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Some Clues To Heavy Snow Forecasting In South Central Ohio

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From 7 pm January 19th through 7 am January 20th, 1986 four to nine inches of snow fell in south central Ohio (Figure 1) as a low pressure center moved south and east of the state. Heavy snow also occurred in West Virginia. A similar storm dumped 6 inches of snow on the southern tip of Ohio during the evening of January 4, 1985. Both heavy snow situations caught forecasters by surprise; however, their striking similarities should be a lesson for the future.

On January 19th, 1986 a surface low pressure center and its associated fronts and upper lows moved across the Ohio Valley and then through the Middle Atlantic States. During the daylight hours of the 19th areas of rain were common across most of Ohio except for some light snow (less than an inch) over the southwest corner of the state. By evening on the 19th as the colder air behind the low became entrenched across the rest of southern Ohio the rain rapidly turned to snow. When the heavy snow began during the evening of the 19th the low center was well east of Ohio. Normally, heavy snow is not forecast under those conditions.

A review of some Air Force "Rules of Thumbs" for forecasting heavy snow outlined in a paper by Przyblinski and Steigerwaldt shows why forecasters weren't expecting the 1986 snow storm.

One of those rules states the heaviest snow usually will fall along, and 60 to 180 nautical miles (NM) to the left of the path of the surface low (Figure 2). In this case the heavy snow fell 200 to 300 NM west of the surface low.

Another heavy snow forecasting rule states the heavy snow is most likely along the 1000-500 mb thickness ridge between 5310 to 5370 meters. During the 1986 storm this rule also failed.

Looking at other criteria for forecasting heavy snow: the heaviest snow should fall in a band from 60 NM to 240 NM to the left of, and from 180 NM to as much as 720 NM ahead of the 850 mb low. On January 19th at 7 am the 850 mb low was over southwest Ohio as shown on Figure 3. By 7 pm the low was over northern West Virginia and at 7 am January 20th the low was over southeast Pennsylvania. Using this rule one would not have forecasted heavy snow for southern Ohio.

Another rule states the heavy snow would be along the track of the 500 mb low. As shown by Figure 5, this rule did not work.

The following clues regarding where to forecast heavy snow did work in this situation.

The -5 Celsius isotherm at 850 mb usually bisects the area which receives the heaviest snow in the following 12 hours. For the 1986 storm the -5 isotherm was on the eastern edge of a pocket of cold air that passed through south central Ohio (Figure 7).

Another heavy snow "rule of thumb" is that the heaviest snow will fall along the track of the 700 mb low. As Figure 4 shows the 700 mb low moved near southwest Ohio during the daylight hours of the 19th, however, generally less than an inch of snow fell by late afternoon. When the heavy snow was beginning across Ohio, the 700 mb low was south of the state and very heavy snow did occur along and to the left of the 700 mb low track in West Virginia.

The most favorable area for heavy snow is found 150 nm to the left of the track of the 500 mb vorticity maximum. Figure 5 shows the positions of the vorticity maximum as per the initial analysis of the Nested Grid Model. It indicated the heavy snow band would be just south and east of Ohio. The heaviest snow in this storm did occur in West Virginia. However, the area of heavy snow extended further north into Ohio than one would expect.

During the 1986 storm most of the heavy snow forecasting rules did not verify in Ohio, the 1985 storm had similar results.

The two storms were almost identical at the surface and aloft. The surface lows in both cases were well east of southern Ohio when the heavy snow was in progress. The lows were of moderate strength, a little less than 1000 mb. During the 1985 storm, freezing rain occurred during the afternoon but quickly turned to snow in the evening. During the 1986 storm, the rain turned to snow with a period of freezing rain and sleet. The atmosphere was on the border between liquid or frozen precipitation and snow in both cases.

Speculating as to why the usual forecast rules did not apply, warm air advection on the west side of 850 mb lows may be the explanation. Comparing the 850 mb charts (Figures 6 and 7) at 7 pm, the time the heavy snow was in its early stages, indicated warm advection was occurring across southern Ohio with a 5 to 6 degree temperature difference between Dayton and Huntington, West Virginia. Also a sharp 850 mb trough was indicated with a north wind at Dayton and a west wind at Huntington.

