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RELATIVE SURFACE WIND ANALYSIS ... A CASE STUDY

Richard S. Leblang
National Weather Service Forecast Office
Bismarck, North Dakota

1. Introduction

When analyzing the surface wind field for areas of convergence and, hence, vertical motion, it is oftentimes of value to subtract out the mean wind component. This resultant wind field is viewed from the frame of reference of the mean wind and not from that of the earth's surface. This type of analysis can be useful because it is in this frame of reference that convergence and circulation can most readily be seen. It is the frame of reference that the "air" sees.

2. Case Study

To study the usefulness of relative wind analysis, a computer program was written to perform a biquadratic objective analysis of the observed wind field. The program takes observed wind speeds and directions from 45 stations in a 600 x 500 mile grid centered over North Dakota. It then performs an objective analysis to the evenly spaced grid field. It is a simple process, at this point, to derive a mean wind vector for the field by averaging the wind at all the grid points. This mean wind vector can then be subtracted from all the grid points to obtain a relative (to the mean wind) or perturbation wind field.

Figure 1 depicts the observed wind field at 13Z on November 4, 1988. Low pressure was centered over Iowa with a trailing trough extending back through southeastern and central North Dakota. A secondary weak low center was near Jamestown (Figure 2). Figure 3 is the derived relative wind field. Note how well the convergence zone shows up over central and eastern North Dakota. Of most interest is the appearance of a perturbation circulation center over the north central part of the state near the Canadian border. This center was positioned very nearly under a mid level vorticity maximum as indicated in the 12Z satellite interpretation graphic issued by the National Severe Storms Forecast Center Satellite Unit (Figure 4). On the other hand, the 12Z NGM analysis had placed the vorticity center over extreme southwestern North Dakota. Although one would not necessarily expect a surface circulation center to be directly under a mid level vorticity maximum, it is interesting to note that the two features moved in tandem to the southeast for the remainder of the day and into that night.

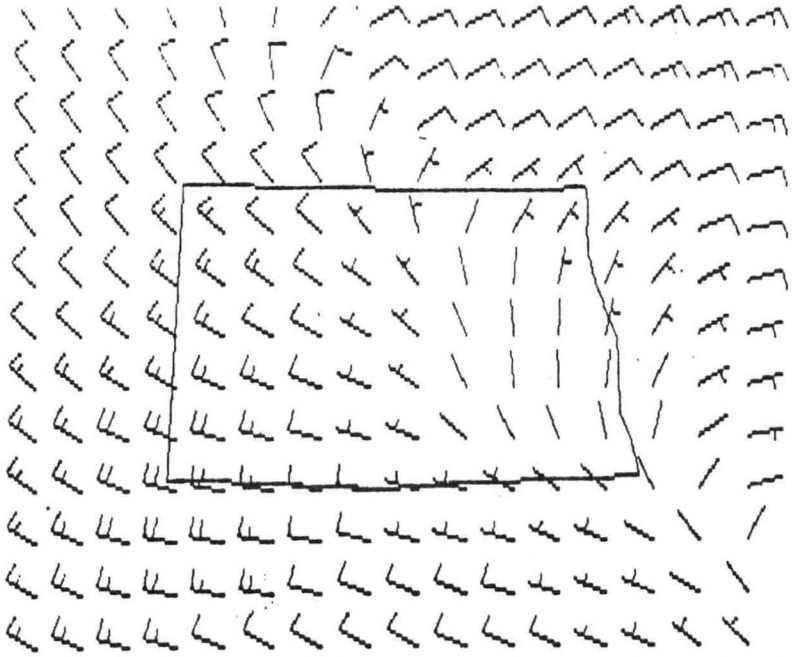

Fig. 1 Interpolated wind field for 13Z, November 4, 1988.

