Shifting Gears - An Analysis of a Transforming Severe Convective Event

Nathan J. Heinert and Jeffrey R. Hedges
Weather Forecast Office, Pocatello, Idaho

1. Introduction

On 2 Aug 2003, southeast Idaho was struck by several severe thunderstorm events. The most significant event of the day was a line of thunderstorms which formed along a fast-moving cold front in western Idaho. The line of thunderstorms began to bow in the Magic Valley of south central Idaho, indicating a transition to a damaging wind producing system. A few high wind reports were received as the bow echo progressed eastward through the Snake River Plain. This was shaping up to be a rather ordinary wind-producing convective event. Shortly after the bow echo entered the Pocatello CWA, it interacted with a boundary produced from earlier convection. This interaction transformed part of the bow echo into a different type of storm, and forced a change in the warning decision-making thought process. This paper will examine the radar indications of the interaction, and the resulting transformation.

2. Discussion

Figure 1 (0114 UTC 0.5 deg reflectivity) shows the north-south oriented line of thunderstorms (A) which had formed along the cold front. When the line entered the Pocatello CWA, reflectivity values had dropped significantly, and much of the radar observed bow echo structure was lost. This was due to beam width limitations resulting from the distance from the radar, rather than actual storm weakening. This is a common occurrence, as the CWA boundary is roughly the midpoint between the Boise and Pocatello RDAs. Earlier convection, which produced wind damage in the Pocatello area, generated an outflow boundary which was progressing northward across the Snake River Plain. The outflow boundary eventually initiated a new line of convection as it neared the higher terrain at the northern edge of the Snake River Plain (B). This was when the boundary was first noticed by the warning forecaster. The movement of both lines of convection suggested that a potential intersection was going to occur in central Blaine County (C). The outflow boundary could easily extend beyond the visible convection, so the intersection could already be in progress at point C.

Typically in Midwestern convective events, interacting boundaries results in an intensification of the convection at the point of intersection. In a number of cases, rotation has been observed at the intersection with subsequent tornadogenesis. Rotation is generally at the lowest levels, and would be susceptible to disruption by complex terrain. The warning forecaster recognized the potential and immediately changed radar interrogation strategy from straight-line winds to tornadic potential. Typically, a warning forecaster would examine base velocity products for a wind event, especially when the bow echo is progressing directly down the radial. The warning forecaster began to examine the 0.5 and 1.5 degree storm-relative velocity products once the intersection potential was identified. After some thought, the decision was made to issue a severe thunderstorm warning, rather than a tornado warning. It was believed that the complex terrain in the area of the intersection would disrupt a low level circulation from evolving into a tornado. Nevertheless, the wind damage was expected to be more intense at the point of intersection.

Figure 2a (0124 UTC 0.5 deg reflectivity) shows many of the suspicions to have come true. The storm has intensified significantly at the point of intersection. Also note that the mesocyclone detection algorithm identified organized rotation at the point of intersection. Figure 2b shows the corresponding 0.5 deg reflectivity storm-relative velocity product. Notice the weak, but organized velocity couplet at the point of intersection (A) near Bellevue, ID. This type of feature has often been observed with enhanced localized wind damage embedded in areas of more widespread but less intense wind damage. Extrapolating the track of the couplet would suggest enhanced wind damage in the Bellevue-Hailey area.

Figure 3 (0139 UTC 0.5 deg reflectivity) shows that the original line of thunderstorms has exploded at and just south of the point of intersection. A small, but intense bow echo (A) developed and passed through the Bellevue-Hailey-Sun Valley area. The lower reflectivities immediately behind the bow (B) indicate a descending rear-inflow jet, and more evidence of severe winds with the bow. The rotation generated at the point of intersection likely boosted the westerly flow which gave the extra punch resulting in the intense bow echo. The severe weather threat is rather obvious by this time, but the opportunity for a warning decision has long passed. Storm Data lists a report of utility poles down across a highway near Hailey, ID, which fit the location of the velocity couplet.