AT 700 mb and 500 mb (Figures 8,9,10,11) warm advection was also taking place and there was a trough over eastern Ohio.

Close examination shows striking similarities at all three upper levels at Dayton and Huntington during both storms. Wind direction and speeds were almost identical at both Dayton and Huntington and temperatures were within a degree or two at each level. Also, during both of the storms cold air was noted early on in the southwest quadrant of the storm. This cold advection was further south than usually occurs after the passage of a low pressure center. This could mislead a forecaster into missing the change from rain to snow in southern Ohio before it occurred in the northern part of the state.

Topography could also play a role as the north-northwest winds would be upslope into south central Ohio.

The 1986 storm produced heavier snow in Ohio and West Virginia. This is probably due to a better moisture supply. In 1986 low level moisture from the Atlantic was wrapping around a cut off low at 850 mb while in 1985 this moisture source was not available.

The main difference between the 1985 and 1986 snowstorms was the location of the low pressure centers. In 1985 the low stayed further south of Ohio, consequently the heavy snow just brushed the state.

Summary:

Winter storms in 1985 and 1986 with similar characteristics produced unexpected heavy snow situation over southern Ohio. There are some key meteorological parameters that should be examined to help predict potential heavy snow events in south central Ohio. They are:

1. If the upper lows pass just a little south and east of Ohio look for an intrusion of cold air over southern Ohio changing rain to snow earlier than expected.

2. A trough should be indicated at 850 mb with at least 4 degrees of warm advection occurring between Dayton and Huntington.

3. A trough is indicated over eastern Ohio at both 700 and 500 mb.

4. The atmosphere should be on the edge between liquid or frozen precipitation and snow.

5. The surface low should be well east of the southern Ohio and of moderate strength.

6. The flow into south central Ohio should be north-northwest at all levels.

References:

1. Chanute Technical Training Center, "Non-Convective Severe Weather" Weather Technician, Meteorological Oceanographic Analyst/Forecaster, August 1983.

2. Przyblinski, R. and Steigerwaldt, H. 1983: A BRIEF DISCUSSION OF VARIOUS "RULES OF THUMB" AND THEIR APPLICATION TO THE WINTER STORM OF DECEMBER 16-17, 1981.

SCIENTIFIC SERVICES DIVISION, ERH
March 3, 1986

ATTACHMENTS (Figures 1 through 11)

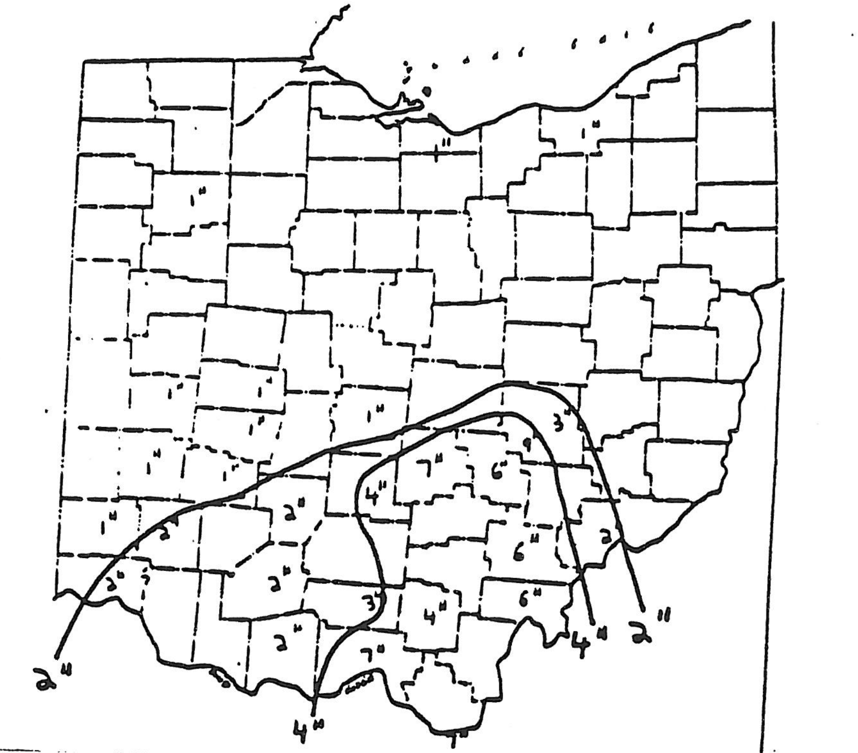

Figure 1. Snowfall over Ohio between 7PM January 19th and 7AM January 20th, 1986.

