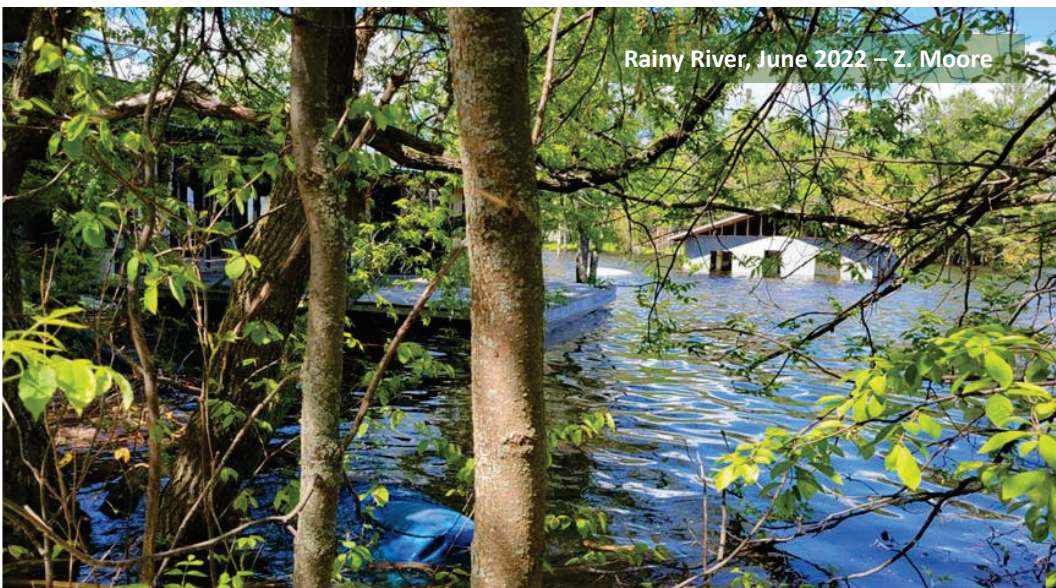




Rainy River, June 2022 – Z. Moore



Minnehaha Creek Fall 2022 – K. Blumenfeld

Understanding Minnesota's Climate: Observations, Trends, and Projections

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Purpose today

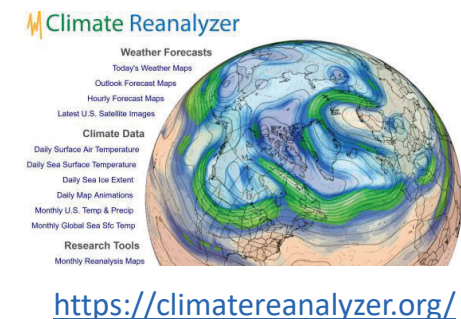
- Discuss Minnesota's climate:
 1. 2025 in review
 2. Long-term warming and moistening of our climate
 - Normal “ups and downs” remain part of the climate
 3. Dry early 2020s shows evidence of continued wet trend
 4. Increased snowfall but declining snow depth!



Not enough time to cover everything!

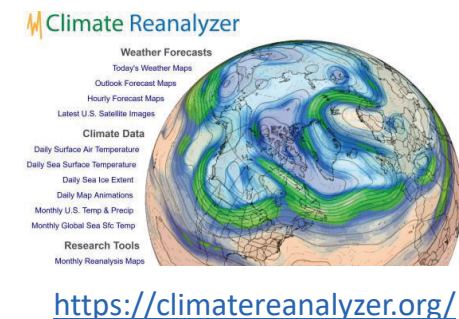
Daily Global Temperature still well above averages (thru late Feb 2026)

- Record global temperatures started July 2023
- Continuing (mostly) through 2024



Daily Global Temperature still well above averages (thru late Feb 2026)

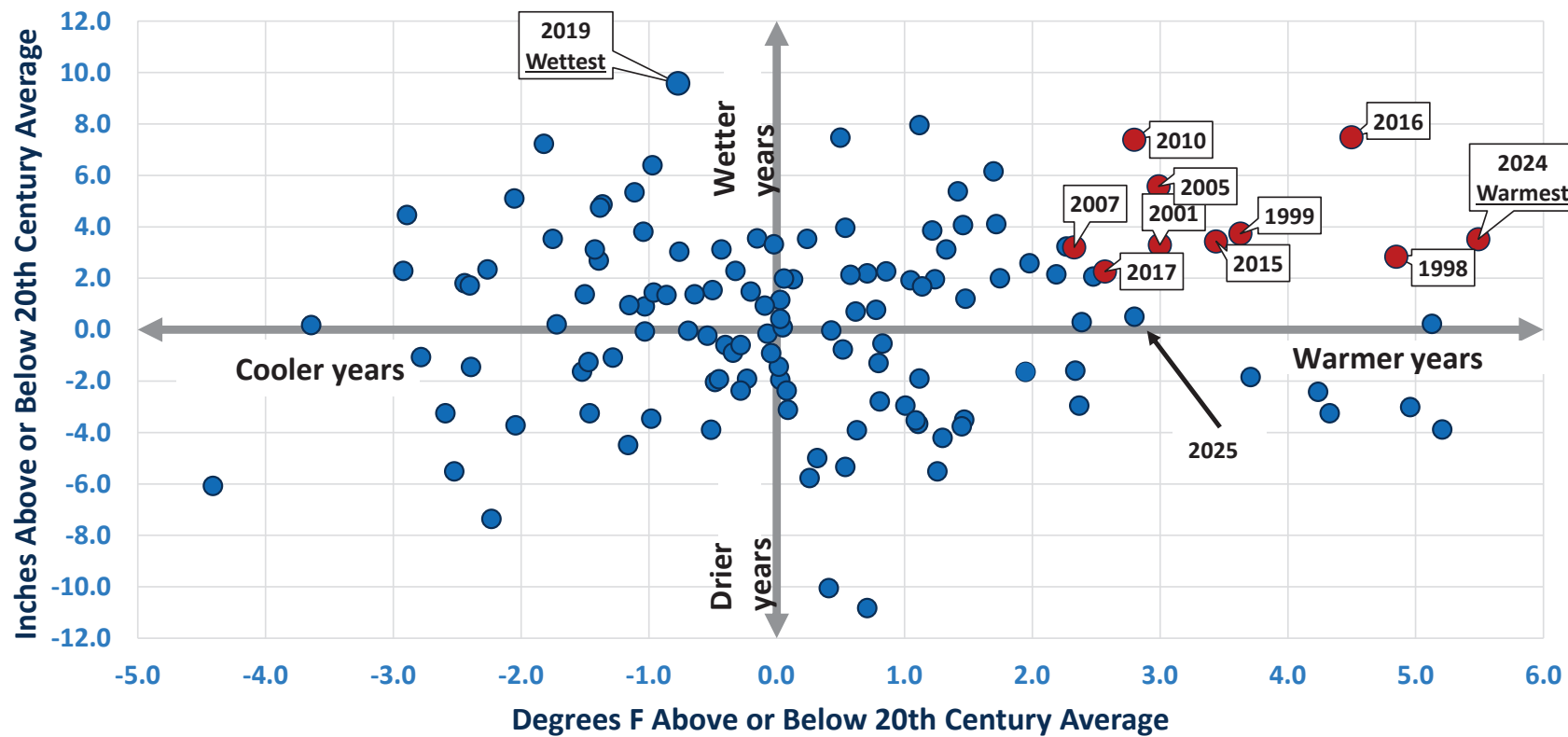
- Record global temperatures started July 2023
- Continuing (mostly) through 2024
- Slight “cooling” underway



<https://climatereanalyzer.org/>

Minnesota 2025: another year in the upper-right quadrant All combined warmest/wettest years are recent!

