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USE OF ISENTROPIC CHARTS IN THE 1980s
PART II - EXAMPLE

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Last week's Technical Attachment put forth the idea that use of isentropic charts was currently feasible and offered an excellent additional diagnostic tool for the evaluation of mid-tropospheric vertical motion. In this and the subsequent discussion in Part III, we shall demonstrate the construction and use of isentropic charts using recent examples. These examples are cases when the isentropic charts were used during the Graduate Forecast Seminar current-weather discussions at the University of Utah. In other words, the following discussions are more a synopsis of the actual discussions rather than hindcasts.

12Z 12 February 1986

On February 12th, there was considerable precipitation occurring in Washington, Oregon, and California with middle and high clouds covering Nevada, Idaho, and western sections of Utah and Montana. There were a few spits of snow in Idaho (see Figure 1). To intelligently forecast the spread and/or continuation of the precipitation, forecasters needed to understand the physical reasons associated with the vertical motion existing, i.e., vorticity and thermal advective patterns and topography. The 500-mb vorticity chart, Figure 2, shows that most of the precipitation in Washington, Oregon, and extreme northern California was associated with neutral vorticity advection! Some positive vorticity advection (PVA) existed in eastern Washington. The thermal advection at 700 mbs, Figure 3, indicates the strongest warm-air advection was over extreme southern Oregon and central Idaho, an area of little or no precipitation. Things seemed backward - precipitation with no PVA and no precipitation where the warm-air advection was strongest. Can the isentropic chart help in this confused situation?

The $\theta = 294^{o}$K isentropic chart for 12Z was constructed using the principles given in Part I (see Figure 4). The 500- and 700-mb isobars were analyzed using the -8^{o} 700-mb isotherm and -32^{o} 500-mb isotherm; the streamlines were analyzed using 700- and 500-mb contours, especially in the Pacific Northwest and over Idaho and Montana. The movement of the θ-surface over the next 12 hours was assessed using the initial (12Z) and 12-hour prognostic (VT 00Z February 13) 1000-500-mb thickness fields (Figure 5). The thickness charts indicated that the θ-surface was moving slightly northward in Washington, Oregon, and Idaho, little change was evident in northern California, and there was rapid motion northeastward in Montana, Wyoming, Utah, and Nevada. Putting this all together says that the strong upglide motion indicated in the Pacific Northwest was truly upwards vertical motion and should continue while the upglide in extreme southern Oregon and part of Idaho and Utah was weaker than indicated, and downward motion actually existed in Wyoming. (Compare the relative differences in the wind speeds given and the θ-surface motion inferred from the forecast thickness changes.) This vertical motion pattern agrees well with the existing weather and calls attention to the large contribution being made by thermal advection.

Recall for a moment that for synoptic-scale systems, it is the Laplacian of the warm-air advection and not the warm-air advection itself that is related to vertical motion (from the omega equation). Referring back to the thermal advection pattern at 700 mb (Figure 3), it is evident that the sharpest spatial change of the thermal advection (i.e., where the Laplacian is large) is associated with the precipitation area of Washington and Oregon. The Laplacian is near zero over southeast Oregon and central Idaho, and then increases slightly over northern Nevada and Utah and southeast Idaho. If we were to schematically graph the magnitude of the warm advection along a line from Seattle to Salt Lake City it would look something like Figure 6 below. It is where the change in temperature advection is greatest that the Laplacian is strongest.

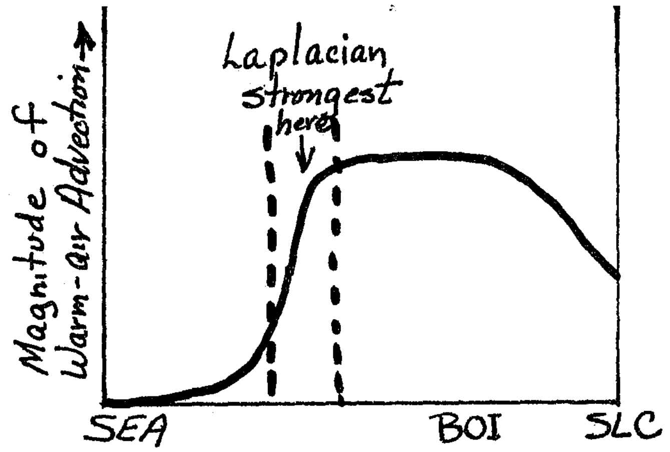

FIGURE 6.

