WESTERN REGION TECHNICAL ATTACHMENT
NO. 87-23
JULY 8, 1987

CROSS SECTIONS IDENTIFY POTENTIAL INSTABILITY

During the few days from June 30 through July 2, 1987, a deformation axis progressed north and east across the northern portion of the Western Region. The associated ageostrophic vertical motions (see WRTA 86-15 for information about deformation zone kinematics and dynamics) enhanced the convective activity on the south side of this axis. In addition, the airmass on the south side of the deformation axis was potentially unstable. The vertical distribution of temperature and moisture in this area were such that lifting could cause the airmass to become absolutely unstable. This potential instability occurs when lower layers of an airmass saturate before the upper layers. Any further lifting will cause destabilization as lower layers cool more slowly than the upper layers due to the latent heat of condensation released. This condition is satisfied when the equivalent potential temperature (Theta-E) decreases with height.

Identifying the deformation axis requires careful examination of the frontogenetical aspects of the thermal advection fields at low levels (again, see WRTA 86-15). Determining the potential instability within an airmass has, until now, been a much more complex process. In the past, hand calculation of Theta-E temperature was required. Now, the new Convective Cross Section Programs (WRCP 55) can do this automatically. In the case presented here, a large area of potential instability existed (Theta-E temperature decreased with height), enough low-level moisture existed so that saturation would occur quickly (dew-point depressions were low), and a lifting mechanism existed (ageostrophic motions south of deformation axis). All of these ingredients combined to generate considerable convective activity in the area.

Figures 1 through 3 show the morning cross sections and lightning accumulation for 30 June through 2 July. In each figure panel A shows the Theta-E cross sections with areas of potential instability dashed. Panel B shows the dew-point depression cross sections with the 10-degree line highlighted. Panel C shows the 24-hour lightning accumulation for each day.

On 30 June (Figure 1), the deformation axis was along the northern Oregon and southern Montana border. The potentially unstable air was in a relatively shallow layer across most of the region, but appeared deeper and most unstable near Winnemucca, NV (WMC). Notice from the lightning chart how the location of lightning strikes clearly defines the deformation axis since most strikes were confined south of the axis.

By 1 July (Figure 2), the area of potential instability had thickened and moved north with the area of greatest instability near Boise, ID (BOI). Also, note that there was more low-level moisture in Montana than during the previous day, making it easier to release the potential instability there. The 24-hour lightning chart shows this northward drift of convective activity quite well. The activity is still confined to the area south of the deformation axis which extended NW to SE across central Montana at this time.

The deformation axis moved very little between 1 July and 2 July, but the region of potential instability moved east. On 2 July (Figure 3), very little instability remained near Winnemucca and a significant decrease in lightning occurred over western Nevada. The potentially unstable layer had become quite deep at Great Falls, MT (GTF), with low dew-point depressions at low-levels. There was a significant increase in lightning activity in Montana on this day as compared to the previous two days.

The cross sections proved to be a useful forecast tool in this convective situation. The information provided by the cross sections gave a sound physical explanation for the thunderstorm activity and helped in forecasting the movement of the convective area. The statistical guidance provided by thunderstorm probability forecasts (not shown) was also exceptionally good at tracking this area of convective activity.

References:

1 Barker, Timothy W., 1987: Convective Cross Section Analysis NOAA Western Region Computer Programs and Problems NWS WRCP - No. 55, June, 1987.

2 Precipitation, Frontogenesis and the Deformation Zone Western Region Technical Attachment - No. 86-15, April 15, 1986.

Editors Note: The referenced CP, WRCP 55, has just been sent out. The software has not been distributed yet, but will be before the end of July.

