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# NEVADA CYCLOGENESIS AND POOR MODEL GUIDANCE

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*[Editor's Note: This Technical Attachment is part of a COMET Partners project, "Weather Forecasting Problems Related to Nevada Cyclogenesis" between Edward R. Carle (WSFO SLC) and David R. Bright (WSFO MSP) and colleagues, and Professor Lance F. Bosart (SUNY/Albany).]*

Previous studies (Grumm et al. 1992, Mullen and Smith 1990, Hoke et al. 1989) have shown that NMC's Nested Grid Model (NGM) has difficulty in handling surface cyclones over the western United States. In all these studies, the NGM tended to place western U.S. surface cyclones too far to the north northeast. This deficiency becomes a serious problem during Nevada Cyclogenesis (NCG) in the lee of the Sierra Nevada Mountains. These systems can produce significant precipitation in the intermountain region and pose a serious forecast problem. Often, all the NMC models (not just the NGM) poorly forecast the surface and upper-level features in these systems. Here, we present the details of NMC model guidance for a typical NCG case that occurred March 10-12, 1991, in an effort to document the poor model performance for these events.

Figures 1-3 are the 48-h 500 mb height forecasts for the LFM, NGM, and AVN, respectively, valid at 12Z, March 11, 1991. Figure 4 is the verifying analysis from the LFM initialization (the NGM and AVN initial analyses were similar). The 48-h forecasts of all three models places the vorticity center too far north and east. The flanking ridges were stronger than forecast and none of the models depicted the short-wave ridge near 130W. The LFM was the most accurate with the vorticity max being the furthest south and west over southern Nevada, while the NGM and AVN placed it over central Utah.

The 36-h LFM forecast correctly placed the vorticity center and continued to do so with its subsequent 24 and 12-h forecasts. The NGM and AVN 36-h forecasts placed the center over southern Nevada (Figs. 5-6). While this was not as bad as their 48-h forecasts, it was still too far north and east. For their 24-h forecasts, the NGM and AVN did a "flip-flop" and moved the center back north: the NGM to south central Nevada, and the AVN to central Nevada (Figs. 7-8). This was very confusing to the forecaster. Frequently, in NCG cases, the models have a tendency to improve on the position of the vorticity center with each successive run, getting closer to the verifying position. This also implies that the main weather will likely be centered further south and west. The NGM and AVN are usually slower to converge on the solution than the LFM. The model's tendency to converge on a correct solution is usually anticipated, and the trend can be recognized by the forecaster. However, when the NGM and AVN jumped the center back north again rather than continuing to converge in their 24-h forecasts, it became very confusing and misleading, because this implied that the main weather would occur further north and east, and closer to what the 48-hr forecasts implied. As it turned out, the NGM and AVN finally placed the center in the correct location with their 12-h forecasts.

At the surface, the model's guidance was just as poor. Figures 9-11 are the 48-h surface forecasts for the LFM, NGM, and AVN, respectively, valid at 12Z, March 1991. Figure 12 is the verifying analysis for the LFM which was the most accurate initial analysis of the models. Overall, the LFM produced the most accurate surface forecasts of the three. However, if the forecaster believed any of the model's

48-h forecasts, he or she could have easily assumed the main surface low, cold front, and surface trough would be moving into the Central Plains at 12Z, March 11. In reality, the cold front at 12Z, March 1991 extended from southern California, north northeast to a 980 mb low just west of Ely (ELY), Nevada, northeast through extreme northwest Utah, to a 980 mb low just west of Lander (LND), Wyoming, and continued north northeast through extreme eastern Montana (Fig. 13).

The models, especially the NGM and AVN, even had difficulty analyzing the surface cyclone in the vicinity of ELY. Figures 14 and 15 show the NGM and AVN surface and 1000-500 mb thickness analyses for the NGM and AVN, respectively (the LFM analysis is in Fig. 12). None of the models analyzed the low pressure near ELY deep enough. The pressure errors in the vicinity of ELY for the LFM, NGM, and AVN analyses were 16 mb, 12 mb, and 23 mb too high, respectively, (compare Figs. 12, 14, and 15 with Fig. 13). A hand analyzed surface chart illustrates the model's poor analyses in the vicinity of ELY, and highlights the model's deficiency with this type of situation.

