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THE ETA PRECIPITATION FORECASTS FOR THE TUCSON AREA DURING THE LANDFALL OF TROPICAL STORM NORA

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Introduction

On September 25, 1997, tropical storm "Nora" moved into Arizona. Tropical storms rarely affect the southwest U.S. so forecaster experience with such events is minimal. The main concern with the arrival of Nora was the amount and coverage of rainfall in Arizona and southern California. Forecasters in this area, including the Tucson weather office, were tasked with providing a forecast of precipitation for the public as well as guidance for the Colorado Basin River Forecast Center (CBRFC).

The National Center for Environmental Prediction (NCEP) forecast models have a hard time forecasting for the desert Southwest in summertime (see Dunn and Horel, 1994). Very little reliable data are available in northern Mexico, which makes model initialization tricky. Weak synoptic flow and the chaotic nature of monsoon thunderstorms also add a degree of difficulty. Forecasters tend to rely on broad synoptic flow, surface observations, and local knowledge to predict the probability of rainfall (see Haro and Bruce, 1997).

Virtually all of the rain produced by Nora moving into the Southwest fell to the north and west of Tucson, with Tucson International Airport receiving only a trace of rain. At least one forecast from Tucson predicted a 100 percent chance of rain, so naturally the local media and the public were expecting more rainfall than what was received.

The Eta model, it turns out, provided excellent guidance in showing little chance of rain. The purpose of this Technical Attachment (TA) is to examine the Eta low-level wind and humidity forecasts, and the resultant precipitation forecasts for the day Nora moved inland.

What Happened

At 1200 UTC on September 25, there was an upper level ridge over northern Mexico and southwest Texas with a broad weak trough off the California coast, providing weak southerly steering flow over northern Baja California north to the Great Basin. Hurricane

Nora was crossing Baja California at approximately 30N 115W, about 250 miles south of Yuma. Over the next 24 hours, the storm moved north, crossing into the southwest U.S. just west of Yuma at 2100 UTC. By 1200 UTC on the 26th, Nora was a tropical depression along the Arizona/Utah border in the vicinity of the Grand Canyon. The 24-hour rainfall at Yuma was 3.83 inches with higher amounts in parts of southwest Arizona and southeast California. Farther east, Phoenix received 0.03 inches and Tucson received a trace.

Eta Performance

The two model runs that will be examined are the 0000 UTC runs from the 24th and the 25th. The focus will be on the forecasts valid at 1800 UTC on the 25th and 0000 UTC on the 26th, as this was when the storm was nearest Tucson and most likely to produce the heaviest rainfall for southeast Arizona. There were negligible synoptic or large-scale dynamics in southeast Arizona through the period, so any rainfall would have to come from a moist (and preferably saturated) lower atmosphere combined with orographic lifting. The extensive cloud cover during the event also helped keep the atmosphere stable, and thus the possibility of convective rain was kept to a minimum.

As can be seen in Figure 1, the 850 mb flow forecast for 1800 UTC on the 25th from the 9/24 run was from the southeast at 20 kt with the humidity around 65 percent. The 9/25 run for the same valid time had winds of 25 kt, and shows humidity around 70 percent (Figure 2). Keep in mind that to the east of Tucson, the terrain rises to the Continental Divide, so low-level southeast flow is downslope (see map of the Eta terrain, also note that to the east of Tucson some of the terrain is above 850 mb). The model "sees" this as well, and in Figure 3 (cross section for 1800 UTC from the 9/25 run, Tucson is in the middle) a low-level dry pocket is evident in the vicinity of Tucson.

At 700 mb (Figure 4) from the 9/24 run (700 mb humidity was not available on the 9/25 run), winds are from the south at 30 kt, with humidity around 75 percent, and a tongue of drier air evident in northern Mexico south of Tucson.

The 850 mb 48 and 24 hour forecasts for 0000 UTC on the 26th (Figure 5 and Figure 6) show winds veering to more south-southwest, but still with low-level humidities a little dry, around 60-70 percent. The cross sections for 0000 UTC on the 26th (Figure 7 and Figure 8, Tucson is in the middle) show this well, and also show the lowest winds from the southeast.

An examination of the Eta Quantitative Precipitation Forecasts (QPFs) for the Tucson area show very little precipitation for the period in question. The forecast for 1800 UTC has significant precipitation (10=0.1 inch) is still a long way from Tucson (Figure 9). The forecast for 0000 UTC on the 25th shows some rainfall, but it is still less than 0.10 inch, which gives little confidence of measurable rainfall. The 9/24 run shows no rain at all for Tucson. Both model runs clearly show the significant core of rainfall well west of Tucson.