Warmth and Wetness Compared to 20th Century

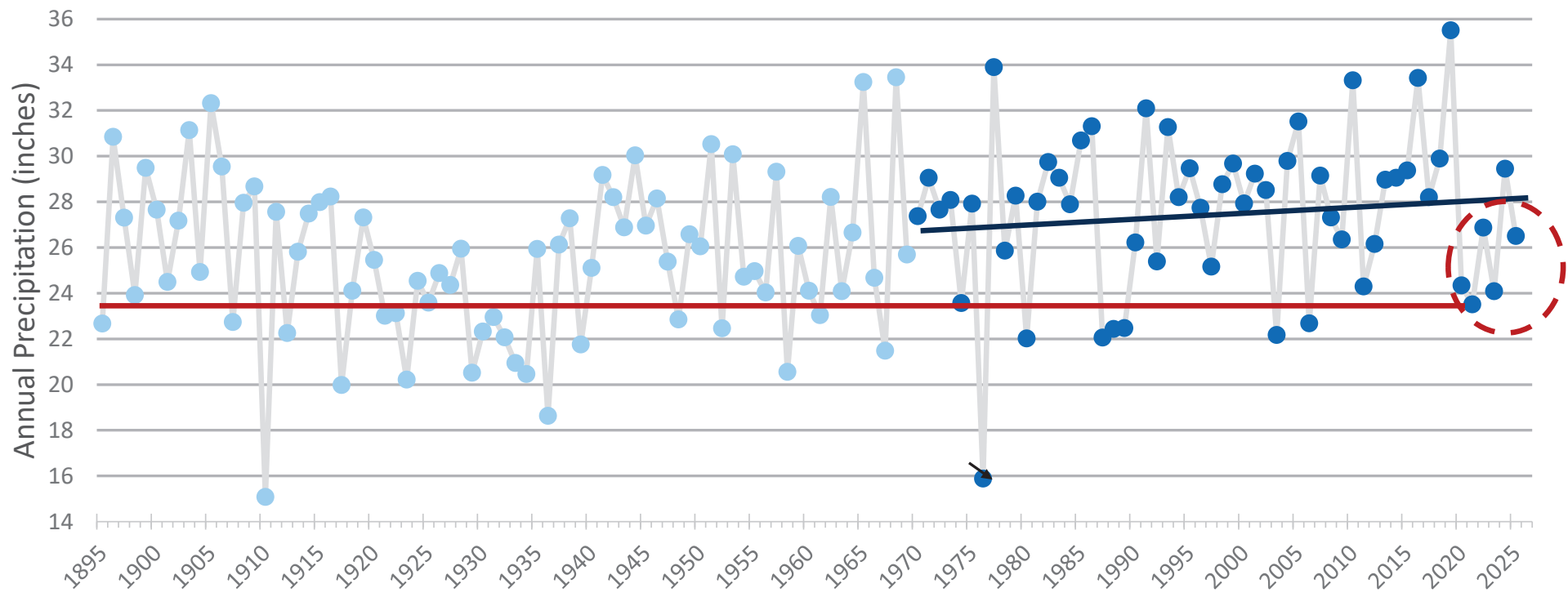


Additional info about 2025 in MN

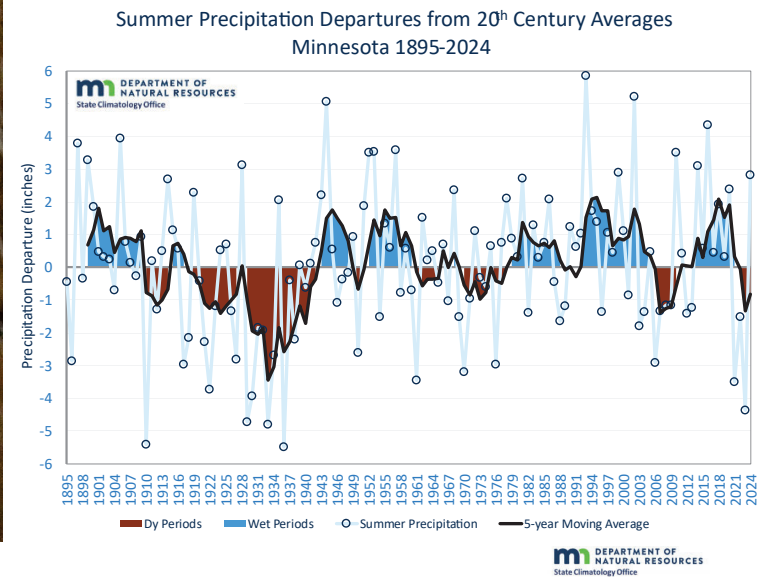
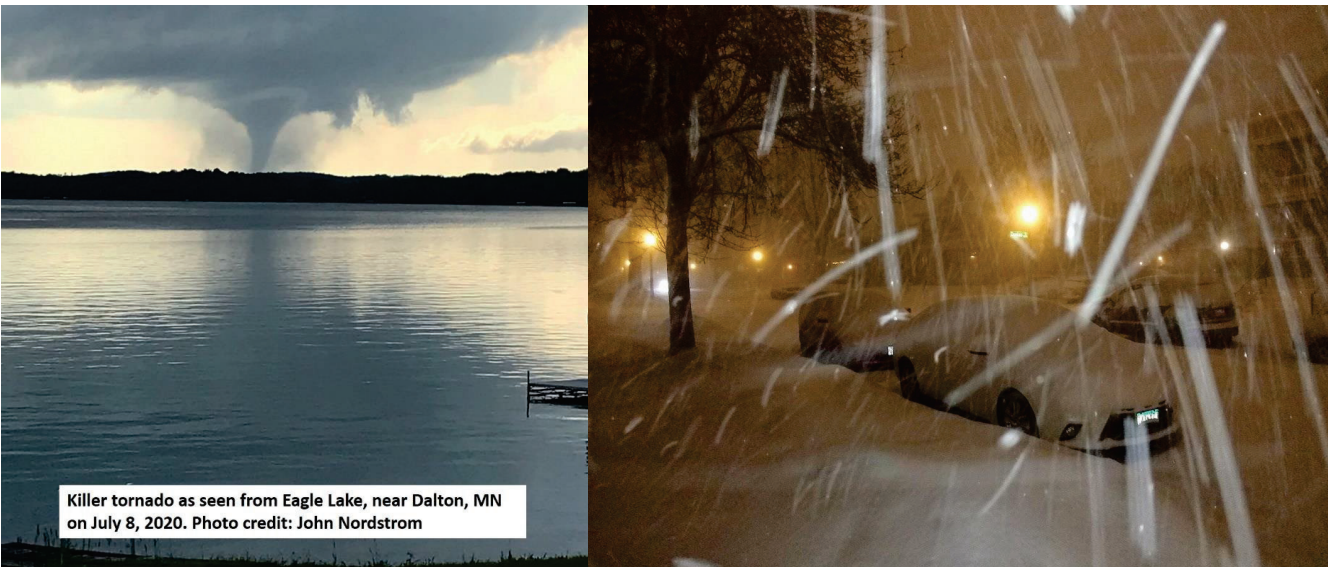
- Though slightly wet vs 20th century, but below recent “normals” (1991-2020 averages) for 5th time in 6 years
- Main events were destructive windstorm near Bemidji and frequent smoke outbreaks from Canadian fires
- Otherwise unremarkable year climatologically
- Some drought in MN, but none truly major

Additional info about 2025 in MN

Minnesota Annual Precipitation, 1895-2025

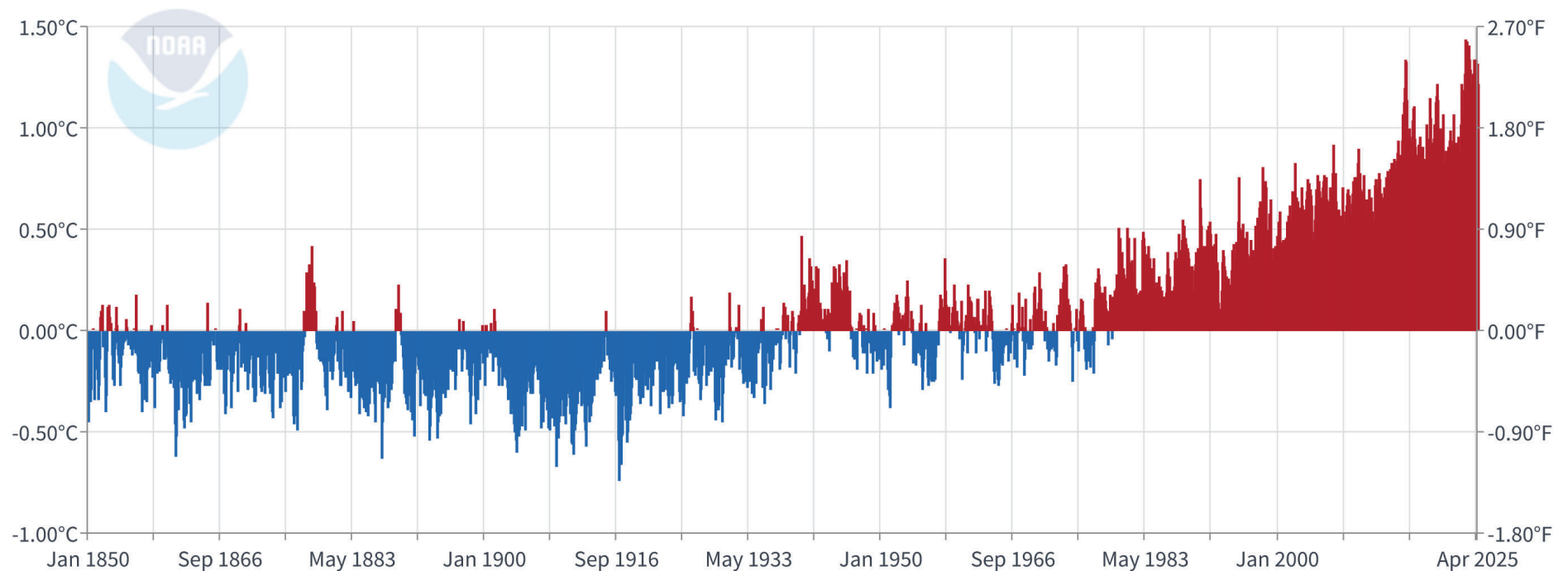


Background Point #1: We have a naturally “extreme” climate with high variability and many weather hazards

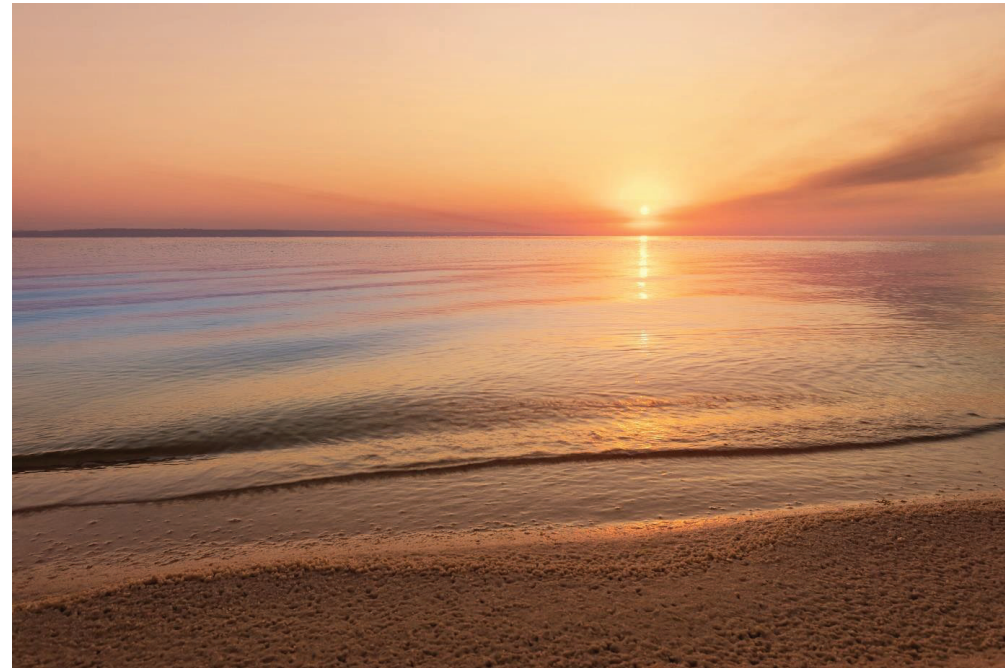


Background Point #2: Global temperatures are rising rapidly, with significant 2023-24 extremes

Global Land and Ocean Average Temperature Anomalies



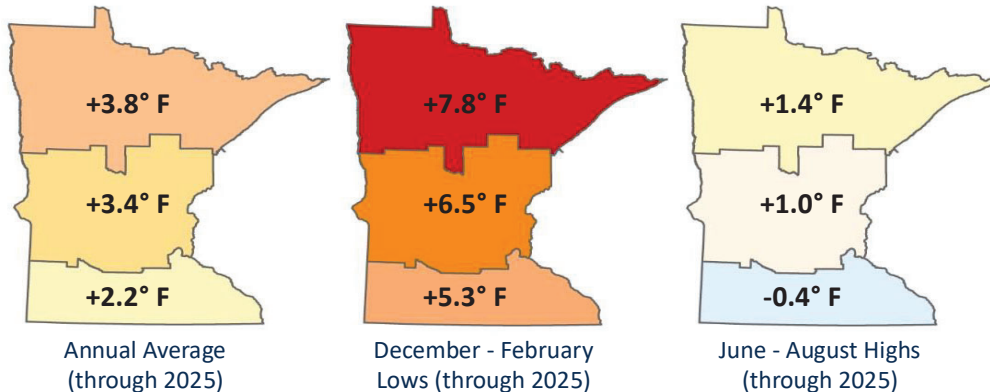
Background Point #3: Rising global temperatures provide more access to heat and water vapor



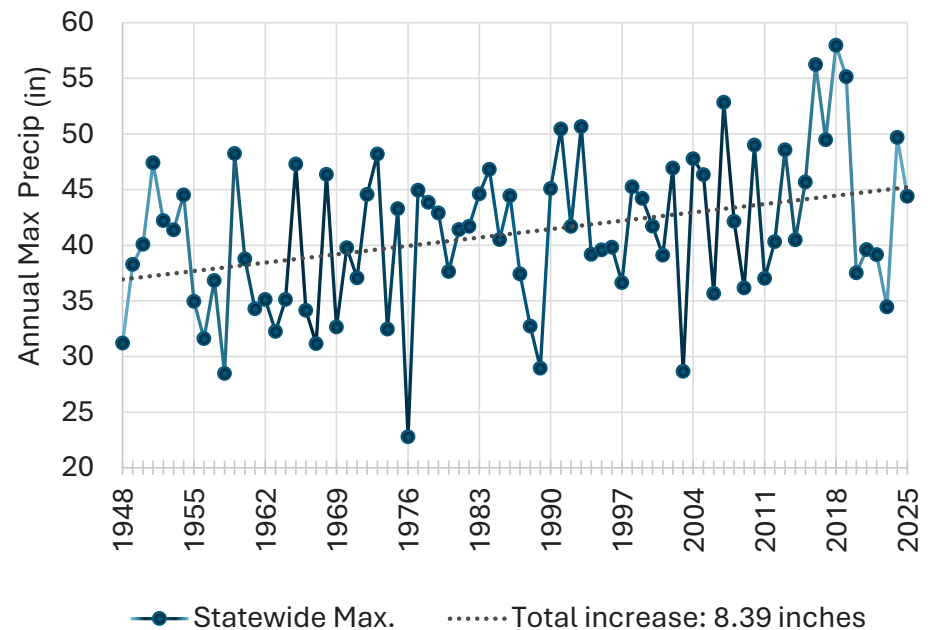
What it has meant for Minnesota: More warmth, wetness, and humidity on average

- 3°+ F total warming, with much **more in winter, less in summer**, & more in north
- More rain and snow, on average
- More precipitation extremes

