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AN AFOS Q-VECTOR PROGRAM UTILIZING MODEL FORECAST DATA

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1. Introduction

The vertical motion field is an important "bottom line" in any operational weather forecast as it is directly related to cloud cover and precipitation area and intensity. In day-to-day forecasting, vertical motion is often inferred from National Meteorological Center (NMC) model guidance using subjective interpretation of vorticity and temperature advection fields. Unfortunately, these two factors are often of opposite sign making even qualitative evaluation of vertical motion difficult.

Vertical motion is also directly available from the NMC models in both graphic and tabular format. However, these fields are often lacking in resolution. Also, they represent the complex physics of the model and may not always be representative of the synoptic scale vertical motion represented by the model's flow pattern. On the other hand, the Q-vector approach of Hoskins (1978) for diagnosing quasi-geostrophic vertical motion has gained a certain amount of popularity in recent years due to the ease of computation and its ready adaptability to micro-computers (Barnes, 1985 and Duran, 1987).

An AFOS program to compute the vertical motion field using the Q-vector approach was developed by the author in 1979. This was updated in 1982 to incorporate an automated data entry, objective analysis, and graphics package.

2. Analysis

One of the main limitations of diagnostic vertical motion from observed data is that its usefulness is limited to the short term or nowcast. The AFOS version of the program was updated in 1984 and 1986 to make it possible to run the program using Nested Grid Model (NGM) forecast data in place of observed data. Thus, diagnostic vertical motion was available using the Q-vector approach not only from observed data, but also for any time period for which NGM forecast data was available in AFOS. An example using this program is discussed below.

The 700 mb height and temperature field from 12Z October 20th is shown in Figure 1. The diagnosed vertical motion field from this observed data overlayed with the radar summary chart is shown in Figure 2. A large area of sinking was shown over the Plains states underneath northerly flow aloft with some weak cold advection. Some rising motion was indicated in the Great Lakes area just ahead of the 700 mb trough. Radar data showed some showers in this area. A second rising area was diagnosed in the warm advection area in Alberta.

The 36-hour NGM 700 mb and 1000-500 mb thickness forecasts valid 00Z on the 22nd is shown in Figure 3. The 36-hour NGM vertical motion forecast is shown in Figure 4. It indicates quite strong rising motion over eastern North Dakota with contributions from both the temperature and vorticity terms. The diagnosed vertical motion field based on Q-vector analysis using model forecast data is shown in Figure 5. In this case the two fields are similar in location and magnitude over North Dakota. Both verified well as up to four inches of snow fell in northeastern North Dakota during this period.

3. Summary

This case is somewhat of an exception in that the diagnosed vertical motion and the NGM vertical motion forecasts are quite similar. However, substantial differences have often been observed and it has been this author's experience that the diagnosed vertical motion is often superior. It goes without saying, of course, that the diagnosed vertical motion is no better than the model data from which it is derived.

4. References

Hoskins, B. J., I. Draghici and H. C. Davies, 1978: A New Look at the w-equation. Quart. J. Royal Meteor. Soc., 104, 31-38.

Barnes, S. L., 1985: Omega Diagnostics as a Supplement to LFM/MOS Guidance in Weakly Forced Convective Situations. Mon. Wea. Rev., 113, 2122-2141.

Duran, D.R., and L.W. Snellman, 1987: The Diagnosis of Synoptic-Scale Vertical Motion in an Operational Environment. Wea. and Forecasting, 2, 3-16.

