A Post Christmas Snowstorm in Northeast Montana: An Ideal Case for the Weather Event Simulator

Brad Temeyer and Thomas Salem
NOAA's National Weather Service
Glasgow, Montana

INTRODUCTION

Intense winter storms are rare in northeast Montana; however, on the last weekend in 2003, 26-28 December, a significant snowstorm left over a foot of snow in numerous locations in northeast Montana. Numerical guidance was inconsistent until nearly the onset of the storm. Therefore, this is a good case for the Weather Event Simulator to help the forecasters with an illustration of numerical weather prediction challenges.

MODEL DISCUSSION

Prior to 21 December 2003, long-range models developed a strong low pressure system in the southwest US. Early projections of the system showed the low re-developing along the leeward side of the Rocky Mountains in Colorado and Wyoming before moving northeast into the Dakotas. However, early model projections from 22 December indicated that the system may be farther northwest than initially expected, casting uncertainty on the forecast.

On the morning of 22 December 2003 (Monday), models showed the system moving into the central plains, and then moving north into the eastern Dakotas(not shown). On Monday morning, the Global Forecast System (GFS) displayed a much stronger system than any of the other models or previous runs. A day later (23 December), all the models had strengthened this storm from previous runs, forming a strong low pressure system over Colorado and moving it to eastern Nebraska by 27 December (Saturday, see Fig. 1). By the evening of Tuesday, 23 December, models trended back to a farther west solution, but not far enough west to where precipitation would have a significant impact on northeast Montana.

On 24 December, Wednesday, all medium and long range models were showing a strong system but differed significantly on the track of it across the US. The European Centre for Medium-Range Weather Forecasts (ECMWF) model indicated the low would track to the east across the central plains, keeping precipitation well to the east of Montana. The Canadian and Eta models moved the system into Colorado and farther north into the Dakotas. However, the GFS depicted the deepest low with a position farthest north and west through Wyoming and the Dakotas. The GFS was not consistent from run to run prior to the 1800 UTC model run on 23 December, thus creating less than normal confidence to this outlier solution. The ECMWF and Eta provided a consistent solution

of a weaker and more eastern system, creating more confidence in an eastward based solution.

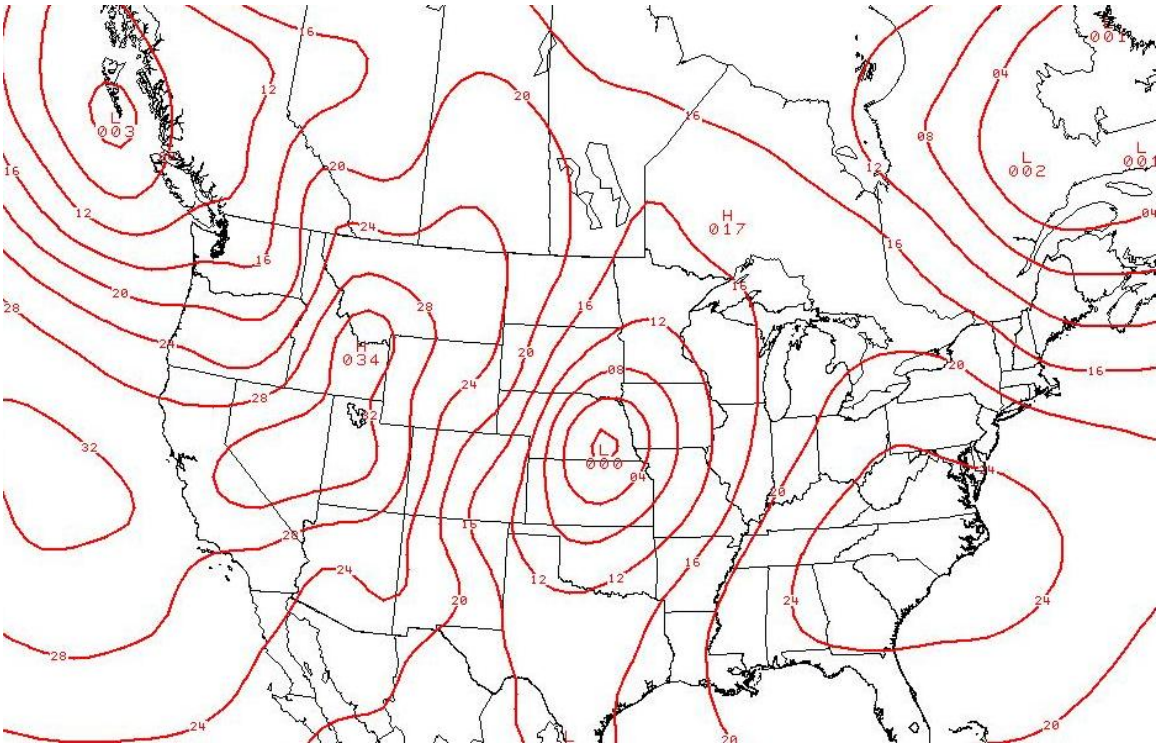

Figure 1. The 108 hour projection of the mean sea-level pressure valid at 1200 UTC 27 December 2003 from the GFS model. The contour interval is 4 mb. The model was initialized at 0000 UTC 23 December 2003.

