Evaluation of Model Guidance and Verification of a High Impact Event in Central Montana on 22 January 2008

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1. Introduction

A rapidly developing storm system produced local blizzard conditions over portions of central Montana on 22 January 2008. The public was adversely affected by this storm as roads were closed in the Great Falls area. Several accidents were reported due to slippery road conditions. As the system moved southward from Canada, forecast model guidance was somewhat divergent on a solution, but it appeared that the primary effects would be felt from the Havre to Lewistown areas, east of Great Falls. A Snow and Blowing Snow Advisory was issued early in the morning of 22 January for Blaine, Chouteau, Judith Basin and Fergus Counties. See Figure 1 for reference counties and cities in this paper.

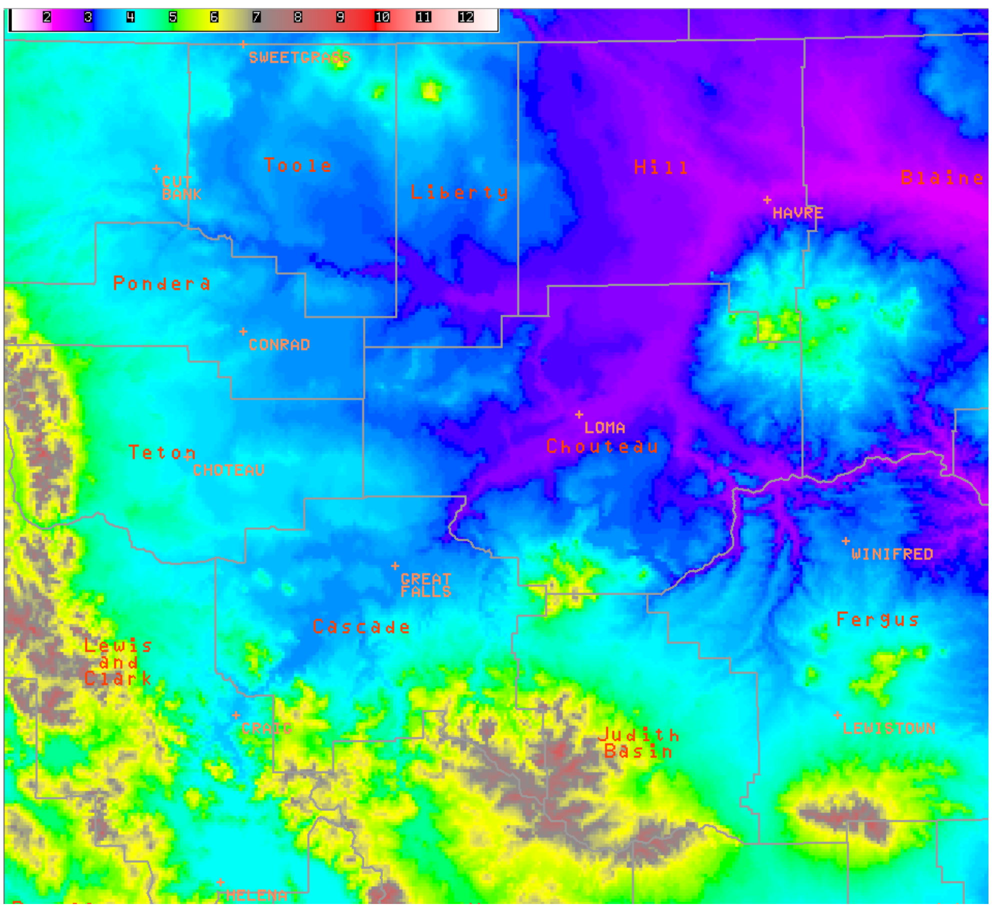

Figure 1. Area map showing county locations, county names and places mentioned in this paper. Colored background is the elevation image.

2. Discussion

Low pressure over Saskatchewan early Tuesday (22 Jan 2008) morning (Fig. 2) was expected to move into northeastern Montana as an upper level disturbance moved south through the region. The surface pressure gradient between the Saskatchewan low and high pressure over southwest Montana was expected to produce gusty westerly winds over north central Montana with blowing and drifting snow. Because of the position of the low, the heaviest snowfall and greatest chance of reduced visibility due to blowing and drifting snow was expected to be across Blaine, Chouteau, Judith Basin and Fergus counties, northeast and east of Great Falls. Snow and Blowing Snow Advisories were issued for these areas as a result.