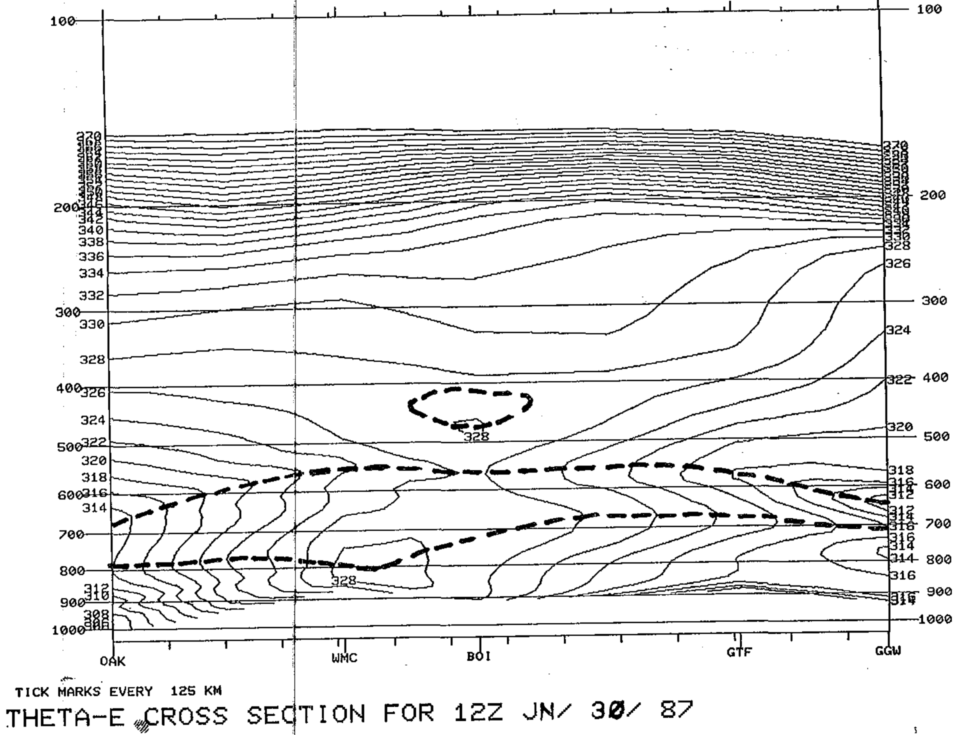


Figure 1-A

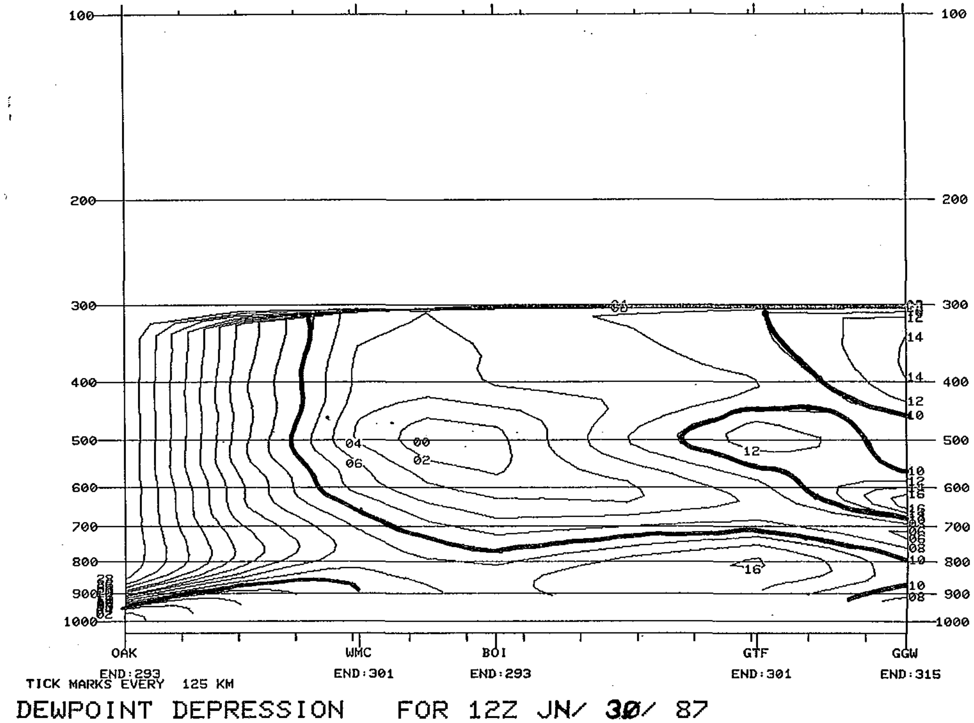