3. Conclusion

Successful warning forecasters develop skills beyond meteorology and radar interpretation. They must develop an expectation of how a severe weather "day" will play out. This mindset allows the forecaster to anticipate convective development and react to early indications, thus achieving significant lead times. The peril comes with having one's thinking channeled to a certain outcome, and thus missing or ignoring changes to the original expectation. This is a common breakdown in situation awareness. In this example, the original thought was for a low intensity linear convection/downburst event. Through most of the afternoon and evening, this is exactly what happened. When an outflow boundary interacted with the prefrontal squall line/bow echo, the scenario transformed to an enhanced wind damage event and possibly a tornadic event. One can even argue that this was in fact a tornadic event, and a tornado warning certainly could have been justified. Warning forecasters must always remain alert for indications that the convection is going to "throw you a curve", and not be resistant to shifting gears to accommodate the changing threat. This makes the difference between lead time and a missed event.

Figure 1

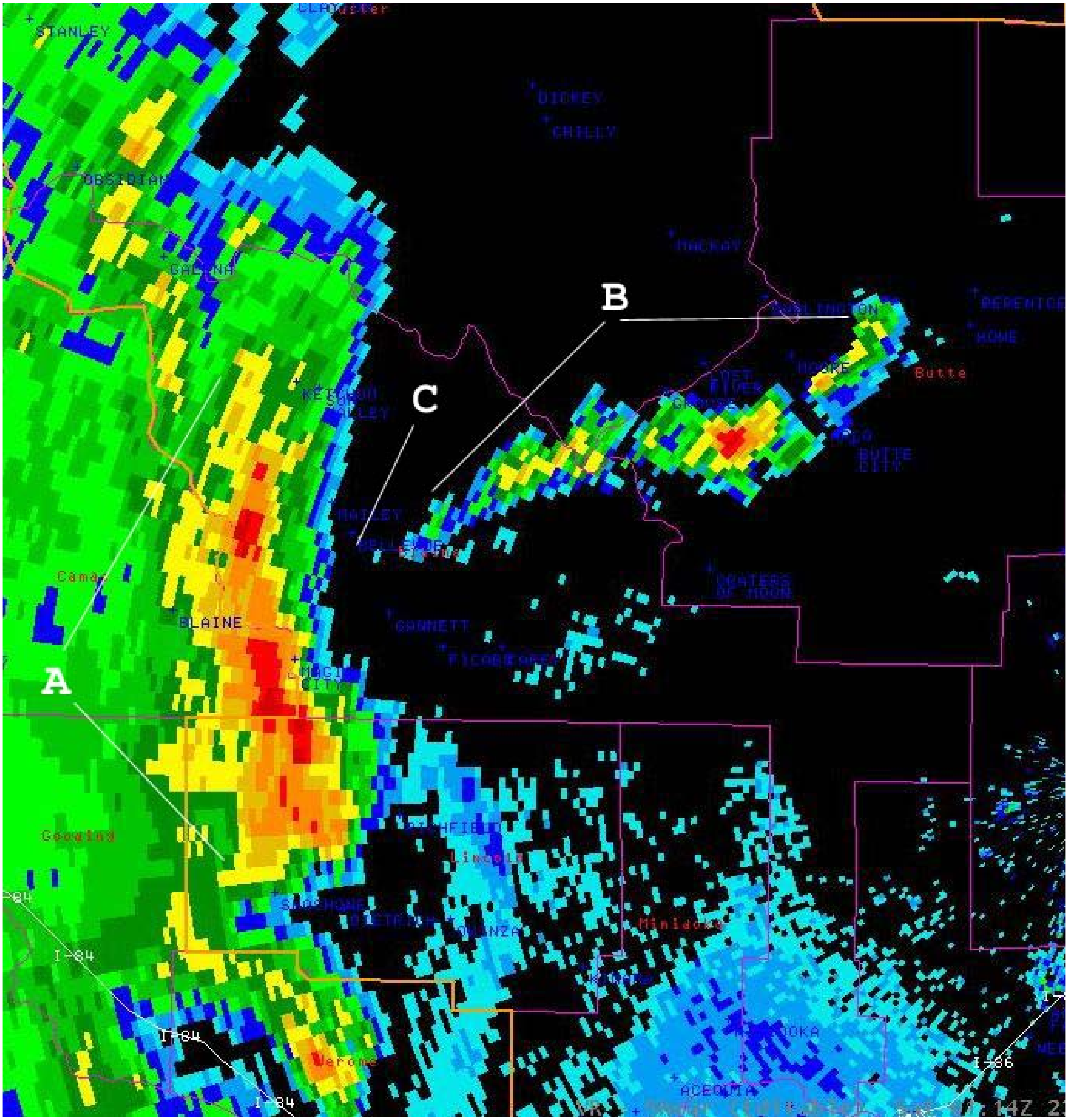

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Figure 2a

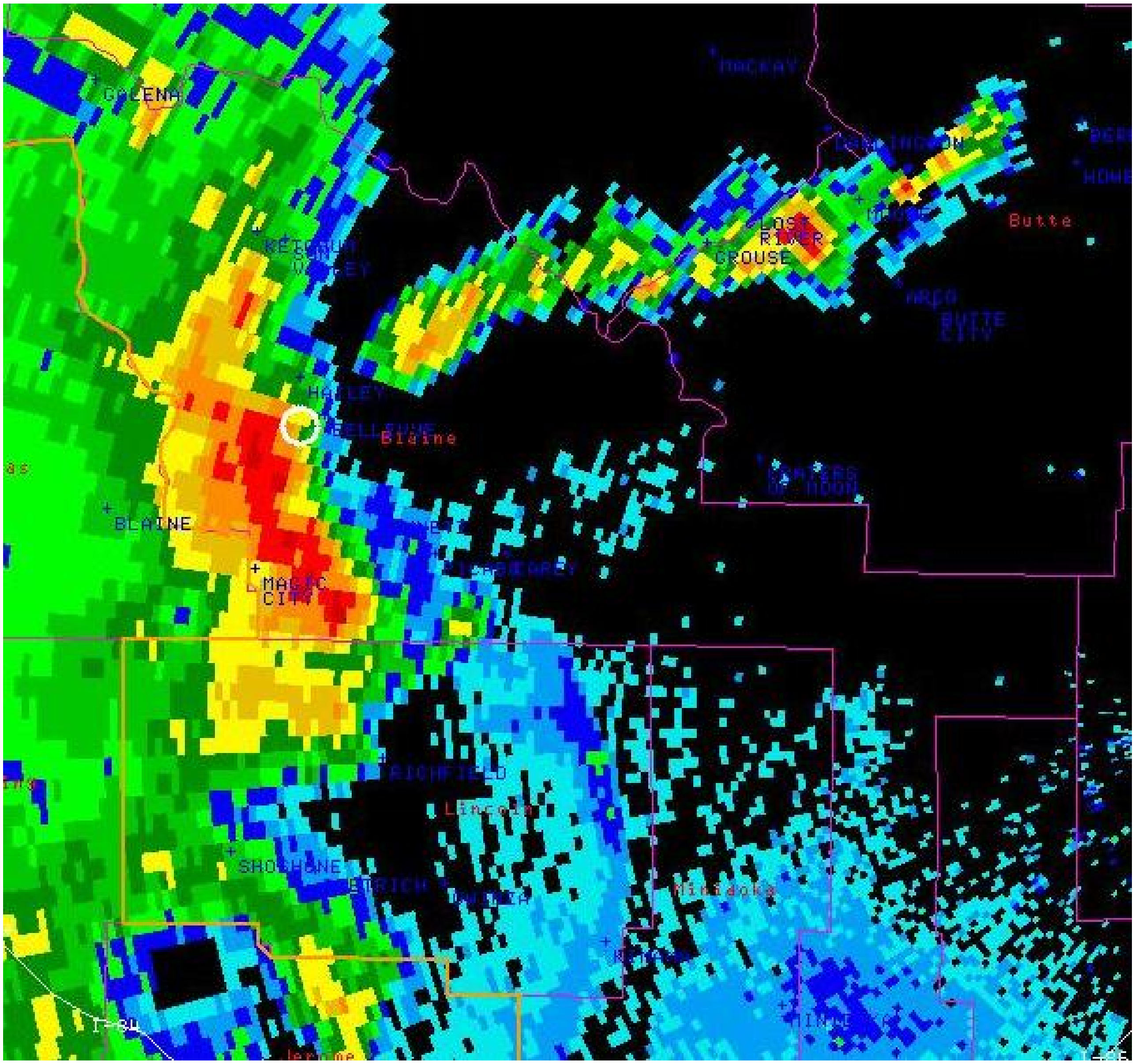
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Figure 2b