We have defined NCG as having occurred when a closed surface low can be analyzed over Nevada using a 2 mb contour interval. By examining 11 cases of NCG that occurred during the spring of 1991, the majority had the lowest pressure in Nevada just west of ELY. It was found that in most cases, all three models forecast the surface low(s) well northeast of where they verified, overforecast the depth of the Rocky Mountain lee trough, and underforecast the development of the surface system further west over Nevada and Utah. The errors at 500 mb were similar, with the models tending to forecast the main features further north and east than where they verified.

Knowing that the models do not handle NCG well, the forecaster needs to monitor the models' guidance during NCG events and be alert for model tendencies we have shown. This, combined with the forecaster's experience that the LFM is often correct forecasting intermountain region systems to be slower and deeper, alerts the forecaster that weather may very well develop much further south and west than the models imply.

The March 10-12, 1991 case is a good example of how poorly the models can perform during NCG cases. It demonstrates the strong NGM bias of placing surface cyclones over the southwestern United States much too far north northeast. In this case, the AVN and LFM exhibited similar errors; however, the LFM was the best of the three. At 500 mb, the models were also marginal, although the LFM was on track beginning with its 36-h forecast.

**References**

Grumm, R.H. et al., 1992: Systematic Model Forecast Errors of Surface Cyclones in NMC'S Nested-Grid Model, December 1988 through November 1990. *Wea. Forecasting*, Vol 7, No 1, 65-87.

Hoke, J.E. et al., 1989: The Regional Analysis and Forecast System of the National Meteorological Center. *Wea. Forecasting*, 4, 323-334.

Mullen, S.L., and B.B. Smith, 1990: An Analysis of Sea-Level Cyclone Errors in NMC's Nested Grid Model (NGM) During the 1987-88 Winter Season. *Wea. Forecasting*, 5, 433-447.

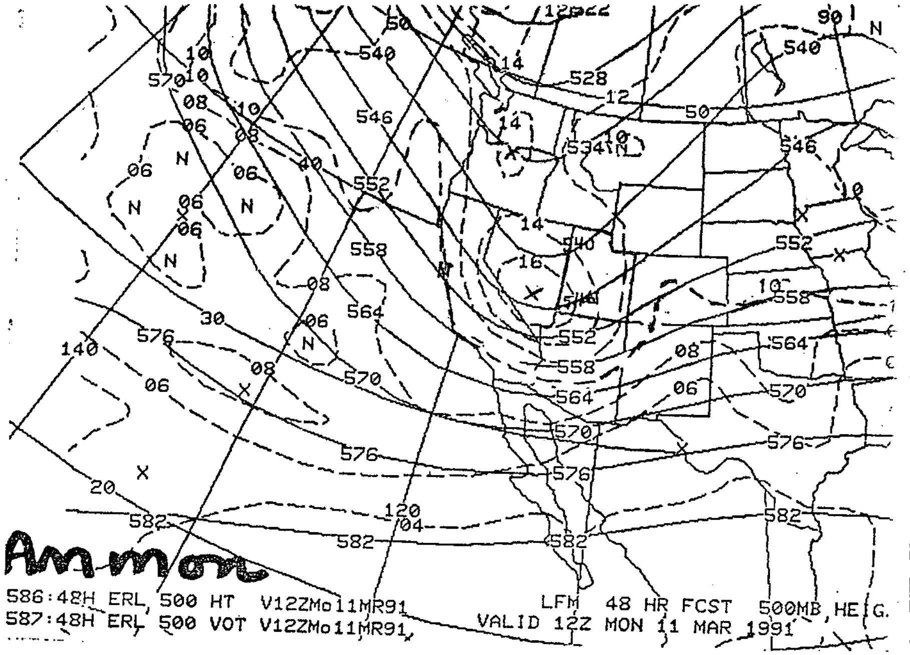



Fig. 1.