Implications from the isentropic analysis were that the precipitation shield covering Washington, Oregon, and northern California would persist and expand slowly eastward over Idaho, Nevada, and Utah. Wyoming would remain clear except for the extreme western sections of the state.

Reference was next made to the 12-hour LFM guidance, Figures 7a and 7b. The fact that there was no significant PVA forecast anywhere in the Western Region, except possibly in eastern Montana, did not deter us from accepting the QPF forecast guidance with high confidence. Note that this included forecasting no precipitation in the PVA area of Montana. Of special interest is that the strong warm-air advection pattern in Figure 3 resulted in strong warming occurring only over Wyoming during the 12th. There was less warming over southern Idaho, northern Nevada and Utah, indicating both warming and upwards motion existing. Essentially no warming occurred in Washington, Oregon, and California indicating significant upwards motion. See Figure 8 and paragraph Ic in Part I.

Summary

In the case of 12 February 1986, construction and use of the 294°K isentropic chart played an important role in the interpretation and weight given to NWP guidance during preparation of short-range precipitation forecasts. This example demonstrates the use of a MAN/MACHINE mix that emphasizes a detailed diagnosis of existing weather as an important first step in interpreting and following or modifying short-term NWP guidance.

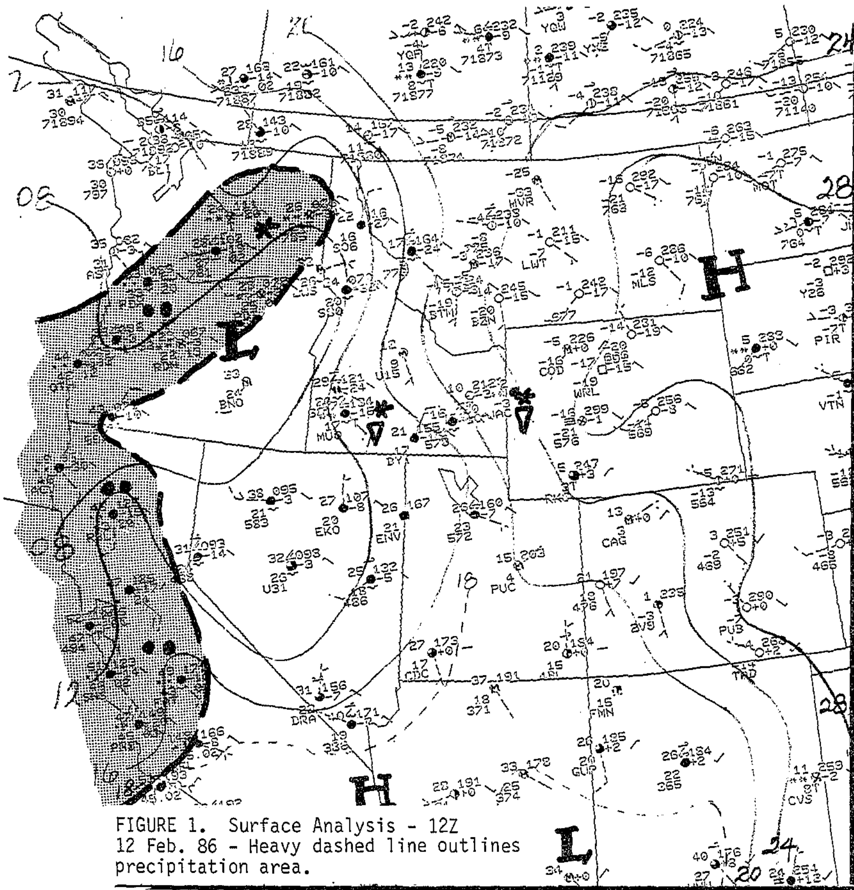

FIGURE 1. Surface Analysis - 12Z 12 Feb. 86 - Heavy dashed line outlines precipitation area.