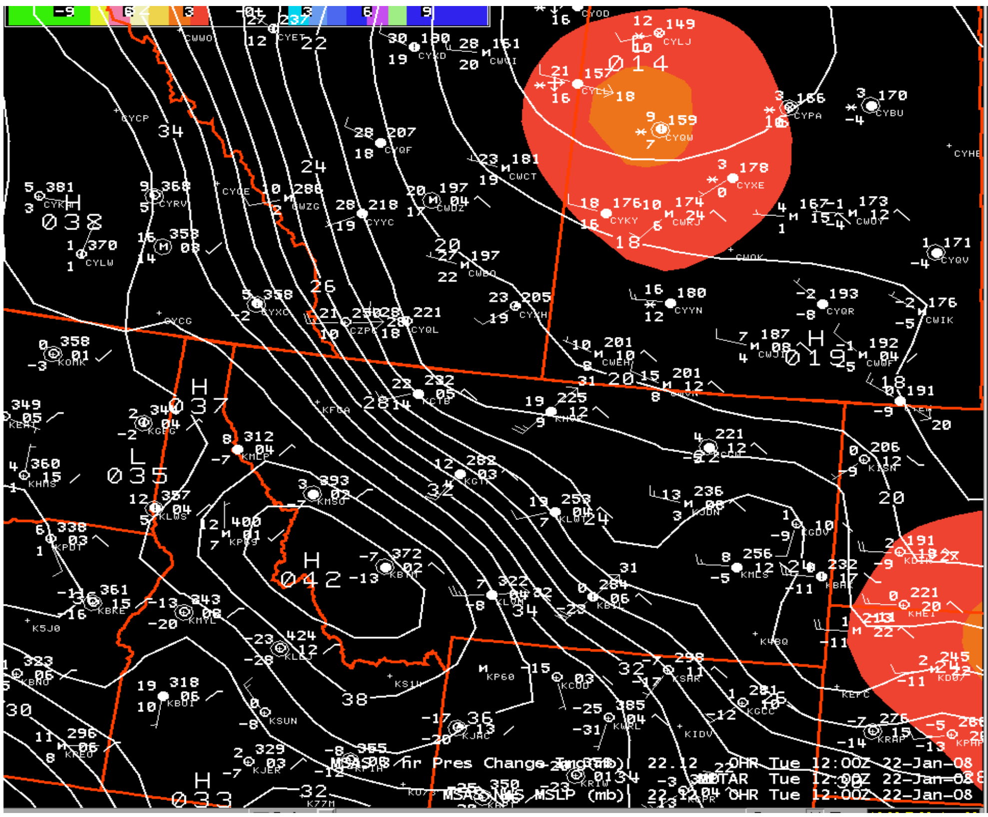

Figure 2. Surface map from 2008 January 22 at 1200 UTC. Surface isobars (white lines) and pressure systems are depicted. Colored areas indicated 3-hourly pressure rises/falls, as indicated by the scale in the upper left of the image. Station model is conventional depiction.

The surface low progressed southeastward during the morning hours on 22 January (Fig. 3). Though the low did not deepen, high pressure over Wyoming intensified slightly and remained over northwestern Wyoming. This caused an increase in the pressure gradient across north central Montana. Additionally, model guidance showed an upper level vorticity maximum associated with a disturbance moving southward through the flow. Though the 0600 UTC run of the Rapid Update Cycle (RUC) depicted the wave and associated vorticity area the best, the Global Forecast System Model (GFS40) also forecast a vorticity center and precipitation moving into north central Montana by 1800 UTC, as shown in Figure 4. The GFS40 also captured the extent of the expected precipitation (Fig. 4). Other short-term model guidance, such as the Short Range Ensemble Forecast (SREF) (not shown) also forecast the areal extent of the precipitation and movement of the surface low well. Figure 5 shows the radar images from near 1800 UTC. Snow had moved into almost all of north central Montana. The heaviest snow was falling over the areas included in the Snow and Blowing Snow Advisory (Chouteau County), northeast of Great Falls. Snow had moved into the Great Falls area around 1700 UTC, with gusty winds, snow, and visibilities less than one mile reported by 1800 UTC (shown in Table 1).