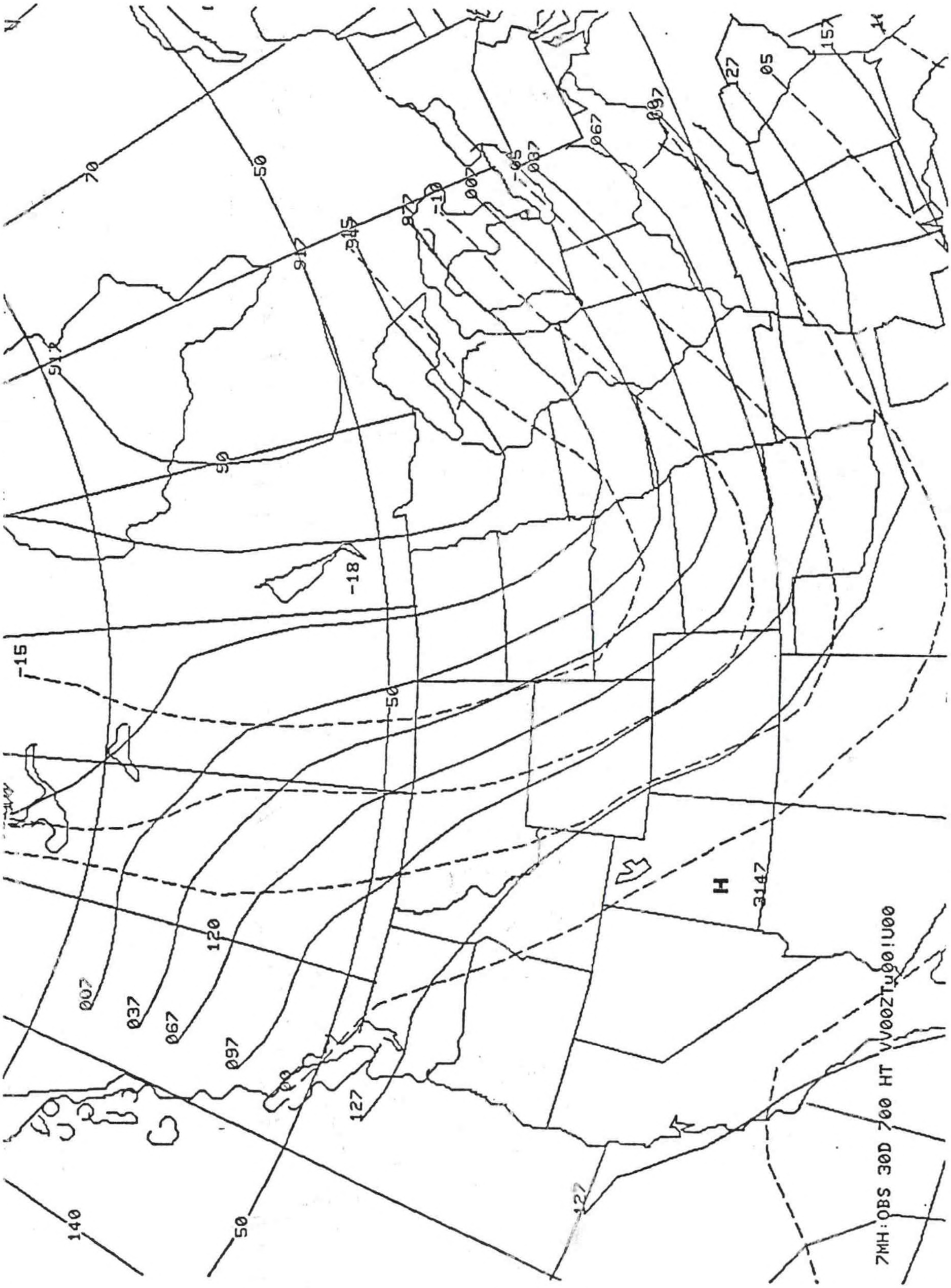

Fig. 1 Observed 700 mb height (solid line) and temperature (dashed line) fields for 12Z, October 20, 1987.