Total temperature change since 1895

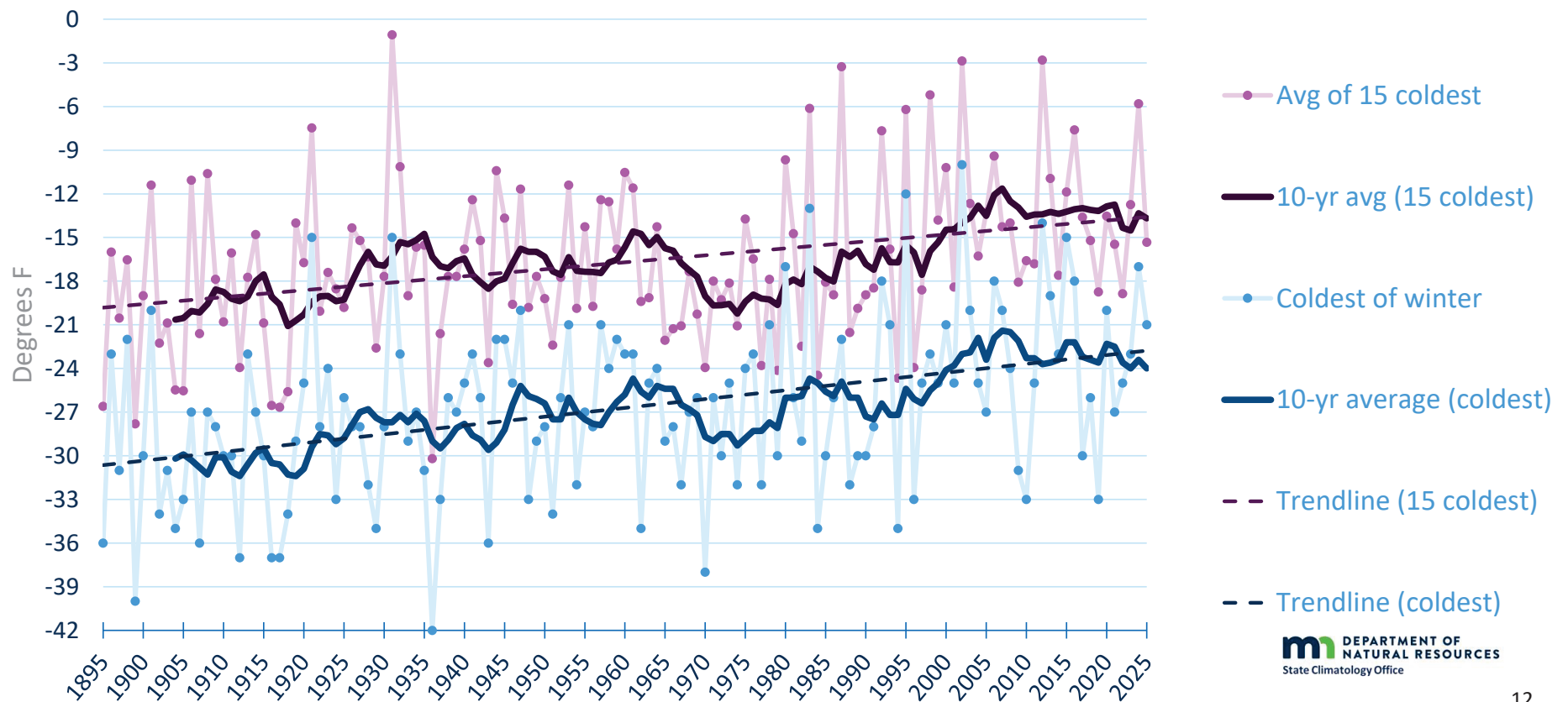


Highest Annual Precipitation by Year
58 Minnesota Stations , 1948-2025

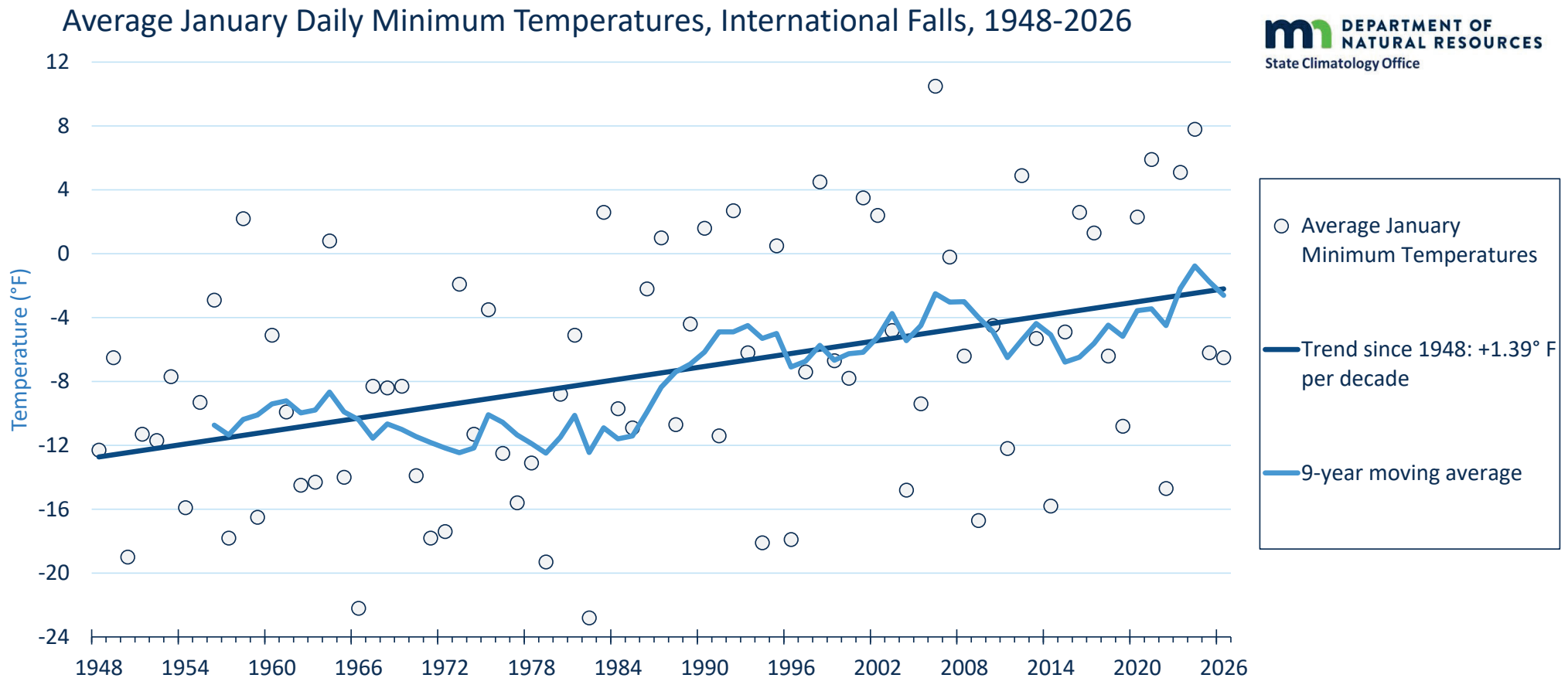


Fewer/lesser cold extremes

Lowest Lows of Winter, Milan (MN), 1895-2025

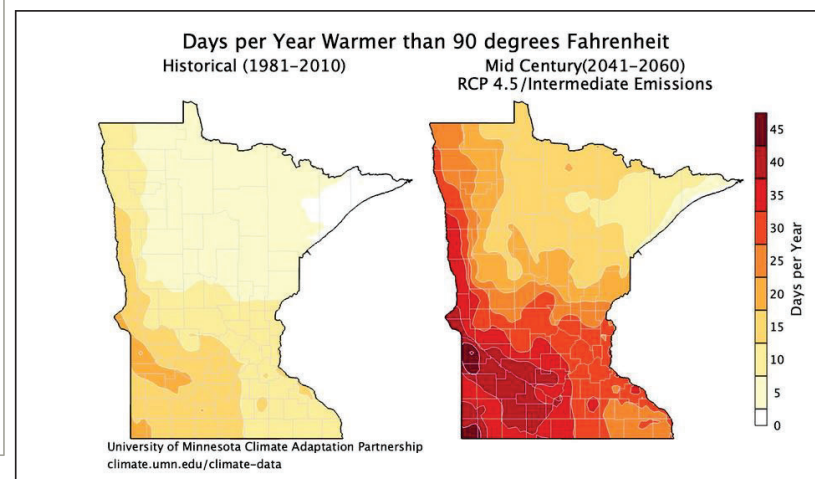
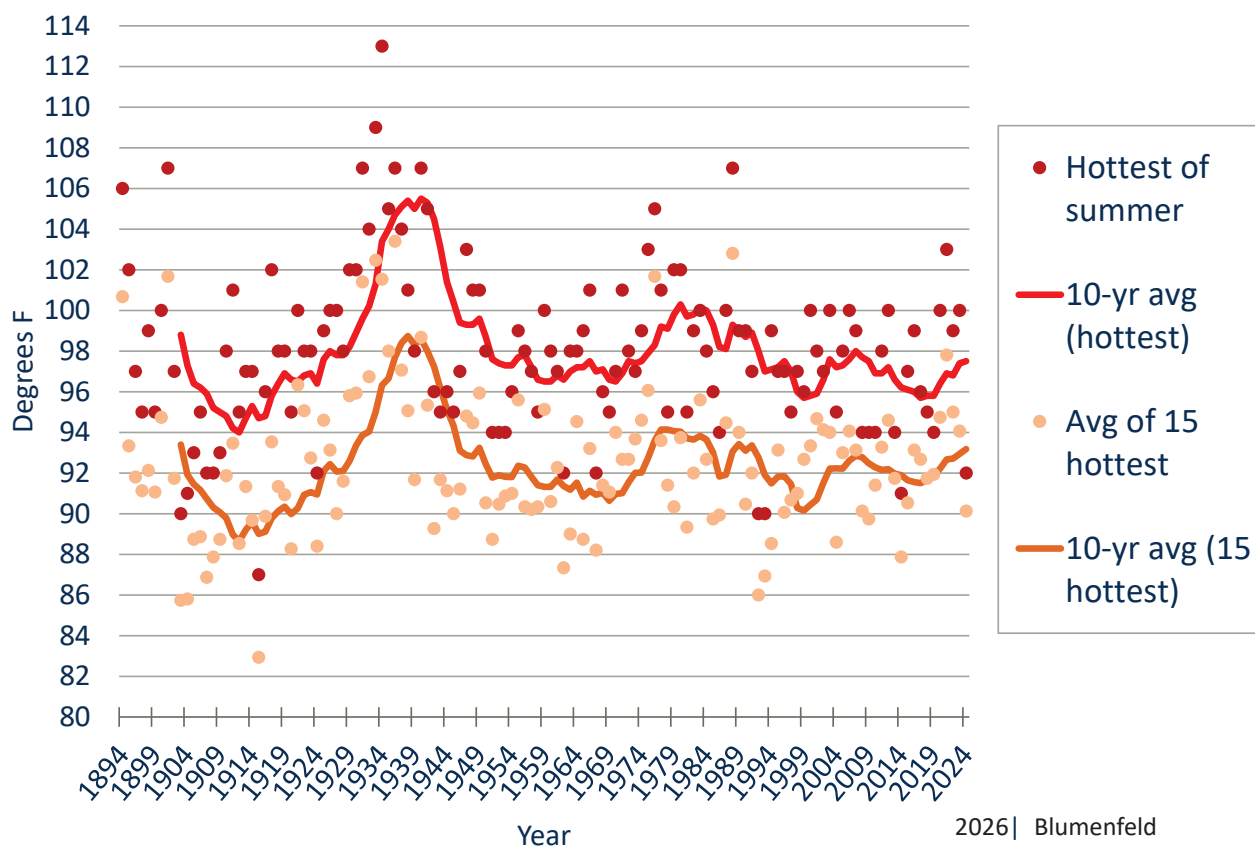


Typical Jan. night in Int. Falls now > 10.5° F warmer!



Summertime high temperatures not increasing YET

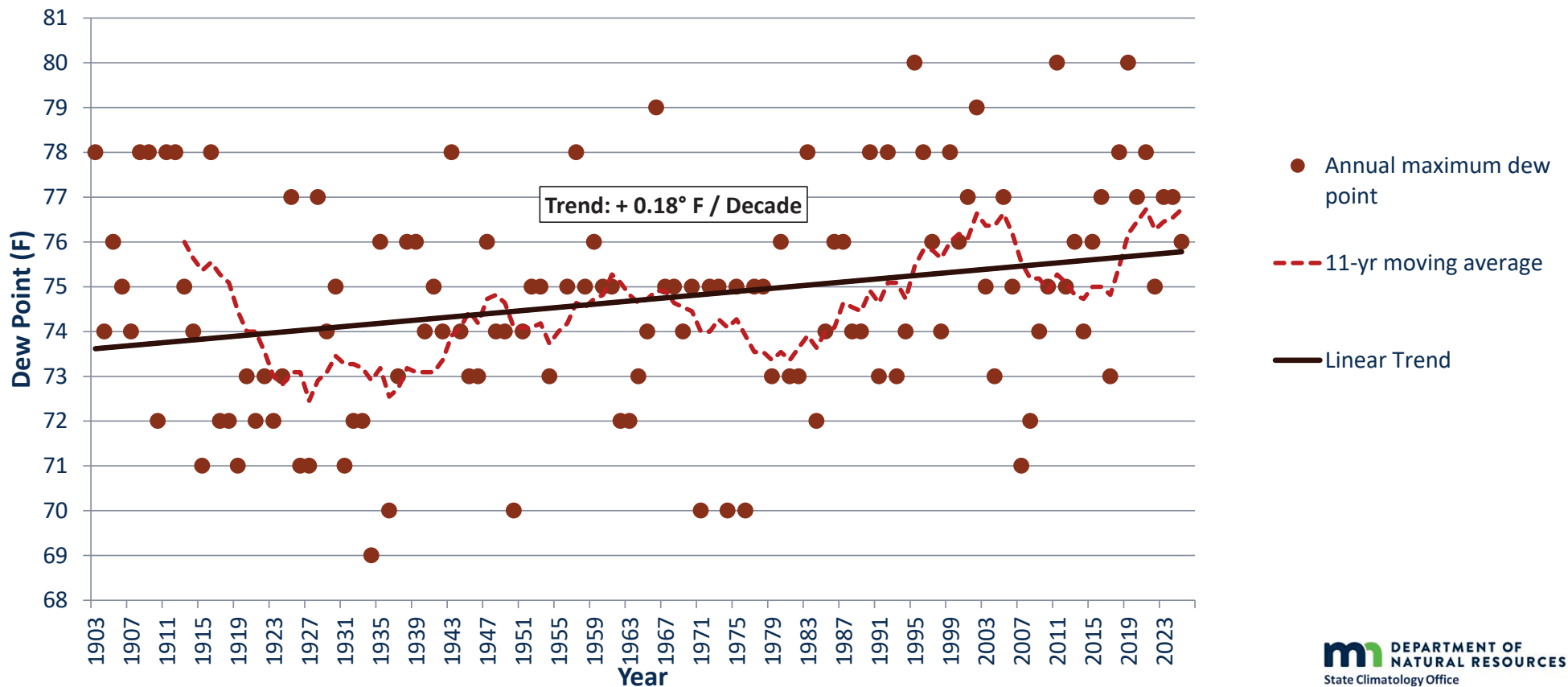
Hottest Days of Summer Milan (MN), 1894-2024



