HENNEPIN COUNTY EMERGENCY MANAGEMENT

The Winter of 2013-2014

Summary, Discussion and Analysis of High-Impact Events

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This report summarizes and describes the most notable elements of the 2013-14 winter, with an eye towards overall impacts on the area, where possible.

Overview 3
Snapshot 3
Excessive Cold December Through March 4
The "Polar Vortex" Event 7
Snowfall 10
February 20-21 Blizzard 11
Persistent Impacts and Threats 13
Frozen Lines 14
Vehicular Issues 16
Historical Context, Implications and Recommendations 16
References 18

Overview

The winter of 2013 was unusual in many respects, most notably because of the depth, duration, and persistence of cold conditions. The November through March period was among the coldest on record, and was punctuated by several bursts of strong winds that led to dangerously cold windchills, including a reading of -48° F on January 6. MSP received 69.8 inches of snow, making it significantly snowier than the recent average, though not in record or even top-ten territory. The period of continuous snowcover lasted 112 days.

Snapshot

Overall	Coldest November-March since 1935-36 and most abruptly-cold on record, going back to 1872
Depth of Cold	53 days at or below zero (F) at MSP
Duration	• 53 of the 89 days (60%) from Dec 5 to Mar 3 at or below 0°F at MSP • Significantly colder-than-normal conditions began early December and predominated through most of May.
Snowfall	• 69.8" at MSP, 60-75" common throughout Twin Cities and surrounding areas • Continuous snowpack from December 4th to Mar 25th
Significant events	• "Polar Vortex" cold outbreak Jan 5-7 • Numerous other wind chill events • Blizzard Feb 20-21
Impacts and Threats	• Cold-related medical conditions • Frozen pipes, mains and hydrants where frost depth greater • Vehicle stalls
Frequency/Recurrence	Winters like this recur on average once per decade. However: • Frequency through 1970s was substantially greater than most recent 3-4 decades. • Winters may be getting more extreme and less predictable
Other Considerations	With small changes, total impacts on infrastructure and public health could have been much greater.
Recommendations	Winter hazard and emergency planning should assume that a similar winter, or one with even more extreme elements, can and will happen again. As no two meteorological hazards are identical, it is important to consider the question "what did not happen that could have?"

Excessive Cold December Through March

The fall of 2013, defined as September through November was relatively mild in the upper-Midwest. Temperatures in September and early October were largely normal or warmer than normal, compared to historical averages. By mid-October, temperatures began falling below normal with increasing magnitude and frequency, and on its own, November was slightly cooler than historical normals (see figure 1).

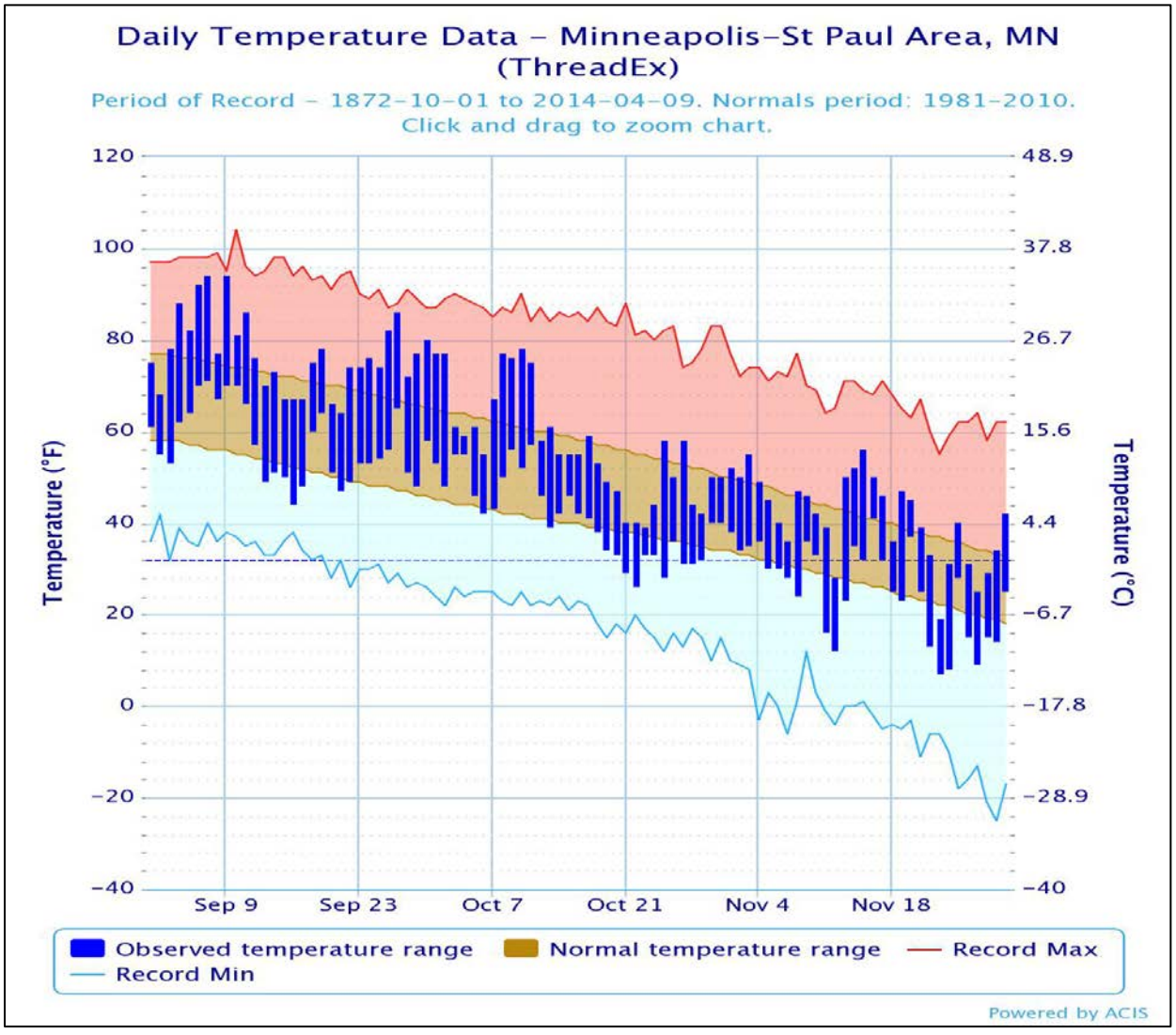

Figure 1. Daily temperatures, Sep 2013-Nov 2013, compared against historical normals. Note that September and early October have many warm days, whereas late October and November have more normal and cool days. Source http://www.nws.noaa.gov/climate/xmacis.php?wfo=mpx

Although the latter part of November was often significantly colder than normal, widespread subzero temperatures did not arrive in southern Minnesota until the first week of December, following a major regional snowstorm. That episode began an unusually long and persistent run of remarkably cold conditions: Beginning December 5th, 53 out of the next 89 days (60%) saw temperatures fall zero degrees or colder at Minneapolis St-Paul International Airport (MSP) (fig 2). The overall significantly-colder-than-normal pattern continued through March, and daily high temperatures often failed to match average low temperature marks (see fig 3).

