MDSS Winter Storm Report: 25-27 Jan 2004

Meteorological Summary

Snow began falling in the Ames area at approximately 2050 CST on the evening of 25 January 2004. A winter storm had been advertised for the weekend beginning with forecasts issued mid-week of the prior week. It was originally expected to impact Iowa beginning Saturday evening or early Sunday morning. However, the storm was slower in developing than originally anticipated, and consequently was delayed almost 24 hours.

Precipitation lasted from Sunday evening through early Tuesday morning. During most of the period, snowfall was light. By Monday morning, approximately 2.5 in of snow had fallen at the Ames garage location, based on measurements made by the MDSS lab observer, Brent Shaw. Throughout the day on Monday, snowfall was light and intermittent. A brief period of moderate snow occurred late Monday night, from approximately 2200 CST to sometime after midnight. Final snowfall totals for Ames remain in question as significant blowing and drifting occurred. The National Weather Service (NWS) forecast office in Des Moines showed an official storm total of 7.9 in for Ames (see Fig. 1). At the garage location, snowfall would appear to have been less, perhaps closer to the 4 or 5 in range. Fig. 2 shows photographs taken Tuesday morning after the precipitation had ended. In Fig. 2a, the snow pad below the ultrasonic snow depth instrument (located at the Ames garage) is completely clear of snow due to the wind. Also note the grass showing through the snow, which would lead one to believe snowfall totals were much less than the 8 in reported by the NWS. Fig. 2b shows an embankment on the north side of westbound US Highway 30 (hereafter referred to as US-30) located a few miles east of the Ames garage. Note the large drifts which would lead one to believe this was a significant snowfall event.

Of more significance than the actual snowfall totals were the cold temperatures and high winds. Throughout the duration of the storm, wind speeds were no less than 10-20 mph, and in the 20-30 mph range on the evening of the 26th. For most of the storm, the winds were directly out of the east, parallel to US-30 and perpendicular to I-35. As the surface low centered to the south of the region finally began to move to the ENE, winds in the Ames area began intensifying and backing to the north by late on the afternoon of the 26th and eventually to the northwest by early in the morning of the 27th. Temperatures were in the low to mid 20s (F) during the evening of the 25th and throughout most of the day on the 26th. Beginning the evening of the 26th, they began to plummet into the teens and eventually the single digits (and some negative single digits) with the arrival of an arctic air mass. The cold temperatures and high winds led to a powdery snowfall with significant blowing and drifting, making even light snowfall a factor for road weather in terms of treatment options and visibility reductions.

In terms of forecasting this event, timing of the onset turned out to be the most problematic component of the forecast. On Thursday and Friday, all indications were that precipitation would begin in the greater Des Moines area between midnight and 6 am Sunday morning. This was in contrast to previous forecasts earlier in the week that showed the even impacting Iowa beginning late Sunday afternoon. As such, travel

arrangements were changed so that an observer would be available at the onset of the storm. Additionally, according to Dennis Kroeger (CTRE), the Des Moines garages made a decision to pre-treat the roads on Saturday afternoon in anticipation of precipitation that evening. Unfortunately, the storm was much slower in developing over the Des Moines area, as previously discussed.

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PNSDSM

PUBLIC INFORMATION STATEMENT...UPDATED AMES
NATIONAL WEATHER SERVICE DES MOINES IA
938 PM CDT MON JAN 26 2003

RECENT SNOWFALL REPORTS FROM THIS EVENING

COUNTY	LOCATION	SNOWFALL
EMMET	ESTHERVILLE	9.5"
STORY	STORY CITY	8.5"
POLK	BEAVERDALE	7"
POLK	JOHNSTON	6"
HANCOCK	KANAWHA	4.5"
TAMA	TOLEDO	2"
STORY	AMES	7.9"
BOONE	BOONE	6"
GRUNDY	DIKE	4"
DECATUR	DECATUR	1"
SAC	LAKE VIEW	8.5"
CASS	WALNUT	12"
POLK	URBANDALE	5.5"

Figure 1. Official NWSFO/Des Moines snowfall reports.