Figure 1-B

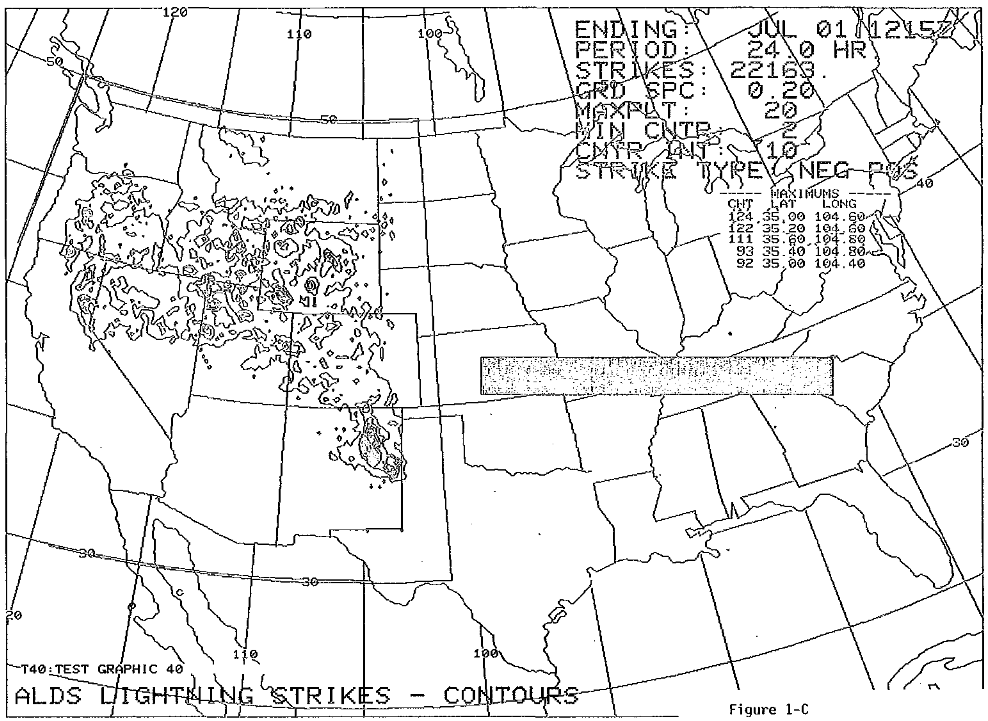


Figure 1-C

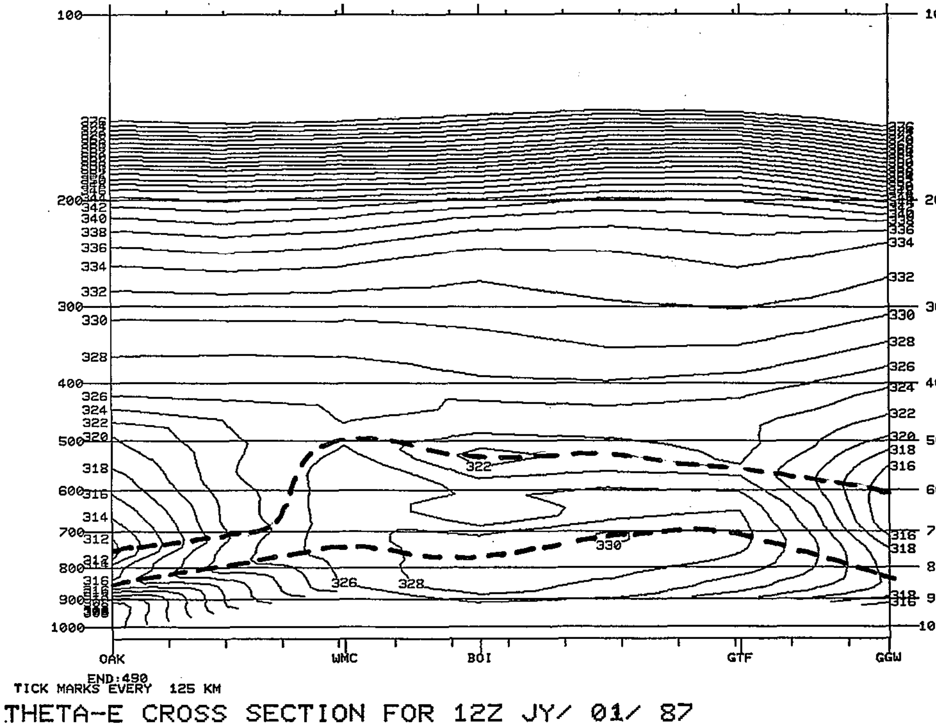