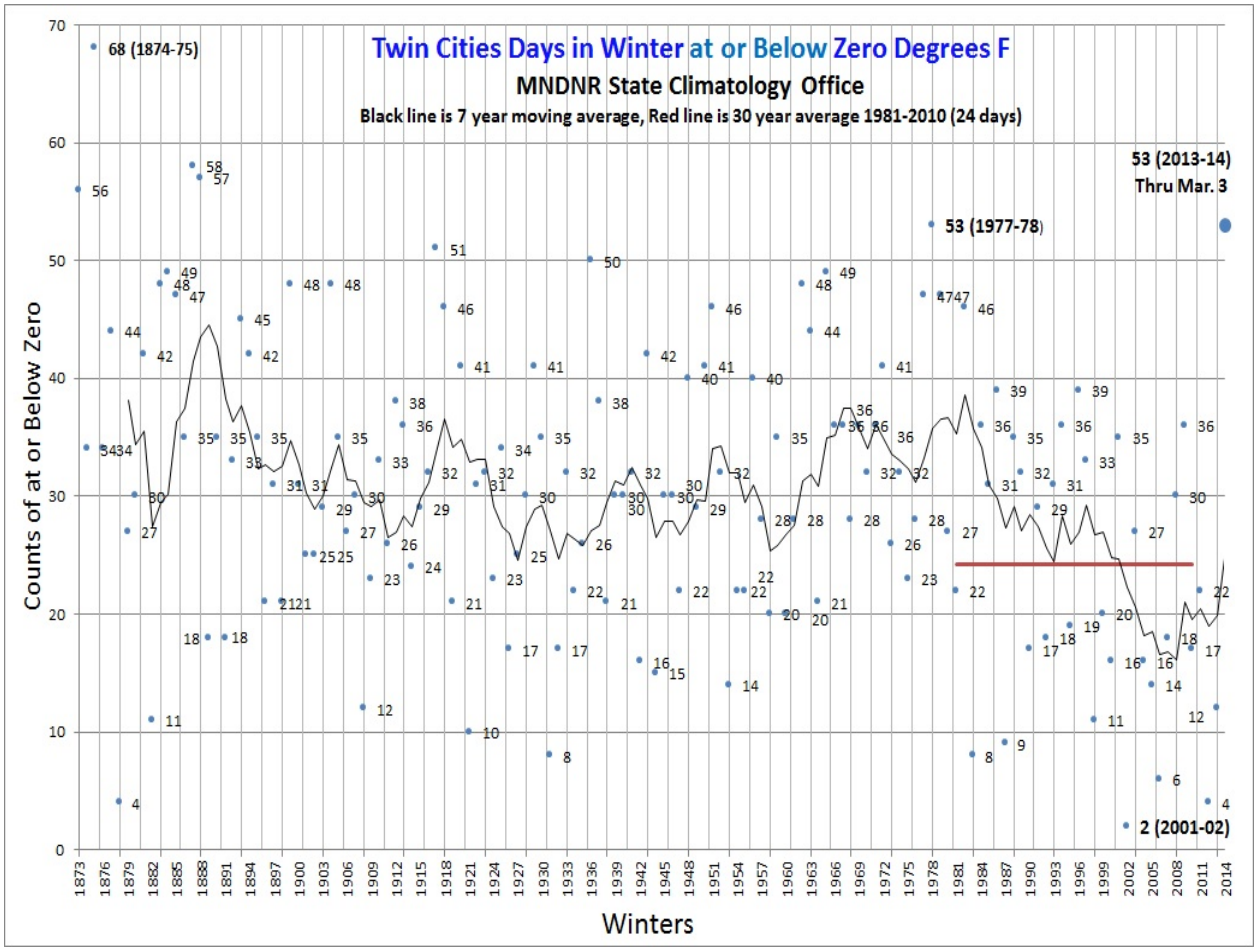

Figure 2. Number of days with temperature at or below 0 deg (F) at MSP. The 2013-14 winterhad 53 such days.

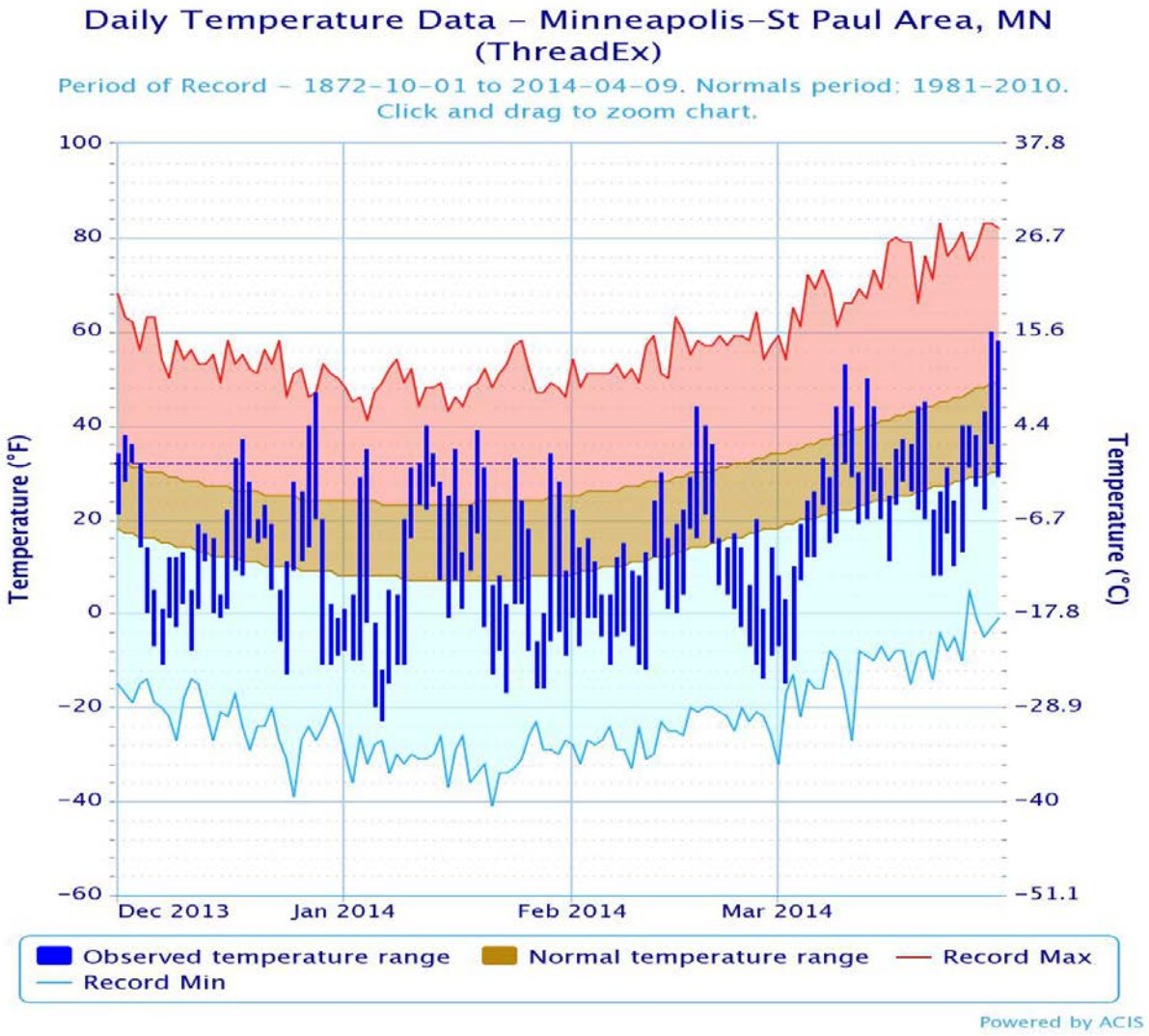

Figure 3. Daily temperatures, Dec 2013-Mar 2014, compared against historical normals. Note the number of days in which the bars are entirely within the lowest shaded region, indicating both the daily maximum and minimum temperatures were colder than the normal minimum temperature for that date. Source http://www.nws.noaa.gov/climate/xmacis.php?wfo=mpx