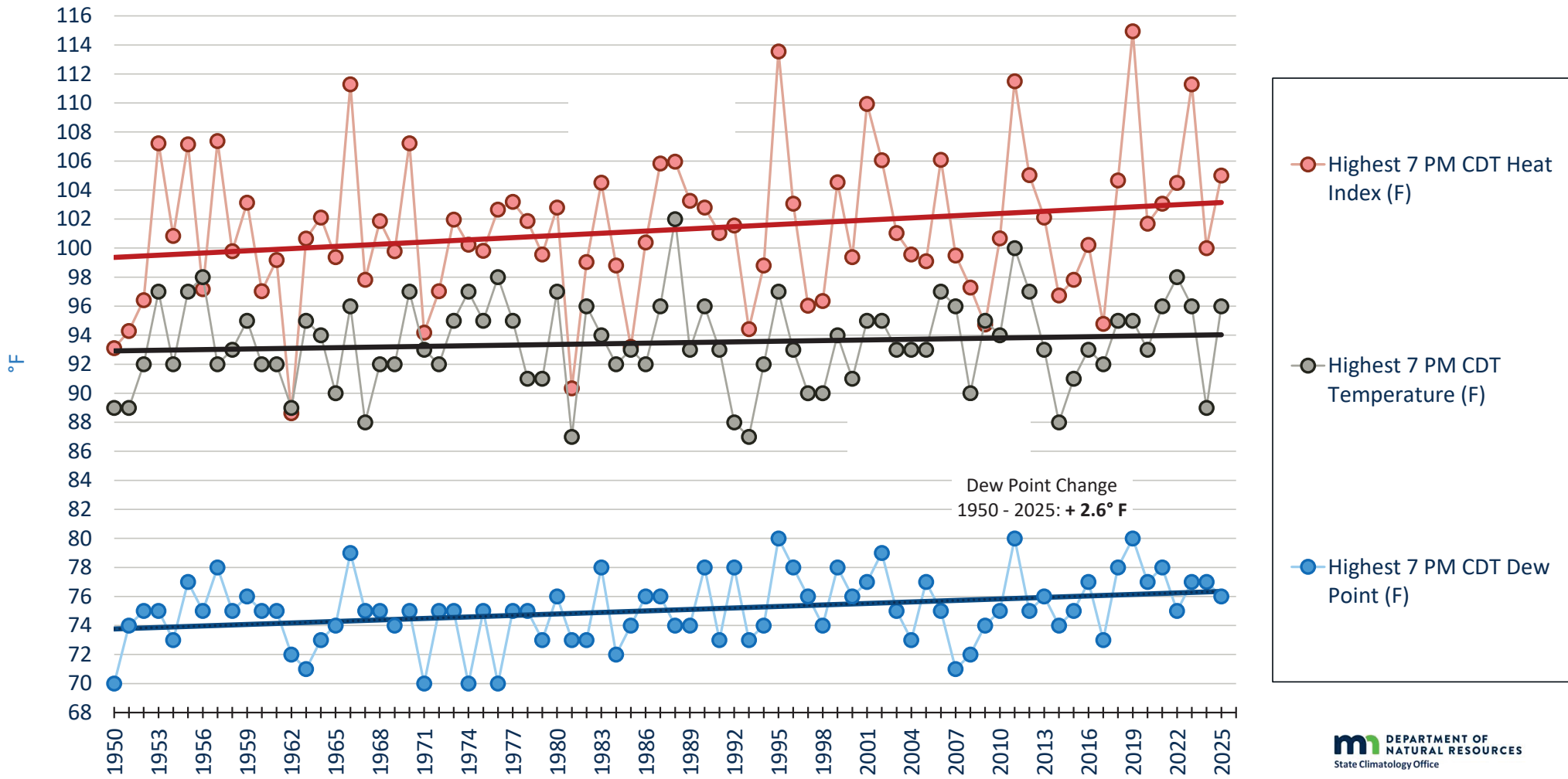
Courtesy of University of Wisconsin Center for Climatic Research and University of Minnesota Climate Adaptation Partnership, based on University of Wisconsin Probabilistic Downscaling v2.0. 2022. climate.elevator.umn.edu.

Extreme humidity beginning to increase

Highest Annual 6 PM CST Dew Points Minneapolis-St. Paul, 1903-2025

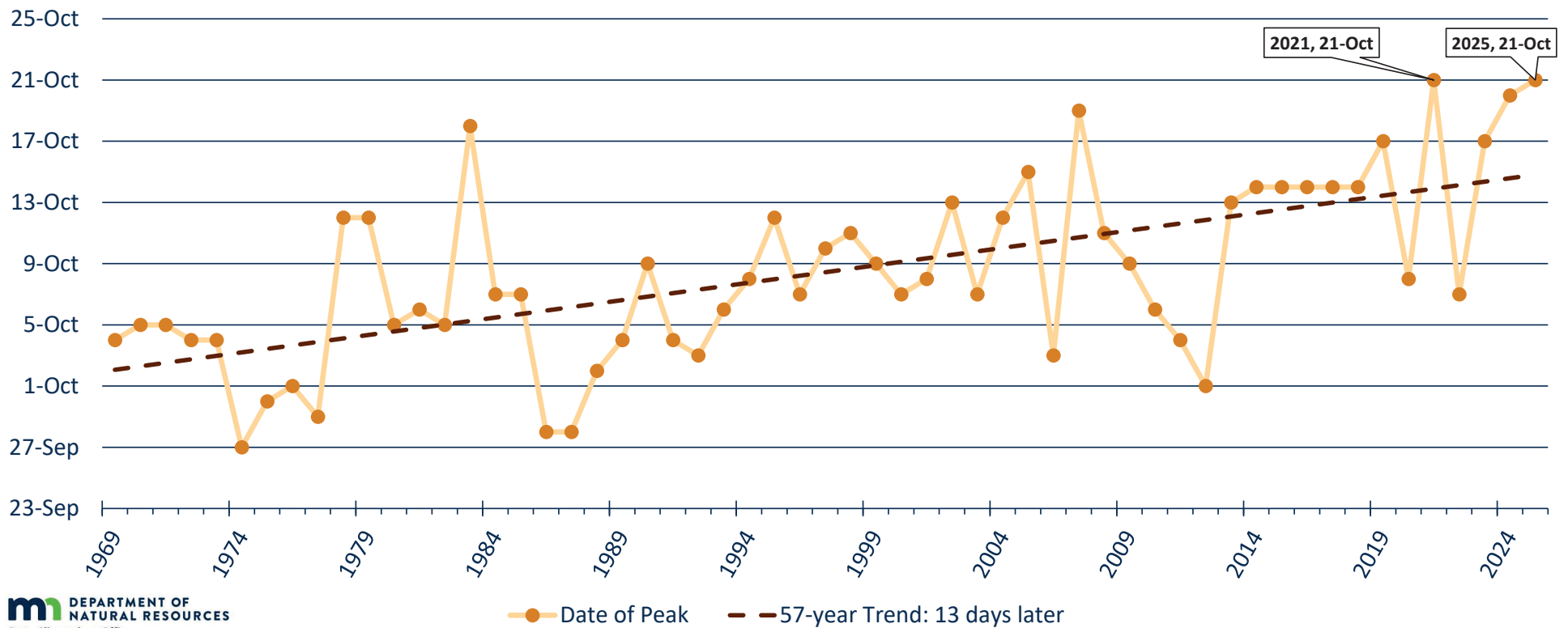


Maximum 7 PM Temperature, Dew Point and Heat Index Values, Twin Cities, 1950-2025



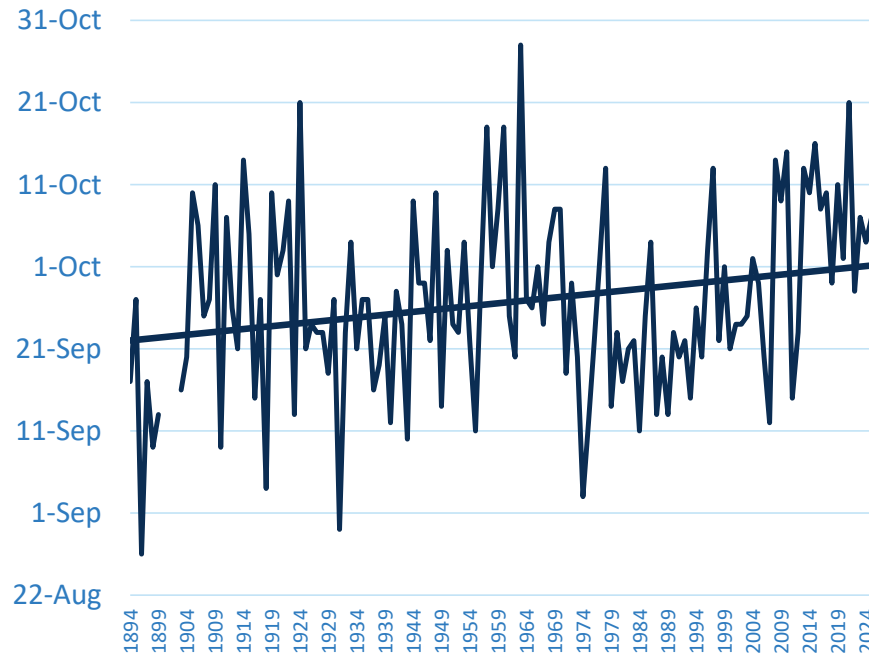
Phenology Changing With Changing Length of Seasons

