Winter WES Case in Northeastern Montana with Changes in Weather by Elevation

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1. Introduction

The high plains of northeastern Montana usually do not have major differences in the weather by elevation; however, 9 April 2005 was a case where the precipitation type was different due to elevation. Northeastern Montana ranges from around 1800 feet above sea level (along the North Dakota border at the Missouri River) to about 5000 feet in southwest Phillips County, with much of northeast Montana being between 2000 and 3000 feet above sea level. On 9 April 2005, most of the area received rain while elevations above 2800 feet received accumulating snow. In addition to the rain and snow, the event had high winds in the second half of the event, which caused blizzard conditions in areas where snow was on the ground.

In this paper, section 2 will be a synoptic overview of 9 April. Section 3, will briefly discuss the observed sounding from Glasgow. Section 4 will provide a brief summary of the event.

2. Synoptic Overview

A surface low-pressure system intensified over eastern Montana (see Fig. 1), producing heavy rain, sleet and heavy snow across much of eastern Montana depending on the elevation. After the precipitation decreased across the region, a secondary system moved through the area and had winds from the northwest with gusts up to 73 kt.

On 8 April, Friday, the low-pressure system moved into central Montana, and intensified during the next 30 hours. Precipitation, starting out as rain, began to fall during the day on Saturday. At locations above 4000 feet (the Little Rocky Mountains in southwest Phillips County, see Fig. 2), snow and sleet were observed during the day. As the temperature cooled slightly on Saturday night, rain changed to sleet, and then into accumulating snowfall at elevations of 2800 feet and above (Big Sheep Mountains and the higher portions of Petroleum and Garfield Counties), see Fig. 2.

The winds switched from the southeast to the northwest late Friday afternoon into early Saturday morning. The speeds on the east side of the Little Rocky Mountains increased into the range of 20 to 35 kt sustained, with gusts up to 73 kt. Moving east, the winds were 18 to 35 kt sustained range with gusts of 43 to 53 kt.

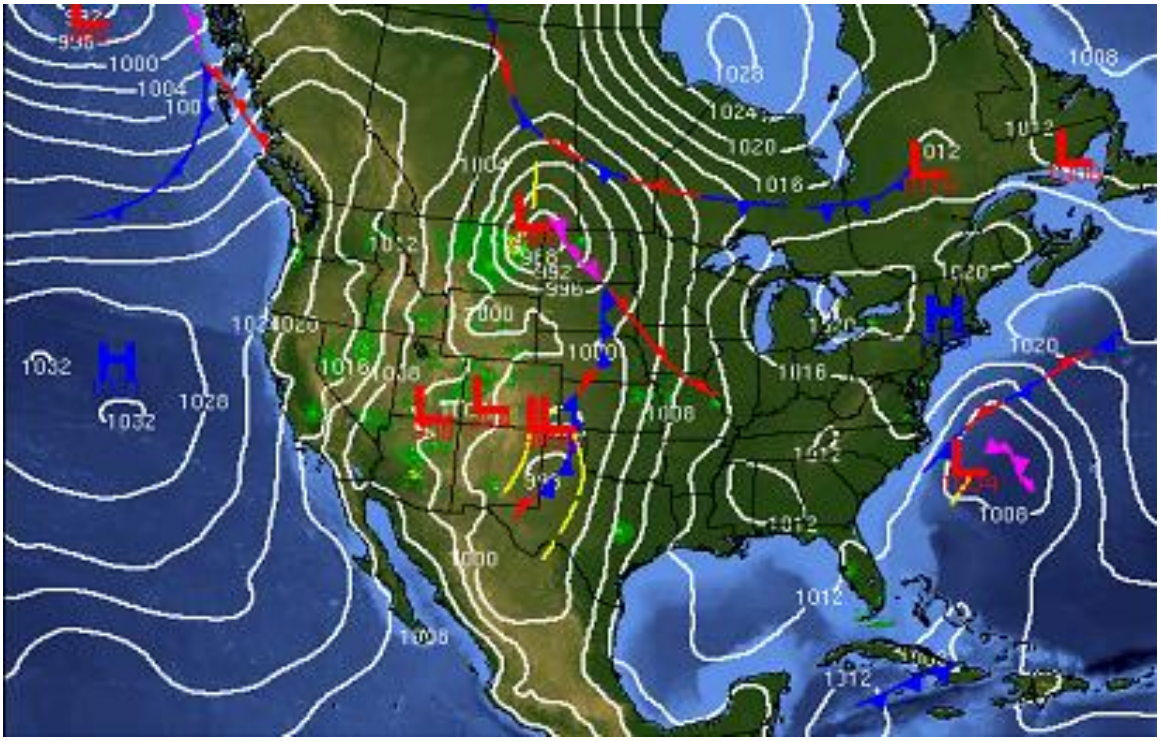

Figure 1. Surface pressure map with fronts and precipitation areas from 2100 UTC 9 April 2005. The pressure contours are in white with an interval every 4 mb. The green and yellow shaded areas are areas of precipitation according to the radar network.