On 25 December, Thursday, the consensus track showed a potential for a heavy snow event in eastern Montana, but there was still disagreement amongst the model solutions. The GFS maintained the farthest north and west track, with the ECMWF proposing a weaker solution, but trending closer to the GFS. The Eta and United Kingdom Meteorological (UKMET) models trended towards south and east surface low position. Meanwhile, the Canadian and Nested Grid Model (NGM) provided solutions between the Eta and GFS solutions. Figure 2 shows the forecast for the mean sea-level pressure from the 1200 UTC 25 December GFS (brown) and Eta (blue) models at 1200 UTC 27 December. Models were in agreement with a stacked system into the weekend (26-28 December), creating a slow moving heavy precipitation event. The models indicated that the precipitation was to begin on Friday (26 December) evening, and last much of the weekend into Sunday (28 December). Throughout the day on Thursday, model runs trended farther to the north and west indicating a greater threat for a significant snowstorm across the northern high plains.

By Friday 26 December, the models were still struggling with the developing system. The 0000 UTC 26 December model runs suffered a data ingest problem, which compounded the problems of the surface low's forecast track. The GFS and Eta model

runs initialized at 0600 UTC 26 December showed the storm system too far north, creating additional uncertainty.

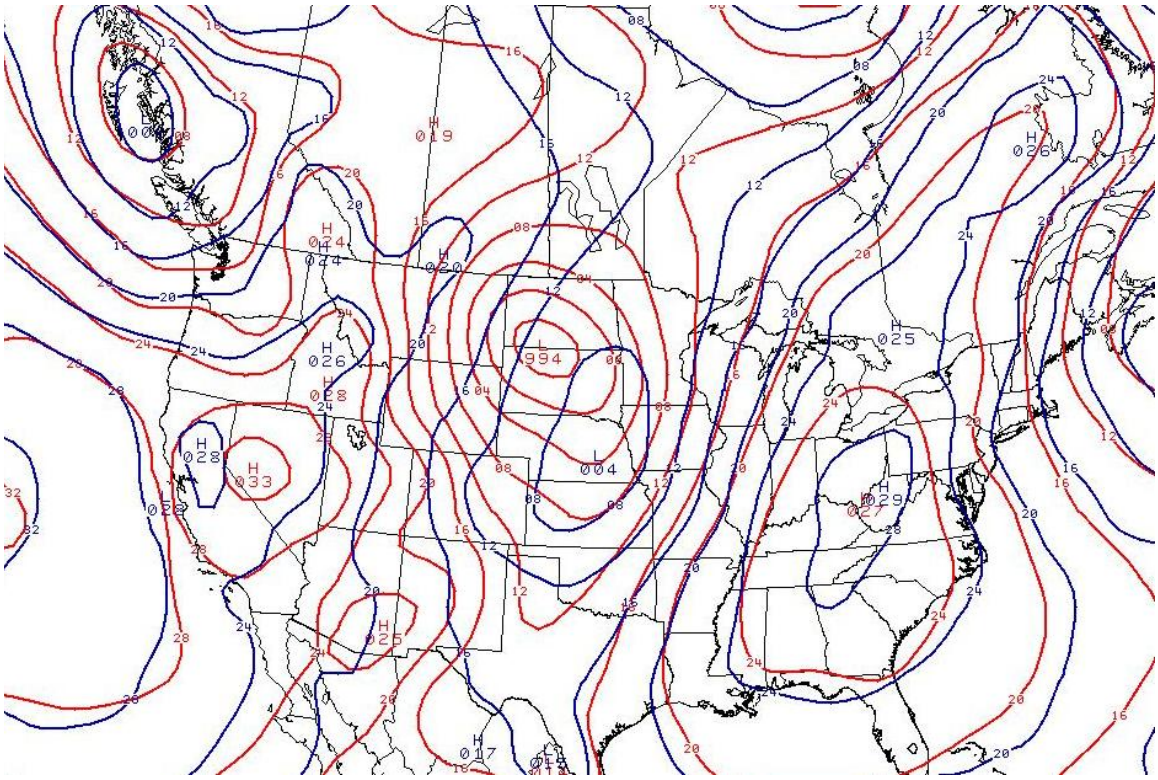

Figure 2. The 48 hour projection of the mean sea-level pressure valid at 1200 UTC 27 December 2003 from the GFS (brown) and Eta (blue). Both models were initialized at 1200 UTC 25 December 2003. The contour interval for the mean sea-level pressures is 4 mb.