During the day on Sunday, the FSL experimental runs of WRF and MM5 were evaluated. They were consistent in forecasting that snow would not begin in the Des Moines area until Sunday evening. They were also quite accurate in depicting the band of snow that occurred all day on Sunday immediately west of the area without impacting the local vicinity (Fig. 3). In particular, the morning runs of the WRF model forecast the onset of the precipitation in the Ames area nearly perfectly, both in time and space (Fig 4), with the snow beginning in Ames around 2050 CST due to some backbuilding development from the east combining with the north-south line of snow moving in slowly from the west. While not directly relevant to this project, the experimental models also nicely forecast the freezing rain event occurring throughout the day on Sunday that impacted Missouri and the Kansas City metropolitan area. In terms of amounts, both MM5 and WRF tended to under-forecast the total snowfall amounts, with 15-h forecast from the 26/0300 UTC (near onset time of storm) showing amounts of slightly less than 2 in falling in Ames, whereas closer 2.5-3 in were observed in this time period. This bias may have been due to the liquid-to-snow conversion algorithm used in post-processing, which assumes a liquid-to-snow ratio based on various parameters. Based on the cold temperatures and type of snow observed (light and powdery), it is possible that the actual liquid-to-snow ratio observed was higher than that used in the forecast model post-processing. In any event, the MDSS forecasts appeared to compensate for this bias, as it consistently forecasted amounts in the 3 in range.

For other sensible weather parameters such as air temperature and wind direction and speed, the models and MDSS performed quite well, as would be expected with strong synoptic-scale forcing. The MDSS also appeared to do a nice job with pavement temperature forecasts, which ranged from the low 20s during the evening of the 25th, warming into the upper 20s during the day on the 26th, and cooling back into the upper teens late on the 26th and early on the 27th.

Figure 2. Weather sensor site at Ames garage (top) and a snow bank along US-30 three miles east of Ames garage. Both pictures were taken around 1000 CST on 27 January.

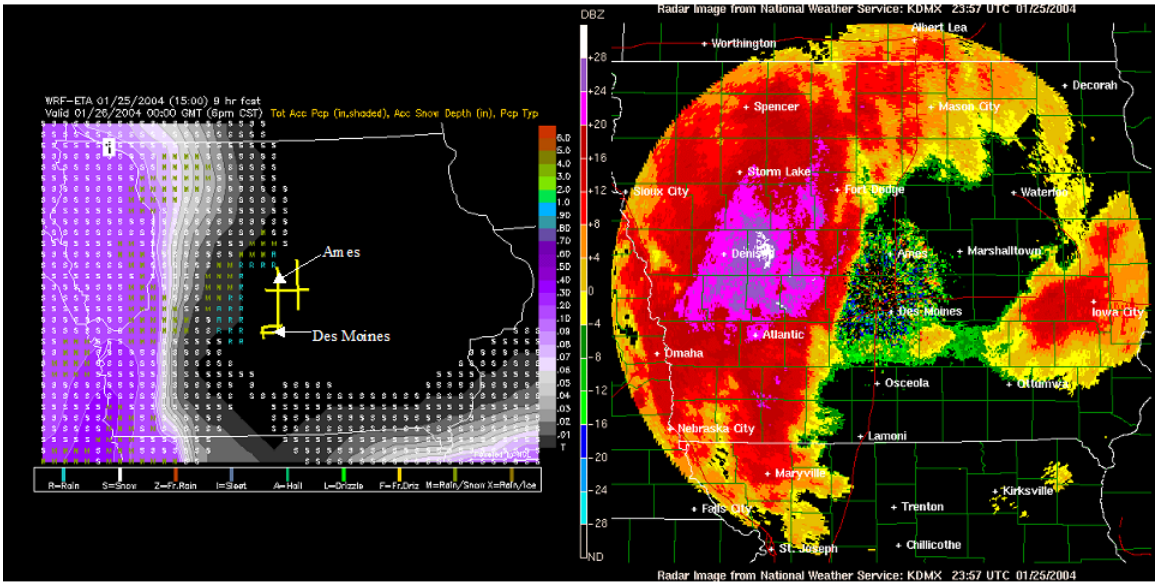

Figure 3. (Left) 9-h forecast valid at 1800 CST, 25 January 2004, of instantaneous precip type and run-total accumulation from the FSL run of the WRF model, showing precipitation remaining to the west and south of Des Moines and Ames. (Right) Des Moines NWS radar image valid at 1757 CST on 25 Jan 2004.