All-in-all, the December through February meteorological winter at MSP was the ninth coldest on record and the coldest since 1978-79[i], and commonly ranked even higher at other Minnesota and Upper-Midwest stations. If we look at the "impact season" of November through March (the full season in which winter weather hazards are common), the 2013-14 winter at MSP was the coldest since 1935-36, and the 11th coldest on record (see Fig 4). The period around and prior to the turn of the 20th century did have a relatively high frequency of colder winters, although instrumentation and siting conditions were different at that time.

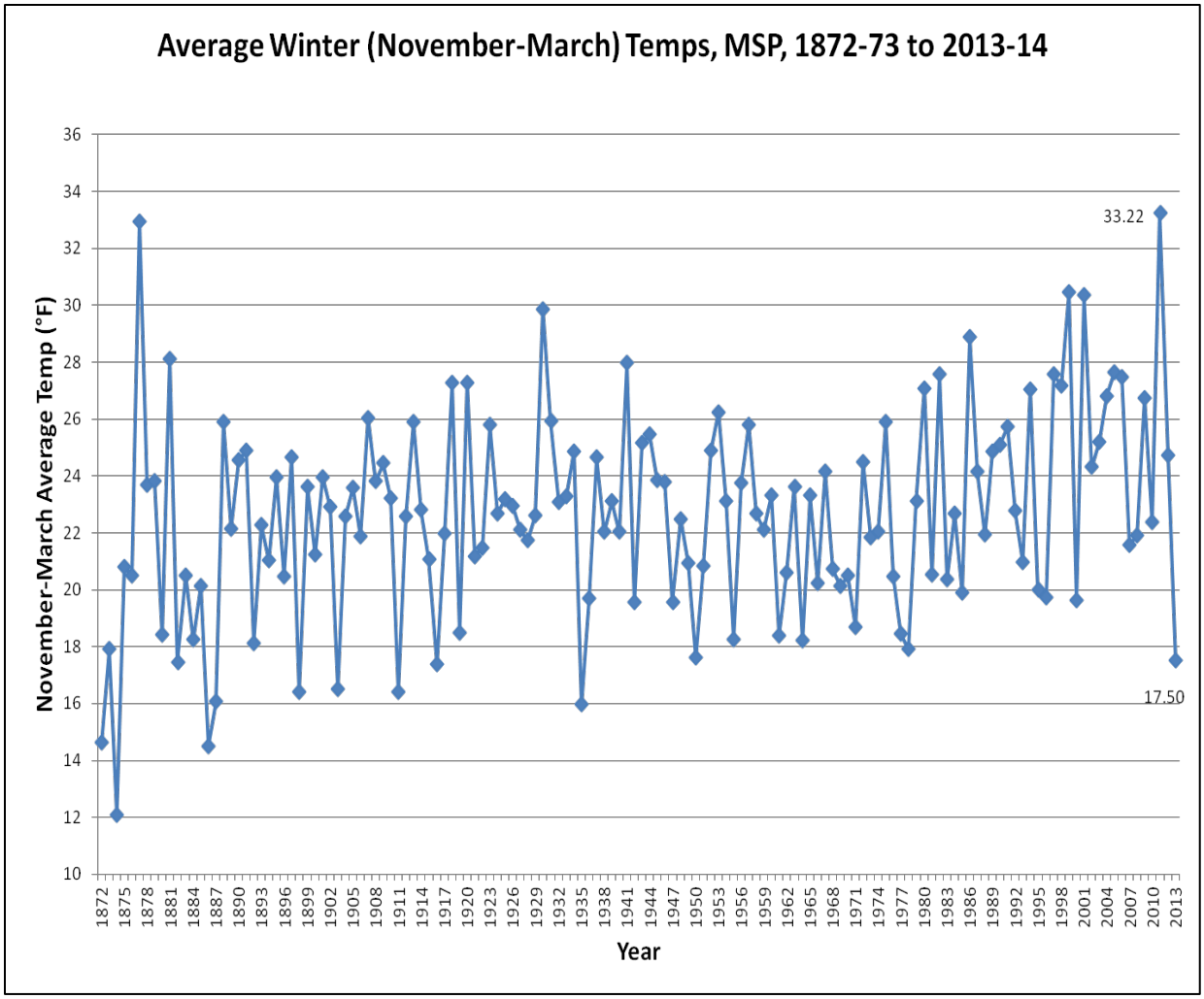

Figure 4. Winter "impact season" (November to March) average temperatures at Minneapolis, beginning with the winter of 1872-83. The 2013-14 winter was the coldest since 1935-36, though numerous seasons from the 1950s through 1970s were almost as cold. Around and prior to the turn of the 20th century, seasonal temperatures were frequently this cold or colder.

The "Polar Vortex" Event

Within the predominantly-cold winter, the extreme cold event of Jan 5-7 garnered particular attention, as one of the most dangerously-cold airmasses in nearly two decades plunged southward from the prairies of Canada on Sunday January 5th 2014, and remained in place for approximately two days (Figs 5 and 6). The cold air had a wide geographical reach, was rare in the context of the previous decade or so, and as a result gained significant media attention. The event became known as the "Polar Vortex," in reference to the semi-permanent high-latitude counterclockwise circulation that broke down and allowed unusually cold air to pour southward with little modification.

The event was noteworthy on three fronts:

1. The winds were unusually strong for such cold air, windchill readings in the -40° to -50°F range in the Twin Cities area on the morning of Monday January 6th. Minimum windchill values colder than -50°F were common throughout greater Minnesota.
2. The outbreak was widespread, with cold air reaching Gulf of Mexico to the south and Atlantic Ocean to the east.
3. Though not many records were set regionally, the cold air and windchills were of a magnitude not experienced since 2004 in some areas, and 1996 in others; in other words, most of the region had not experienced this intensity of cold and wind in at least a decade.