EVENT DISCUSSION AND SUMMARY

During the morning of Friday 26 December, the storm took a more westerly track than indicated by many of the model runs. With the morning runs, it became clear that all of eastern Montana was going to receive significant snow and by late in the morning, snow began to fall across areas in central Montana in Petroleum, Garfield and Phillips counties. In many locations in northeast Montana, the storm system began as rain then changed to freezing rain, before finally changing to snow.

As of Saturday (27 December) morning, 6 to 10 inches of snow had fallen across northeast Montana. Cold air, which was pooling across central Alberta, remained north until the low moved farther east. The storm was projected to move across the Dakota throughout the day on Saturday, Fig. 3, before moving into extreme northwest Minnesota.

On Saturday, 27 December, snow began to taper off in many locations throughout the morning hours. The total snowfall in Glasgow, Montana, for the storm was 13.7 inches. This total fell over two days (26 and 27 December), but the amount fell in less than 24 hours. The greatest single day total of snow received in Glasgow was 14.1 inches, four

tenths of an inch greater than received in this event. Strong northwest winds of 20 to 40 mph behind the system caused snowdrifts up to 12 feet high across northeast Montana. The highest drifts occurred in central and southern Phillips County, where a highway was closed for 3 consecutive days.

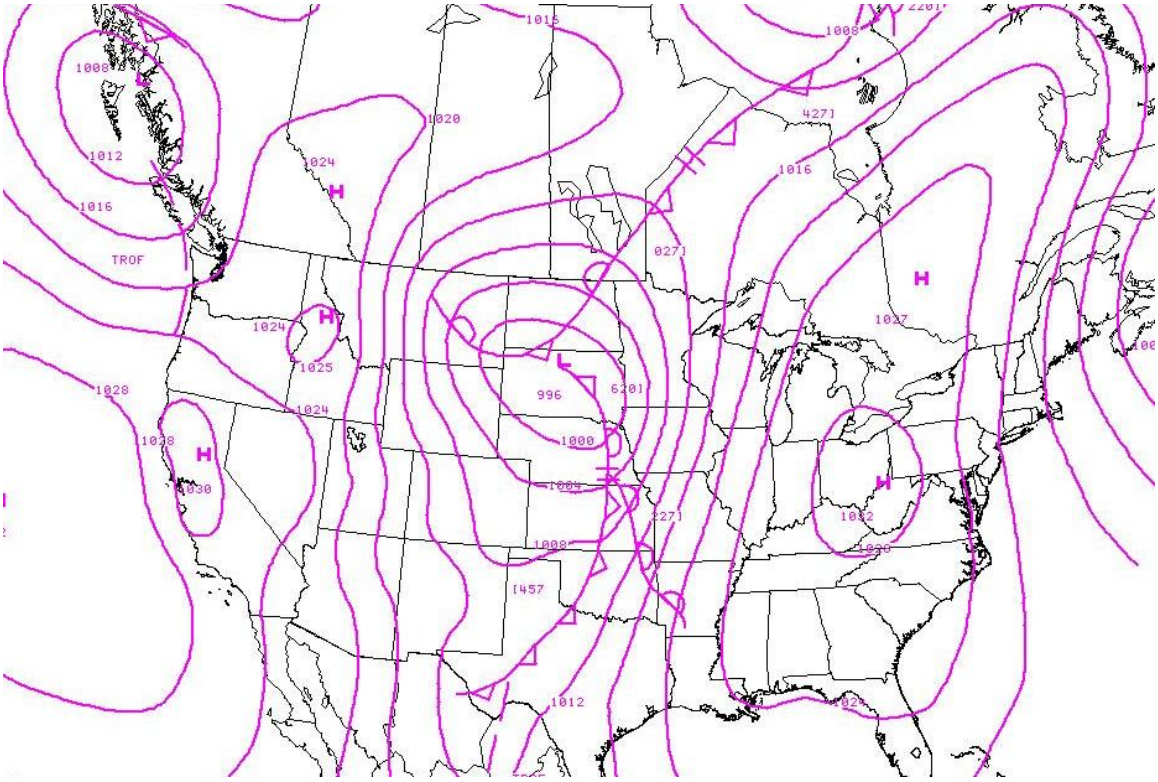

Figure 3. The mean sea-level pressure analysis and frontal locations plotted for 1200 UTC 27 December 2003. The contour lines are every 4 mb for mean sea-level pressure.