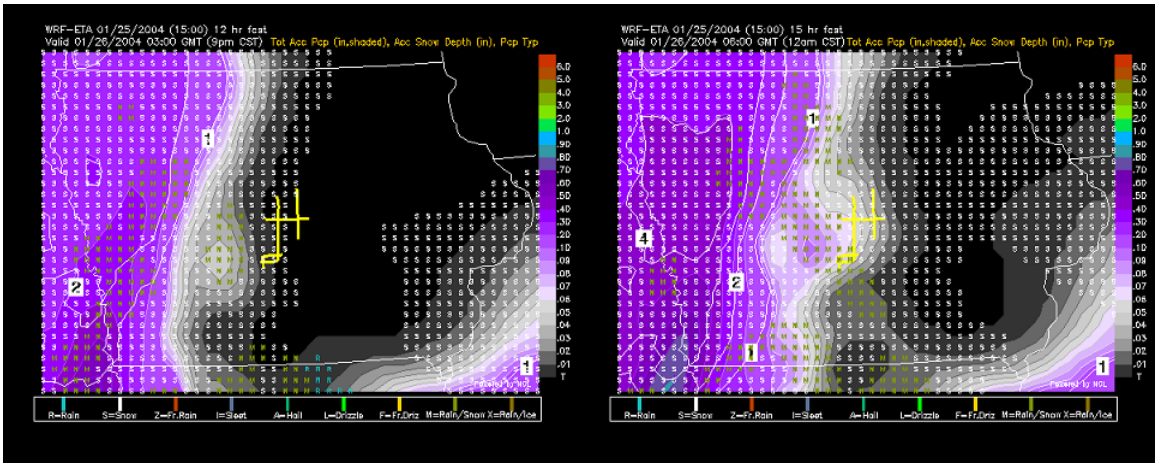

Figure 4. 12 and 15-h forecasts from same WRF run as in Fig. 3, depicting forecast of surface precipitation type and amount valid at 2100 CST on 25 Jan and 0000 CST on 26 Jan, respectively. Note that precipitation began in Ame around 2050 CST as a result of precipitation developing immediately east of the area an backbuilding to the west to merge with the slow eastward advance of the north-south line to the west of the area.

Observer Summary (Brent Shaw, FSL)

Beginning of Storm: 25/2050 CST to 26/0230 CST

I arrived at the Ames garage soon after snow began on Sunday evening, 25 January, at approximately 2110 CST. At this time, very light traces of snow were observed blowing along the surface of US-30 en route to the Ames garage. Upon arriving at the Ames garage, the on-duty supervisor, Lynn Deaton, was out surveying the roads and the office was locked. I returned to the hotel, noting that the snow continued to lightly blow around on the dry surface of US-30. As a note to the other observers, the on-duty Ames supervisor will always have the cell phone with the 290-2105 number, which is listed as Jim Van Sickles number on the Iowa MDSS contact information sheet. I would recommend using this number when checking on the status at the Ames garage outside of normal operations hours.

I returned to the Ames garage at approximately 2300 CST. At this point, snow was still falling. The air temperature was 24F, and winds were out of the east at 10-15 mph. US-30 was still dry with no observed slick spots, but streaks of blowing snow were more prevalent and a dusting of snow was present on grassy areas. Lynn Deaton was contacting staff to come in at midnight to begin operations. Because of the nature of the snow (dry and blowing), Lynn felt that the operations overnight would primarily consist of monitoring conditions and occasional plowing without treatment, but deferred to the oncoming supervisor, Jim Van Sickle.