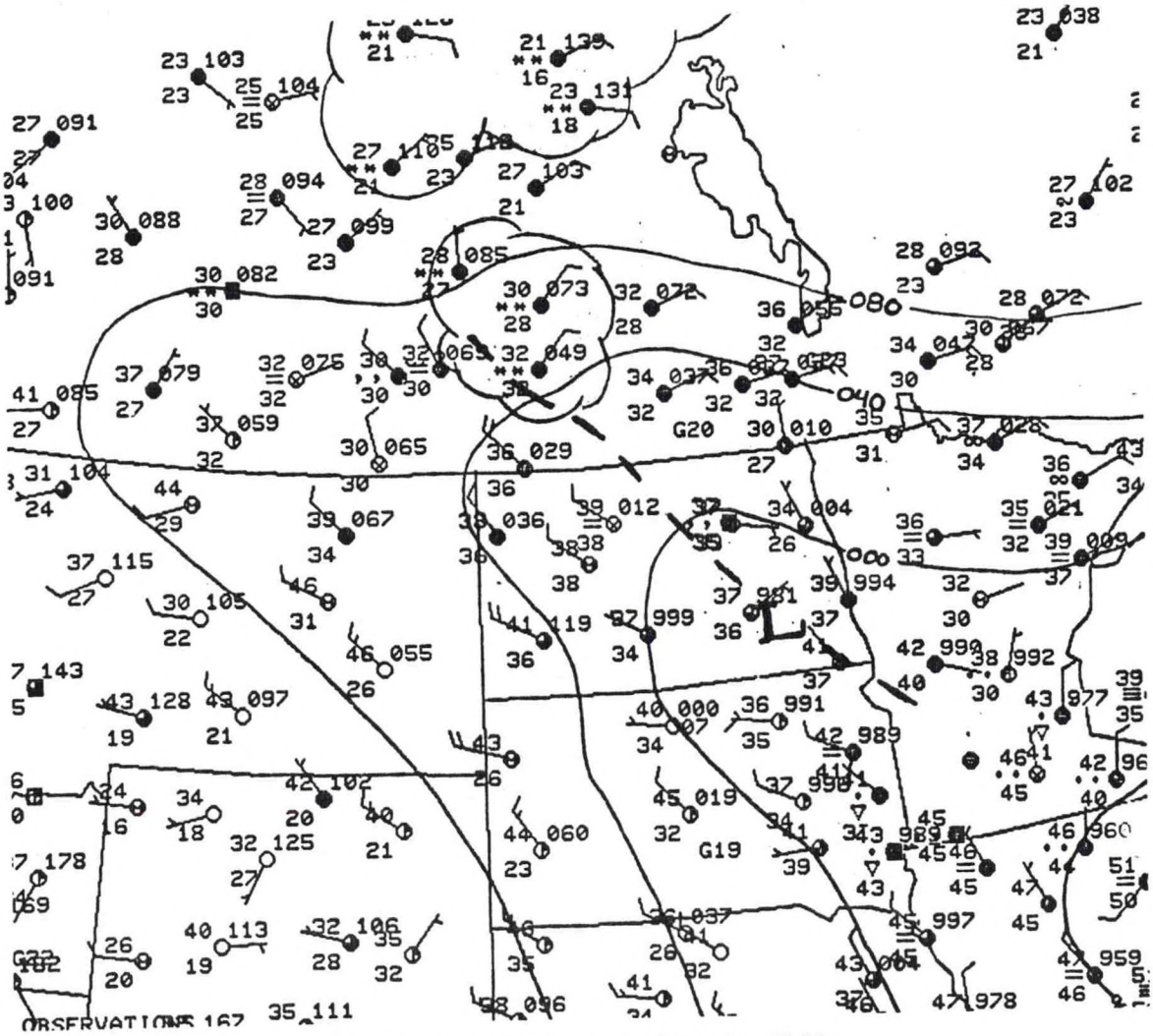

Fig. 2 Surface analysis for 13Z, November 4, 1988.