3. Environmental Data

On the evening of 9 April 2005 many areas across northeast Montana were raining, however, some areas had been snowing and/or sleeting for most of the day. The Glasgow 0000 UTC 10 April 2005 sounding (Fig. 3) shows just a shallow layer of temperatures higher than freezing.

In Figure 3, the temperature profile crosses the 0 degree Celsius line at about 850 mb. Above 850 mb, the temperature stays at freezing or just below freezing for about 50 mb (to 800 mb) before increasing to above freezing until around 730 mb. Therefore, locations with elevations near 3000 feet above sea-level would be in the layer that is at freezing or just below freezing. In addition, the highest temperature between 800 mb and 730 mb was 1 degree Celsius, which studies have shown should produce at the most a mix of snow and sleet. Meanwhile, the surface temperature was 3 degrees Celsius, which indicated the snow would melt (Baumgardt 2006).

Also, Fig. 3 shows that the wind up to about 700 mb is veering with height—an indication of warming in that layer. The wind just above the surface was 50 kt, which was able to mix down in several locations across northeast Montana causing high winds.

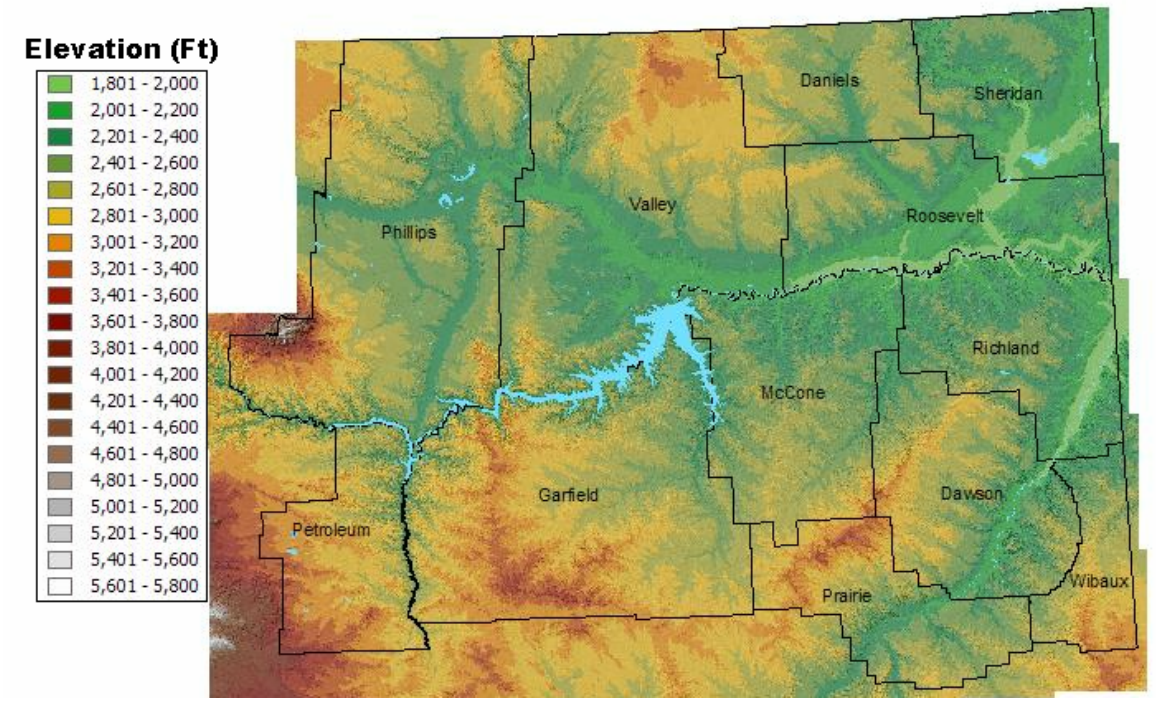

Figure 2. Topographical map of northeast Montana, the legend corresponding elevations to color is on the left. Areas in light brown are above 2800 feet. The counties are labeled. The Big Sheep Mountains are in Prairie and Dawson Counties and the Little Rocky Mountains (Little Rockies) are in southwest Phillips County.

4. Summary of event

Most areas in northeast Montana received around 1 inch of liquid equivalent precipitation and most areas had winds of about 40 to 50 kt, with a couple places have wind gusts greater than 60 kt [at Zortman RAWS (73 kt) in southwest Phillips County and King Coulee RAWS (63 kt) in southwest Valley County].