With low-level humidities around 70 percent and little vertical motion, confidence of rainfall is not very high, and heavy rainfall is unlikely. Also, low-level winds from the southeast are not orographically favorable in southeast Arizona because they are downslope.

Conclusions/Summary

The main conclusion to draw from this is that the Eta model did a pretty good job forecasting rainfall for the Tucson area. The Eta forecasts from 0000 UTC on 9/24 and 9/25 showed that significant precipitation would fall west of Tucson, and that Tucson would get little or no rain from this event. The Eta model clearly showed low-level southeast winds and somewhat dry air near the surface, indicating that rain was not very likely and significant rain was certainly not forecast.

The Eta model, with its improved resolution and physics, is being used with more and more confidence as forecasters realize its superiority in forecasting certain events, especially orographic events.

Acknowledgments

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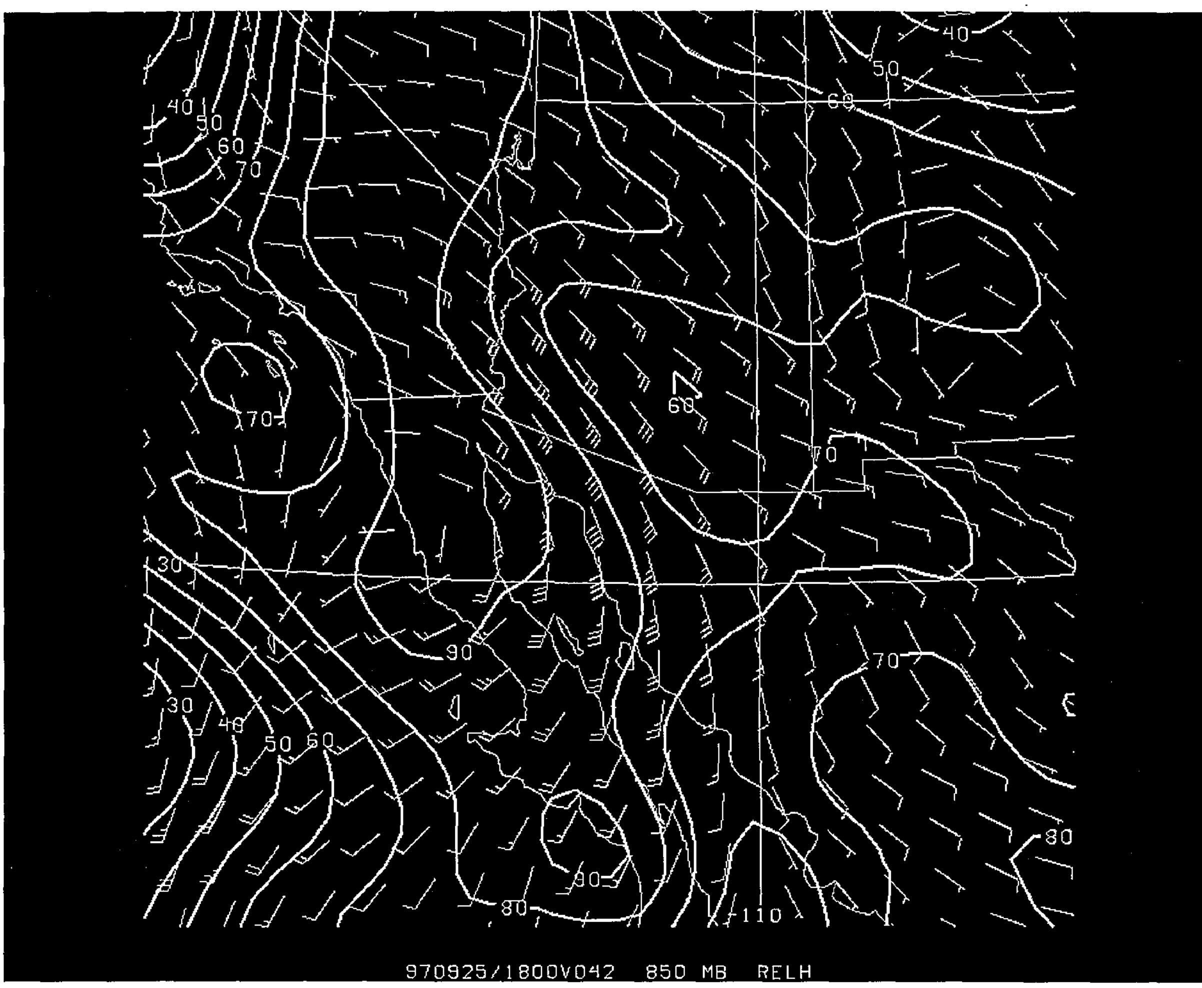

Figure 1.