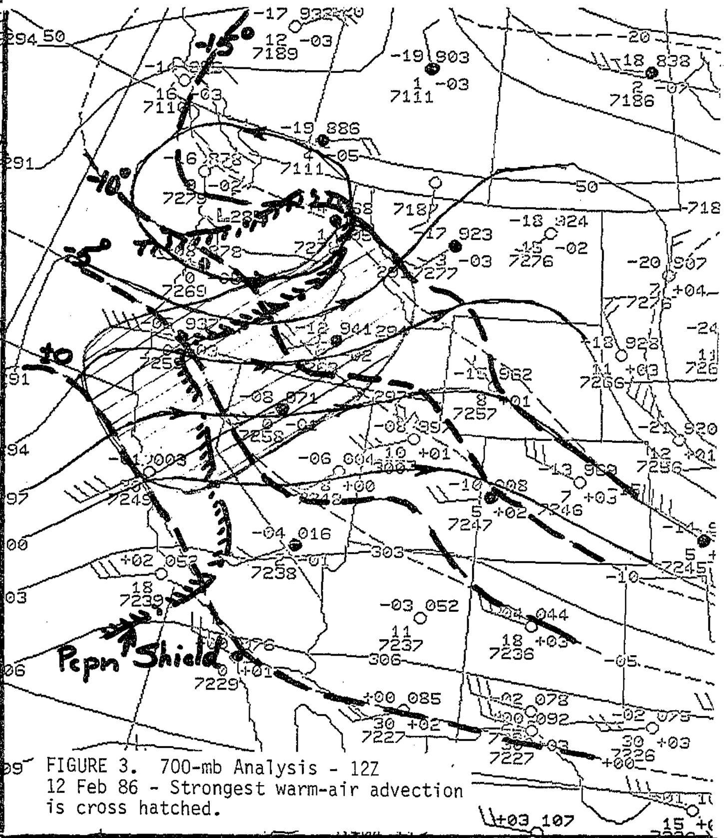

FIGURE 3. 700-mb Analysis - 12Z 12 Feb 86 - Strongest warm-air advection is cross hatched.

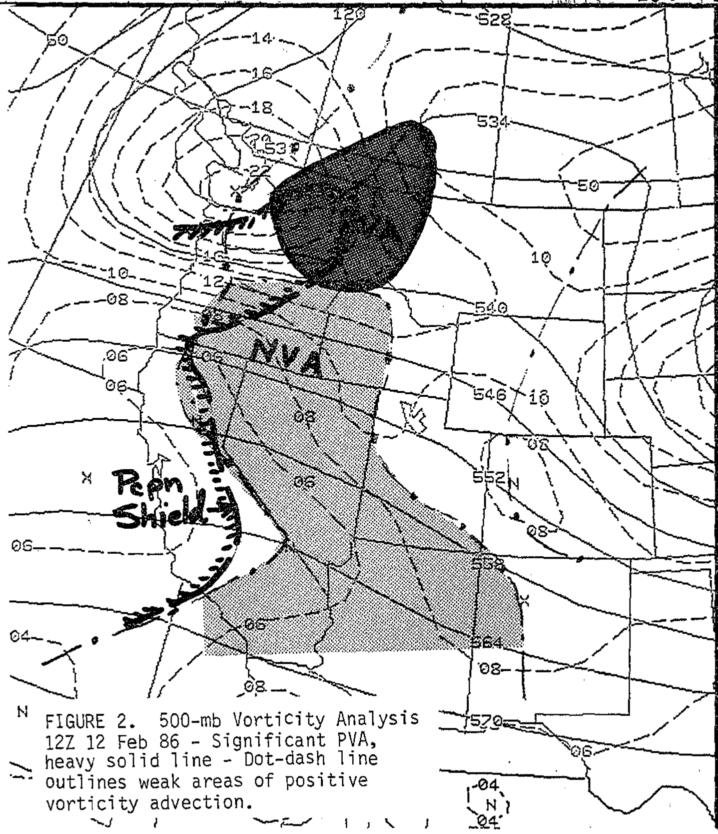

FIGURE 2. 500-mb Vorticity Analysis 12Z 12 Feb 86 - Significant PVA, heavy solid line - Dot-dash line outlines weak areas of positive vorticity advection.

