The Changing Winters of Northeastern Minnesota: Phantoms, Throwbacks, and Large Variations

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Northeast Minnesota’s pronounced *OBSERVED* trends

1. Annually: wetter and warmer
   - Major shift observed, projected to continue

2. Winter: shorter, less cold, more snowfall, less snow cover
   - Rapid loss in cold extremes, projected to continue

3. Summer: fewer cool nights, more frequent and heavier downpours
   - More and larger “big” events, projected to continue
How Northeast MN Differs from Rest of State

- Faster warming (annually)
- More warming during summer, including summer days
- Precip increasing during winter, but steady rest of year
- Winter still “insulated” but large changes underway
MN Getting Warmer and Wetter
Minnesota Average Temperature and Precipitation

Annual Precipitation (in.) vs. Annual Temperature (F)

Data from 1895-1986

Source: Department of Natural Resources
State Climatology Office
Minnesota Average Temperature and Precipitation

Annual Precipitation (in.)

Annual Temperature (F)

1987-2018
1895-1986
2016
Census of 1-inch precip days by year at 39 long-term stations
2” and 3” precip events increasing too

Census of 2-inch precip days by year at 39 long-term stations

Census of 3-inch precip days by year at 39 long-term stations
Even 4-inchers increasing

Census of 4-inch precip days by year at 39 long-term stations
Heaviest rain in state often larger, more variable
Before

Source MPR
After

Source MPR
Projections: Continued increase in “upper 2 percentile” rainfall

Source: 2014 National Climate Assessment, Midwest Chapter
Northeast MN winter warming 3-4x faster than summer

<table>
<thead>
<tr>
<th>Season</th>
<th>Temperature Metric</th>
<th>Avg. change per decade since 1895</th>
<th>Avg. change per decade since 1970</th>
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</thead>
<tbody>
<tr>
<td>Winter</td>
<td>Seasonal Avg.</td>
<td>+ 0.43°F</td>
<td>+ 0.88°F</td>
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<td>(Dec - Feb)</td>
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<tr>
<td>Summer</td>
<td>Seasonal Avg.</td>
<td>+ 0.15°F</td>
<td>+ 0.23°F</td>
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<td>(Jun - Aug)</td>
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Minnesota Average Winter Minimum Temperatures 1896-2019

Avg Min Temp  7-yr moving avg  1896-2019 Trend: +0.49 F/decade
Northeast Minnesota Average Winter Minimum Temperatures 1896-2019

Temperature (F)

Season Beginning


-16 -12 -8 -4 0 4 8 12 16

Avg Min Temp 7-yr moving avg 1896-2019 Trend: +0.53 F/decade
30-Year Average Minimum Winter Temperature

Minimum Temperature
High: 11.5°F
Low: -11.0°F

0°F Contour
5°F Increment
1°F Increment
Days entirely above freezing increasing dramatically

Freeze-Free Characteristics at Milan, MN

- Average number of above freezing days per year (right axis)
- Days between last freeze of spring and first freeze of fall (left axis)
Lowest Low of Winter, Cloquet
Loss of Cold Extremes Across MN

Count of Minimum Temps -35F or Lower, by Decade
Grand Rapids Forest Research Station

* Prorated
Fewer -25 F Lows and 0 F Highs in Cloquet

Cold Nights and Days, by Decade
Cloquet

- Avg. Ann. Lows -25 F or lower
- Avg. Ann. Highs 0 F (or lower)
Mid-century modelling, RCP 4.5: January temps increase an additional 4-5 degrees F
Annual snowfall steady or increasing
Days with ≥ 4 inches increasing

Average Annual Snowfall and Days with 4"
Duluth
Liquid Precip Increasing During Winter

Avg # Nov-Mar Days With Rain or Melting Snow, Duluth

- Blue: Nov-Mar Days w meas. precip and Low >32
- Orange: Nov-Mar Days w 0.10"+ prec and Low >32
- Gray: Nov-Mar Days w meas prec and NO snow
Snow Depth Declining

November-March Snow Depth Statistics
Duluth

Average November-March Snow Depth (in.)

-25%
-35%
+63%

Days Per Nov-Mar Season

0.0 20.0 40.0 60.0 80.0 100.0 120.0

Avg Nov-Mar Snow Depth
Days 6" Snowcover Nov-Mar
Days 12" Snowcover Nov-Mar
Days no Snowcover Nov-Mar

9/26/2019
Lake ice season decreasing

• Long-term state-avg decline is 1.8 days per decade
• Decline from 1987-2017 is -4.2 days per
• (Source DNR internal analyses)
Minnesota Average Summer Maximum Temperatures 1895–2018

- Avg Max Temp
- 7-yr moving avg
Northeast Minnesota Average Summer Maximum Temperatures 1895–2019
Extreme heat not increasing--yet

Highest High of Summer, Cloquet, 1912-2018

Max High
10-yr avg (hottest)
Extreme heat not increasing--yet

Average # 90-degree days per year, Duluth
However, additional days above 95 F projected by mid-century

Source: 2014 National Climate Assessment, Midwest Chapter
“Hydrothermal deficit” and stress noted in northern MN forests

Box 1: Forest droughts have increased in recent decades.

What changes in drought are in progress now?

Cumulative drought severity index of forests

Additional consecutive dry days projected by mid-century, though no “smoking gun”

Source: 2014 National Climate Assessment, Midwest Chapter
In Summary

1. Northeast MN has gotten warmer, with profound changes during winter

2. Snowfall has remained steady, with increases in heavy snow

3. However, snow depth is declining

4. Summer warming is lesser, but still greater/faster than rest of MN

5. Further warming projected, with continued increases in precipitation extremes
Thank You!

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