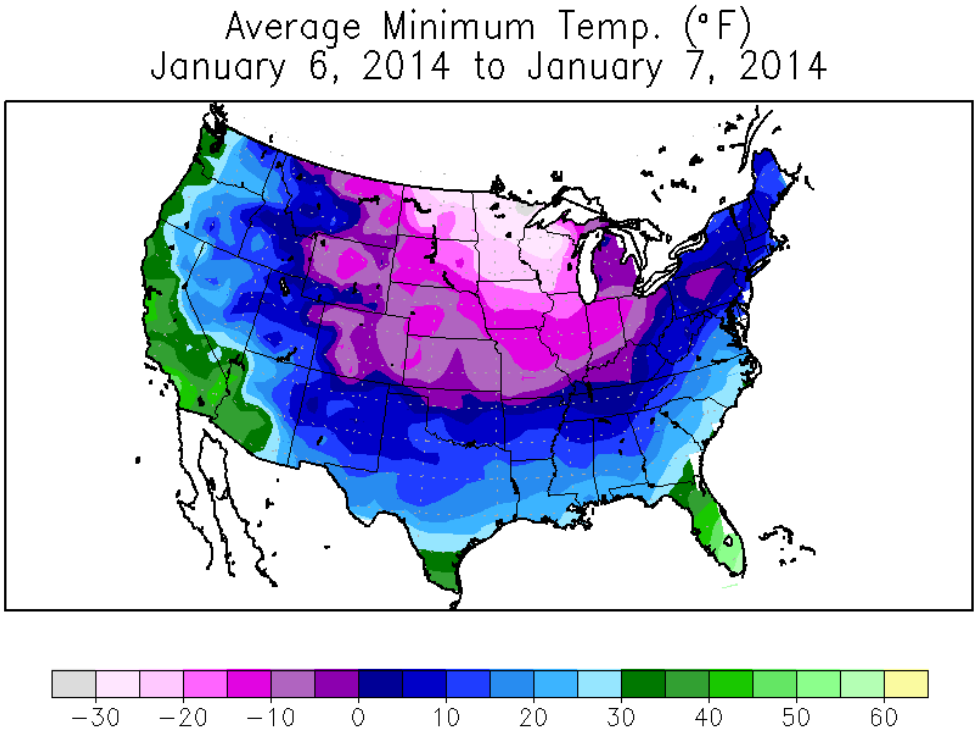

Figure 5 Low temperatures averaged over Jan 6 and Jan 7

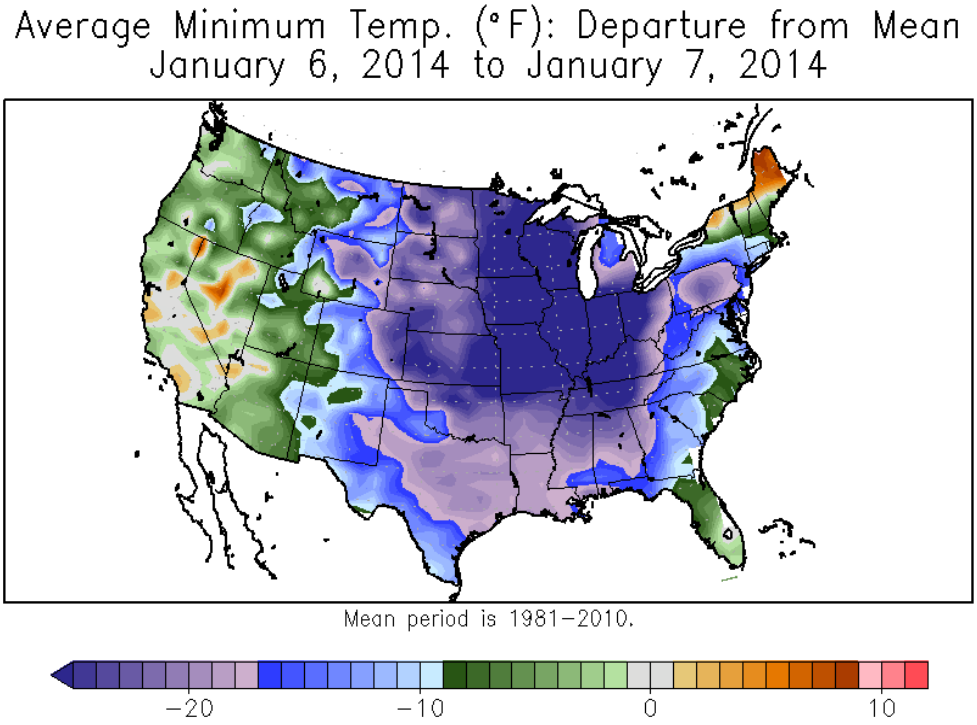

Figure 6. Low temperatures, averaged over Jan 6 and 7, expressed as departure from normal

The cold air outbreak's impact was very well warned, and despite media coverage suggesting that the event had triggered spikes in frostbite and hypothermia cases[ii], discussions with area hospitals suggested that the event itself was indistinguishable from much of the rest of winter. Hennepin County Medical Center's own data showed that while cold-related patient intake did increase towards the end of the event, more patients were admitted during New Year's and Christmas. The first subzero outbreak of the season, following the early December snowstorm, resulted in more total intakes, even though conditions were not as cold (Fig 7).

Though it was the backdrop for an otherwise difficult winter, the already well-entrenched cold regime may have lessened the negative effects of the Polar Vortex cold outbreak. Furthermore, the multiple days of forecast lead-time, along with school cancellations on the 6th and 7th, numerous government and office closings, all helped to keep the population inside, in relative safety.