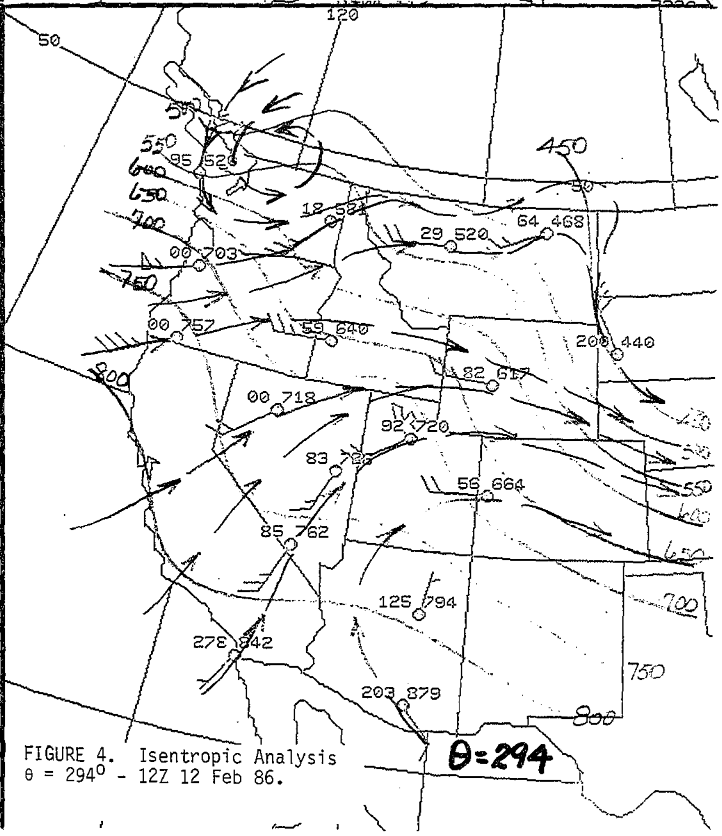

FIGURE 4. Isentropic Analysis θ = 294° - 12Z 12 Feb 86.

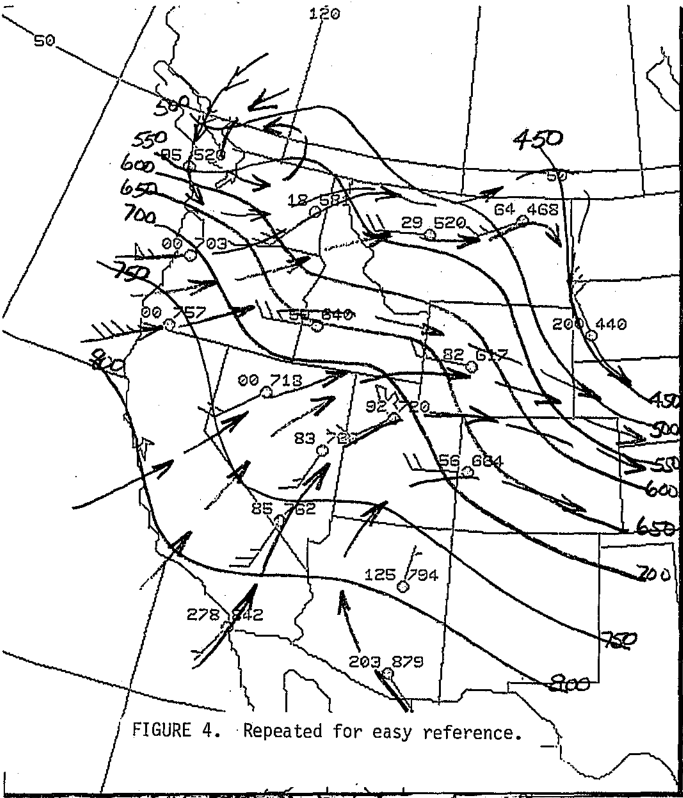

FIGURE 4. Repeated for easy reference.