I decided to ride with Jim on his initial survey, which began at about 2350 CST and lasted until approximately 0200 on the 26th (Monday morning). As we were departing the garage, the snow had increased in intensity and the flakes had become larger. Our first leg was the southbound side of I-35 from US-30 to exit 99. The passing lane of southbound I-35 was already becoming snow covered by this time, with the driving lane and both northbound lanes largely clear. This was due to the snow being blown in a direct cross wind from east to west. Snow on the northbound lanes was being kicked up by traffic and was blowing completely to the grass median. On the southbound side, traffic was remaining primarily in the driving lane. Snow on this side was being kicked up and blown completely off the highway. However, snow blowing from the median into the passing lane was not being kicked up by traffic and as such was rapidly collecting. Because of this, Jim made the decision to increase overnight staffing to commence plowing operations. Pavement temperatures as measured from the GSO truck were around 23F.

Our second leg was northbound I-35 from exit 99 to exit 128 (Story City) and back to US-30. As mentioned earlier, northbound lanes were largely clear with snow blowing from right-to-left across the driving path.

The third leg was UE-30 westbound from I-35 to mile 144 and back. This was the worst leg of the survey, as snowfall was heaviest on the western end of the US-30 leg and because US-30 was parallel to the wind flow, so that snow was not being blown off the road like I-35. Both lanes were starting to become snow covered, but were remaining dry with snow blowing on the surface.

The final leg was from eastbound US-30 from I-35 to Colo and back. While also becoming snow covered, the coverage was less than the western segment of US-30 because of less intense snowfall. Fig. 5 shows a photograph of the US-30 road surface at the US-65 junction near Colo taken during this leg around 0130 CST on the 26th.

Figure 5. US-30 at US-65 junction near Colo at 0130 CST, 26 January 2004.

Upon returning to the garage around 0200 CST, we discussed the operations planned for the rest of the pre-rush hour time frame and reviewed the MDSS forecasts, which were calling for snow to continue with accumulations of around 3 in. MDSS was recommending the use of salt at the rate of 450 lbs/l-mi. However, based on his experience with these dry snows and the current temperatures, Jim felt that only plowing would be the course of action for the night (NOTE: The DoT staff cannot select a "Plow Only" option in the MDSS client. It allows a "Plow and Sand", but Ames rarely, if ever, uses sand). The thinking was that the snow was powdery enough that it would continue to blow off the road due to wind and traffic, and that those areas where it did collect could be cleared by plowing only. The fear of using salt in this situation was based on previous situations where snow that would have otherwise easily blown off the road stuck to the road due to the slight wetting induced by salt application. Thus, the decision was made to plow, with selective treatments applied to trouble spots (e.g., bridges, etc.) at the driver's discretion. Most of the trucks deployed were loaded with a half-load of material.

Figure 6. Snow plow preparing for operations at approximately 0220 CST, 26 January 2004.

After logging some data on the condition of US-30 section in front of the Ames garage and noting weather and pavement conditions, I decided to return to the hotel at approximately 0215 for a 2 hour nap, having been up since 0700 the previous morning. Prior to departing the Ames garage, I shot the nice photo of a snowplow in front of the facility shown in Fig 6, which shows the snow falling and beginning to significantly accumulate. On the drive back to the hotel, I captured the photo in Fig. 7 depicting conditions on US-30 as I approached the exit 146. Note that the US-30 was completely snow covered by this time and was becoming slick.

Figure 7. Photo of US-30 west at exit 146 at approximately 0230 CST, 26 January 2004.

Mid-Storm: 26/0500 CST to 26/1700 CST

I returned to the Ames garage at approximately 0500. Temperature at this time was 18F, winds were ENE at 12 mph, and the pavement temperature was 20 F. US-30 from exit 146 to the garage were 100% snow-covered and with intermittent slick spots. I began reviewing the latest MDSS forecasts and recommendations. MDSS was still predicting snow to continue throughout the day, with a short break from late morning into early afternoon, continuing again throughout the evening with a total accumulation of around 3 in for the US-30 segment. Recommended treatment was still 450 lbs/l-mi, but at this point, DoT staff were still primarily plowing without treatment, except for bridges, overpasses, and other trouble spots.