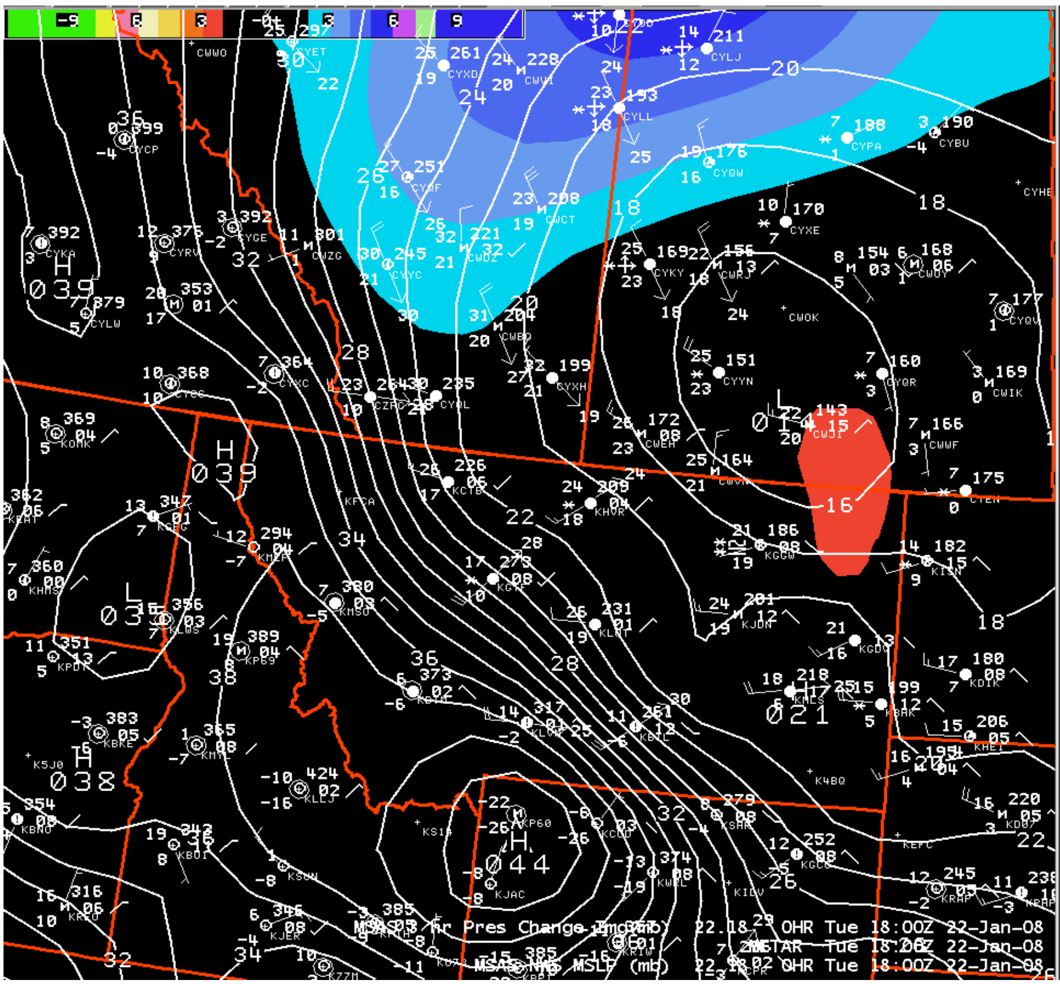

Figure 3. Surface map from 2008 January 22 at 1800 UTC. As in Figure 2.

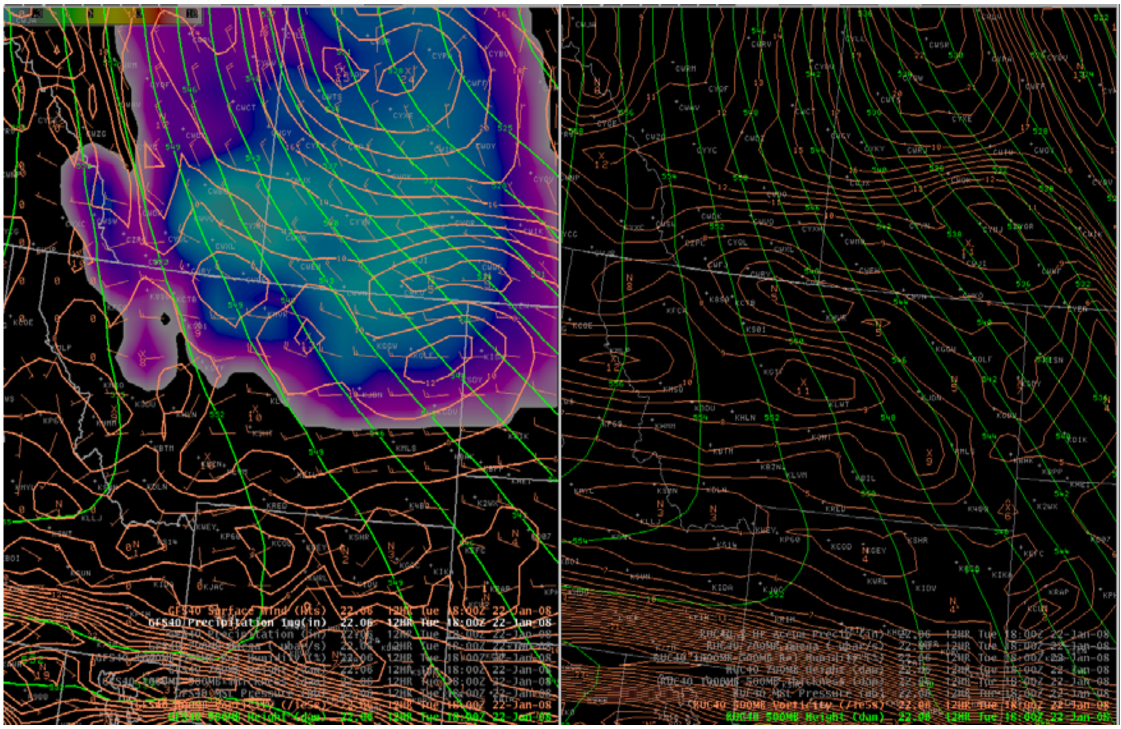

Figure 4. GFS40 (left) and RUC (right) showing 12h forecast 500 mb and vorticity patterns valid at 1800 UTC 2008 January 22. The colored area on the GFS40 image is the forecast 12h precipitation.