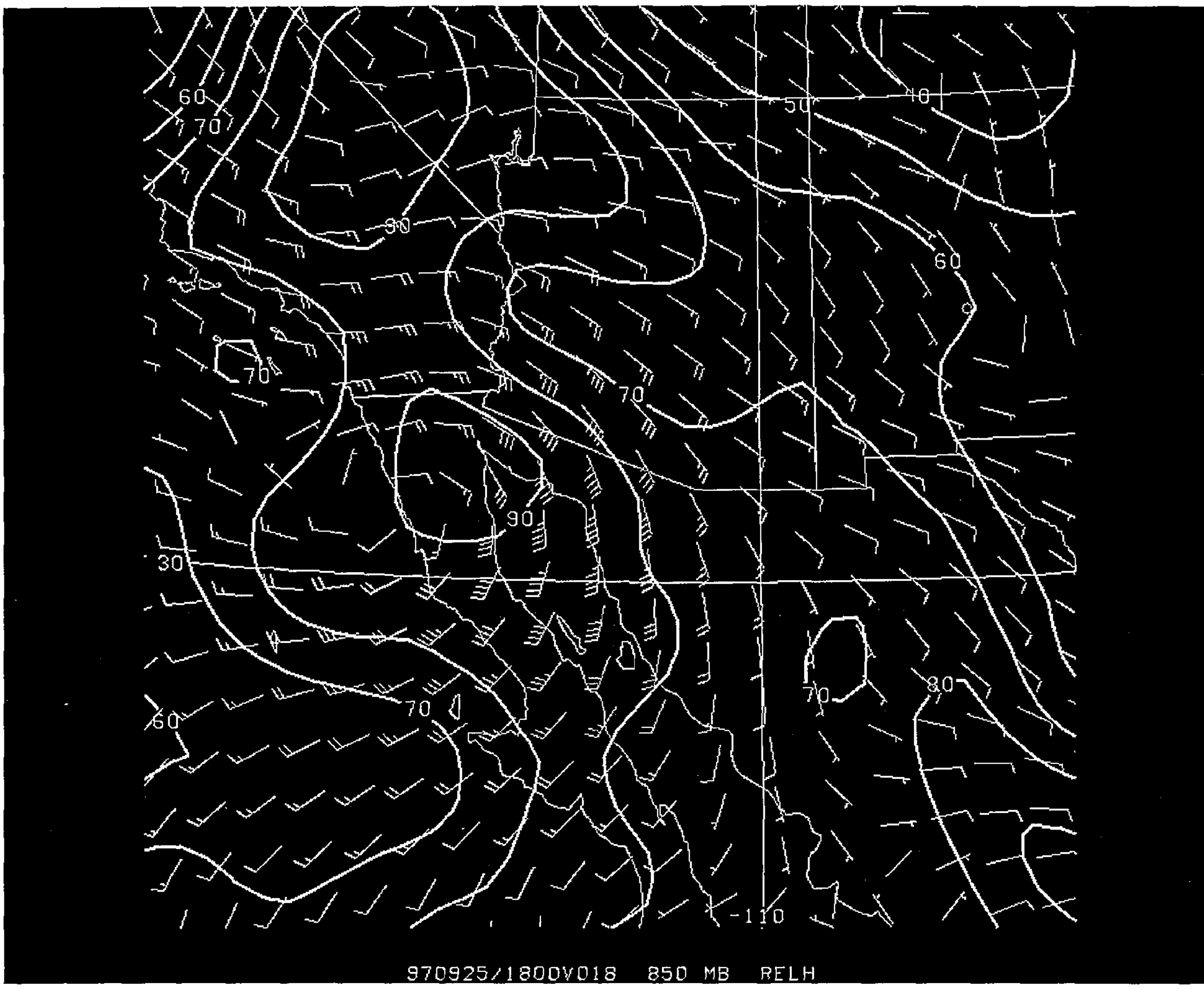

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Figure 2.

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Figure 3.