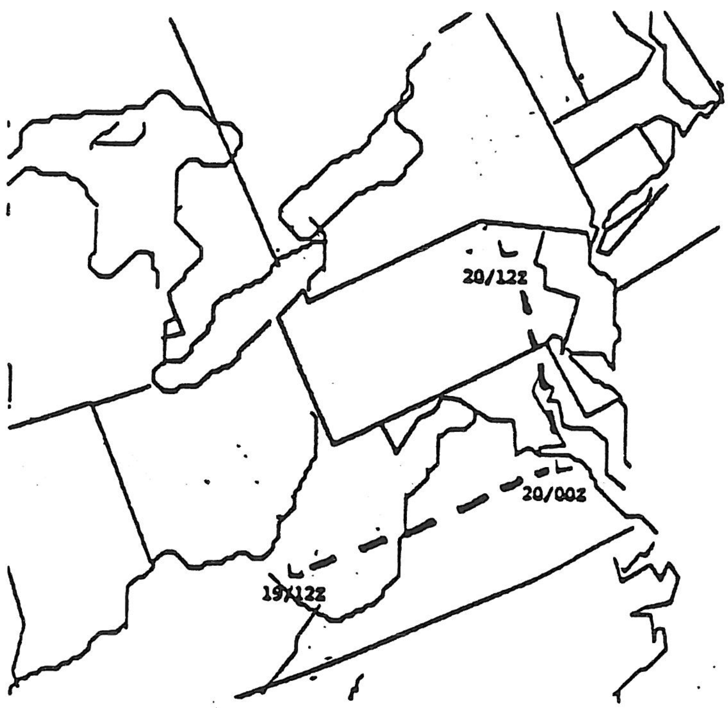

Figure 2. Track of surface low from 1/19/86 at 12Z to 1/20/86 at 12Z.

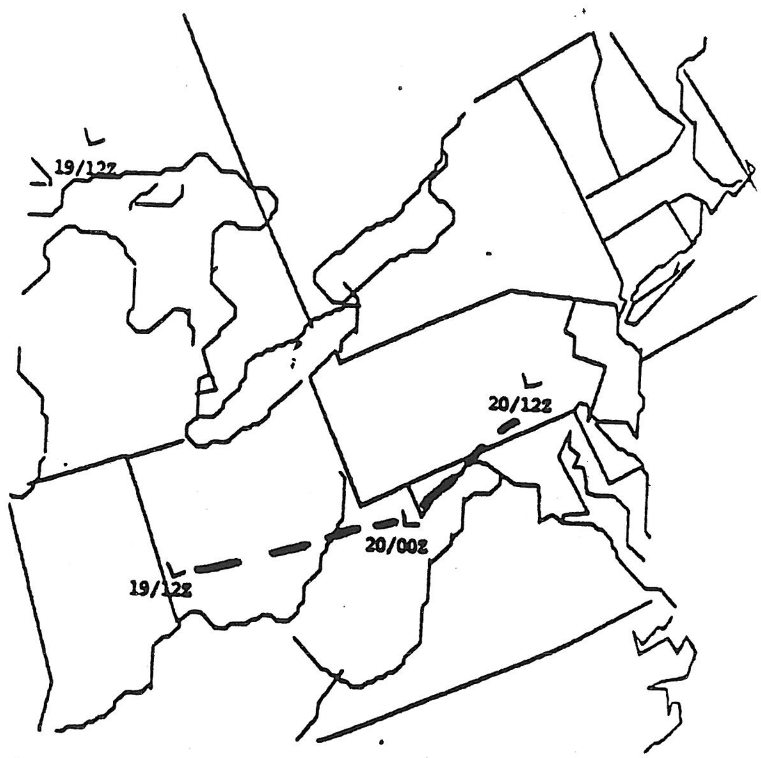

Figure 3. Track of 850 mb low from 1/19/86 at 12Z to 1/20/86 at 12Z.