Date of Observed Peak Fall Foliage
Carver County, 1969-2025

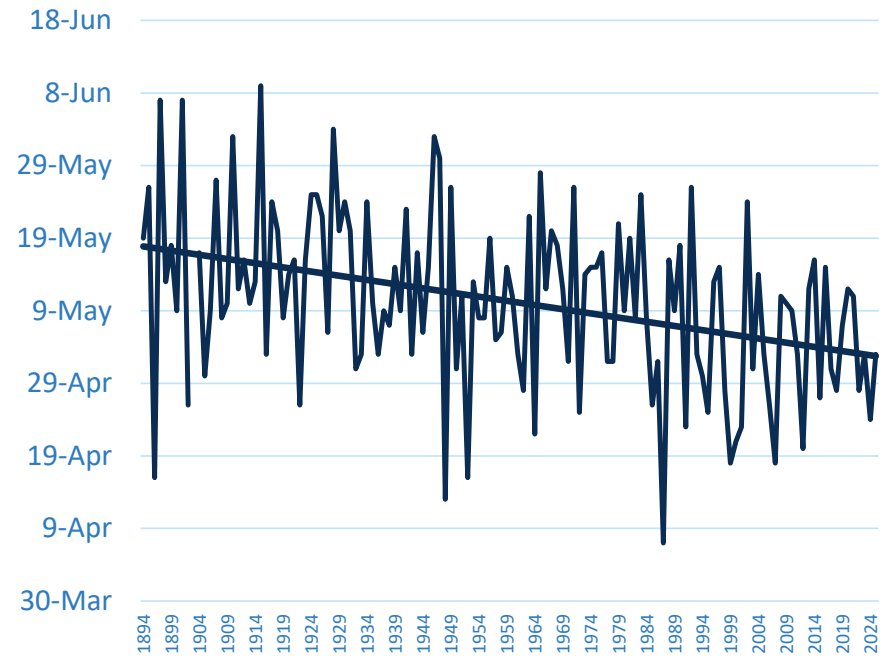


Freeze Season 2-4 weeks shorter

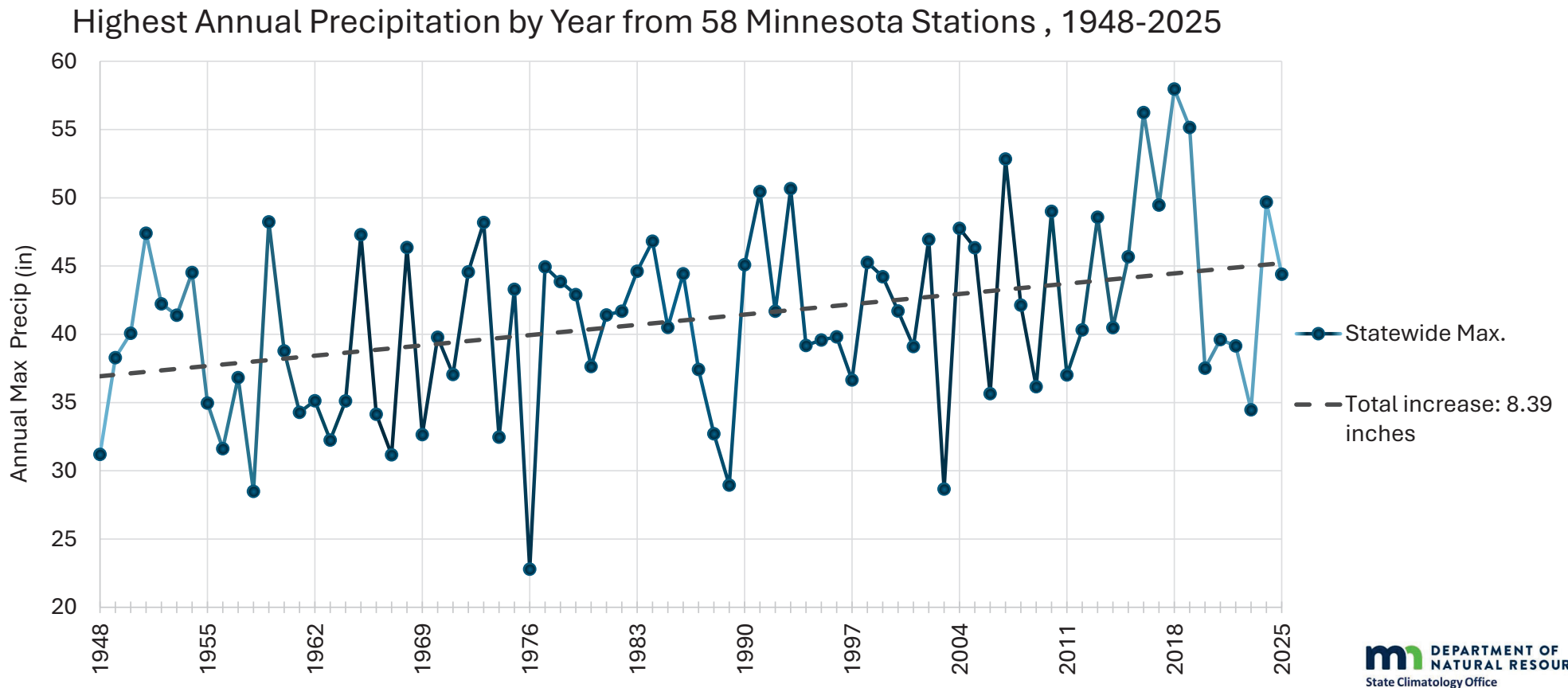
First 32F of Fall
~9 Days Later—Milan (through 2025)



Last 32F of Spring
~15 Days Earlier—Milan (through 2025)

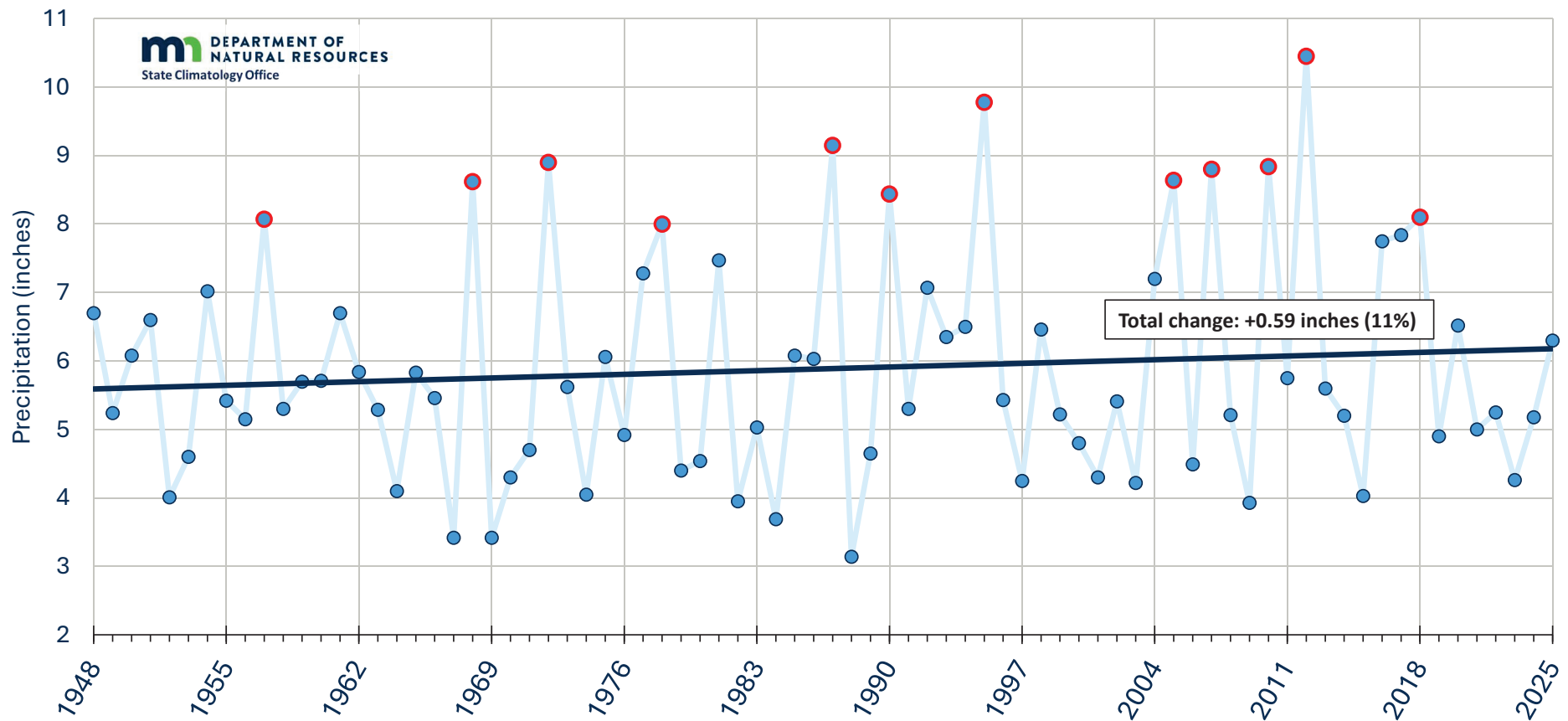


Wettest place in the state getting wetter

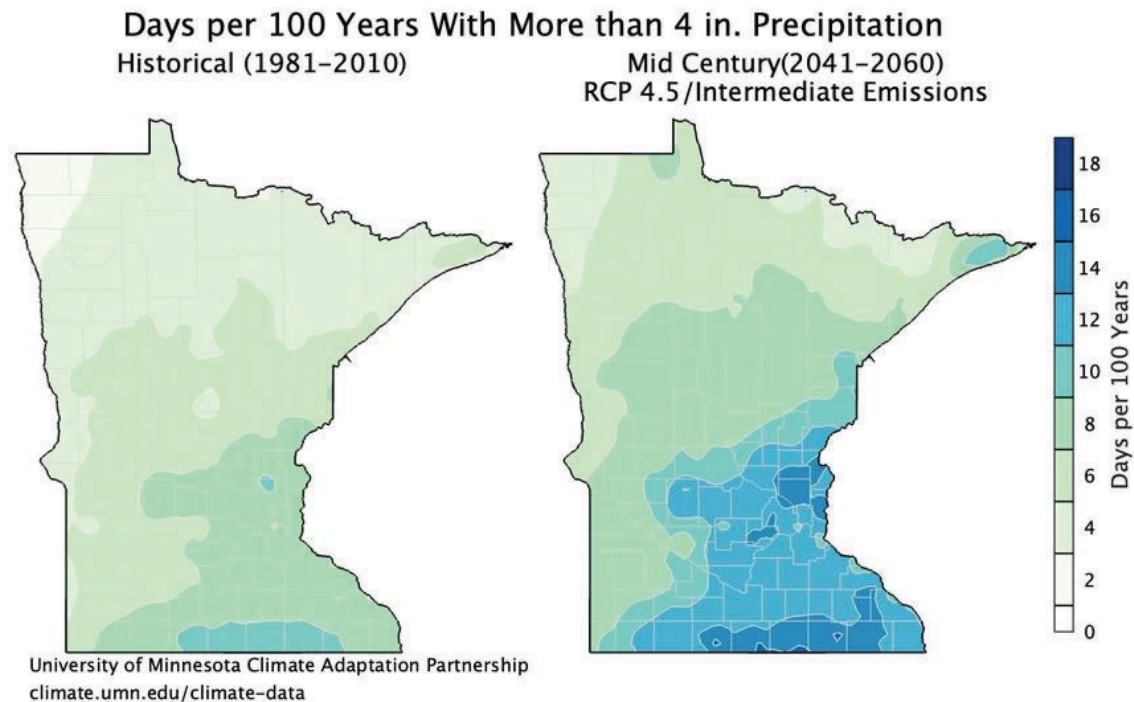


Wettest day of year getting wetter

Single Largest 24-hour Rainfall Each Year, 1948-2025, From 58 Minnesota Stations



More heavy precipitation projected



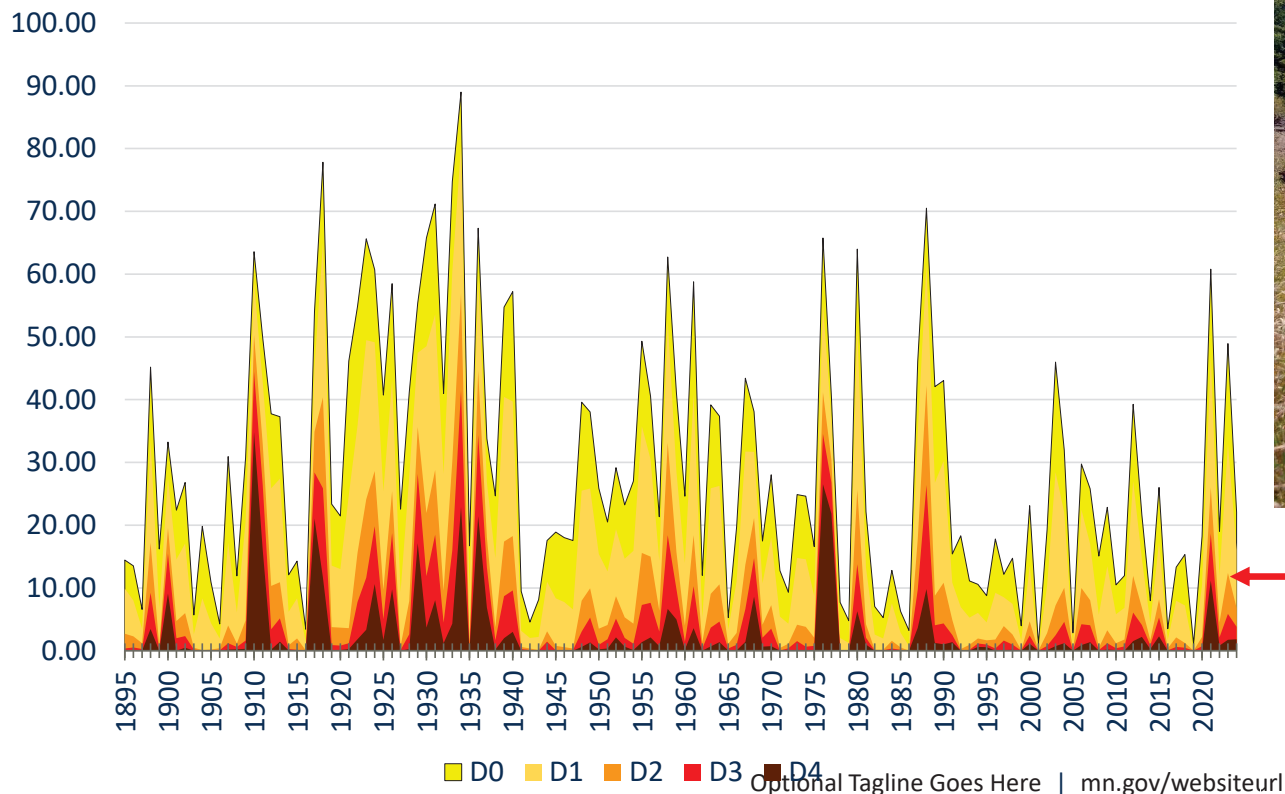
Courtesy of University of Wisconsin Center for Climatic Research and
University of Minnesota Climate Adaptation Partnership, based on University
of Wisconsin Probabilistic Downscaling v2.0. 2022. climate.elevator.umn.edu.

