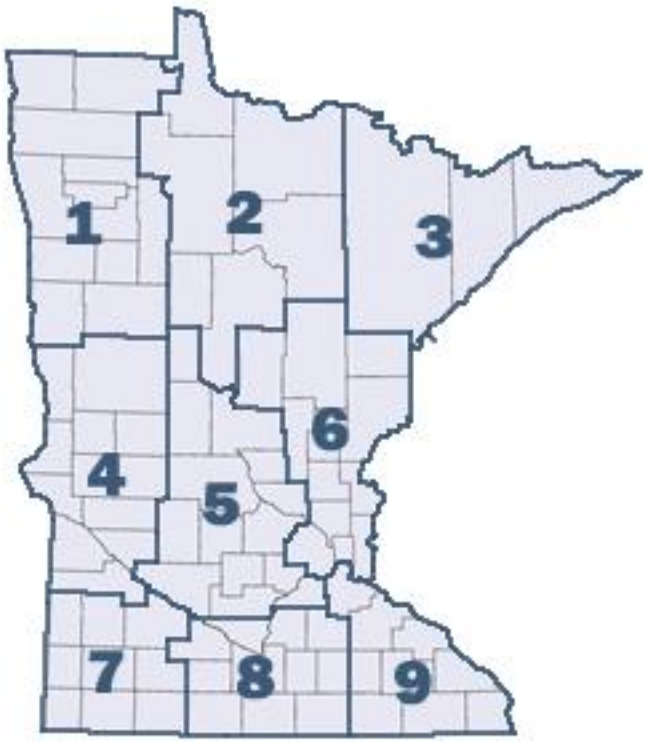
Extreme Events Factoids

- Three "1,000-year floods" have occurred in our state in the last eight years.
- The summer of 2012 saw flood-related disaster declarations in 11 counties last summer simultaneous with drought-disaster declarations across much of Minnesota.
- Summertime dewpoints are more frequently reaching levels typical of, say, Cancun.
- The highest heat index on the entire planet for July 19, 2011, was recorded at Moorhead: ***134°F***

Climatic Divisions



- Sub-regional, multi-county divisions of similar climate
- Balance of local context with multi-location, monthly averages
- Provides coverage in areas with few long-term continuous station records
- Useful for monthly, seasonal, or annual temperature, precipitation, and drought index

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Station Observations

- Point-based observations (NCDC GHCN/WMO data)
- Provide record of daily variability and extremes, can be aggregated to seasonal, annual averages
- Useful for identifying locally-specific changes

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Key Climate Changes for the Twin Cities

- Warmer average temperatures
- Warmer low and winter temperatures
- Shorter winters
- More total precipitation
- More severe precipitation events

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Key Potential Impacts

- **Public Health**
  - Reduced relief during heat waves due to increased humidity and higher overnight lows
  - Reduced water quality
  - Changing ecology, new pests, disease

- **Infrastructure Damage**
  - Stormwater management challenges, extreme precipitation, flooding
  - Potential changes in the number of freeze-thaw cycles, form of winter precipitation

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GREAT LAKES INTEGRATED SCIENCES + ASSESSMENTS