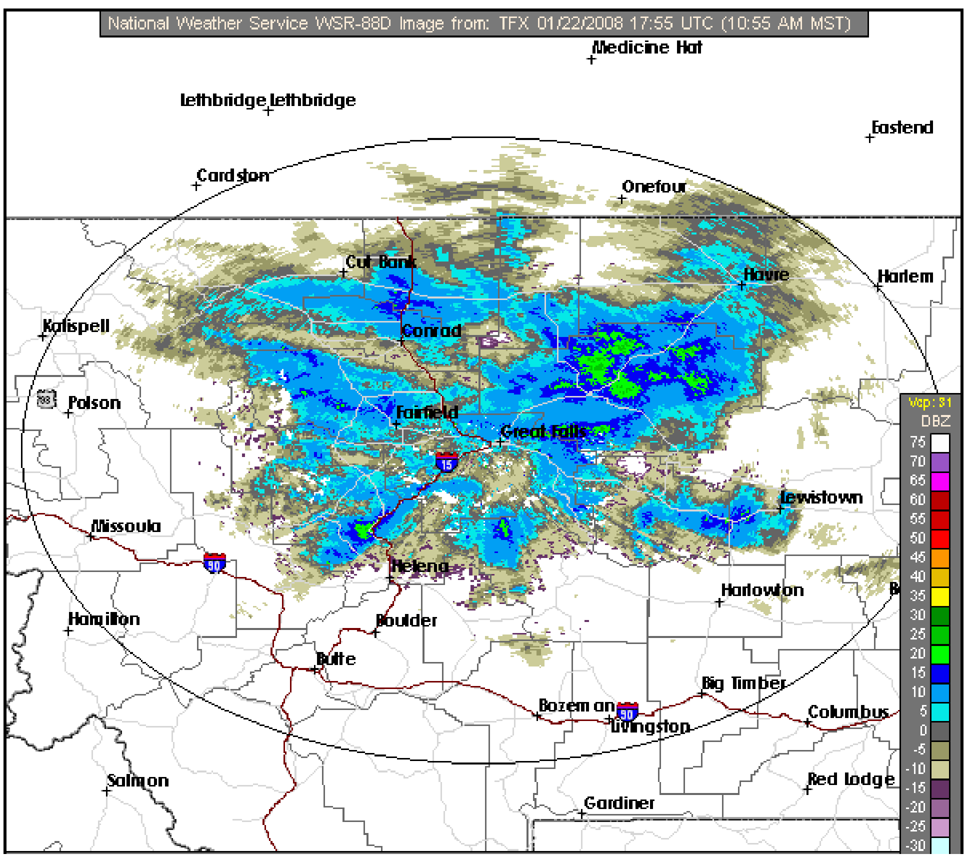

Figure 5. KTFX Weather Surveillance Radar (WSR)-88D Base reflectivity radar image from 1755 UTC 2008 January 22.

In the late morning, the areas of snow and blowing snow continued to expand with lowering visibilities, so Cascade and northern Lewis and Clark Counties were added to the Snow and Blowing Snow Advisory around 1800 UTC. From 1900 through 2200 UTC, visibility was less than one mile at Great Falls (Table 1). Gusty winds contributed in reducing the visibility by blowing the snow. The radar image from 2000 UTC showed the coverage of snow continuing to expand across central and north central Montana (Fig. 6). The back edge of the snow was aligned with the surface trough just moving across the international border (Fig. 7).

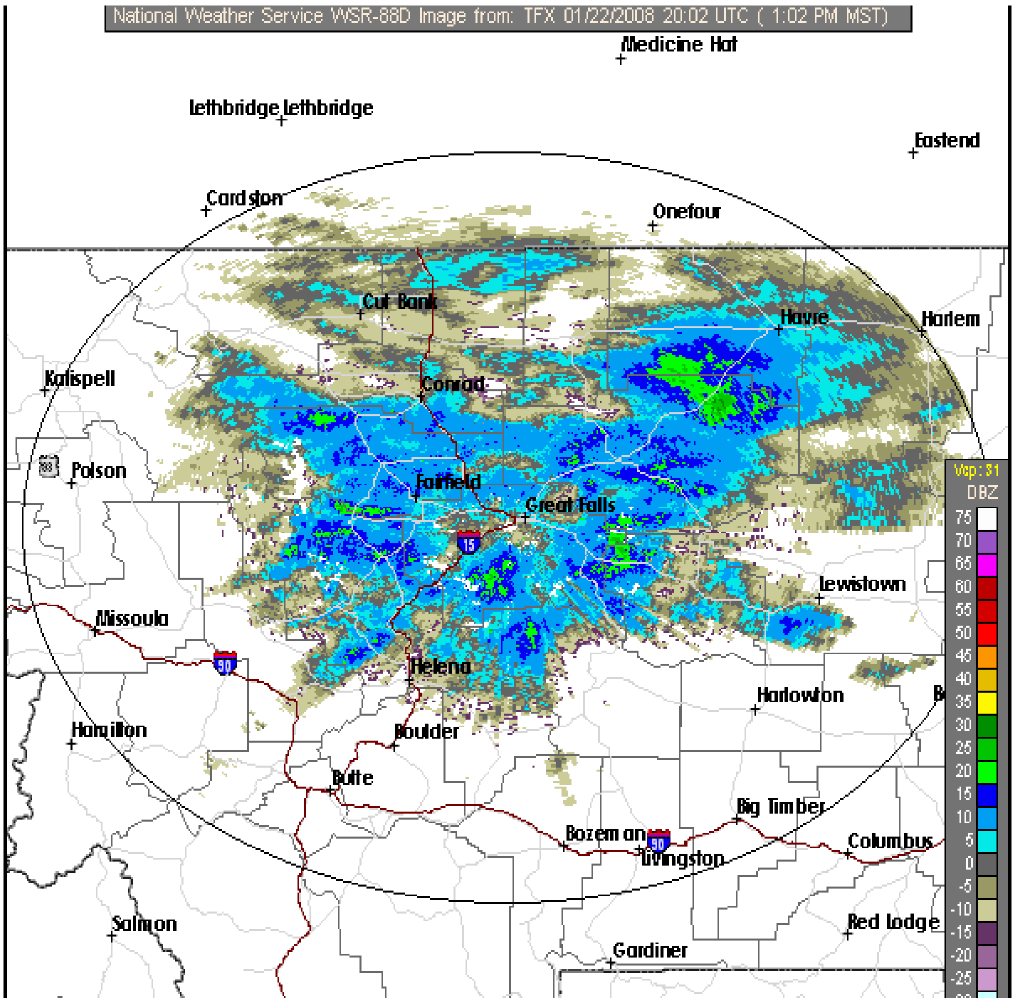

Figure 6. KTFX WSR-88D Base reflectivity radar image from 2002 UTC 2008 January 22.