Figure 2-A

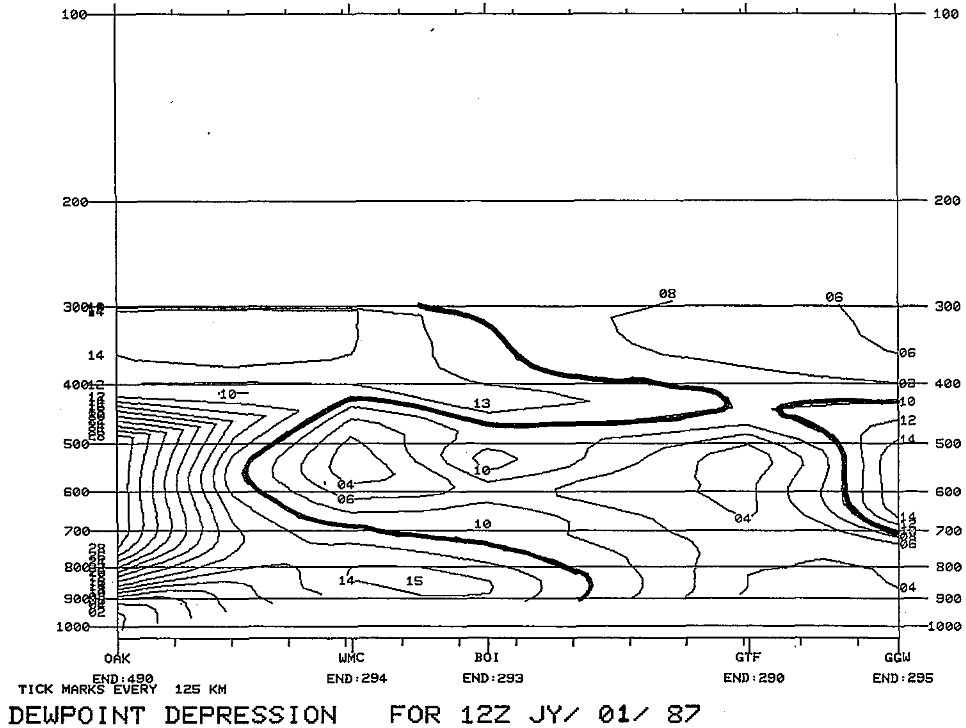
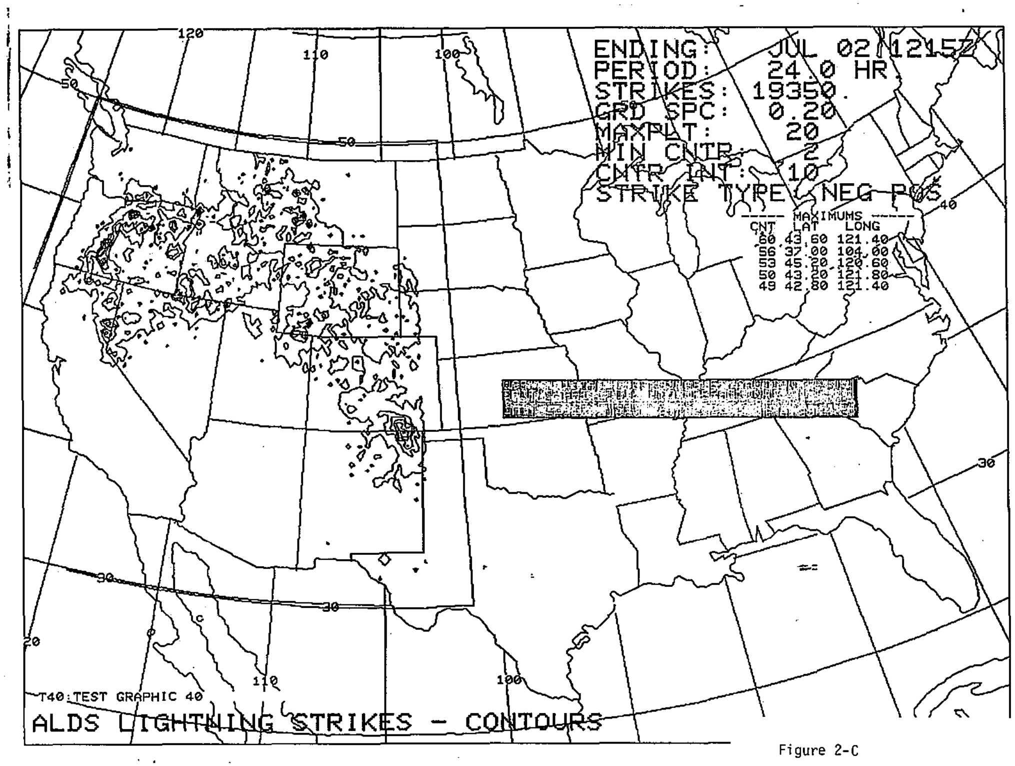