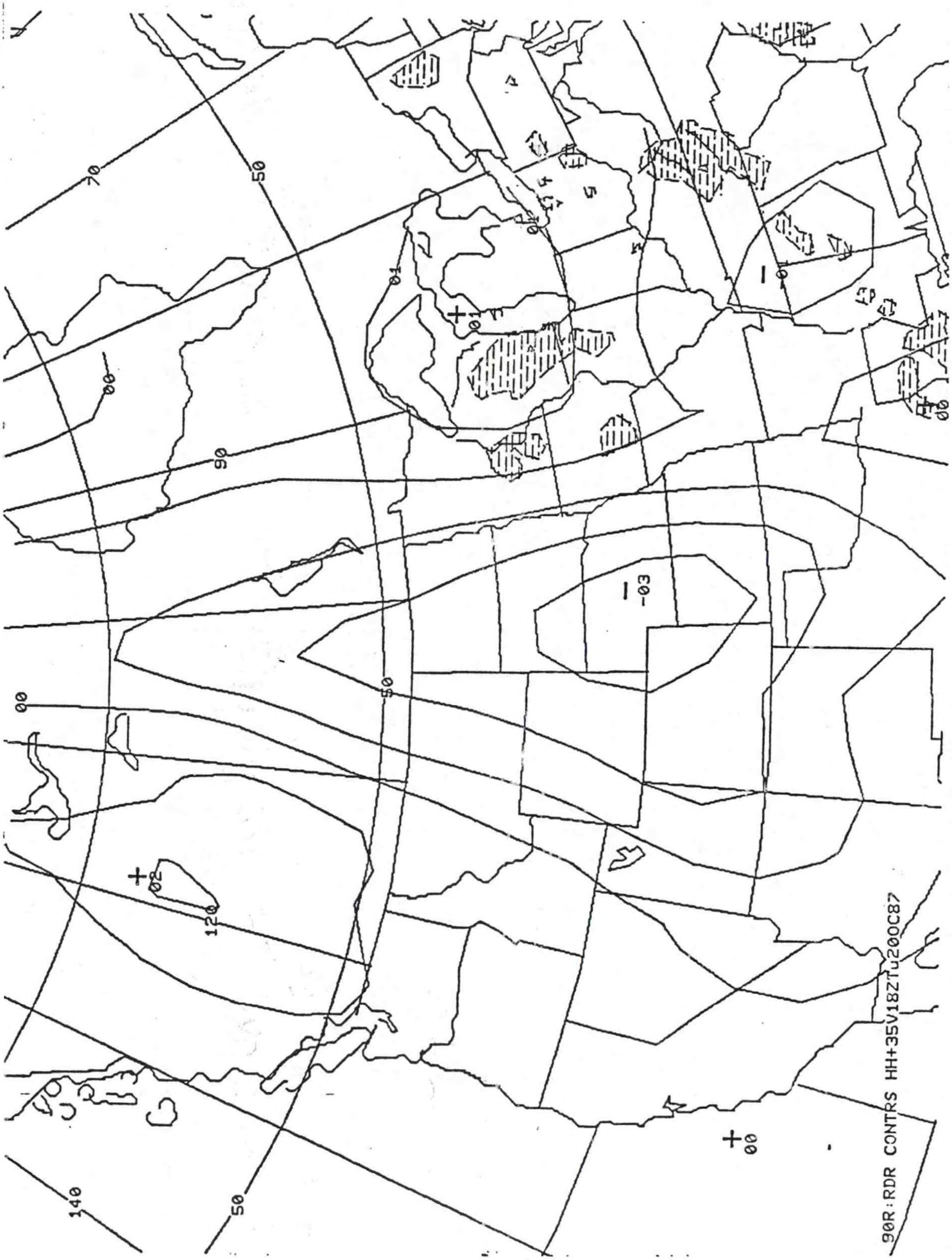

Fig. 2 Diagnosed 700 mb vertical motion using observed data and radar summary charts for 12Z, October 20, 1987.