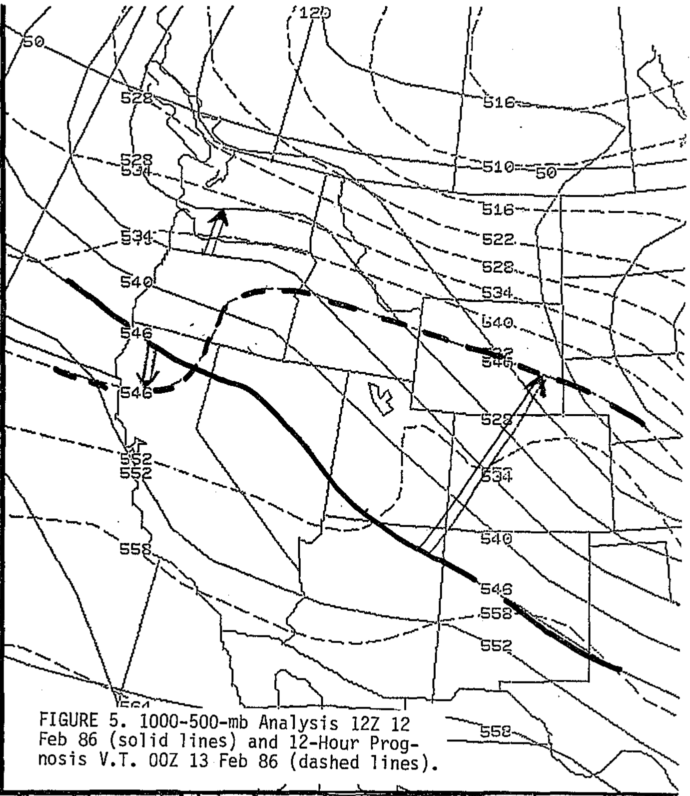

FIGURE 5. 1000-500-mb Analysis 12Z 12 Feb 86 (solid lines) and 12-Hour Prognosis V.T. 00Z 13 Feb 86 (dashed lines).

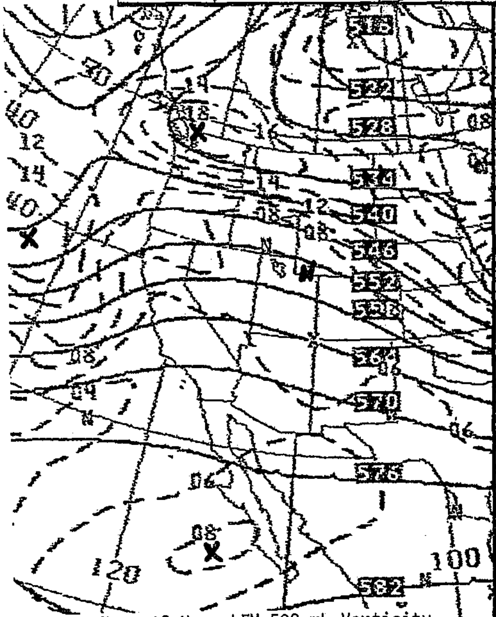

FIGURE 7a. 12-Hour LFM 500-mb Vorticity Prognosis V.T. 00Z 13 Feb 86.

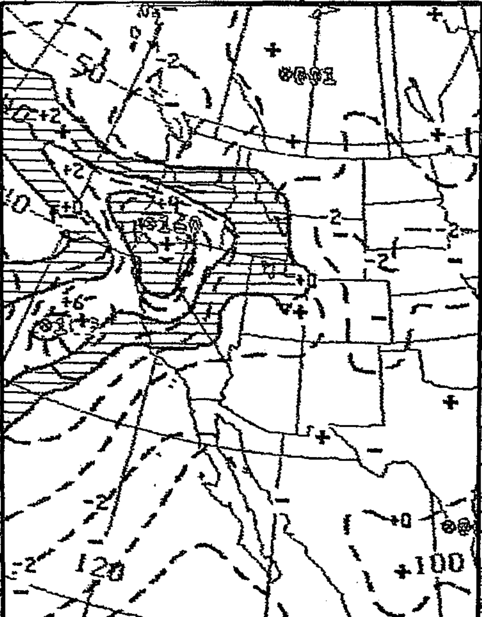

FIGURE 7b. 12-Hour LFM Precipitation Forecast V.T. 00Z 13 Feb 86.

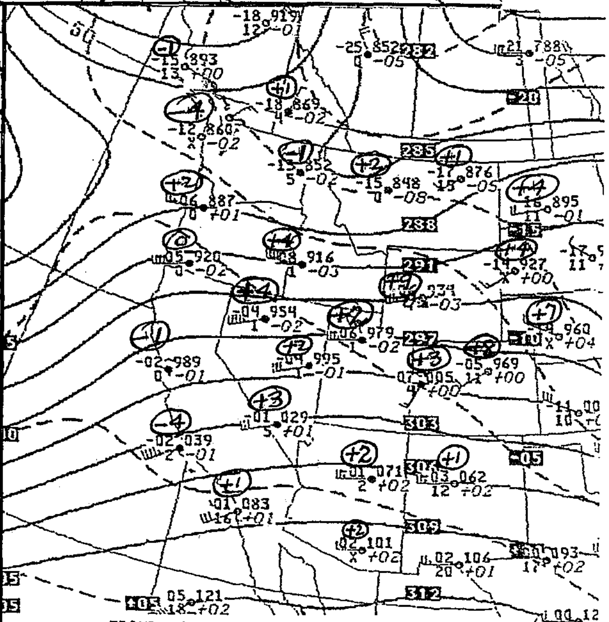

FIGURE 8. 700-mb Analysis 00Z 13 Feb 86. Circled numbers 12-hour temperature changes 12Z/12th to 00Z/13th.