Shortly after I arrived, the Ames garage supervisor, Paul Durham, arrived to take over the morning shift. I boarded his truck and rode with him for his assessment from 0510 until approximately 0700 CST. We drove I-35 south and north, followed by US-30 west and east. Occasional slick spots were encountered during Paul's aggressive testing, but by and large the snow was dry and blowing around. My discussions with Paul led to some significant insights. This was a particularly difficult situation with no clear-cut solution regarding whether or not to treat the roads. Treating with salt could cause the problem described earlier where otherwise dry/blowing snow becomes a bit stick and begins to stick to the road. Not treating could lead to problems due to warming of the pavement from rush-hour traffic, thereby causing the snow to stick without any additional

treatment to continue the melting. Complicating matters was that this was a Monday morning, meaning a higher volume of traffic than one would expect on a weekend. **Treatment strategy for these tricky situations can be driven largely by the expected traffic volume, something not accounted for in the current MDSS treatment recommendations.** Ultimately, Paul decided to continue plowing and selective treating on I-35. Because of the greater snow coverage on US-30, he decided to do one treatment of US-30 with 400 lbs/l-mi of salt, beginning at 0600 CST. Note that a series of road and weather conditions for the portion of US-30 in front of the Ames garage for the periods spanning the treatment is contained later in this document. Upon returning to the garage around 0715, I made a snow measurement in the far parking lot of approximately 2.5 in of accumulation.

From 0740 to 0845, I decided to make another independent run over US-30 to observe conditions, since this was our route of focus and was also undergoing treatment. By this time, the air temperature at was 19F, pavement temperature was 20F, and winds were ENE10-15. Additionally, increased traffic volume was evident, with fairly consistent westbound traffic noted east of I-35. Much less traffic was noted for the eastbound lanes, as you would expect with morning influx of people from rural areas into Ames. Eastbound lanes were around 80% covered in the driving lane, and 100% covered in the passing lane. Westbound lanes were a bit better, with about 70% coverage in both lanes, presumably due to the higher traffic volume combining with the treatment to reduce the snow cover.

From 1000-1200 CST, I rode aboard the left-wing snowplow assigned to cover US-30. During that period, we covered most of the US-30 segment twice. From 1000-1030, we went east from the garage to exit 144, plowing the left shoulder and treating bridges and elevated lanes with approximately 400 lbs/l-mi of salt. Driving lane was generally 80-90% covered, and the passing lane was nearly 100% covered. From 1030-1100 we covered the portion from the garage out to Colo and back. Some minor indications of wetting from the previous treatment were visible. Finally, by the time we returned to the garage and headed west toward Ames again (approximately 1100 CST), US-30 was becoming mostly wet and slushy. Pavement temps measures on board the plow were running 24-26F with an air temperature of 18 F. As forecast by the morning MDSS, snow tapered off during the late morning and early afternoon. Figure 8 shows conditions at approximately 1145 CST along US-30 as taken from the plow.

After taking a break for lunch, Dennis Kroeger and I performed some additional data collection activities. Dennis collected tapes from the traffic monitors and we attempted to take 3 brine samples using the tares provided by CCREL. Unfortunately, temperatures continued to fall and snow began to increase again, so areas that had been wet earlier were once again becoming snow covered, and we abandoned the collection of brine samples. Fig. 9 shows some pictures taken during this period of conditions.

Figure 8. View from plow on eastbound US-30 east of the Ames garage. Note wetting of road as a result of prior treatments, despite an 18 F air temperature.

Figure 9. A variety of photos taken along or by US-30 from 1500-1600 CST, Monday 26 January, while collecting data. Snowfall was on the increase again as temperatures continued to fall into the teens. Center picture is on the State Avenue bridge at the autoscope site overlooking US-30. Lower-left is the view of US-30 toward the east from the autoscope site.

