NWS-CR-TA-89-10

CRH SSD
MARCH 1989

CENTRAL REGION TECHNICAL ATTACHMENT 89-10

A METHOD TO DETERMINE THE WIDTH OF A SNOW BAND ASSOCIATED WITH WINTER STORMS BY USING INFRARED SATELLITE DATA

Allan L. Morrison
National Weather Service Forecast Office
Chicago, Illinois

1. Introduction

Significant snowfalls in the upper Midwest normally fall in relatively narrow bands ranging from 50-200 nautical miles (nm) in width. Snow typically falls along the north and west edge of an organized area of precipitation. This area of precipitation is often associated with an upper level short wave. Prior to the availability of satellite data, the method most commonly used to predict the spatial relationship between the snow band and various parameters such as the surface low (850 mb low, etc.) was a statistically derived technique using previous storms. The basic weakness of using a statistical method is that the variability of the forecast data must be considered. The greater the variability, the more useless the technique is in forecasting a future storm. What is needed is a fairly accurate method to pinpoint the expected location of the snow band within each individual storm. This information can then be used to extrapolate the expected snow band location.

2. Discussion

Short waves, especially the stronger ones when clouds are more likely to be in evidence, can be identified using satellite data. The cloud signature most commonly associated with a short wave on the satellite data is the "comma cloud" that usually evolves when the short wave phases with a baroclinic zone. Often surface cyclogenesis occurs at this time. Figure 1 relates the location of snow within the comma cloud and in relationship to the paths of various other weather parameters.

Since comma clouds have several distinct features, it seems reasonable to assume that the precipitation associated with the comma cloud would normally occur in only a portion of it. As might be expected, there is a correlation between location of the snow band and the enhanced portion of the comma cloud. Goree and Younkin (1966) found the heaviest snow fall occurred about 2.5° north and about 7° downstream of the 500 mb vorticity maximum. In all cases examined for this study, snow fell in a band related to the lower half of the comma head and in the general region mentioned by Goree and Younkin. This was determined by examining the infrared (MB curve) satellite pictures of several snowstorms

(January 9, and 19-20; March 29-30, 1987, and March 5, 1989). On each satellite picture, the comma head was bisected to the point where it intersected the path of the dry intrusion (see Figure 2). The lower half of the comma head was overlaid on a visual satellite picture, following the snowstorm, that depicted the snow band. By repeating this procedure on successive satellite pictures, a composite of overlays onto the visual picture indicated an almost perfect fit between the snow band and the lower half of the comma cloud head.

More importantly, it was found that the location of significant snowfall could be accurately pinpointed on a real time basis. Employing the technique of overlaying the enhanced portion of the comma cloud (ignoring the discontinuous fragmented portions) on a weather depiction chart, the precipitation area was well defined, and was found to coincide with that area of the comma cloud determined by bisecting the comma cloud from head to tail (see Figure 2). The snow was almost exclusively confined to the lower half of the comma head and to the left of the dry intrusion path as previously suggested. Hence, the southern edge of the enhanced portion of the comma cloud often times determines the southern edge of the snow band and the northwest edge of the bisected comma edge corresponds to the northern edge (see Figure 3).

3. Conclusion

A method has been discussed which can be used to determine where significant snow has fallen using only infrared satellite images. This method is unique in that it relies solely on satellite information available.

As with any method, there are times at which significant snow may fall outside of this calculated snow band. The most likely exception would be the upper portion of the comma tail if the air mass was initially cold enough to produce snow. This is the area just to the right of the dry slot path. If the precipitation in this portion of the comma cloud begins as snow, predicting how much will fall is difficult as it often changes to rain. Fortunately, due to the nature of the comma cloud tail in this area being oriented along a narrow band perpendicular to the approaching dry slot, the duration of precipitation is short. However, with the case of convective type precipitation, a quick "shot of heavy snowfall" could result in several inches of snow.

4. References

Browne, R. F., and R. J. Younkin, 1970: Some relationships between 850 mb lows and heavy snow occurrences over the Central and Eastern United States. Mon. Wea. Rev., 98, 399-401.

Goree, P. A., and R. J. Younkin, 1966: Synoptic climatology of heavy snowfall over the Central and Eastern United States. Mon. Wea. Rev., 105, 1071-1074.

Kadin, C., 1982: The Minneapolis snow event -- what did the satellite tell us? Nat. Wea. Dig., 7, 13-16.