Figure 2-B



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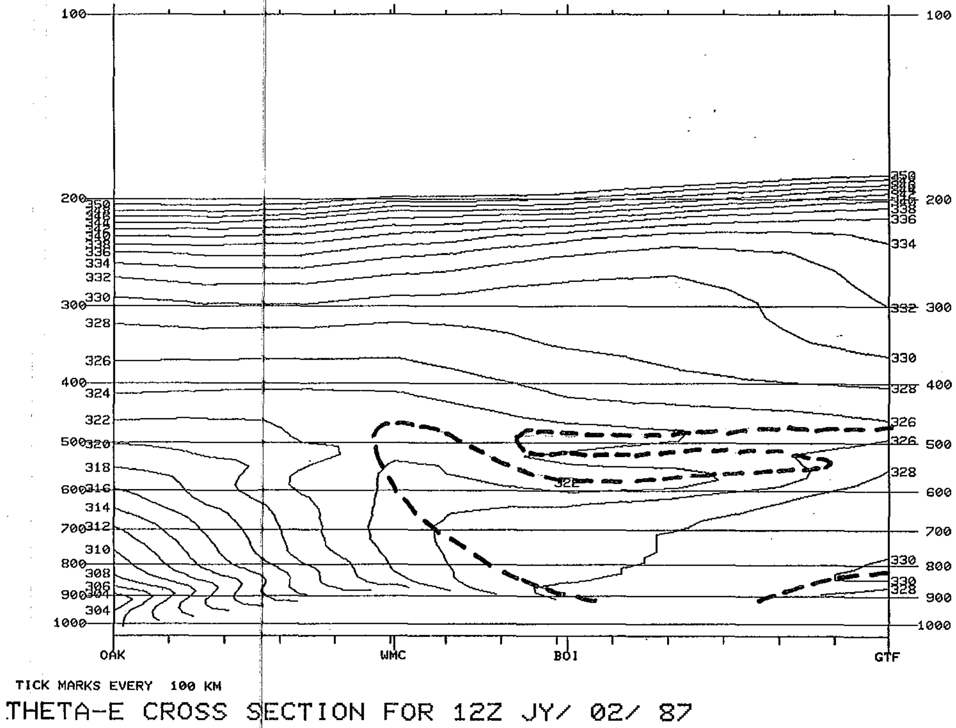