Snow continued to fall at moderate to heavy rates during the afternoon. It greatly affected the evening commute by reducing visibility and causing icy roads. In retrospect, the GFS40 and MOSGuide (GFS Gridded Model Output Statistics Guidance) products gave the best forecast guidance (Fig. 8). Though they both underplayed the probability of precipitation over Cascade and Lewis and Clark Counties, both forms of guidance best captured the event by showing higher probabilities of precipitation with the broadest coverage. This was likely due to the fact that the upper level support associated with this

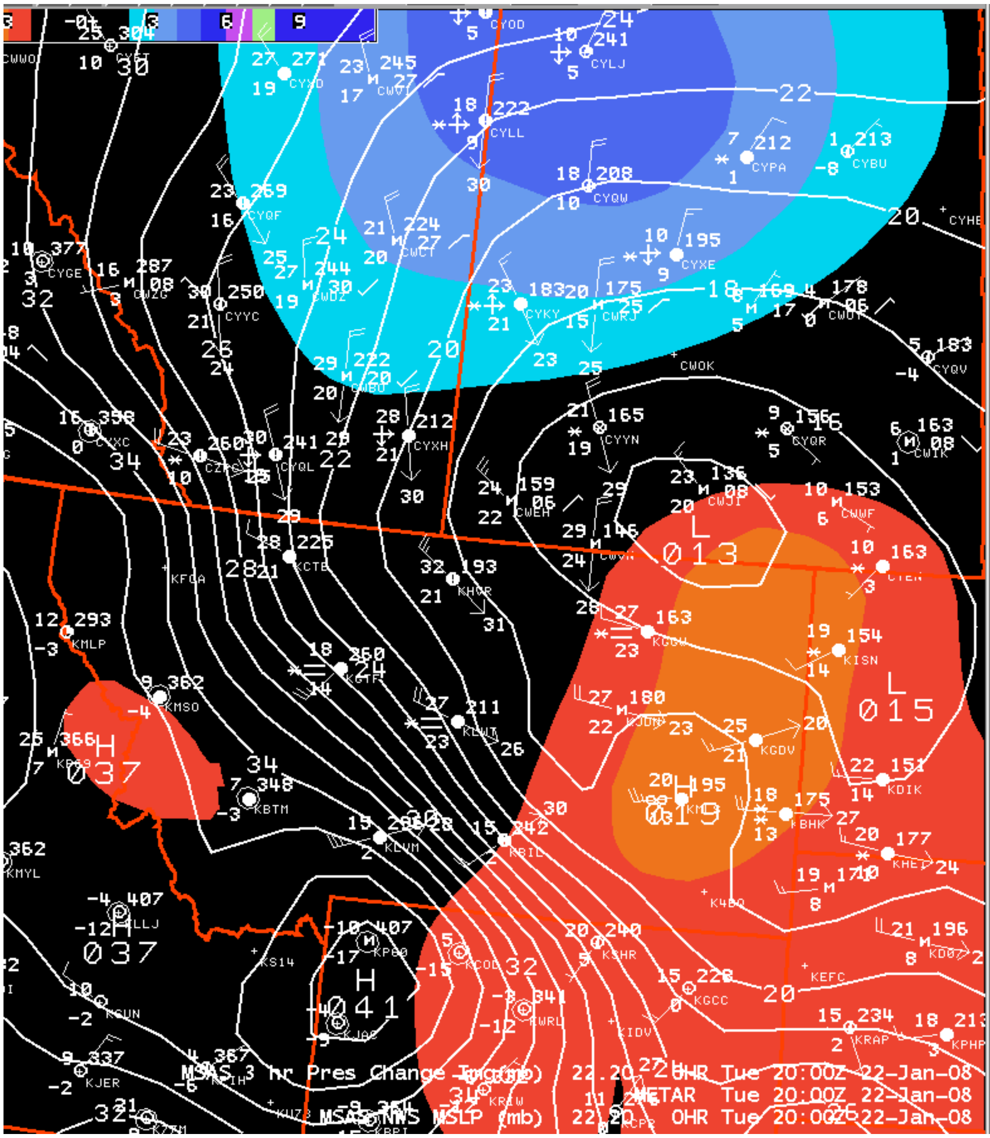

Figure 7. Surface map from 2008 January 22 at 2000 UTC. As in Figure 2.

storm was better handled by the GFS40. This better guidance can also be illustrated by a value histogram of the probability of precipitation (PoP) (Fig. 10). Again, the official forecast most closely resembled the stronger solution offered by GFS40, but with higher probabilities. Other models, such as the North American Mesoscale Model (NAM) and the European Center for Medium range Weather Forecasting (ECMWF), were also reviewed on the Western Region Quantitative Precipitation Forecasting (QPF) Verification Application webpage. Here too, the GFS40 showed the better performance, compared with what actually occurred. Figure 9 shows the official forecast for the period. The WFO TFX forecasters increased the probability of precipitation to the 50 to 60 percent range and higher in the areas that were under the Snow and Blowing Snow Advisory. Though the PoP grids were unavailable, the grids were updated later in the morning so that the advised area had 70 to 80 percent PoPs.