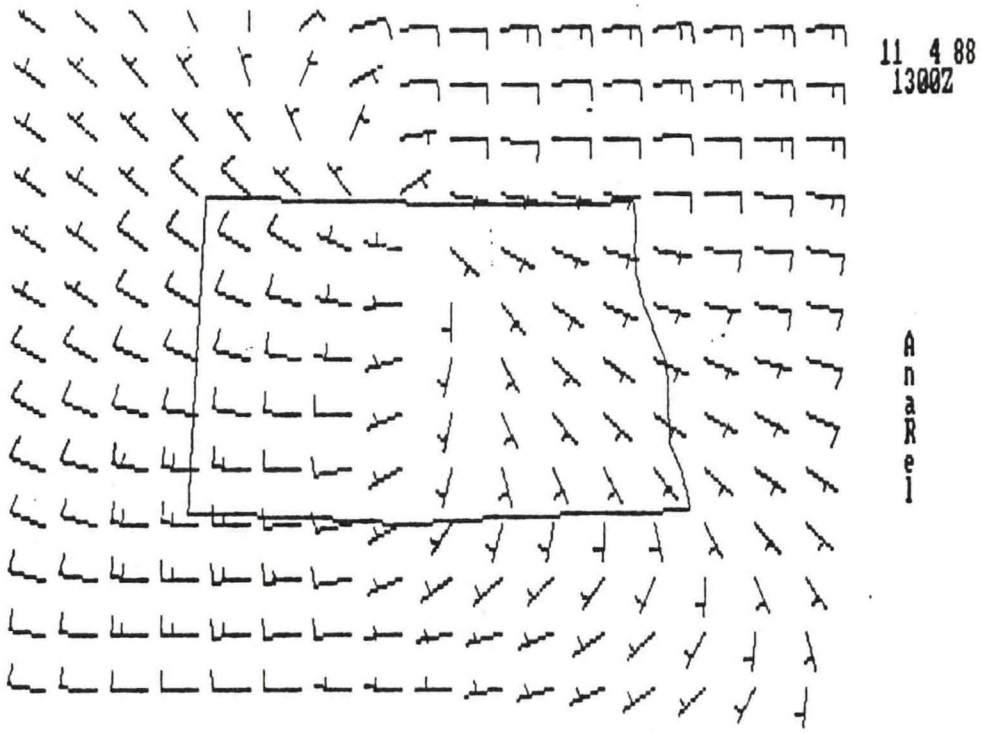

Fig. 3 Relative (perturbation) wind field for 13Z, November 4, 1988.

Fig. 4 SIM graphic issued 12Z, November 4, 1988.

Figure 5 depicts the relative wind analysis later in the day at 22Z. The circulation center had moved southeast along the convergence zone into South Dakota. Surface observations indicated that the passage of the circulation center preceded the onset of snow and rain along and east of the convergence zone by approximately two hours. Note also the position of the north end of the convergence zone along the Canadian border. This coincided with the north, or "back" edge, of the precipitation event.

3. Conclusions

The detection of vertical motion fields and the mid level dynamic structures associated with them is of significant importance in forecasting clouds and precipitation. The location and movement of these vertical motion fields and mid level vorticity centers can, at times, be deduced from associated surface convergence zones and circulation centers. A relative wind analysis can uncover or highlight these areas by removing the mean component of the wind field. This case study suggest that tracking these surface perturbation circulation centers allows one to follow, hour by hour, the motion of mid level structures and also verify the accuracy of the various atmospheric analyses and forecasts. In the short term, under the right set of circumstances, it could possibly allow one to make one to three hour forecasts of precipitation onset.

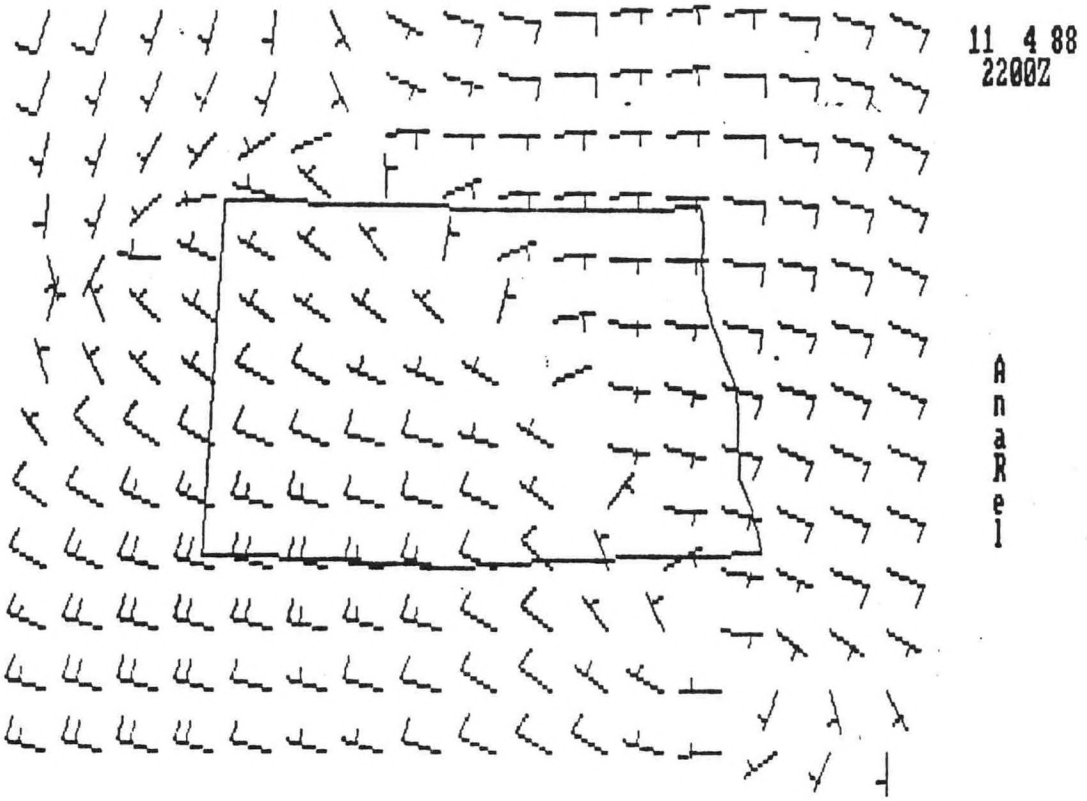

Fig. 5 Relative (perturbation) wind field for 22Z, November 4, 1988.