End of Storm: 26/2145 CST-27/0100 CST

After catching another 2 h snooze at the hotel to regain some sense of coherency, I returned to the Ames garage at 2145 CST Monday evening. Jim Van Sickle was on duty again. I reviewed current radar imagery, model output, and MDSS forecasts. It appeared there would be one more burst of moderate snow, but that the precipitation would end by early Tuesday morning. As such, operations were beginning to focus on the blowing and drifting aspect, as winds continued to strengthen. At 2145, winds were NW15G25, temperature was 17F, and the pavement temperature was 18F. With such cold temperatures and wind, the operational strategy shifted back to plowing without treatment.

I rode with Jim from 2200 until 0015, covering I-35, US-65, and US-30. Roads appeared to be better than they actually were. Driving lanes appeared to be mostly clear of snow except for occasional drifts, but the wheel tracks were becoming glazed. The hope is that the wind and colder temperatures would help dry those spots out. Generally, the driving lanes were more clear than the passing lanes. However, leaving some snow on the road (impossible not to do with continuous blowing) can actually serve to make drivers more aware of slick conditions rather than becoming complacent and careless in the driving lane where wheel tracks were deceivingly slick. Thus, the decision to stick with plowing only seemed to be effective. This strategy continued throughout the night, and by 0900 CST Tuesday, most state routes were dry and declared "winter normal." Temperatures by Tuesday morning were 0F under sunny skies and 25 mph NW winds.

Data Collection

List of Data Collected

a. Autoscope tapes of US-30 westbound lanes from the State Avenue bridge for most of the daylight hours on Monday, 26 January (D. Kroeger).

b. Data cards from the GPS-equipped snow plows for Ames and Des Moines garages (D. Kroeger).

c. Garage logs (TBD, D. Kroeger).

d. Three glass wool road salt samples for CCREL. Only one of the three was placed in a wet enough spot to get a significant sample. The first two may not have enough usable brine to be of value. Because temperatures were so cold, it became too difficult to find safe locations where the pavement was wet for collecting the samples. Additional guidance from CCREL needs to be obtained on sampling methodology, etc. as no instructions were included in the box. (B. Shaw)

e. Numerous digital photos of road conditions, etc. taken throughout the period (B. Shaw).

f. Observer notes from Brent and Dennis (provided separately).

g. Manual observations of US-30 conditions in front of garage from beginning of event through the treatment phase, summarized in the table below. Note that pavement temperatures were estimated based on Ames RWIS site and temporal interpolation of temperatures measured from the truck sensors.

Table 1. Road and weather conditions for US-30 in front of Ames garage.

Day/Time (CST)	Air Temp (F)	Surf. Temp. (F)	Wind (deg/mph)	Treatment (lbs/lane-mile)	Snow/ice Coverage
25/2200	23	21	090/10	None	<10%
25/2300	23	21	090/10	None	<10%
26/0200	23	20	090/10	None	90-100%
26/0500	18	20	070/12	None	100%
26/0600	18	20	090/10-15	400	100%
26/0700	17	20	070/15	No addl.	100%
26/0800	18	22	060/15	No addl.	60-80% (Less on westbound)
26/0845	18	23	060/10	No addl.	50-70% (Less on westbound)

Summary and Conclusions

This was an interesting case because of three factors: (1) cold temperatures, (2) high winds, and (3) time of occurrence. These three factors made the operational treatment decision difficult, and no "blanket" solution was applied across all routes. From my limited experience on this project, it would seem like time of day and whether or not the day is a "work" day (i.e., not a holiday or weekend) may need to be considered in an MDSS solution, since it is clear that increased traffic will increase pavement temperatures. Because there was not a single mandated strategy for all routes, collecting data on amounts and locations of treatment application was virtually impossible. Data collected from the on-board system will be critical to post-analysis work, as amounts and locations were highly variable and somewhat at the discretion of the experienced snow plow drivers and the supervisor in the field. Finally, in the case of blowing snow (high winds), crosswind component appears to be an important factor. In this case, US-30 was treated because the winds were parallel to the highway and unable to blow the snow off the surface. On the other hand, I-35 experienced direct crosswind components, so the primary maintenance strategy was to plow and allow traffic and wind to kick the snow

off the pavement. Thus, another enhancement to MDSS would be to consider crosswind component on a route by route basis to determine the impact of blowing snow.