The storm system continued to progress through the area during the late afternoon of 22 January. The satellite image clearly showed the back edge of the snow (Fig. 11). During this time, snowfall intensity decreased across Chouteau and Blaine Counties, so that at the regular afternoon forecast issuance, the Snow and Blowing Snow Advisories were cancelled for these areas. Table 1 shows the improvement in visibility and wind speeds as the system moved through the Great Falls area. Conditions rapidly improved as the edge of the system passed through shortly after 0000 UTC 23 January 2008.

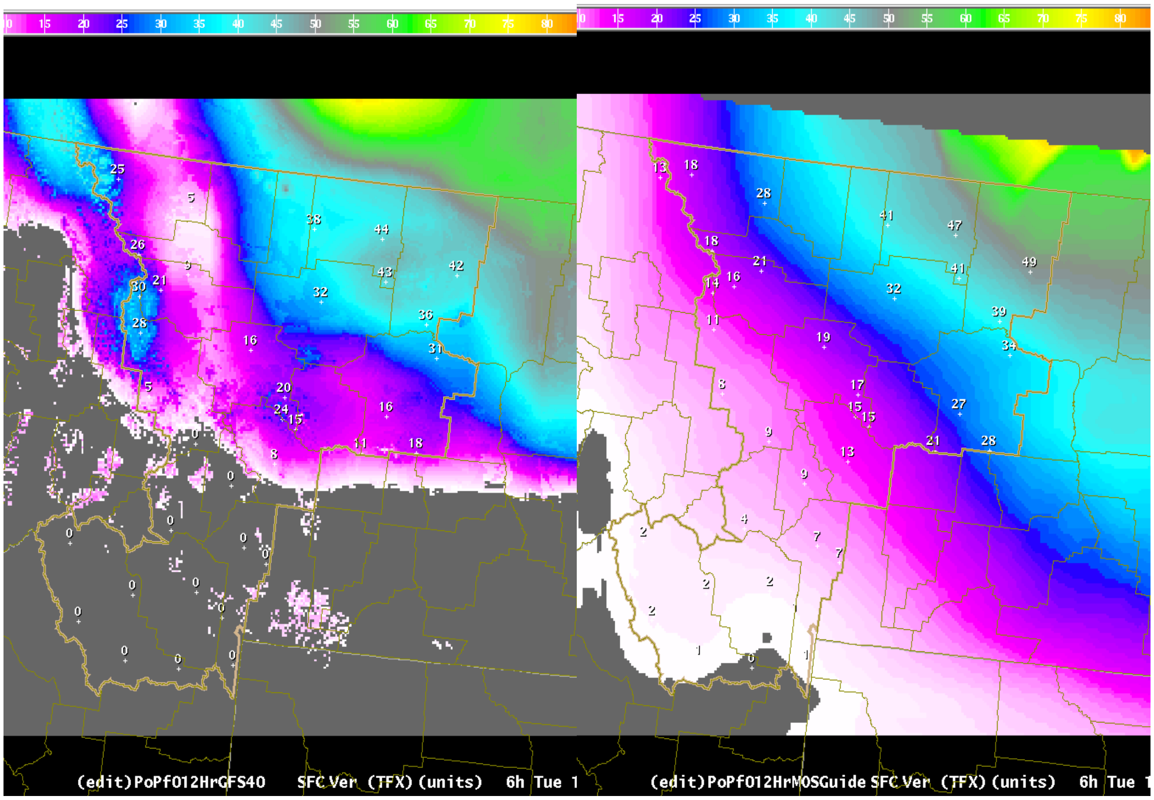

Figure 8. GFS40 (left) and MOSGuide (right) 12h probability of precipitation forecasts for the 6h period 1800-2400 UTC 22 January 2008.