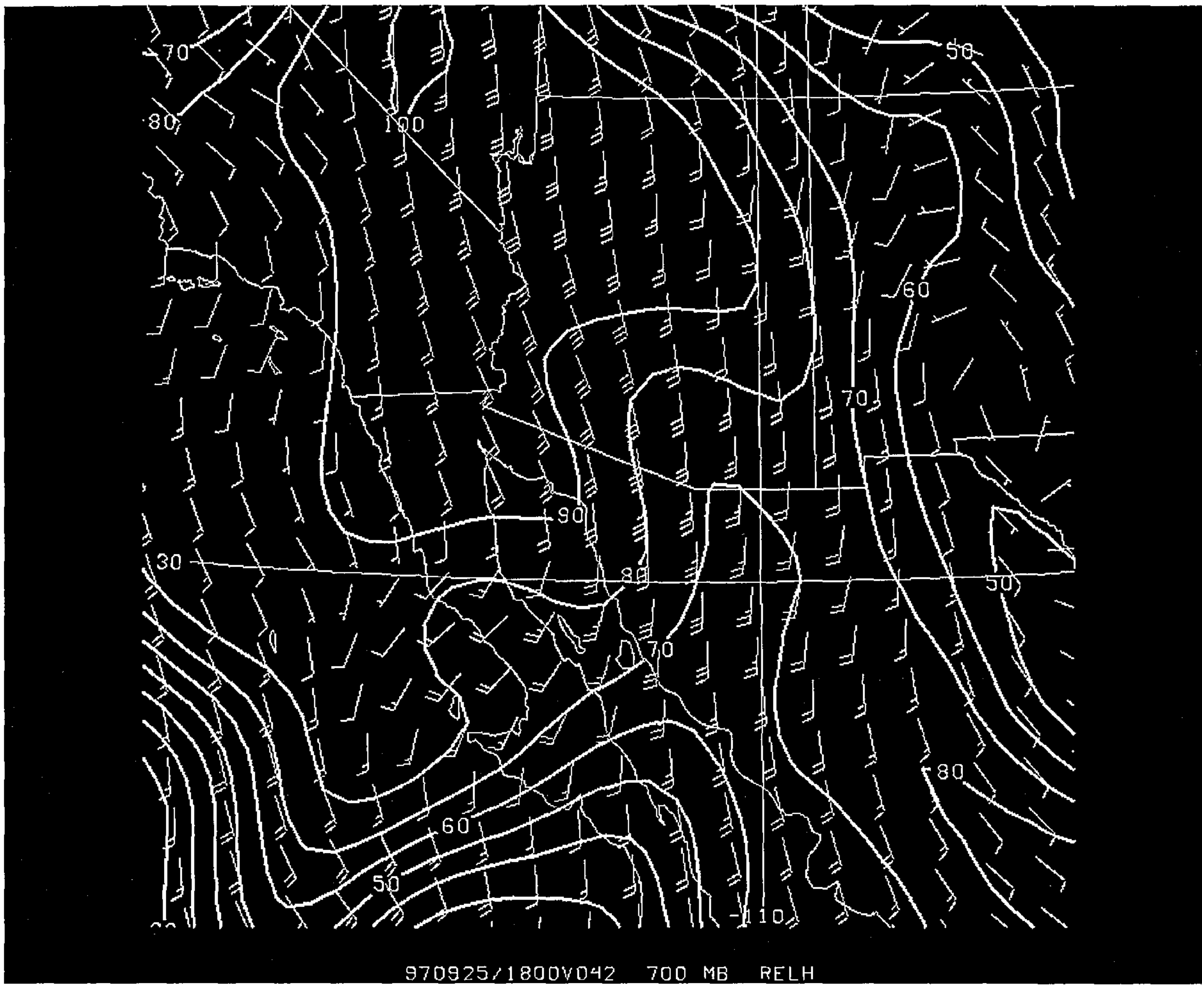
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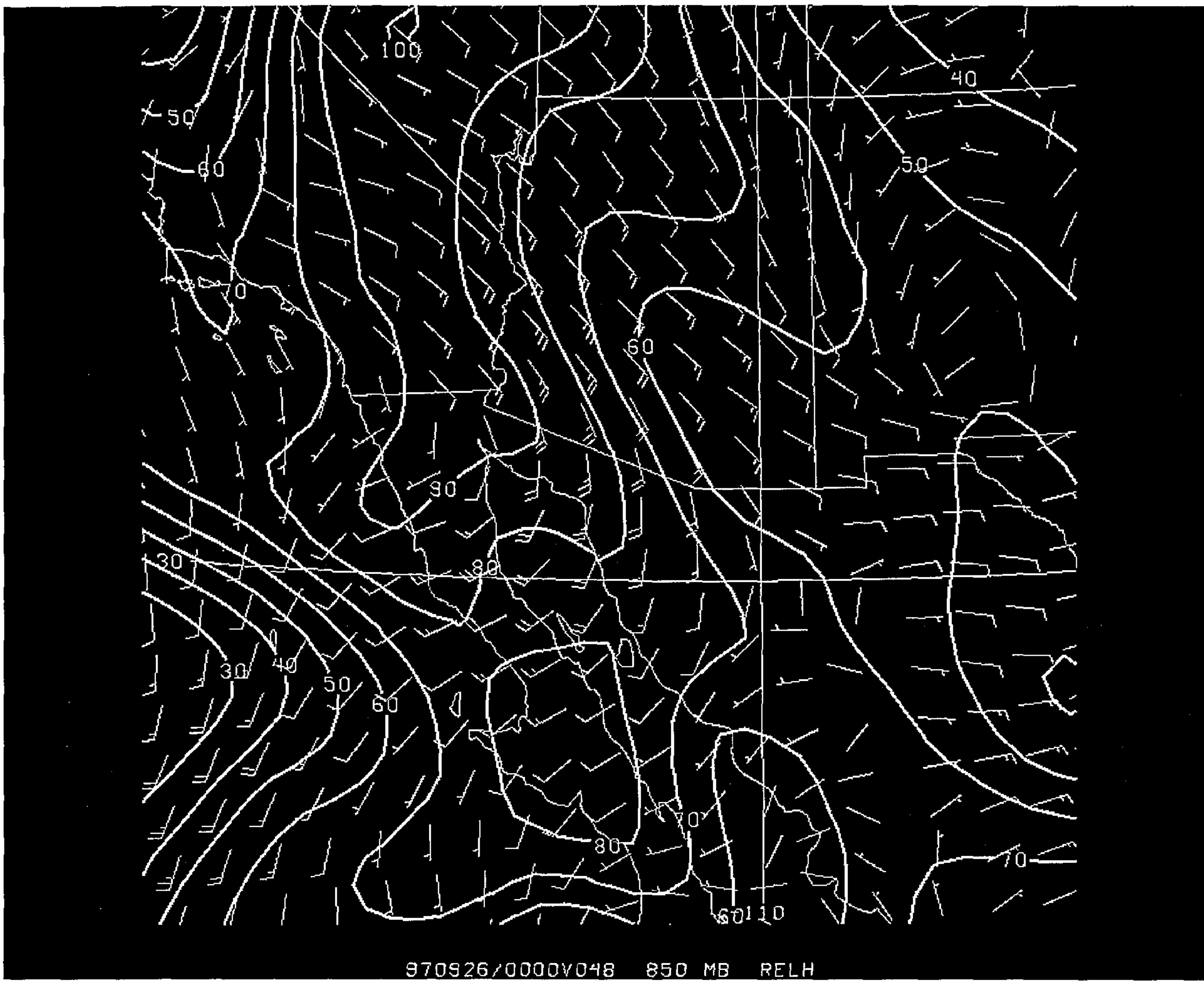
Figure 4.