Scenes of warmer winters and more extreme precipitation



Drought duration, areal extent, and severity not increasing (Yet)

Average % of MN in Equivalent Drought Categories

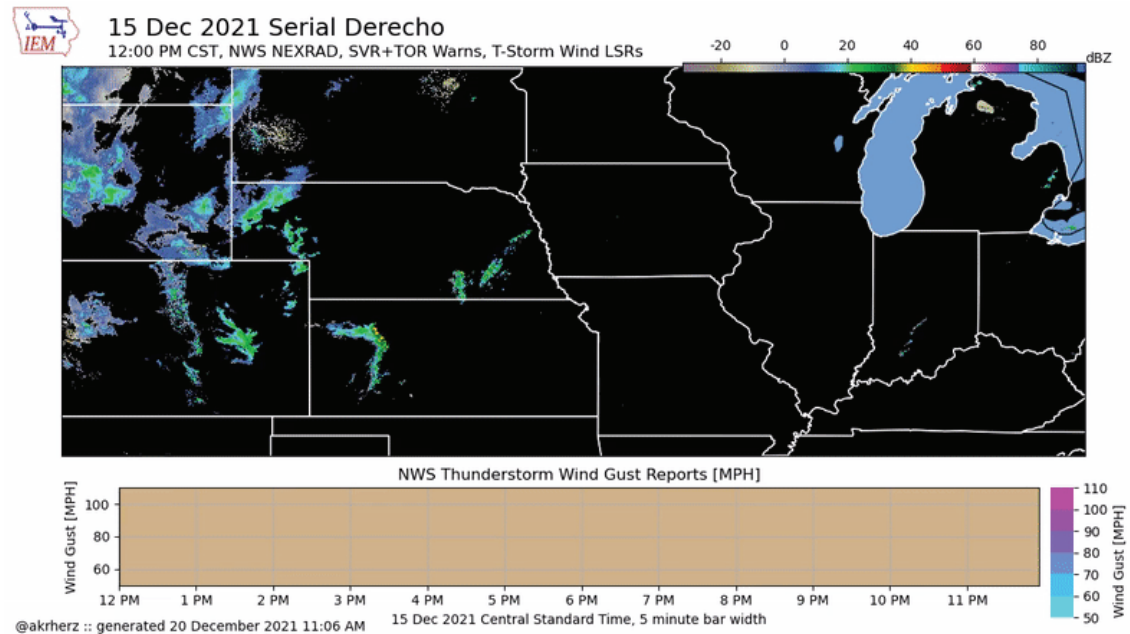


Tornadoes and severe thunderstorms expanding seasonally and geographically

Snowfall 10-20 inches, December 10-11, 2021



Large tornado outbreak 5 days later



Wildfire and air quality hazards emerging trends

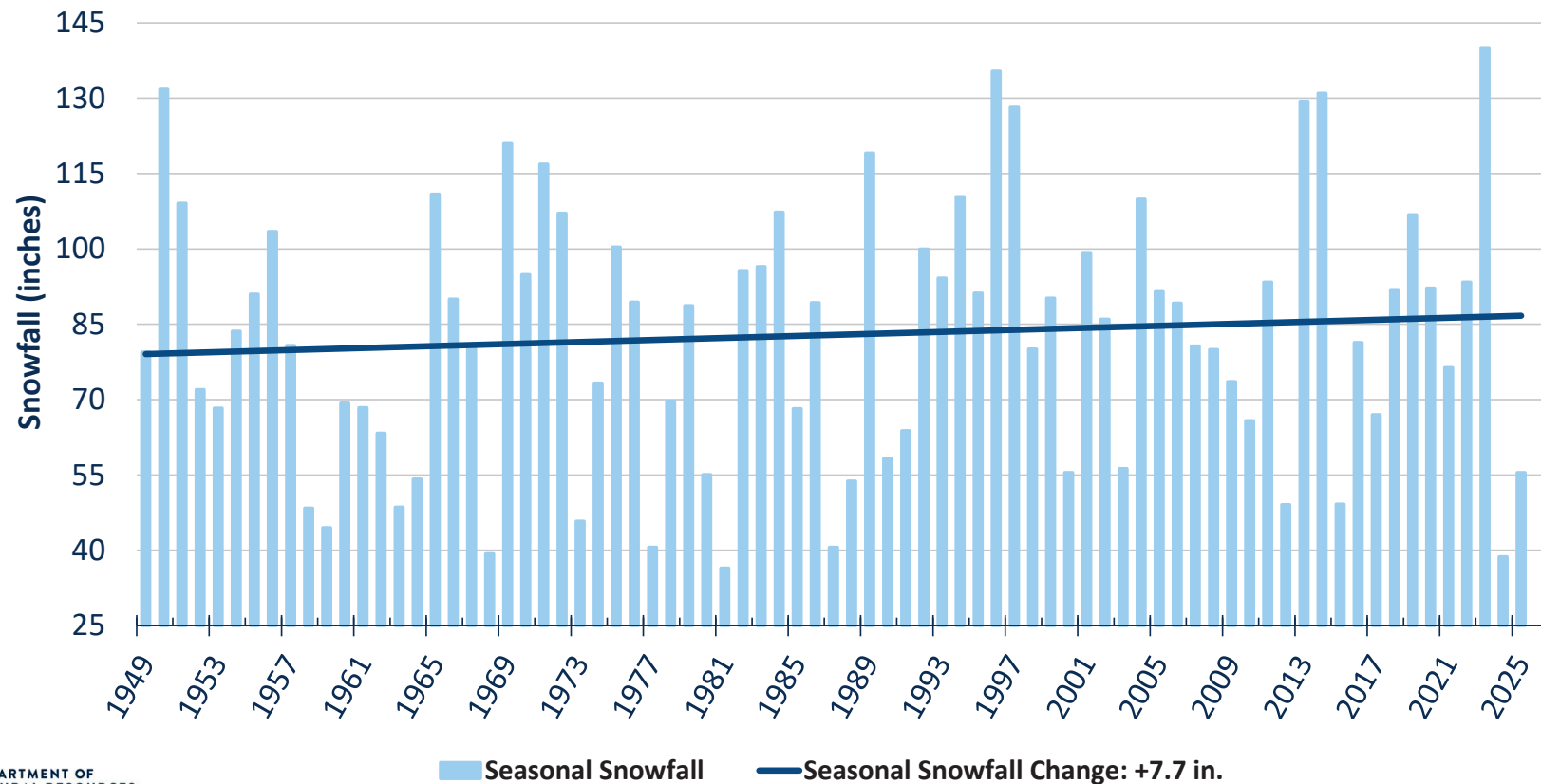
- Wildfire from drought + ecological stress
- Degraded air quality especially from wildfire smoke)



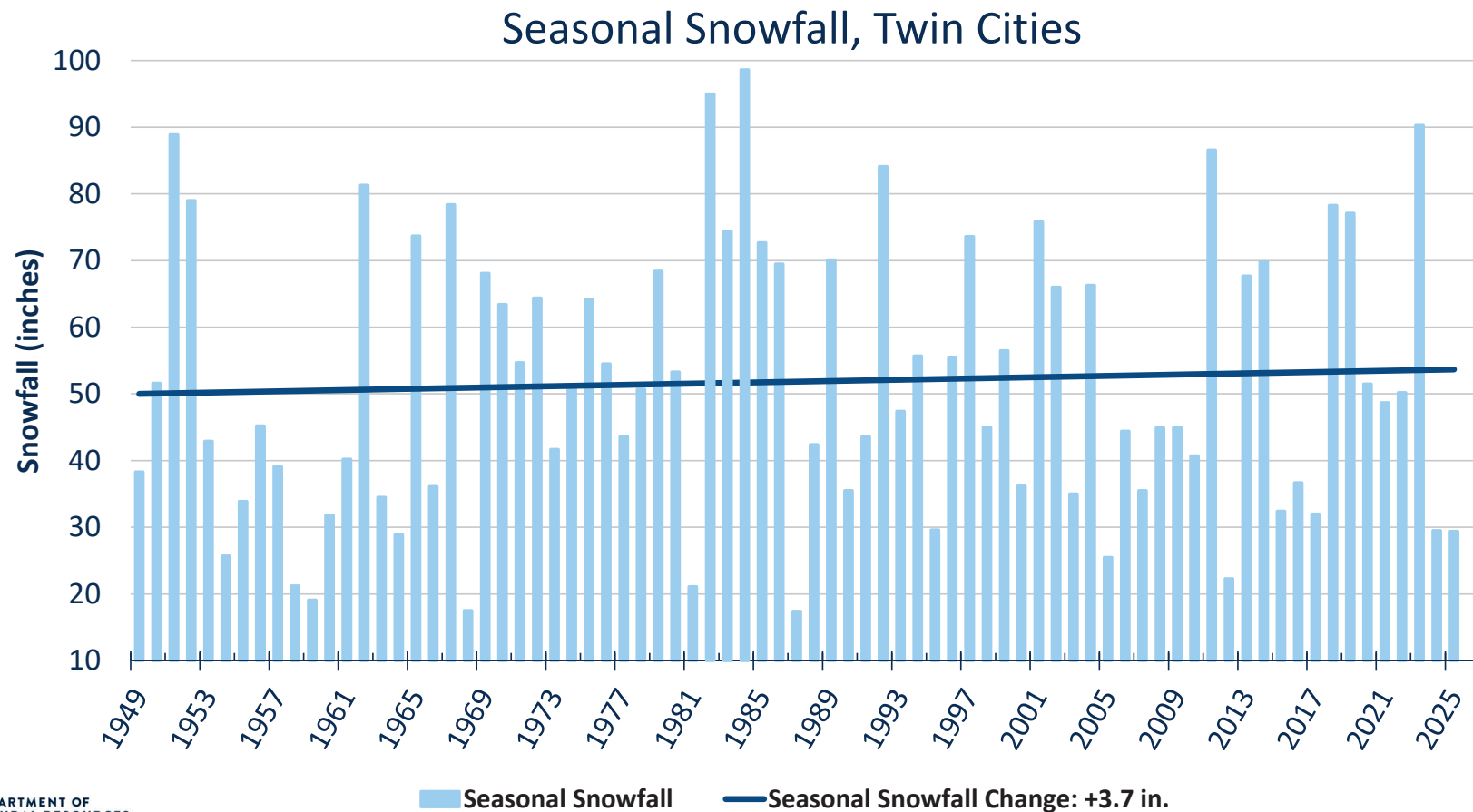
Winter Trends

Seasonal Snowfall Up ~7.7 inches at Duluth airport (includes last two winters)

Seasonal Snowfall, Duluth

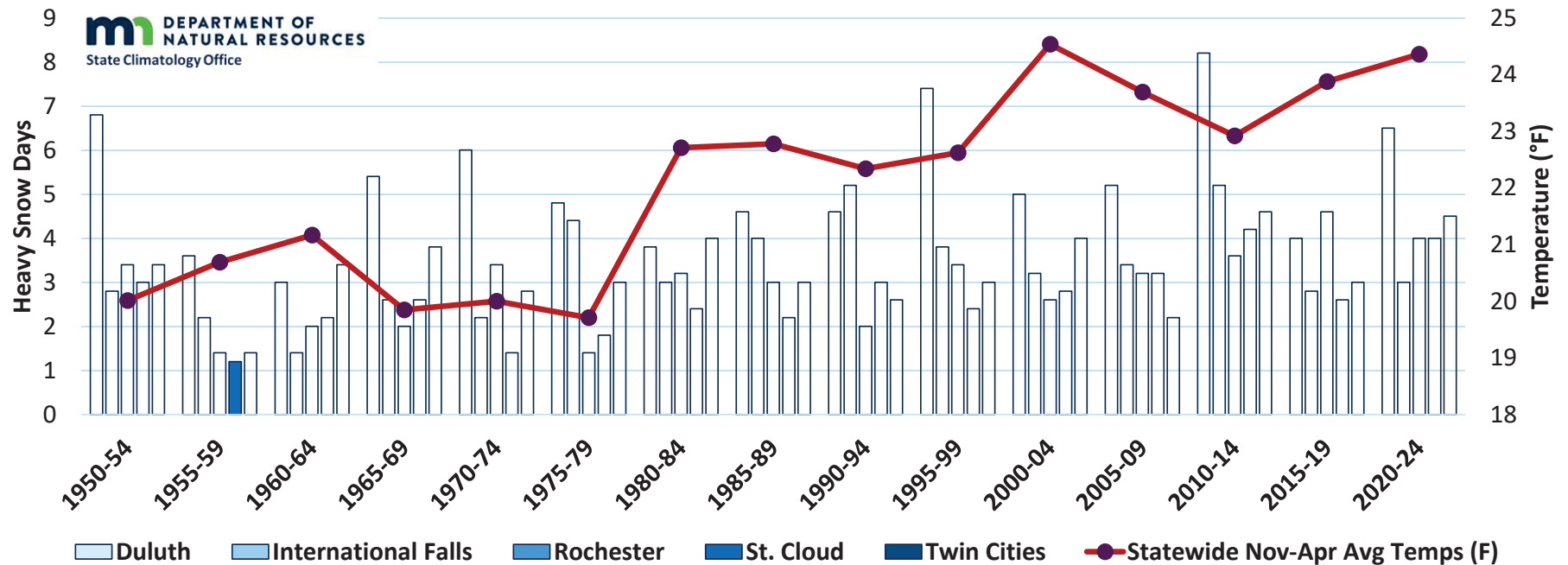


Seasonal Snowfall Up ~3.7 inches at MSP airport (includes last two winters)