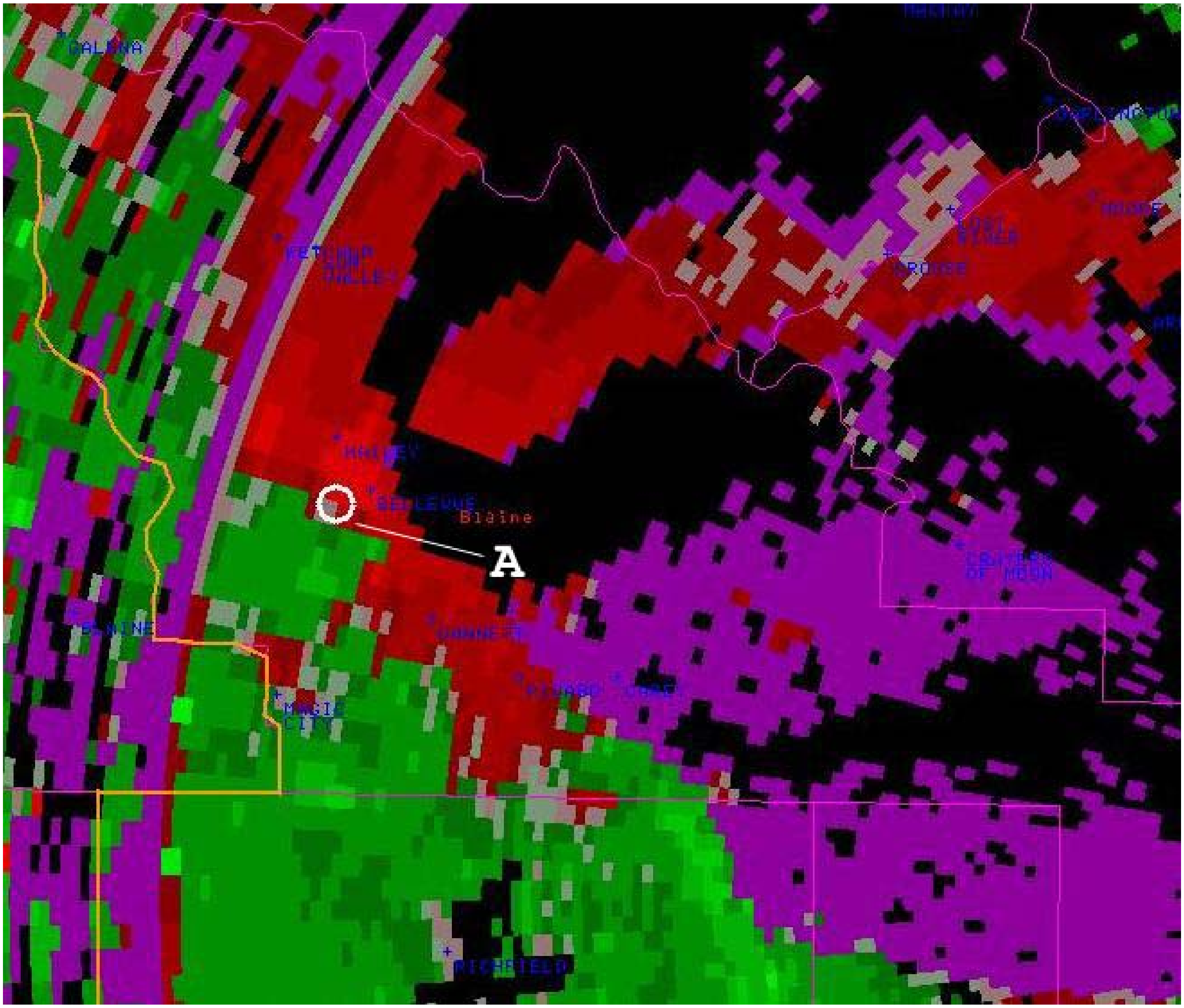
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