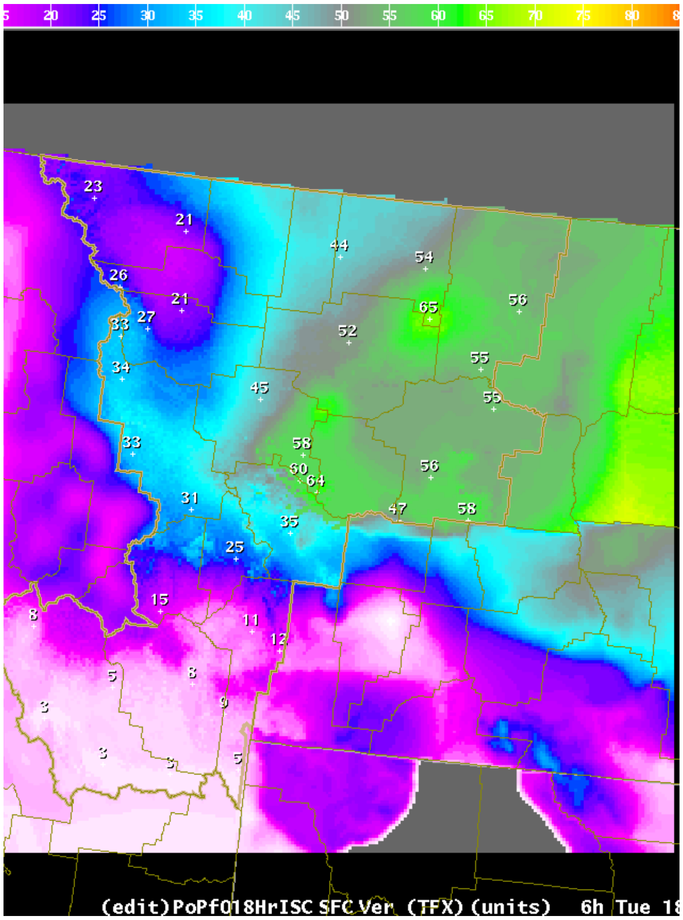

Figure 9. TFX 18h probability of precipitation forecast for the 6h period 1800-2400 UTC 22 January 2008.

Table 1. Observations at Great Falls from 1053 am to 502 pm MST on January 22 2008. Temperature (T, Td) in Fahrenheit; Wind speed (W spd) in miles per hour; Visibility (Vis) in statute miles; Sky condition values in hundreds of feet; Altimeter in inches of mercury; precipitation in inches.

Time	T	Td	W dir	W spd	Vis	Weather	Sky condition	Altimeter	6-hr precip
22 Jan 5:13 pm	25	19	WNW	15	9.00		FEW014 SCT021 OVC032	30.16	
22 Jan 5:02 pm	23	19	WNW	16G28	5.00	-SN BR	SCT012 BKN019 OVC028	30.15	
22 Jan 4:53 pm	23	21	W	16	1.00	-SN BR	BKN012 OVC019	30.15	0.08
22 Jan 4:46 pm	23	21	W	14	1.00	-SN BR	FEW007 OVC012	30.14	
22 Jan 4:11 pm	19	18	SW	9	0.50	SN FZFG	SCT003 OVC010	30.12	
22 Jan 3:53 pm	20	18	SW	13	0.25	SN FZFG	VV004	30.12	
22 Jan 3:23 pm	19	18	SW	16	0.25	SN FZFG	VV004	30.11	
22 Jan 3:16 pm	19	18	SW	16	0.25	SN FZFG	BKN005 OVC015	30.10	
22 Jan 2:53 pm	20	17	SSW	18	0.75	-SN BR	BKN007 OVC015	30.07	
22 Jan 2:27 pm	19	16	SSW	21	0.75	-SN BR	BKN009 OVC017	30.07	
22 Jan 2:22 pm	19	16	SSW	20	1.00	-SN BR	BKN011 OVC017	30.07	
22 Jan 2:07 pm	19	16	SSW	18	0.75	-SN BR	BKN011 OVC017	30.07	
22 Jan 1:53 pm	19	16	SSW	22	1.00	-SN BR	BKN013 BKN018 OVC024	30.08	
22 Jan 1:26 pm	19	14	SW	24	1.25	-SN	FEW016 OVC028	30.08	
22 Jan 1:18 pm	18	14	SW	25G32	1.50	-SN BR	FEW028 BKN040 OVC049	30.08	
22 Jan 1:06 pm	18	14	SW	24	2.00	-SN BR	FEW026 BKN036 OVC050	30.08	
22 Jan 12:53 pm	18	14	SW	28	1.00	-SN BR	FEW012 BKN021 OVC046	30.08	
22 Jan 12:48 pm	18	14	SSW	28	1.00	-SN BR	BKN015 OVC022	30.08	
22 Jan 12:34 pm	18	14	SW	29G36	0.50	SN FZFG	BKN012 OVC018	30.09	
22 Jan 11:53 am	17	12	SW	29G36	1.25	-SN	BKN013 OVC020	30.09	
22 Jan 11:39 am	18	12	SSW	26G32	1.50	-SN	BKN013 OVC020	30.10	
22 Jan 11:21 am	18	10	SSW	26	1.25	-SN	OVC020	30.10	
22 Jan 11:02 am	18	10	SW	28	1.50	-SN	OVC020	30.11	
22 Jan 10:53 am	17	10	SW	25G32	2.00	-SN	OVC022	30.11	