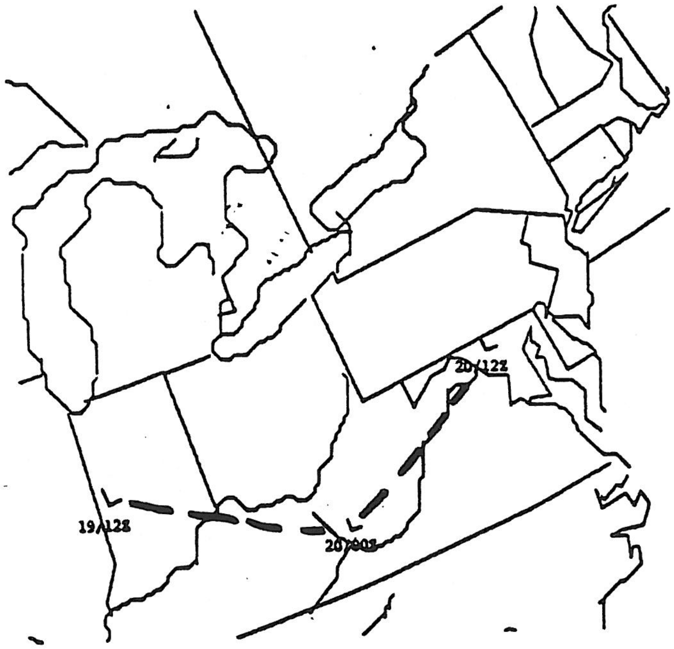

Figure 4. Track of 700 mb low from 1/19/86 at 12Z to 1/20/86 at 12Z.

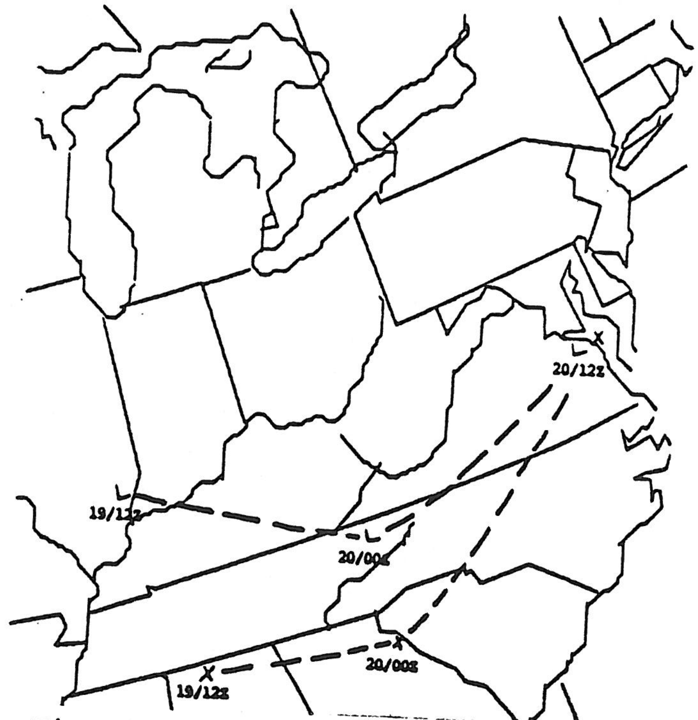

Figure 5. Track of 500 mb low and vorticity center from 1/19/86 at 12Z to 1/20/86 at 12Z.