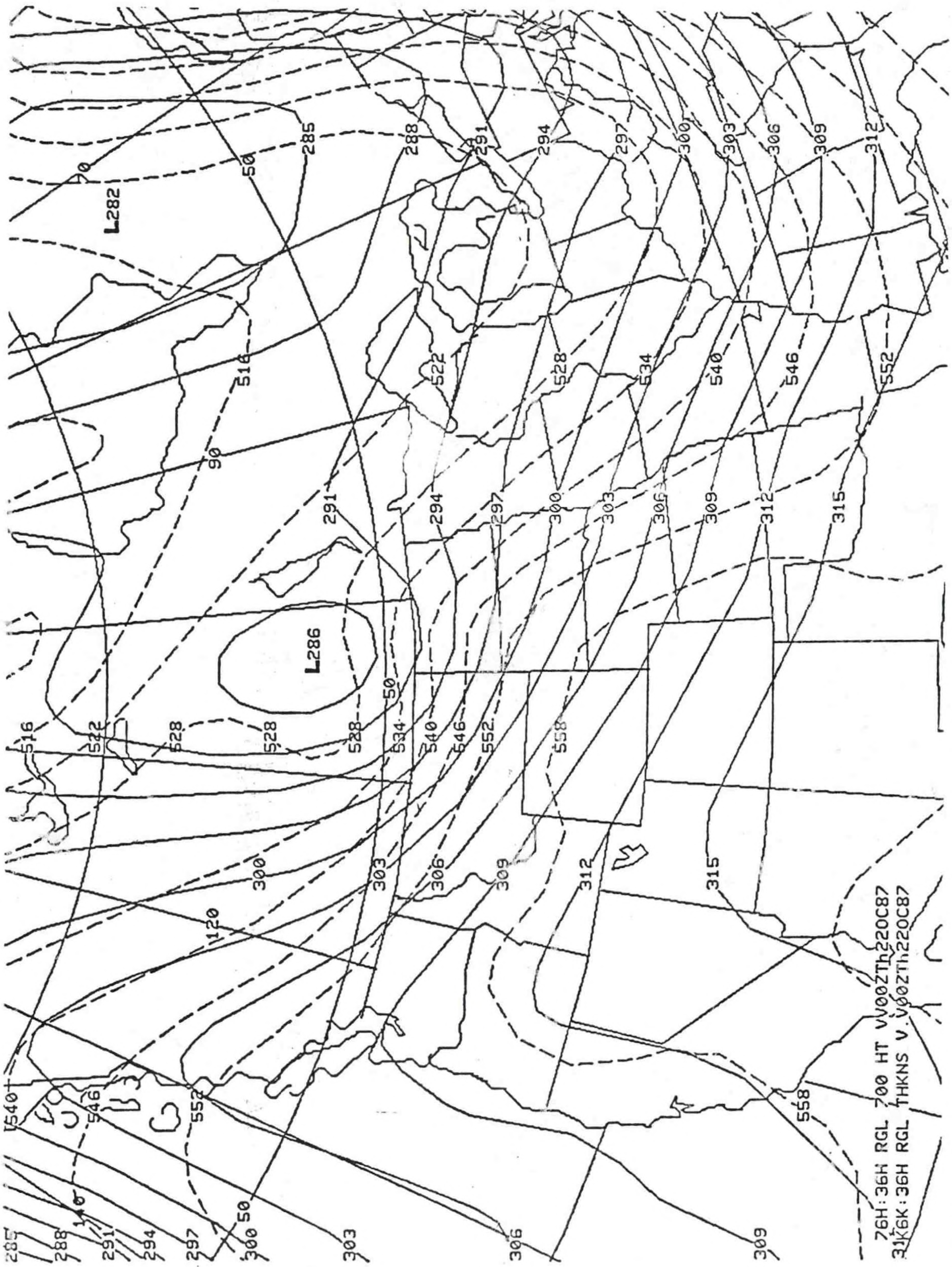

Fig. 3 The 36-hour NGM forecast for 700 mb heights (solid) and thickness (dashed) valid 00Z, October 22, 1987.

Fig. 4 The 36-hour NGM vertical motion forecast valid 00Z, October 22, 1987.