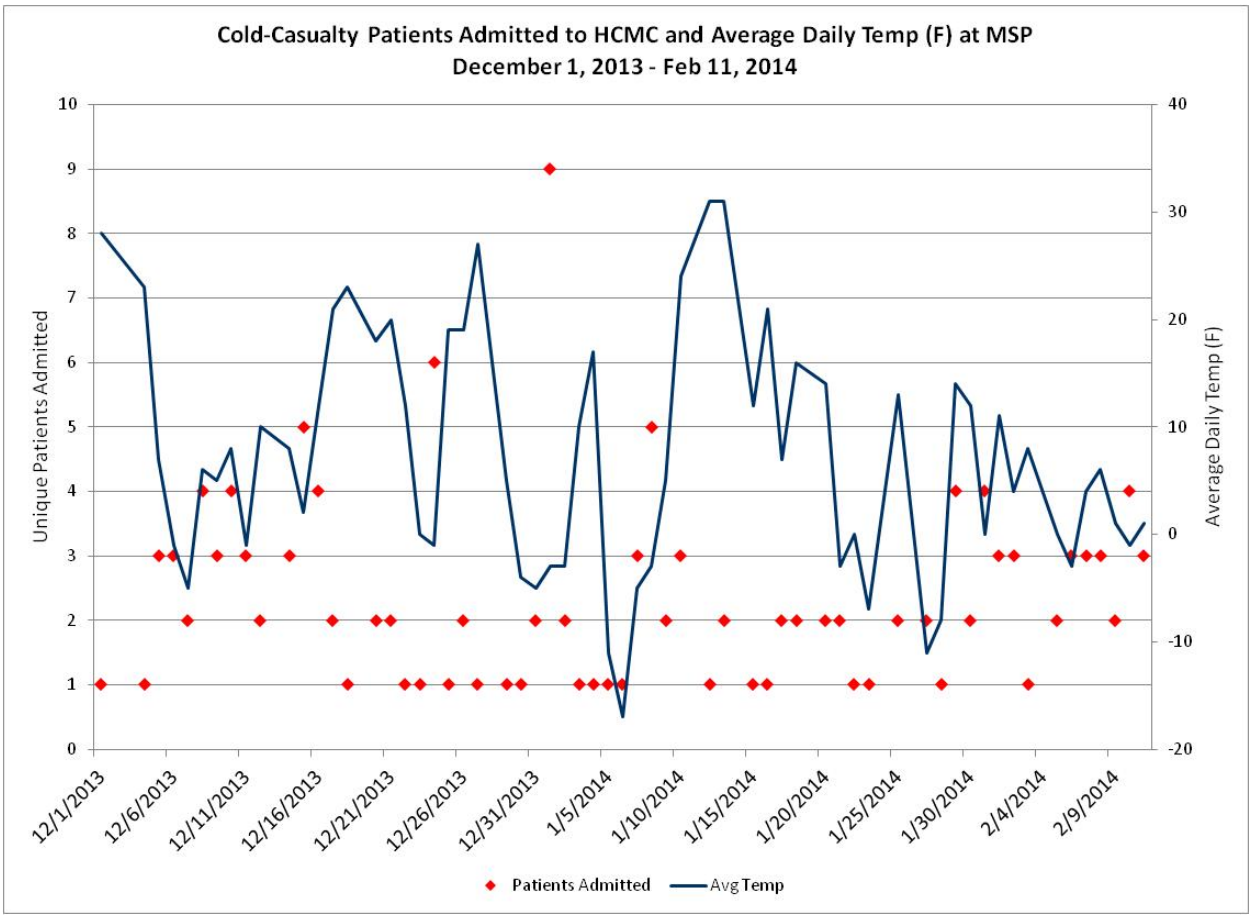

Figure 7. Patient intakes for cold weather-related conditions at HCMC, compared against daily mean temperature at MSP, early December through mid-February. Note that cold temperatures with Polar Vortex event, and again later in the month, led to slight increases in intakes, whereas early-season cold, plus the holidays of Christmas and New Year's led to more patient intakes.

Snowfall

Seasonal snowfall was generally above average in the region, but not to the same extent that temperatures were colder than average. At MSP, the snowfall total was 69.8 inches, which significantly snowier than normal, though not a historical top-ten amount.

Meteorologically, snow and cold often reinforce one another: snow on the ground reflects 80-95% of the already weak (low-angle) winter sunlight, meaning it is that much harder to heat the surface of the earth. Thus, a snowpack makes the air substantially colder than it would have been without snow.

The 2013-14 winter really began with the December 4 snowfall event, which kicked off 112 straight days of snow on the ground at MSP. The relationship between individual snowfall events, the cold conditions, and the depth of snow was exceptionally clear and strong this winter. The cold weather maintained the snowpack, and the individual events allowed it to grow, with the depth reaching 24 inches on February 21st (Fig 8), the most since January of 1982.

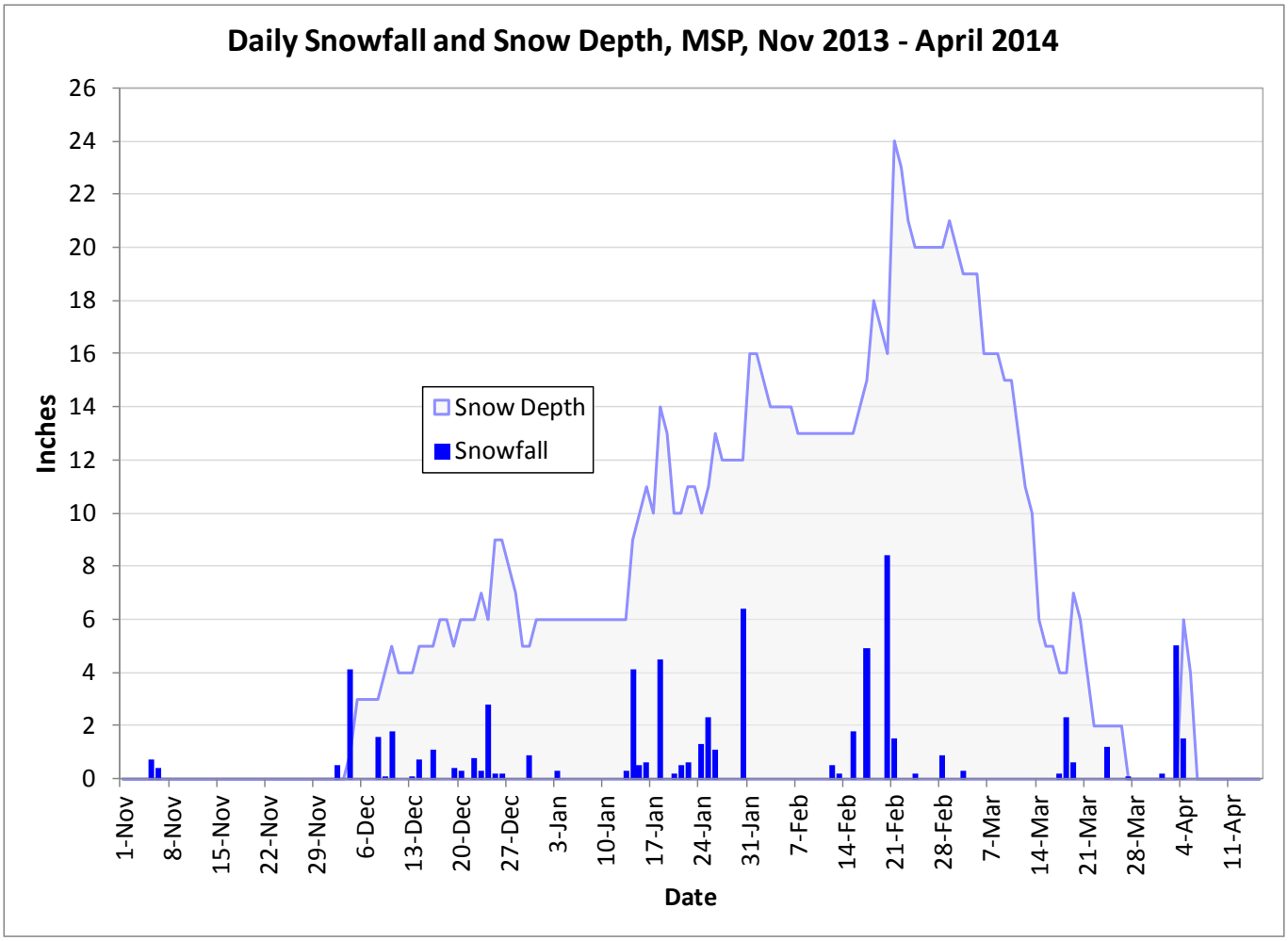

Figure 8. Daily snowfall and total snow depth at MSP during 2013-14 season. Snowpack began with event on December 4th and persisted 112 days until Mar 25th, reaching maximum depth in the wake of the Feb 20-21 blizzard.