Figure 3-A

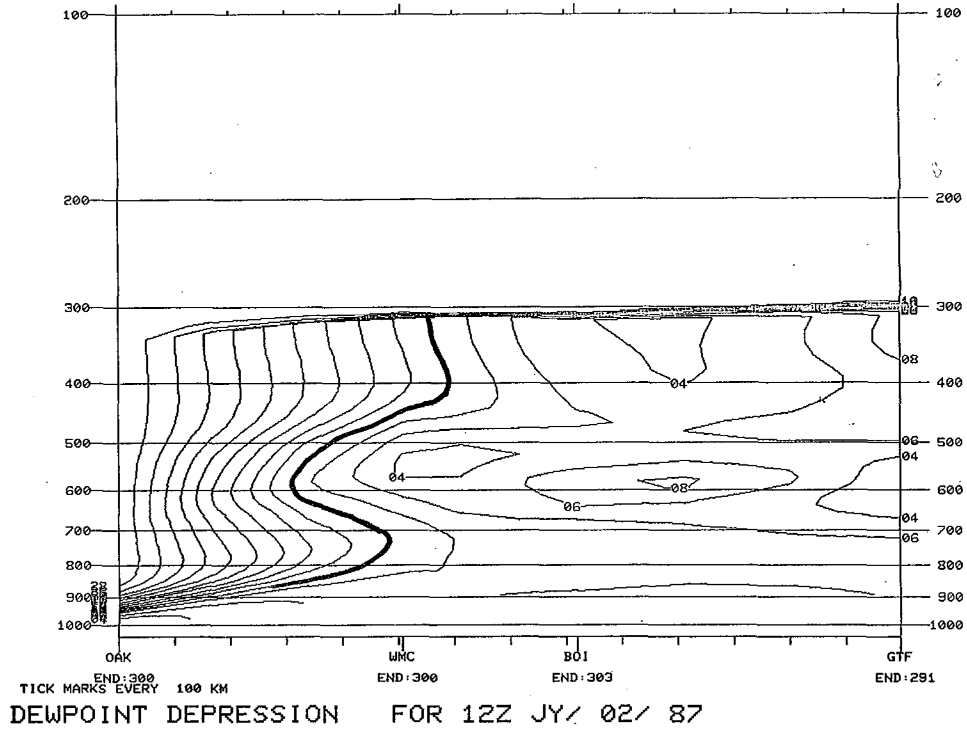

Figure 3-B

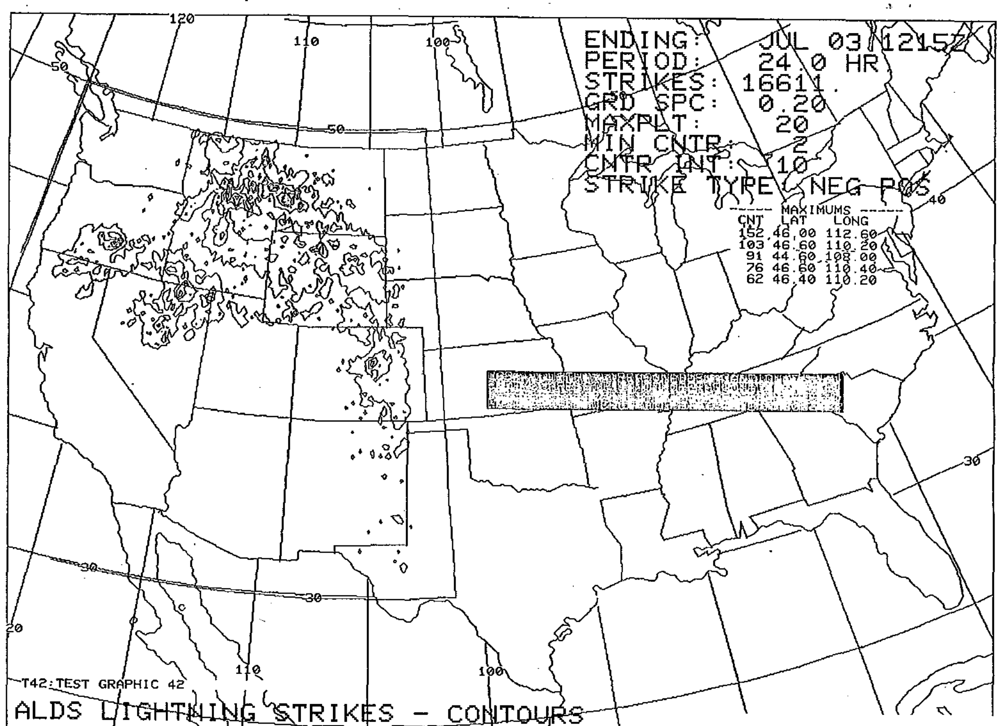

Figure 3-C