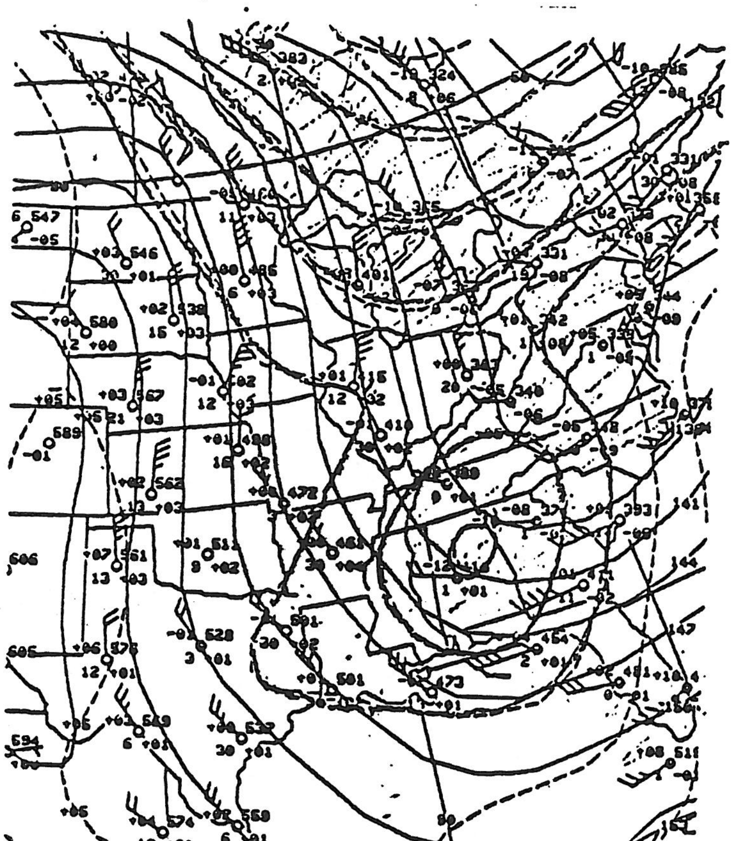

Figure 6. 850 mb chart for January 5th 1985 at 00Z.

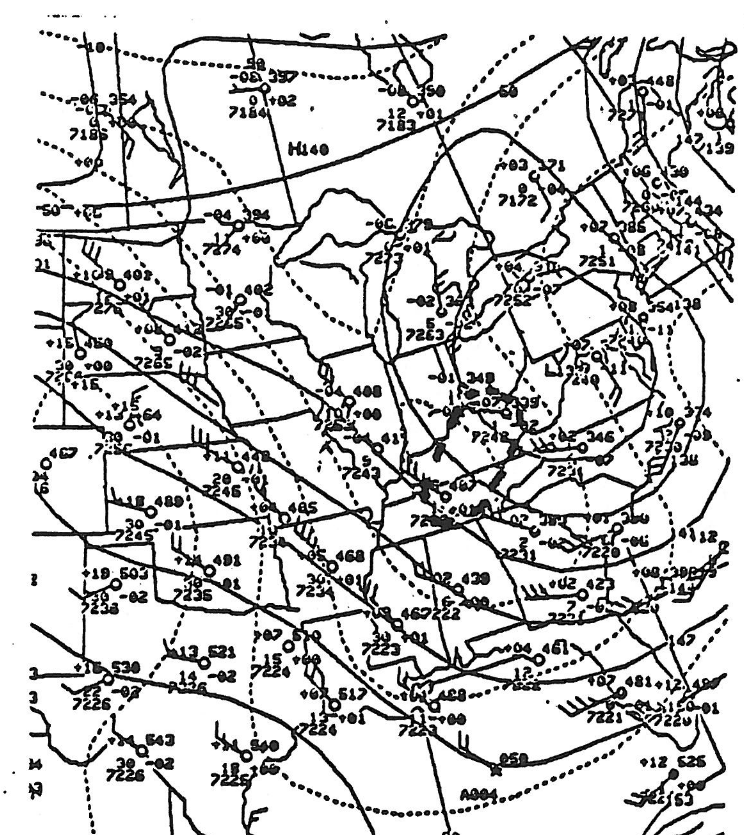

Figure 7. 850 mb chart for January 20th 1986 at 00Z.