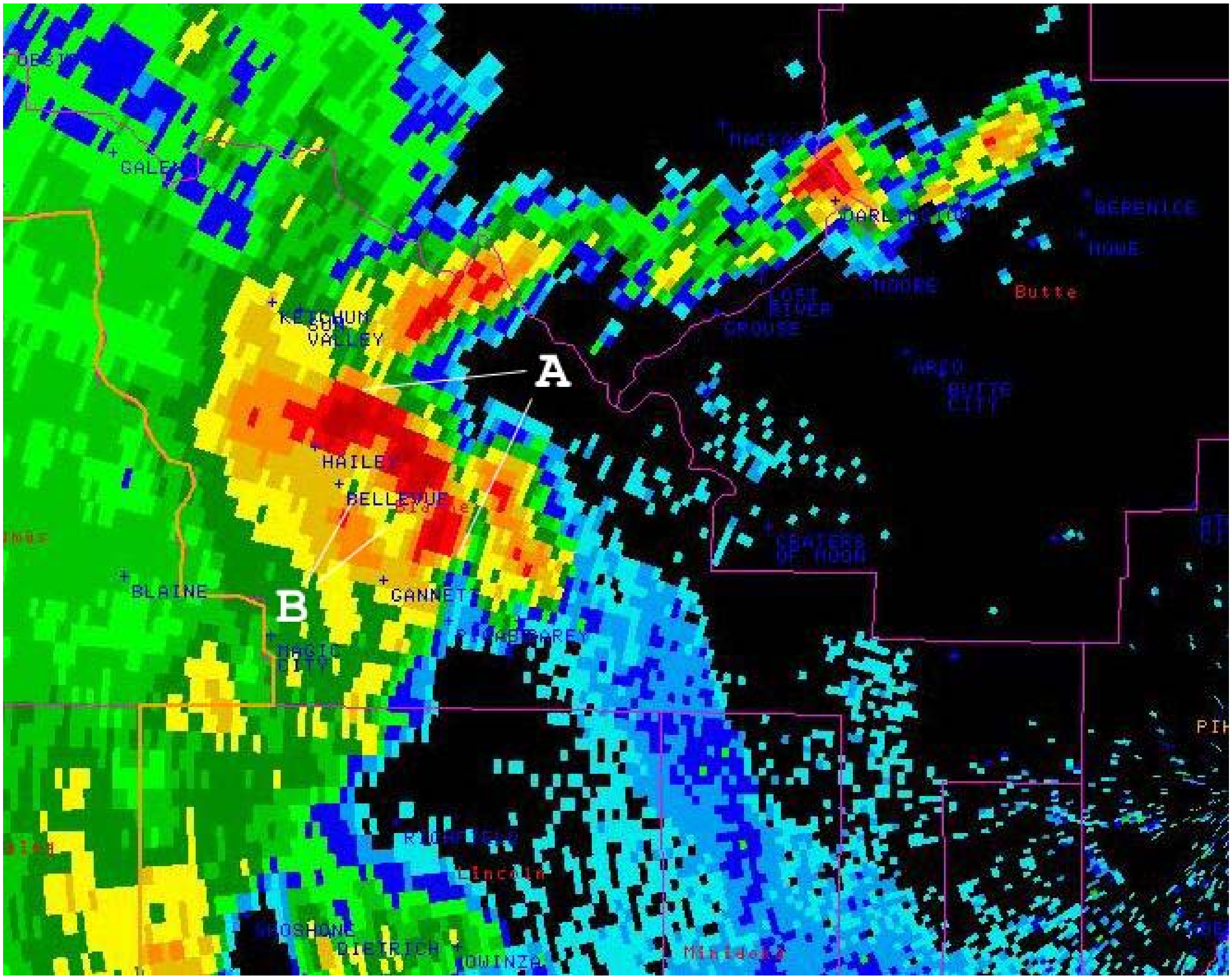
Figure 3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