February 20-21 Blizzard

Though the season had many notable snowfall events, the highest impact one came on Thursday and Friday February 20-21, when 6-10 inches of snow fell across the region (Fig 9). Though the snowfall itself was not historical, the first several inches that fell had an extremely high water content, making it quite heavy. Moreover, the storm was notable for its intense winds, especially from Thursday evening into Friday morning, when wind gusts exceeded 40 mph across the Twin Cities, and 50 mph in parts of outstate southern Minnesota.[iii]

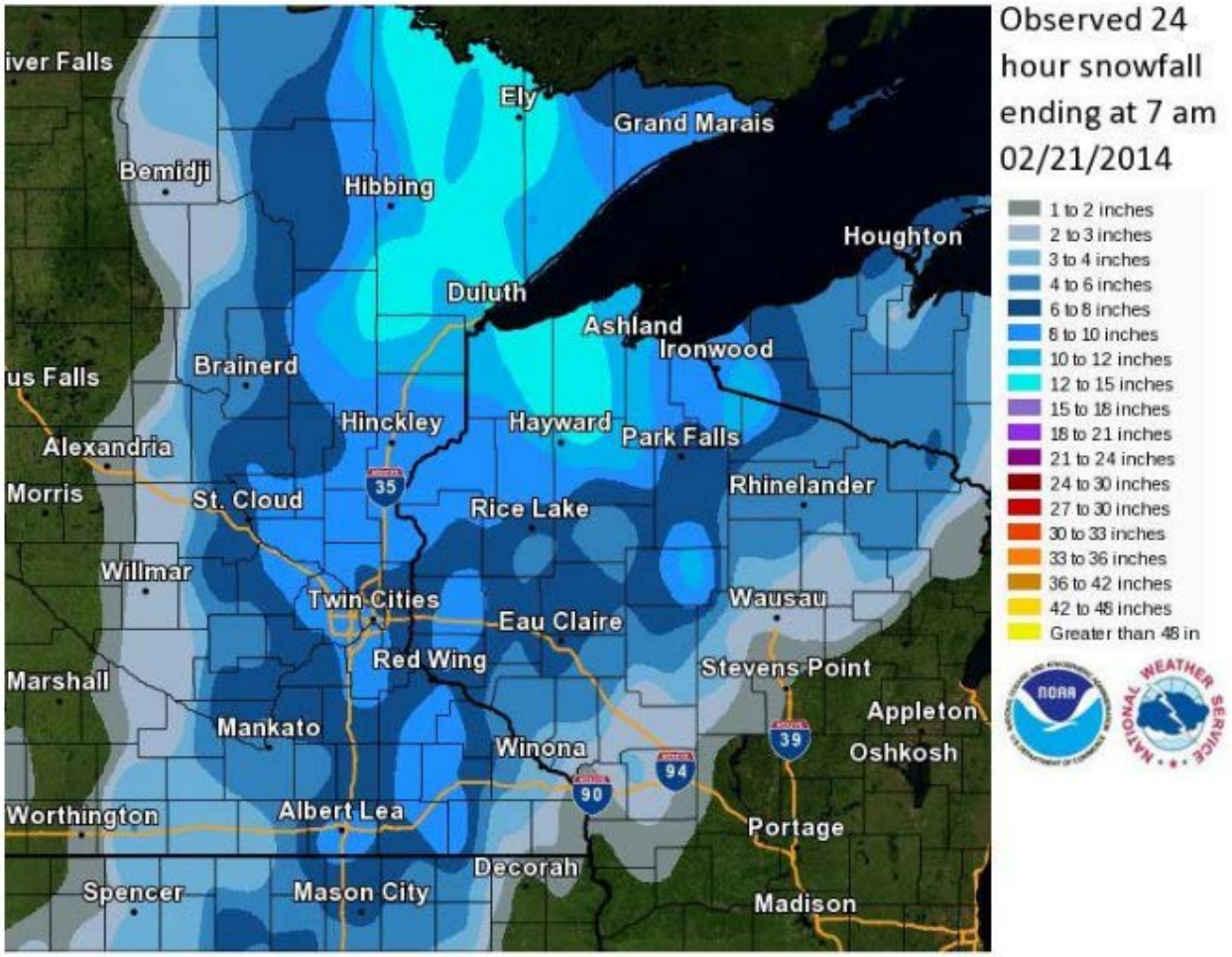

Figure 9. Map of snowfall totals from Feb 20-21 snowfall event. Courtesy of NWS Chanhassen (http://www.crh.noaa.gov/images/mpx/Feb20.2014Snowstorm.pdf)

The impact on the roads was extreme, with road closures common across far southern parts of the state, and in hazardous conditions across the Twin Cities (fig 10). In the Twin Cities area alone, the State Patrol reported 685 crashes, nearly 2000 off-the-road spin-outs, 66 semi trailer jackknives, and 809 stalled vehicles[iv]. Additionally, the sticky wet snow combined with strong winds to knock down tree limbs and occasional powerlines, resulting in nearly 30,000 power outages in Metro-wide.[v]

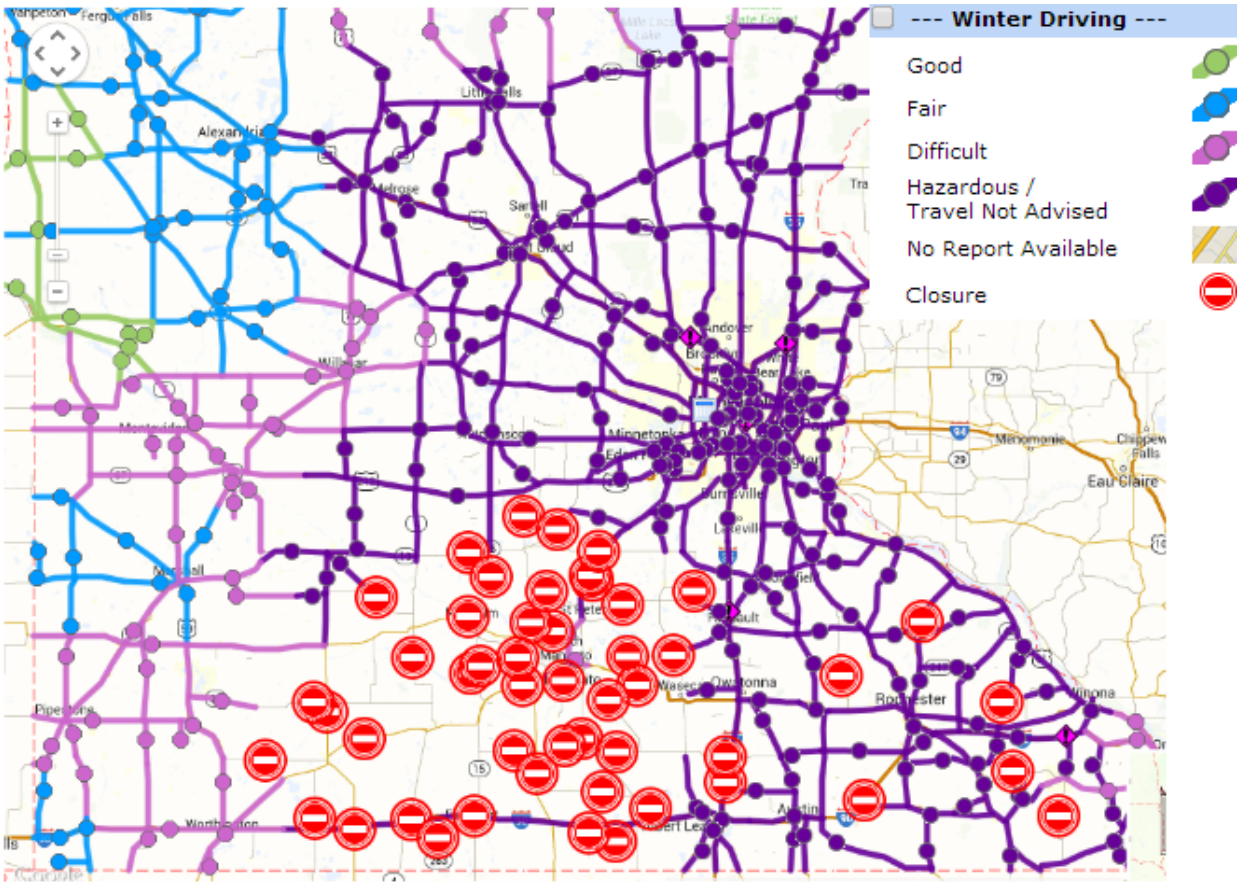

Figure 10. MnDOT map of road conditions at 6 AM Friday Feb 21, hours after snow had stopped falling.