Scofield, R. A., and L. E. Spayd, 1986: A Technique that uses satellite, radar and conventional data for analyzing and short-range forecasting of precipitation from extratropical cyclones. Weather Service Forecasting Handbook No. 6, Chapter 3, E1-51.

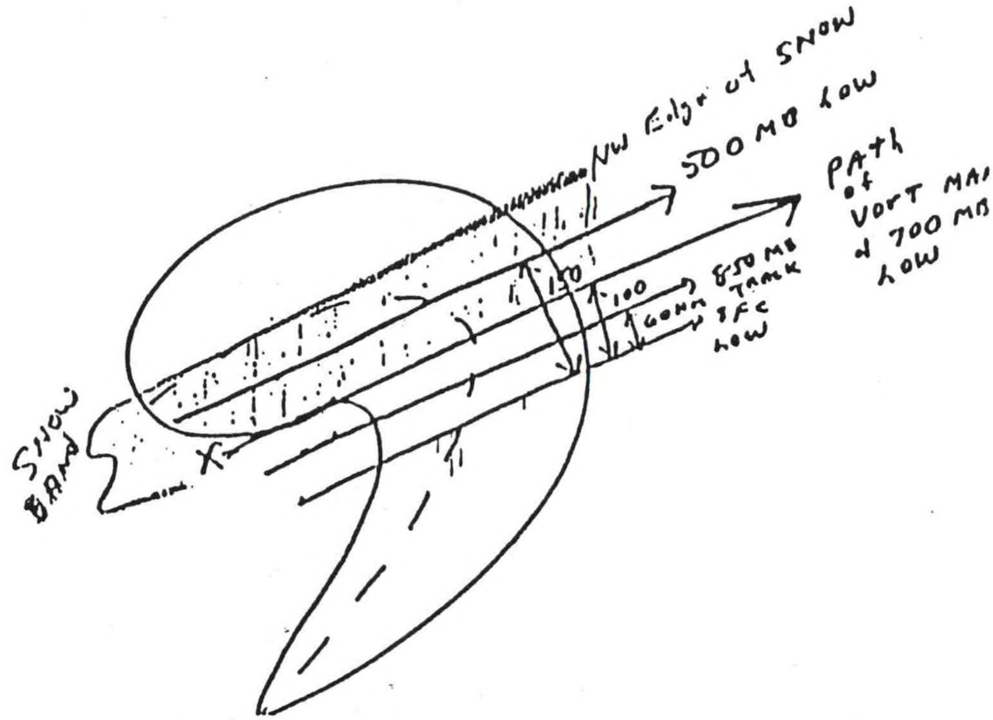


Figure 1 Relationship between satellite picture "comma head," snow bands, and other conventional weather parameters.