By Sunday (28 December) morning, some locations in north central Montana received up to 30 inches of snow (Fig. 4). Figure 4 also shows the locations in eastern Montana that received much less snowfall than areas in central Montana.

This storm system was difficult to predict through out the week due to the inconsistent model forecasts, and a data ingest problems. The GFS had the most accurate solution, but the model's inconsistency lowered forecaster confidence early in the storm's evolution. Forecasters are encouraged to scrutinize the latest observational data and model initializations, and do continuous comparisons using all available models including ensembles. In the future, this approach should provide the greatest lead-time and accuracy in forecasting significant winter storms.

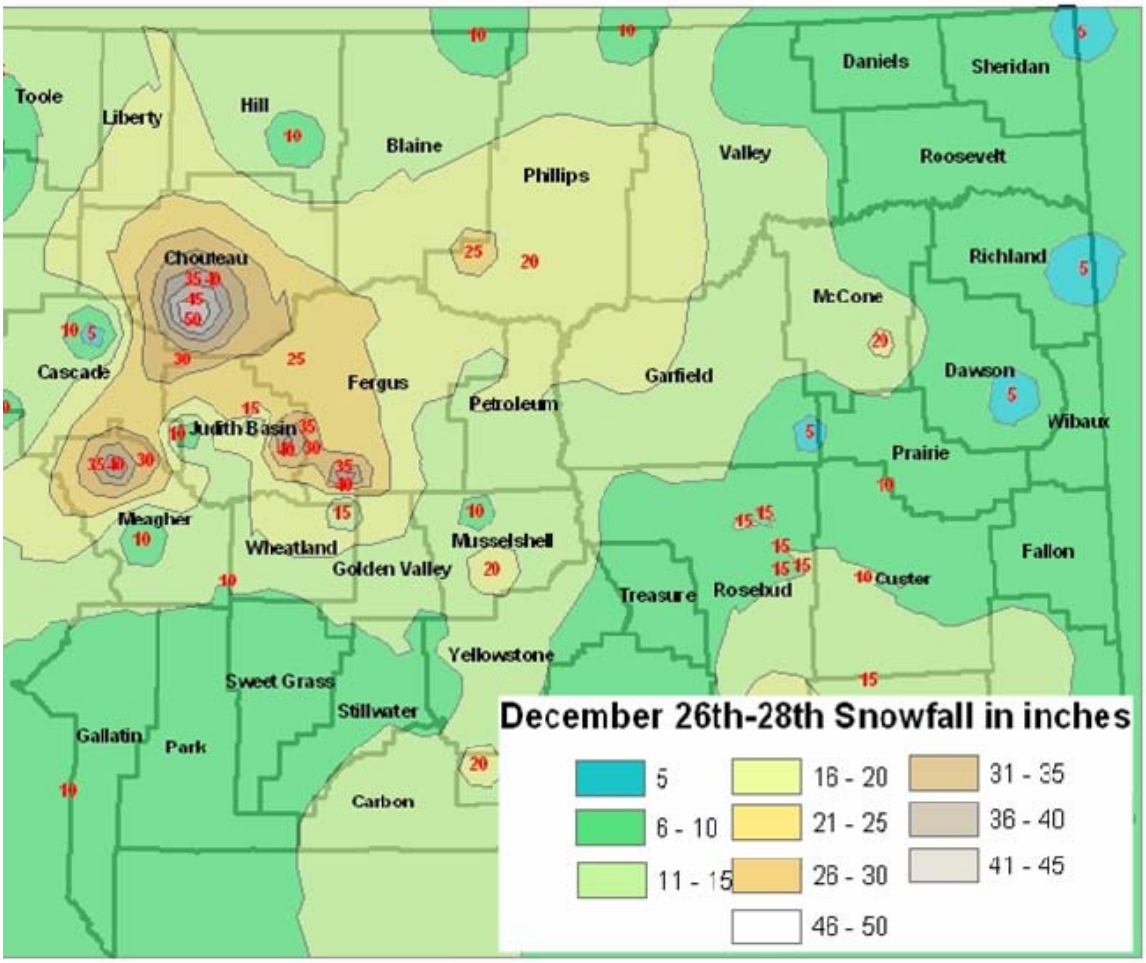

Figure 4. Analysis of measured snowfall observation, in inches, for 26-28 December 2003.