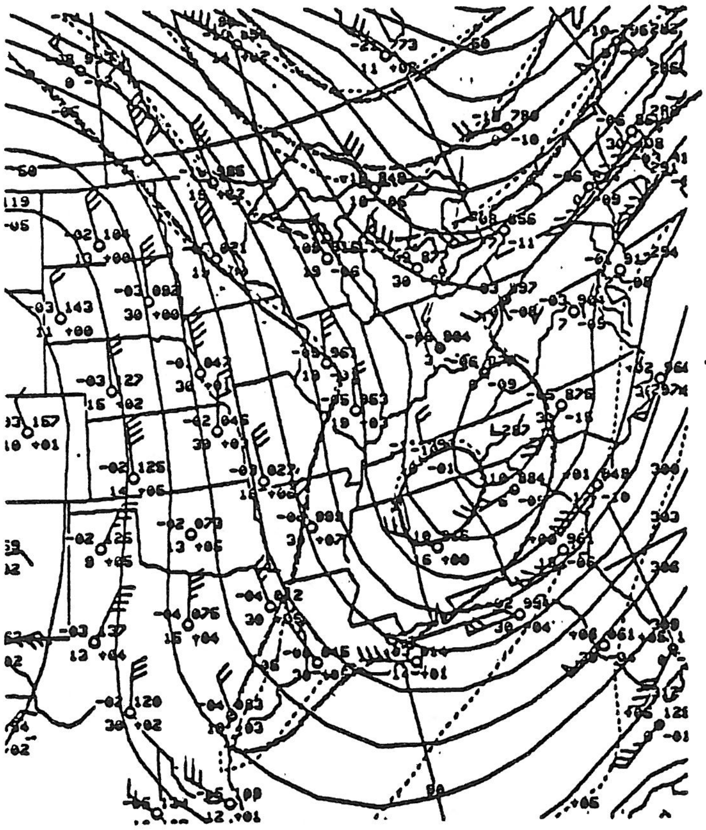

Figure 8. 700 mb chart for January 5th 1985 at 00Z.

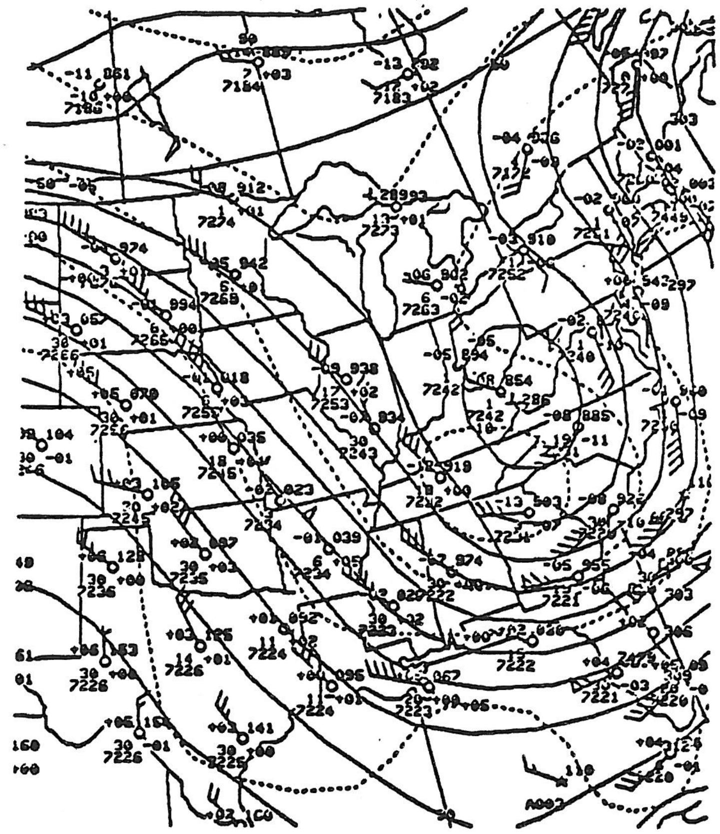

Figure 9. 700 mb chart for January 20th 1986 at 00Z.