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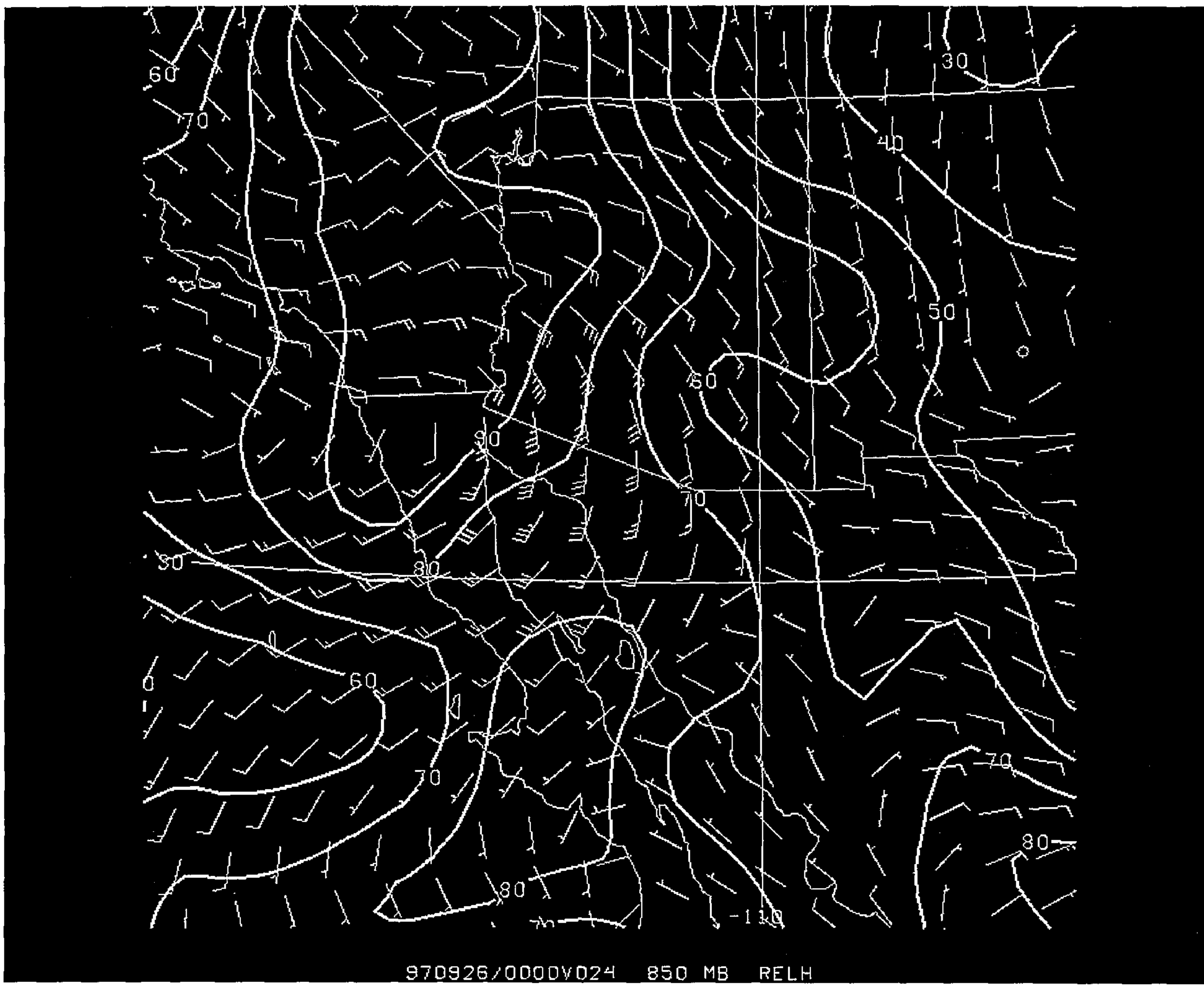