Persistent Impacts and Threats

Aside from the "Polar Vortex" event, the February 20-21 blizzard, and many of the other snowfall, wind and cold events during the winter, there were two other persistent threats and impacts from the long cold winter:

1. Frozen mains, pipes and hydrants
2. Stranded and stalled vehicles from snow, cold or both

Frozen Lines

The intense, persistent cold posed problems not seen in some time in the area, as frost depths reached numerous water mains and other lines. The problem was most noteworthy under roads and other generally cleared surfaces, where the insulating properties of snow were not available to prevent frost from reaching several feet below ground. Public works crews throughout the region noted frost at or below the depths of municipal water lines, sometimes to 8 feet deep.[vi]

The most common impacts were frozen residential lines, though occasionally commercial and municipal facilities were impacted also. Impacts to hydrants did exist but were the exception rather than the rule. Cities commonly offered bottled water to affected residents, and in the worst of cases, residents had to leave their homes.

The impacts of deep frost lines were felt throughout the region, especially where the snowcover was shallower and/or less consistent. While most impacts were significant, they could have been substantially worse. Winnipeg, Manitoba, for example, suffered a frozen pipe emergency of disastrous proportions[vii]. Thousands of residents were without water, prompting significant and widespread sanitation, potable water and housing needs. Indeed, as of June 1, despite having temperatures into the 80s (F), many residents still had frozen pipes.[viii]

Hennepin County Emergency Management asked municipal water utilities and fire departments to provide information regarding their experiences with frozen water lines during the 2013-14 winter. The information is summarized below:

- **Bloomington:** 80 incidents reported, distributed somewhat evenly throughout the city, though one subdivision had five homes impacted, lasting 5 days. The city did not need to provide bottled water and no residents were evacuated. One (1) fire hydrant was frozen and marked out of service along with the water main serving it. The hydrant is privately maintained and the housing complex was able to thaw the main and hydrant which are back in service. Fire protection service freeze-ups also occurred (independent of the service line) at commercial facilities, nursing homes/assisted living centers, and hotels. Typical outages can lasted 4-5 days depending, on when contractor arrival time and whether it is a private or public responsibility.

- **Brooklyn Center**: 47 incidents reported, mostly residential. No bottled water was provided. One resident was temporarily displaced. Service interruptions typically lasted up to six days, and no impacts to fire services were noted.

- **Brooklyn Park**: 63 incidents reported, with 61 residential and 2 commercial. Bottled water was distributed by the fire department. Some residents have had to leave their homes. The typical outage was been solved in one week or less. No fire service impacts were observed.

- **Crystal:** 30 incidents reported throughout the city, with 28 residential customers and 2 commercial impacted. The city supplied temporary water to one residence. No residents had tp leave their homes. The typical service interruption was resolved in 24 hours. No impacts on fire services were noted.

- **Excelsior:** One water line freeze up and 1 sewer line freeze-up. The water line freeze was at a school. The sewer was residential. The service outage was resolved within 2 days. Fire service was not impacted.

- **Golden Valley:** 19 incidents reported, with some being repeat freeze-ups after the city thawed the line. Most cases were spread throughout the city, but one cluster included 4 residents and the water main was suspected of freezing there as well. All impacts were residential customers, though a 120-bed nursing care facility was thought to be at risk.The city provided bottled water to affected residents, some of whom left their homes voluntarily over sanitation concerns. Service outages ranged from 1 to more than 7 days. Fire service impacts were not observed.

- **Hopkins:** 25 incidents reported across the city. Both residential and commercial customers were impacted. The city did not need to provide bottled water and no residents left their homes. The typical service interruption lasted 4 days. No impacts on fire services were reported.

- **Maple Grove:** Four incidents reported to the city, though it is suspected that more were handled strictly through private channels.

- **Plymouth:** 13 incidents reported, all residential. Most impacts were noted in ¾ inch services or shallow depth lines (4.5 to 7 feet). Bottled water was not issued by the city and no residents left their homes. Typical outages lasted 1-2 days, and only two cases have lasted more than a week. No fire service impacts noted.

- **Richfield:** 14 incidents reported, with 12 residential, 1 commercial, and 1 city-owned facility. The city provided bottled water to affected residents, and neighbors often provided them with buckets of water for toilet flushing. Typical outages lasted from 1 to 2 days.

- **Saint Anthony:** No incidents noted

- **Saint Louis Park:** 30 incidents of water line freezing, and 3 sewer line freeze ups were reported, with 2 residential and 1 commercial. Customers were hooked into temporary water services. No residents left their homes. Incidents not thawed on the same day had the temporary service by-pass installed until permanent fixes were made. No impacts to fire services were reported.

- **Hennepin County Medical Center (HCMC):** – no incidents noted.

Vehicular Issues

The long, cold winter, in combination with periodic snowstorms made this the busiest season on record for AAA Minneapolis[ix]. The agency reported over 50,000 calls from December through February, 86% of which were specifically cold-weather related:

- 36% for battery-related difficulties
- 30% for tows
- 10% for flats (more common in cold conditions)
- 10% for extrications

Regionally, it was a busy season for vehicular service calls, with over 100,000 reported by AAA Minnesota-Iowa as well.

Historical Context, Implications and Recommendations

Climatological analysis indicates the 2013-14 winter was the most severe in many years, but far from the most severe on record (9th coldest if using Dec-Feb; 11th if using Nov-Mar). Perhaps most notable was the degree to which the winter stands out from others of its era. Re-examining the Nov-Mar temperatures shows that winters of similar severity were much more common from the 1950s through the1970s, and that even colder ones were common in the early 20th and late 19th centuries (Fig 11). It had been 35 years since the area had seen such a severely cold winter, and an entire generation had never seen anything like