The highest areas (above 4500 feet) in the Little Rockies received 6 inches of snow, with a liquid equivalent of 1.7 inches. One report from the Little Rockies had the location receiving 18 inches of snow. Other areas with elevations above 2800 feet received 4 to 7 inches of snow in Garfield and southwest Valley Counties.

Glasgow with an elevation of 2293 feet above sea-level, received a trace of snow overnight. The temperatures remained above freezing (1 degree Celsius) the entire night. Snow or sleet occurred for 4 hours with no accumulation. The highest wind gust at Glasgow was 40 kt.

5. Conclusion

While winter storms are not rare in northeast Montana, it is rare for winter storms to have different precipitation types across the area due to elevation. However, the event from 9 April 2005 was such an event.

The 9 April event had a sounding (Fig. 3) that shows that slightly higher elevations than Glasgow would have snow or sleet while Glasgow had mainly rain with no accumulating snow. In addition, the sounding shows warm advection in the lowest layers. Surface observations from across the area (not shown) have temperatures and dew points either at or above freezing, therefore it was going to be tough to bring in much colder air and have accumulating snow across the entire area.

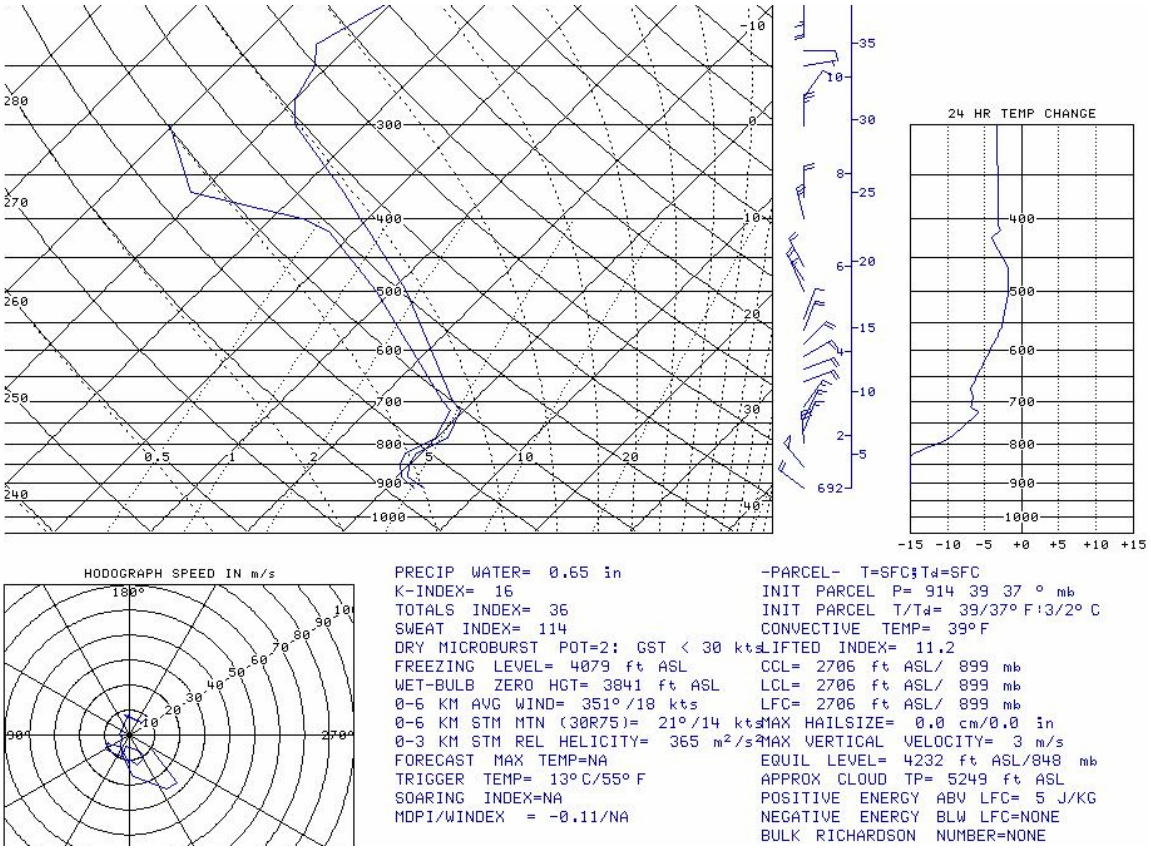

Figure 3. 0000 UTC 10 April 2005 observed sounding from Glasgow.

References

Baumgardt, D., 2006 cited: Wintertime Cloud Microphysics Review. Available online at http://www.crh.noaa.gov/arx/micro/micrope.php