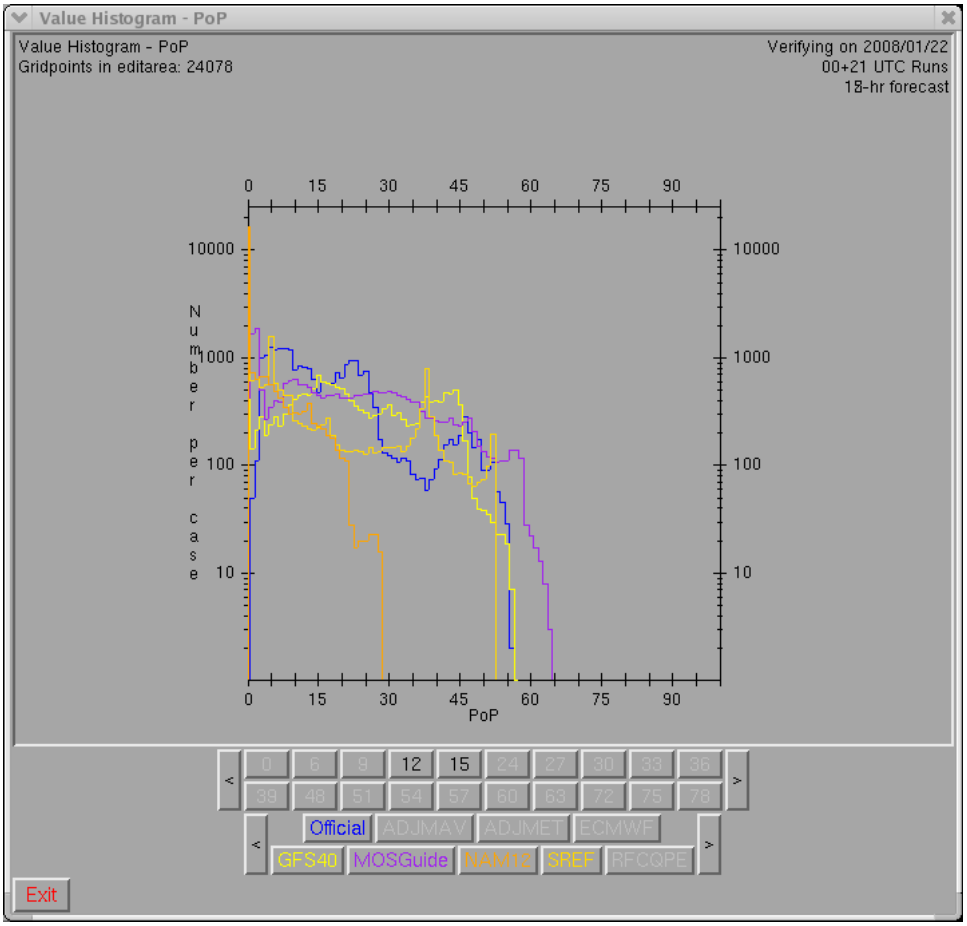

Figure 10. Value histogram of the probability of precipitation. The MOSGuidance (magenta), SREF (burnt yellow) and GFS40 (bright yellow) were all very close in their solution to the probability of precipitation. They were also very close to the official forecast for the period (12h forecast).

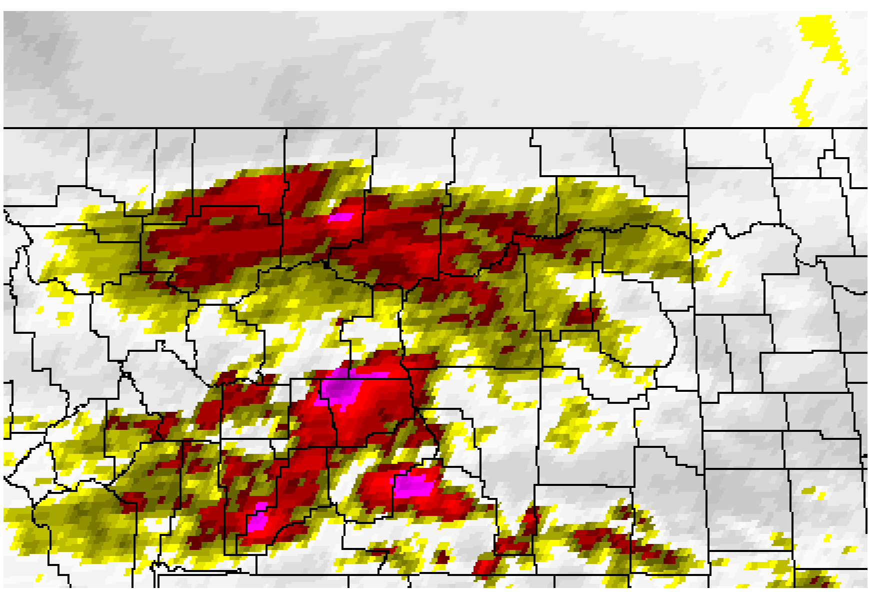

Figure 11. GOES Infrared Satellite image from 22 January 2008 at 2130 UTC.

3. Conclusions

This high impact case was not handled well by some of the available numerical weather prediction models, including the NAM and ECMWF. The GFS40, and SREF to a lesser degree, did the best job with this rapidly developing and moving system. In spite of the divergence in guidance, forecasters did a good job in outlining the initial area for inclement conditions by issuing a Snow and Blowing Snow Advisory on the midnight shift. The main storm affects and precipitation occurred more to the west than forecast by the GFS40. Snow already on the ground, plus any additional would be easily blown by gusty winds ahead of, and accompanying, the system. Forecasters did anticipate this; however, because the system did become more intense, conditions were worse and further to the west of the initial Snow and Blowing Snow Advisory. This evaluation also showed that the RUC was more correct in its placement and intensity of the upper level dynamics. However, the RUC did not depict such widespread precipitation (not shown) as the GFS40. As such, the GFS40 handled this system the best from a precipitation probability verification standpoint, but not in placement.

Based on the forecast issued early in the morning on 22 January 2008, it appeared as if the Great Falls National Weather Service forecasters were influenced by the better model output, and forecast high precipitation probabilities in the area during this event. GFS40 model output has proven to be a better depiction of feature strength in the past, so forecaster experience played a role in the forecast process. Given that road closures occurred with the snow and blowing snow, the advisories issued covered the event well. The advisory for Cascade County was issued a bit late, but was issued well before roads were actually closed. In all, the forecasters did a good job given the divergent available guidance.