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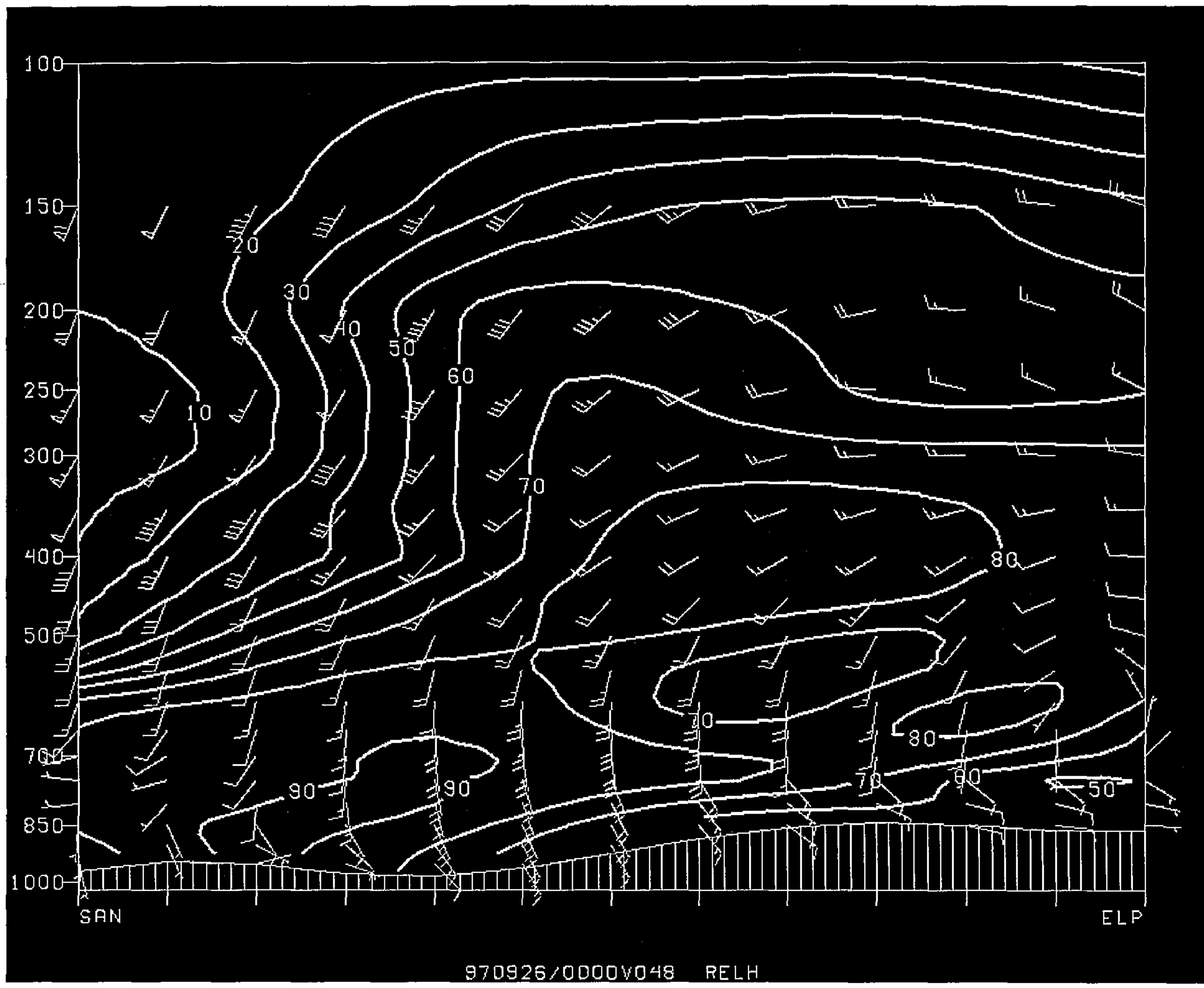
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Figure 7.