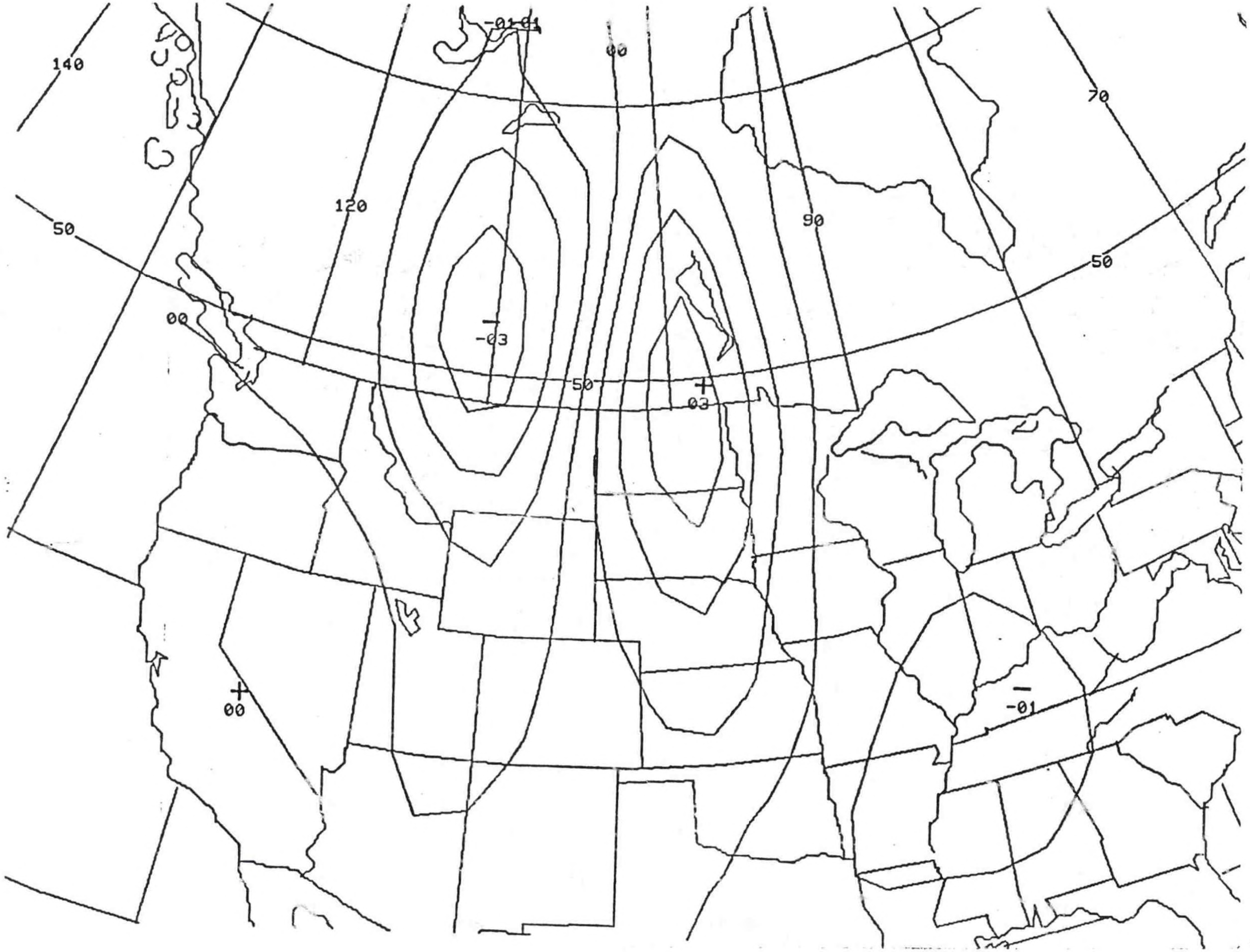

Fig. 5 Diagnosed vertical motion applying Q-vector analysis to model forecast data valid for 00Z, October 22, 1987.