Heavy Snow Increasing, Even as Winters Warm

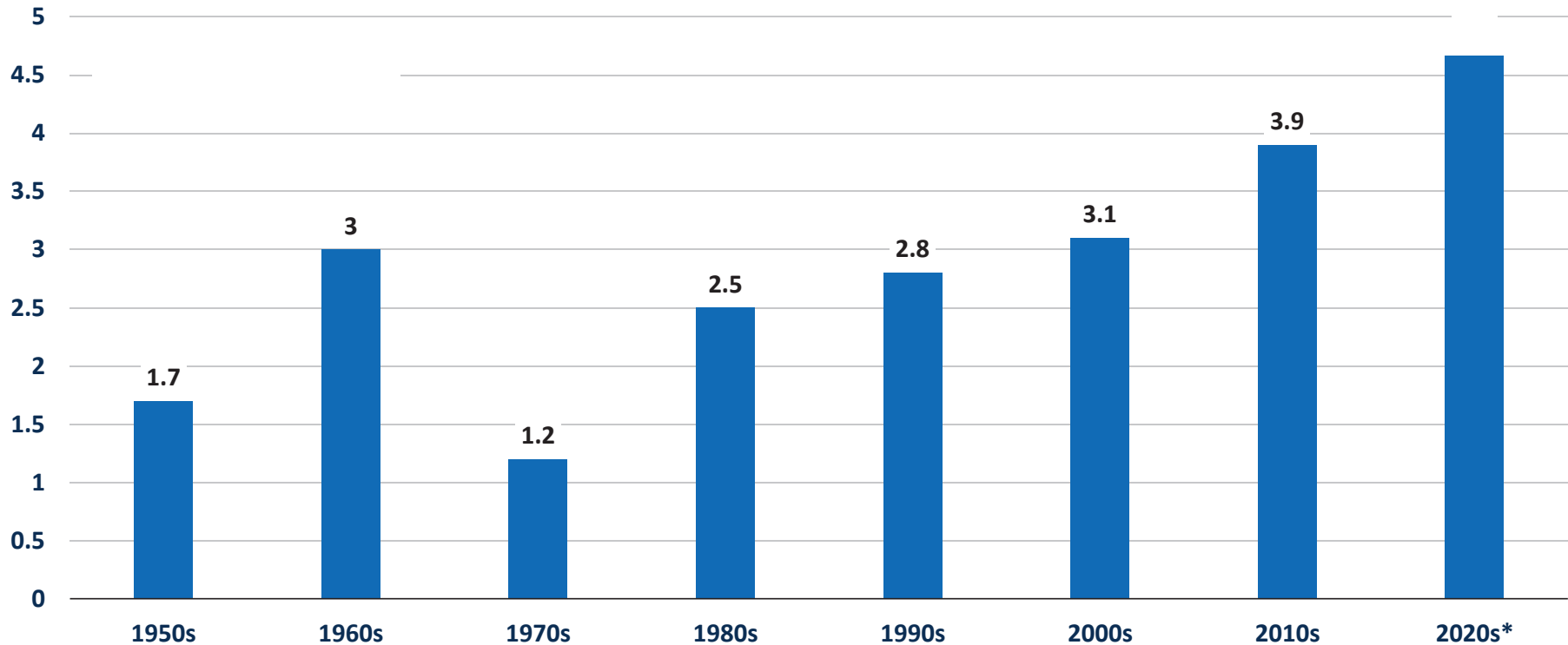
Average Seasonal Heavy Snow Days (4+ inches)
With Statewide Average November - April Temperature



- Snow data from NOAA/NWS Cooperative Network, accessed via Applied Climate Information System (ACIS) (<https://xmacis.rcc-acis.org/>).
- Temperature data obtained from NOAA via Minnesota Climate Explorer (<https://arcgis.dnr.state.mn.us/ewr/climateexplorer/main/historical>)

Liquid Precip Increasing During Winter

**Average Annual Winter Rain Days, Duluth
(December – February -- through 2025)**

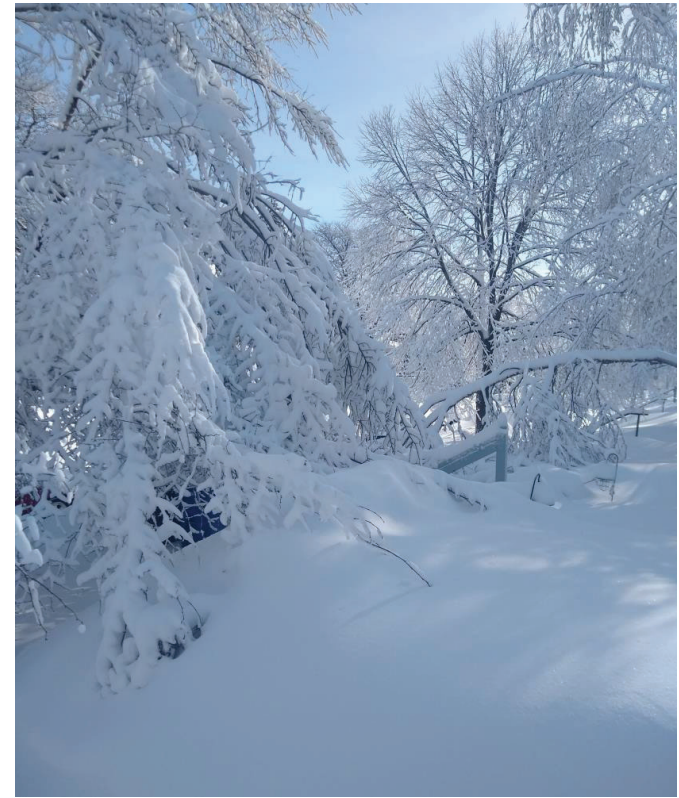


Wet Snow & Rain in Winter is a Problem



2/25/2026

December 2022
Courtesy P. Goff



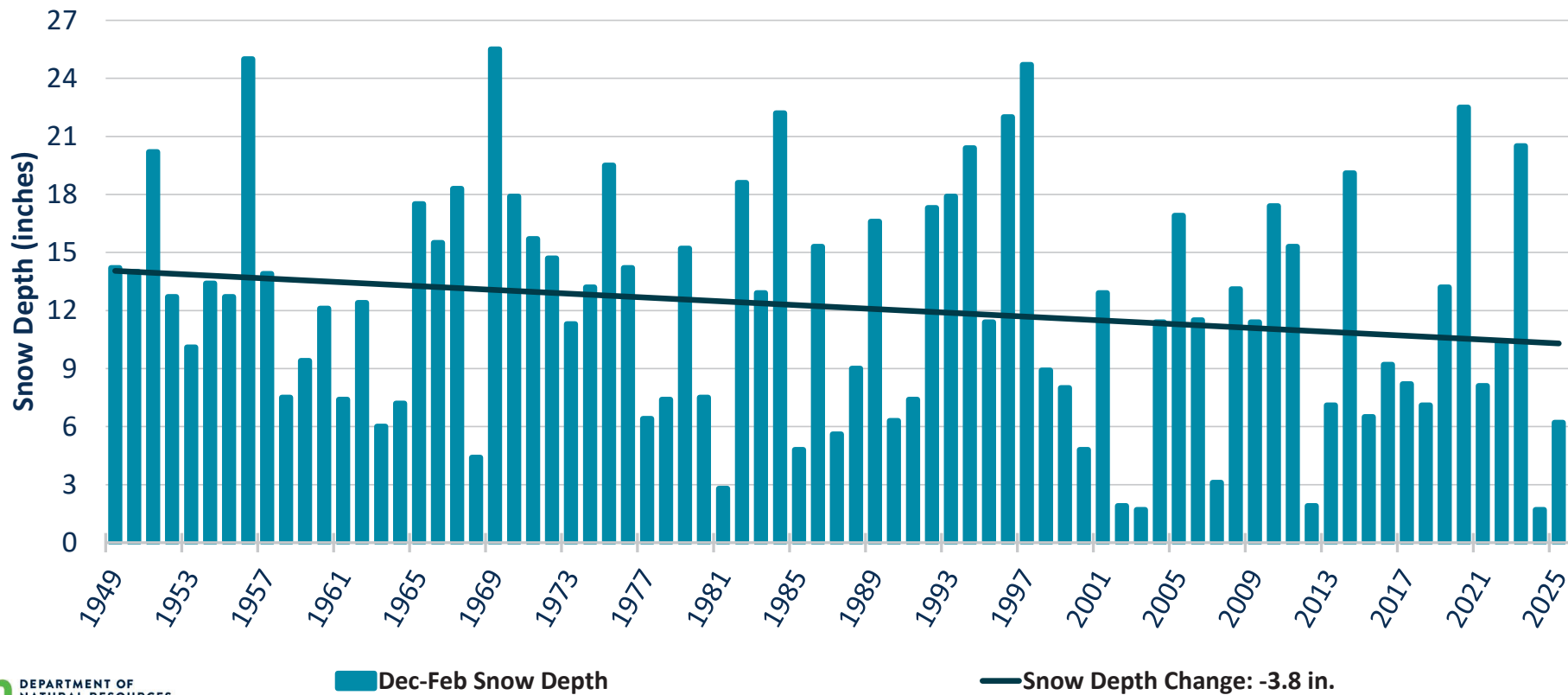
2026 | Blumenfeld

April 1, 2023
Courtesy MN DNR State Climatology Office

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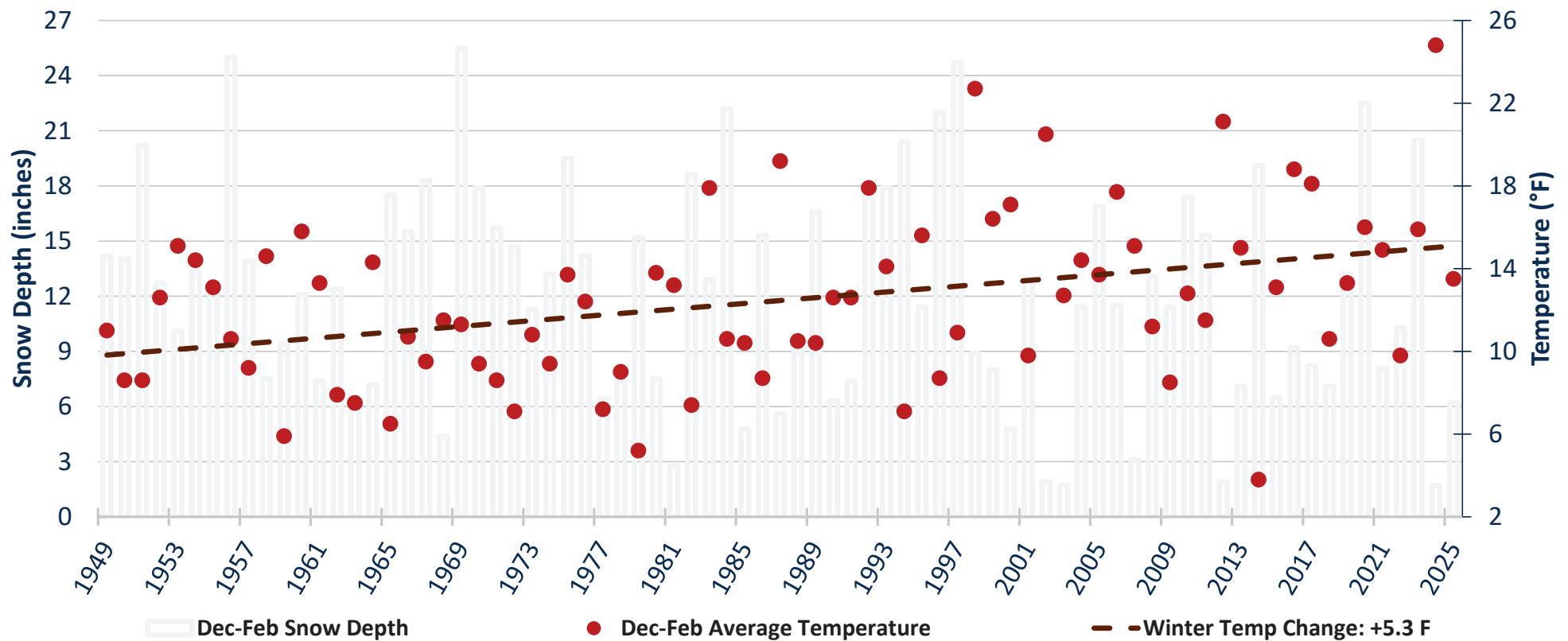
Average Winter Snow **Depth/Cover** has Decreased 3.8 Inches (27%)