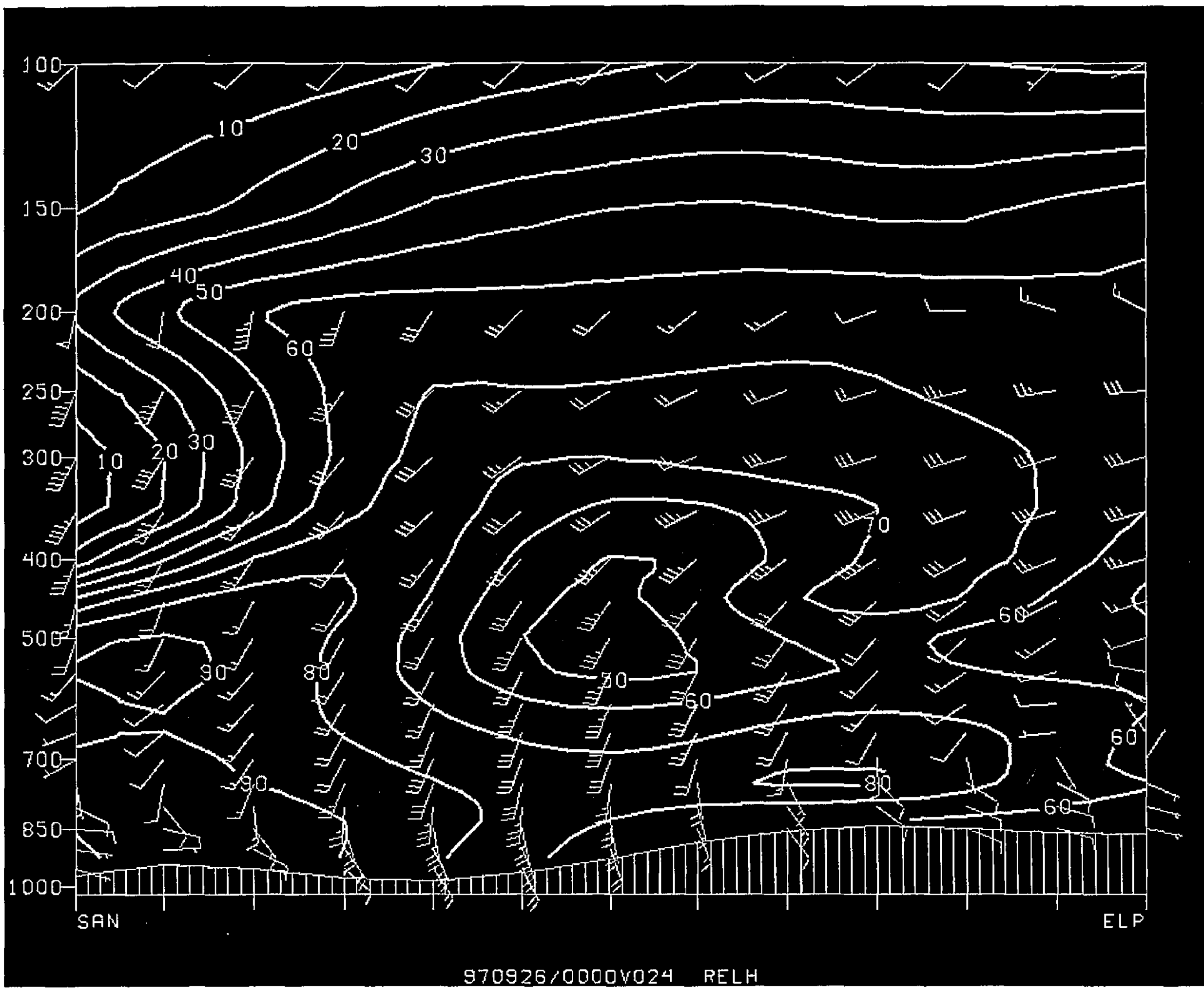
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Figure 8.