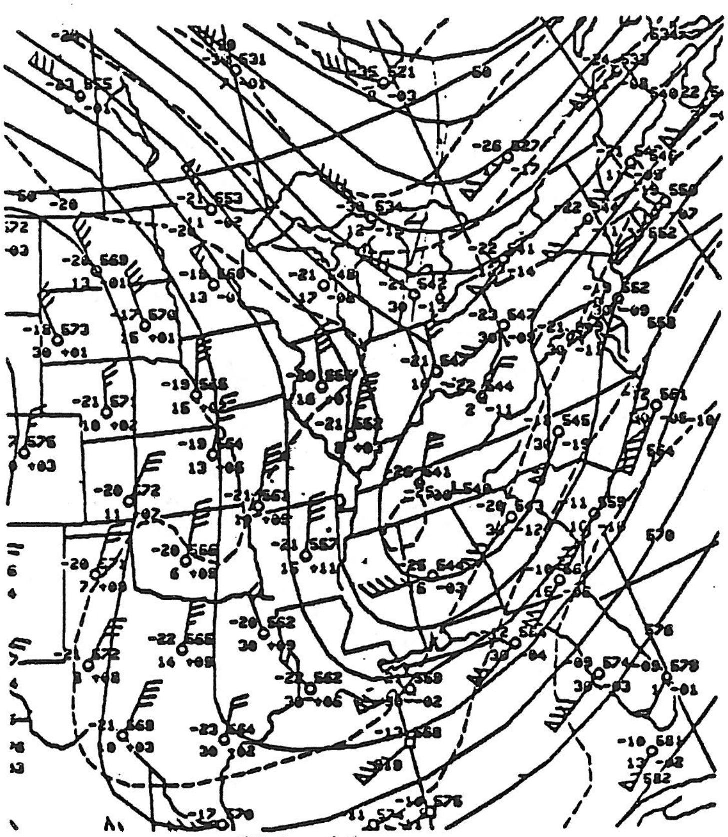

Figure 10. 500 mb chart for January 5th 1985 at 00Z.

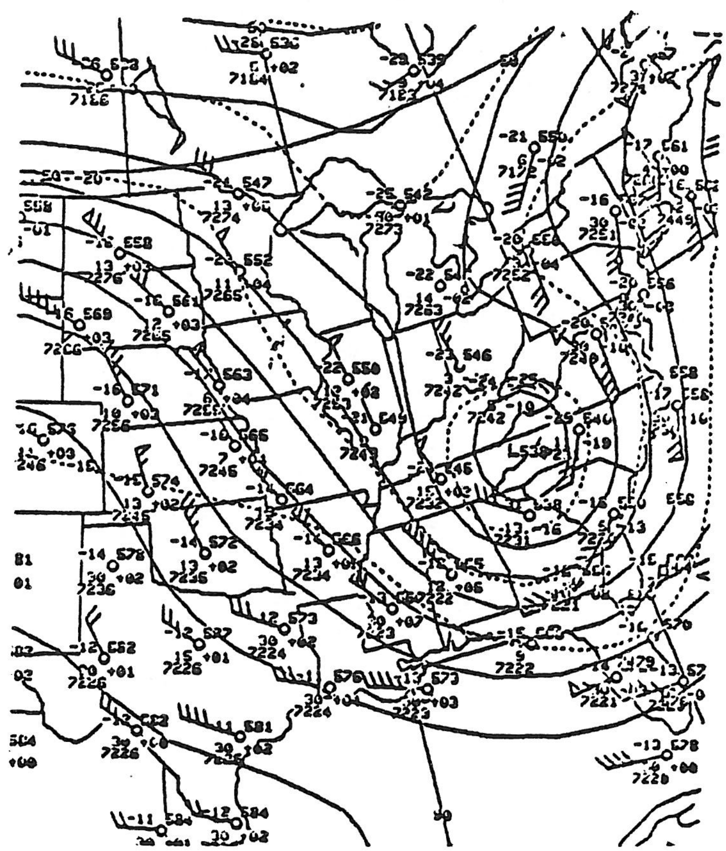

Figure 11. 500 mb chart for January 20th 1986 at 00Z.