Dec-Feb Average Snow Depth, Duluth



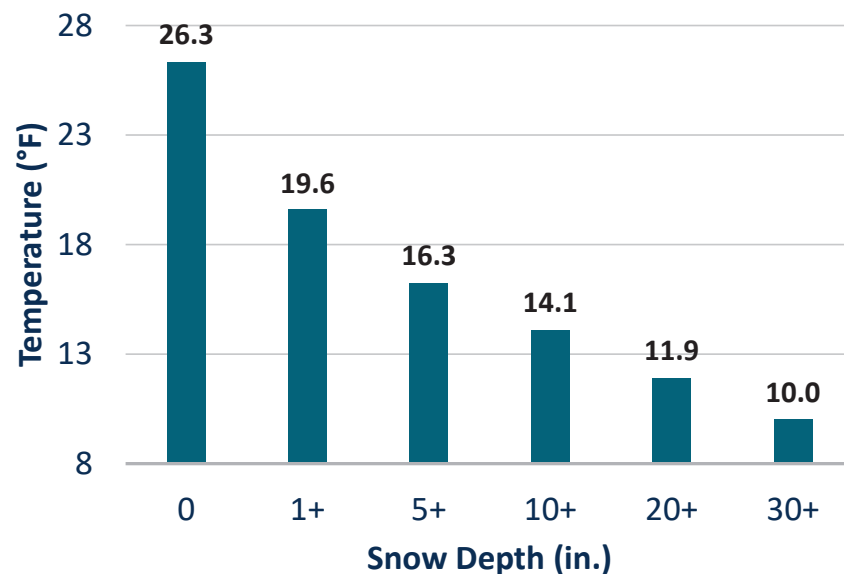
Duluth winter temperatures have increased 5.3° F during this time

Dec-Feb Average Temperature, Duluth

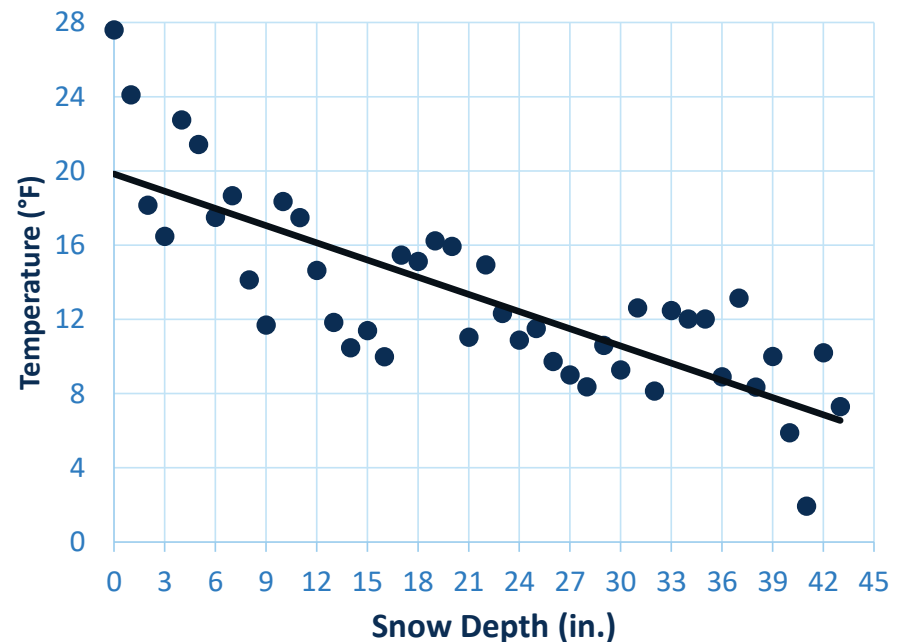


Winter Temperatures Strongly Influenced by Snow Cover (I.e., the “Ice-Albedo feedback” is real!)

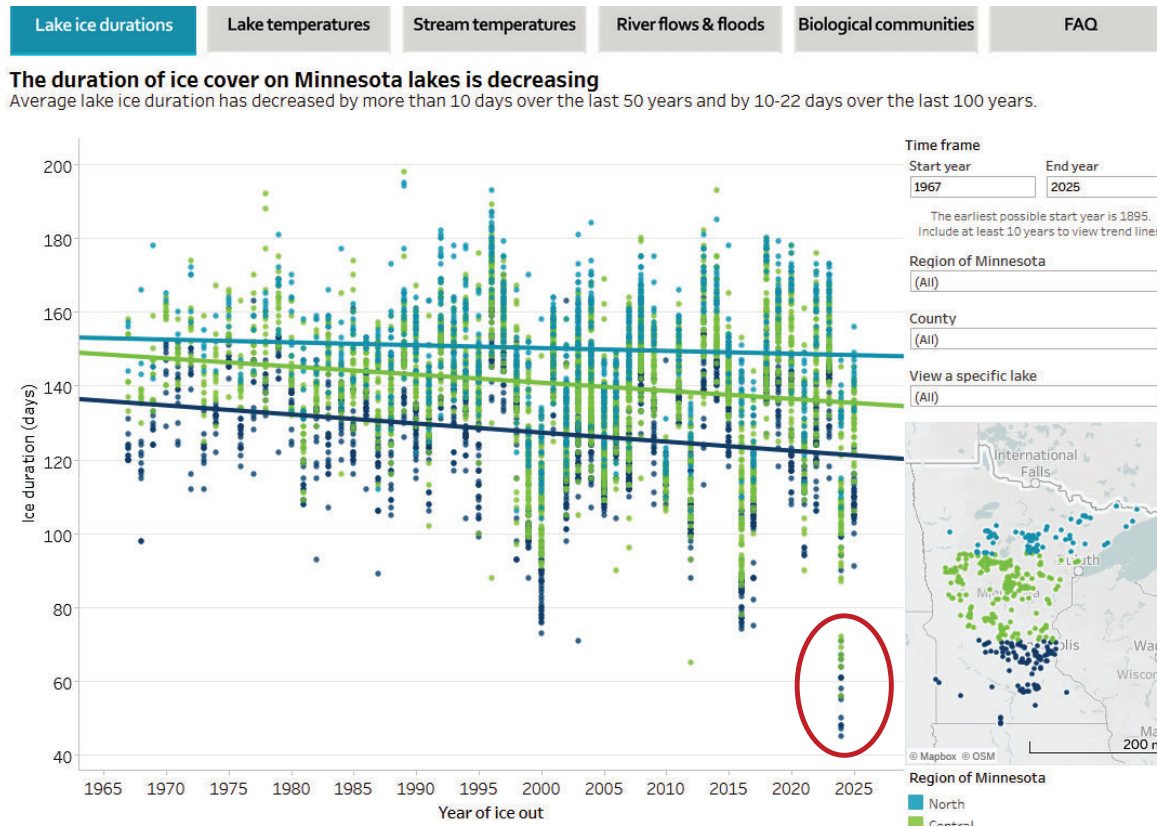
Mean Daily Temperature at Different
Snow Depths
Wolf Ridge ELC (Dec-Feb, 1994-2024)



Mean Daily Temperature vs Snow
Depth **Wolf Ridge ELC, 1994-2024**



Lake ice cover (a proxy for cold) getting shorter



<https://public.tableau.com/app/profile/mpca.data.services/viz/ClimateChangeandMinnesotasSurfaceWaters/Lakeicedurations>

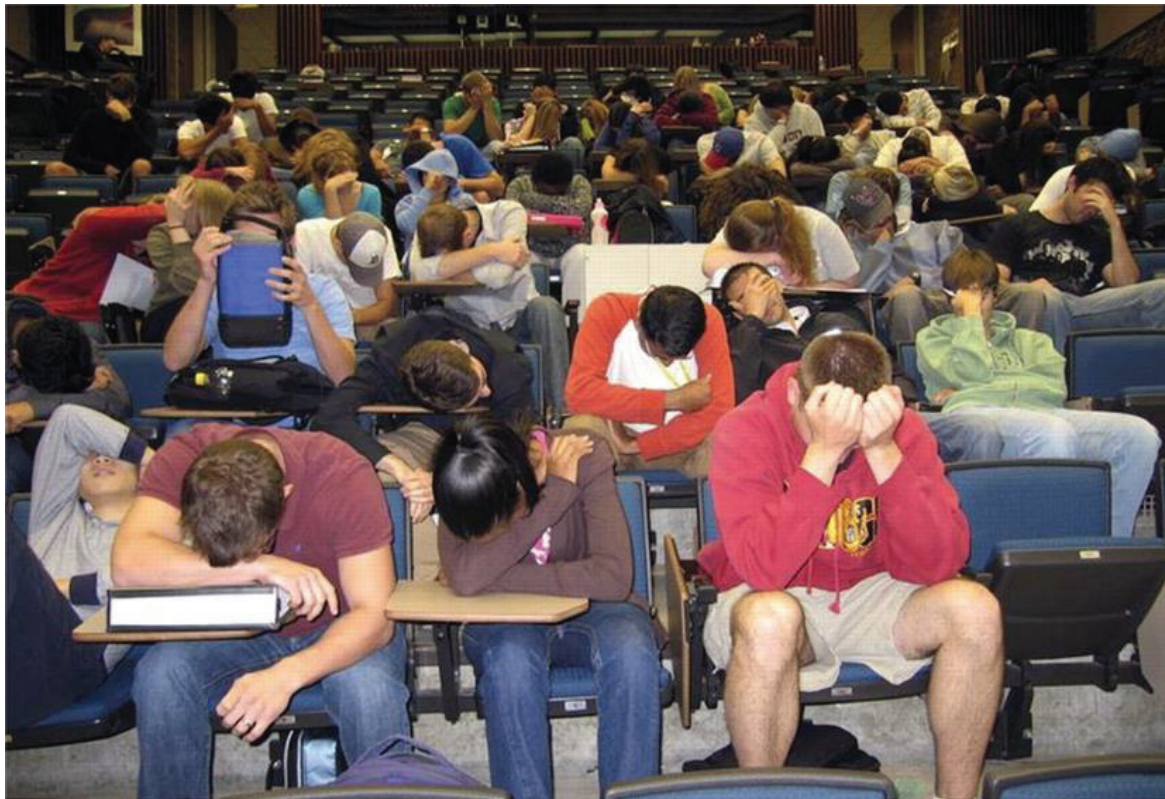
Winter Recreation Conditions and Trends

	Ideal Winters	Extreme Winters	Winterless Winters
Characterized by	Normal to abundant snowfall, below-normal temperatures	Frequent heavy snows and/or severely cold outbreaks	Lack of consistent snow cover and/or abnormally high temperatures
Conditions	Many good, safe, usable days	Can be dangerously cold; deep snow may bury hazardous obstacles	Few opportunities for trail use because of low snow
Examples	2008-09, 2019-20	2013-14, 2018-19 (2 nd half) 2021-22 (esp. north), 2022-23	2015-16, 2023-24, 2024-25
Trends	Becoming less common	Cold less common, but heavy snows more common	Becoming more common

In Summary

1. Main trends continue: warmer (especially in winter) and wetter, on average. Bigger precip extremes. Heavier snows.
2. Projections indicate more everything, plus more humid heat waves and increased
3. Severe weather season is expanding; more compound/cascading power failures
4. Wildfire and degraded air quality are new/emerging hazards
5. Winter conditions becoming more variable and less dependable, driven by joint increases in snowfall and winter temperatures

You



Thank You!

Kenny Blumenfeld

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