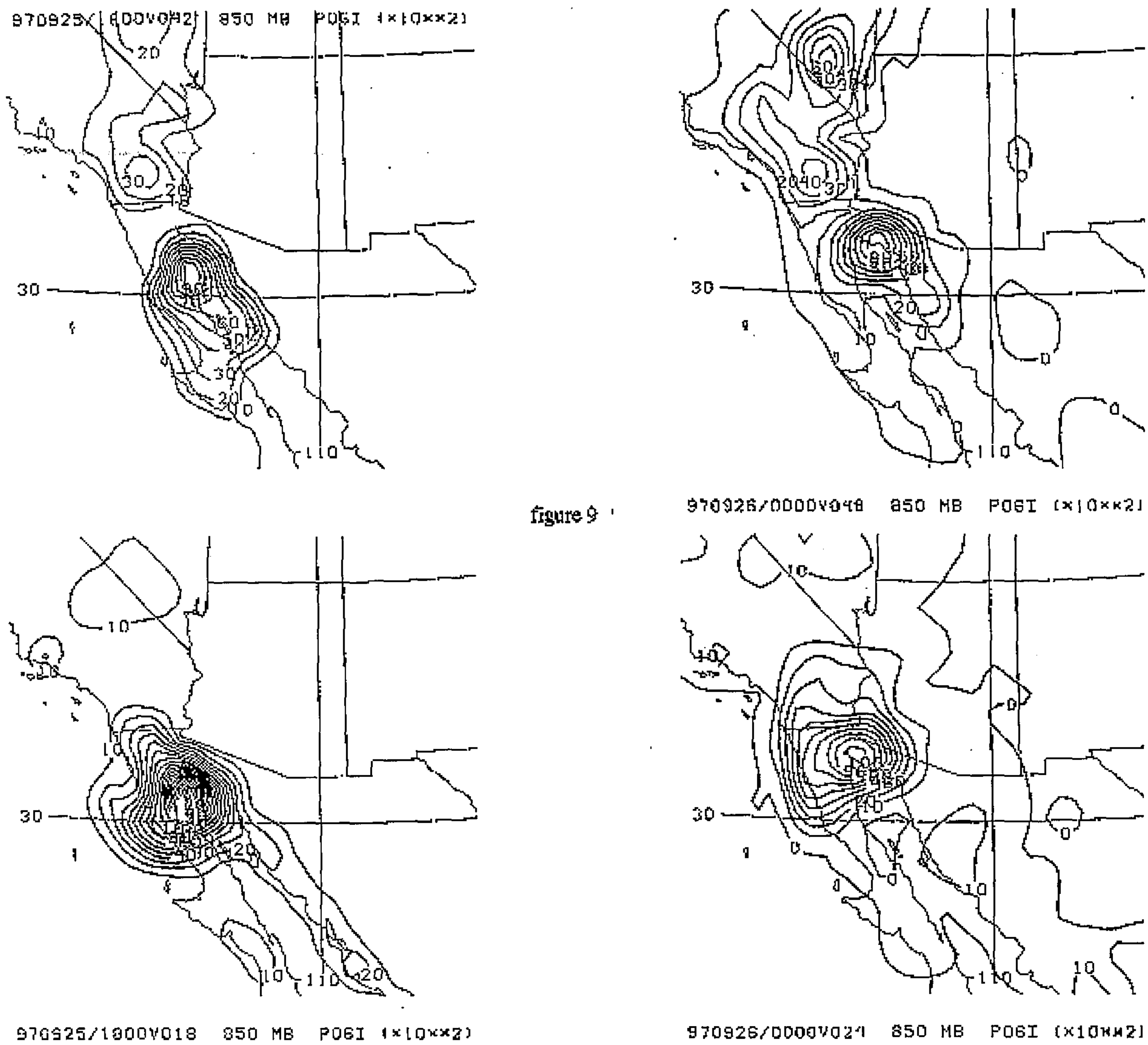
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figure 9
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Figure 9.