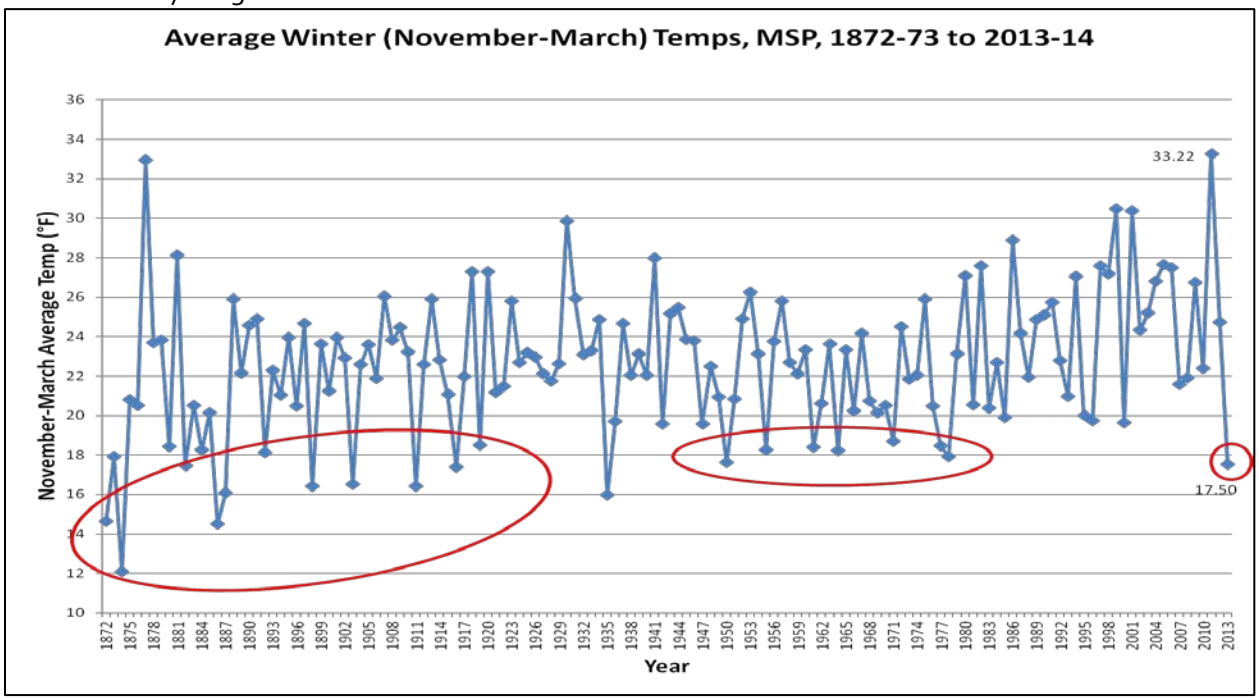

Figure 11. Historical temperatures at MSP, with markings to indicate periods with winters similar to or colder than that of 2013-14.

The Nov-Mar 2013-2014 period was 7.2 degrees (F) colder than the average Nov-Mar temperatures for the most recent 30 winter seasons. That negative difference is larger than the difference between any other Nov-Mar period and *its* previous 30 seasons. It is the largest negative difference on record. In other words, the 2013-14 winter was more unlike its era than any other season in recorded history. It was the most abruptly cold winter on record (Fig 12).

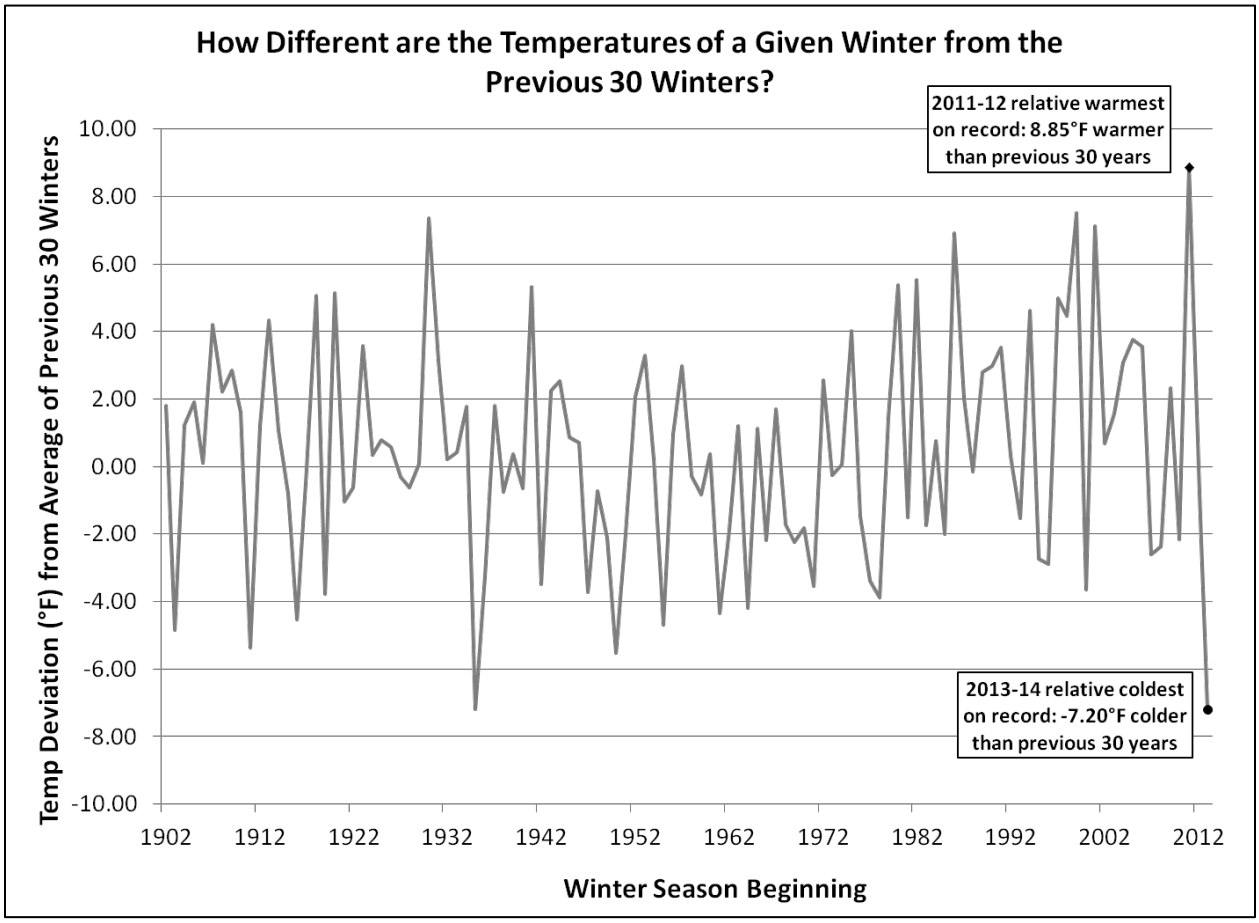

Figure 12.Graph of difference between each winter (Nov-Mar) and the previous 30 winters. Most abruptly-cold was 2013-14, just two seasons after most abruptly warm, 2011-12.

Not only was 2013-14 abruptly cold, but it came just two seasons after the most abruptly-warm winter on record (Fig 12). Thus, determining whether the area is in a warm winter regime or a cold one is nearly impossible, as is guessing at the likelihood of recurrence of a winter like the one from 2013-14.

Winter has warmed faster than any other season in response to climate change. However, the regime that led to the 2013-14 winter established itself during March of 2013, suggesting that the tendency for unusually cold weather may have some persistence. The region is in an exceptionally changeable and extreme pattern; having the most abruptly warm and abruptly cold winters on record only two years apart bears witness to this.

It is therefore recommended that until the evidence is overwhelmingly otherwise, planning should accommodate the expectation of both ends of the extreme—warm, almost snowless winters like 2011-12 should be expected right alongside significantly cold and snowy winter, like that of 2013-14.

References

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[v] *Winter's siege continues with road closures, outages.* Star Tribune, Feb 21, 2014. http://www.startribune.com/local/246487111.html

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[vii] *Winnipeg to declare frozen pipe crisis a disaster. CBC news. Mar 26, 2014.* http://www.cbc.ca/news/canada/manitoba/winnipeg-to-declare-frozen-water-pipe-crisis-a-disaster-1.2587120

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[ix] *AAA Minneapolis reports record winter for service calls.* Star Tribune, April 9, 2014. http://www.startribune.com/local/minneapolis/254644201.html