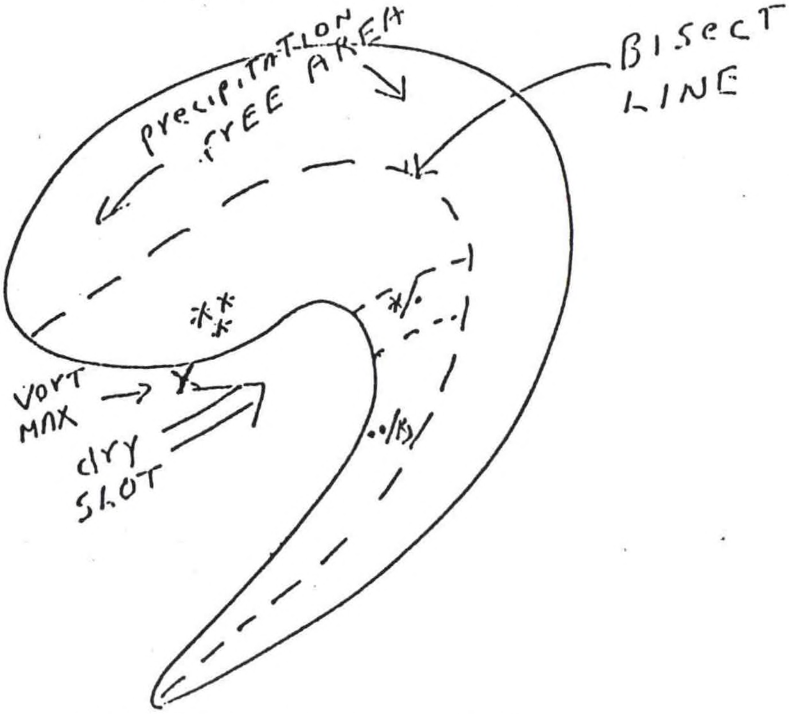
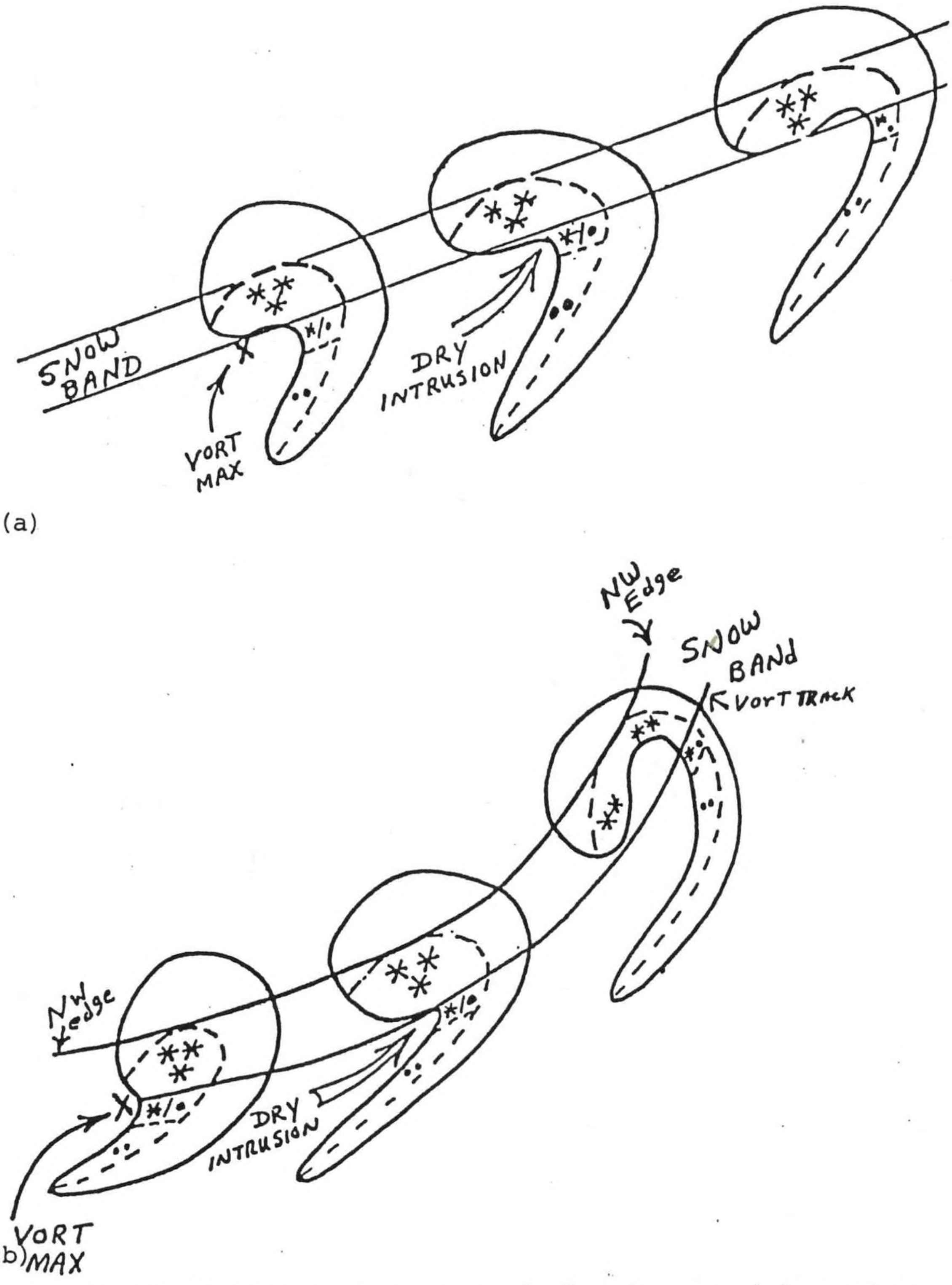


Figure 2 Bisected comma head cloud.



(a) (b)

Figure 3 Relationship between snow band, dry slot, vorticity center and short waves that (a) shear out, or (b) undergo occlusion.