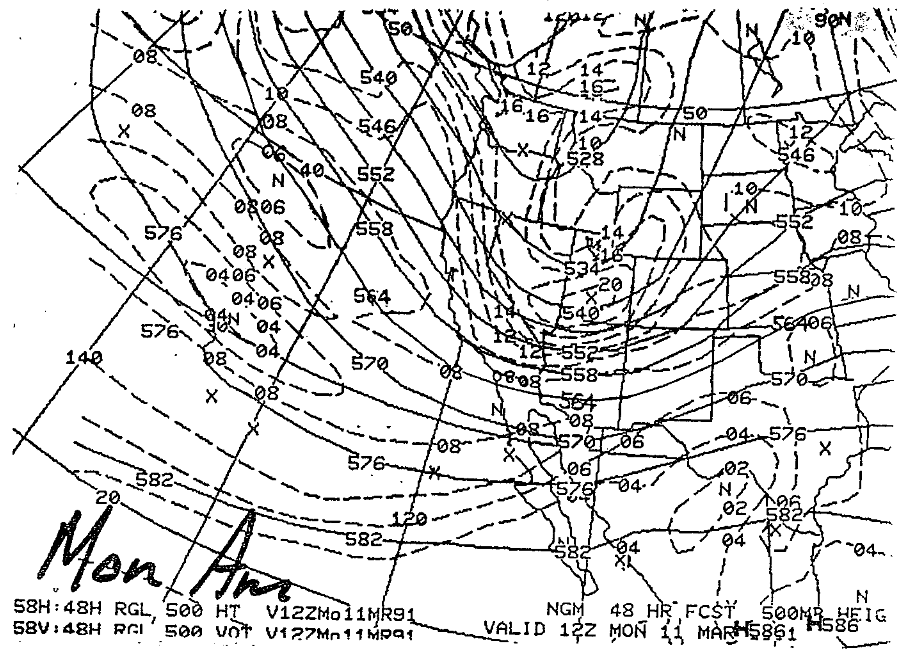



Fig. 2

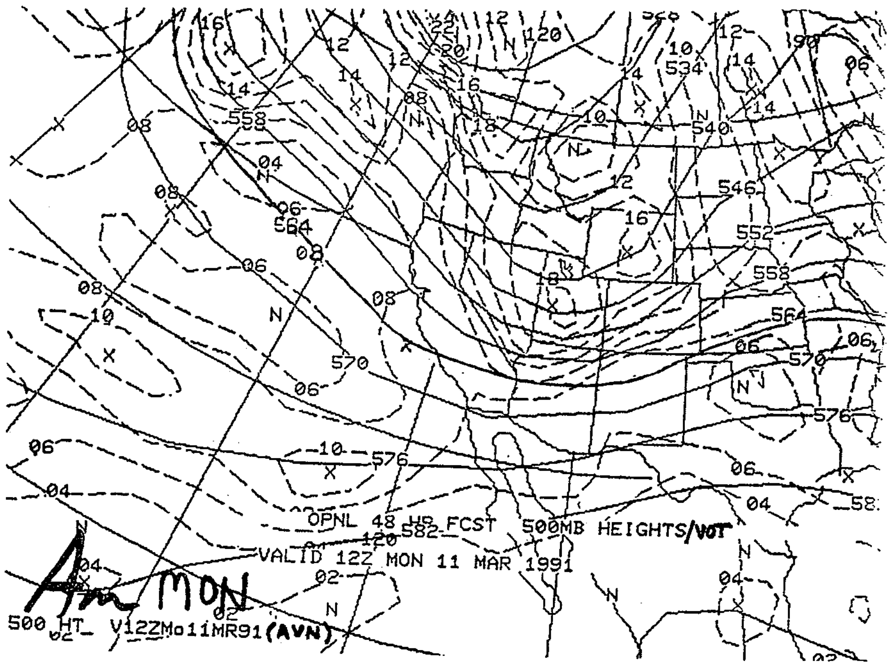



Fig. 3

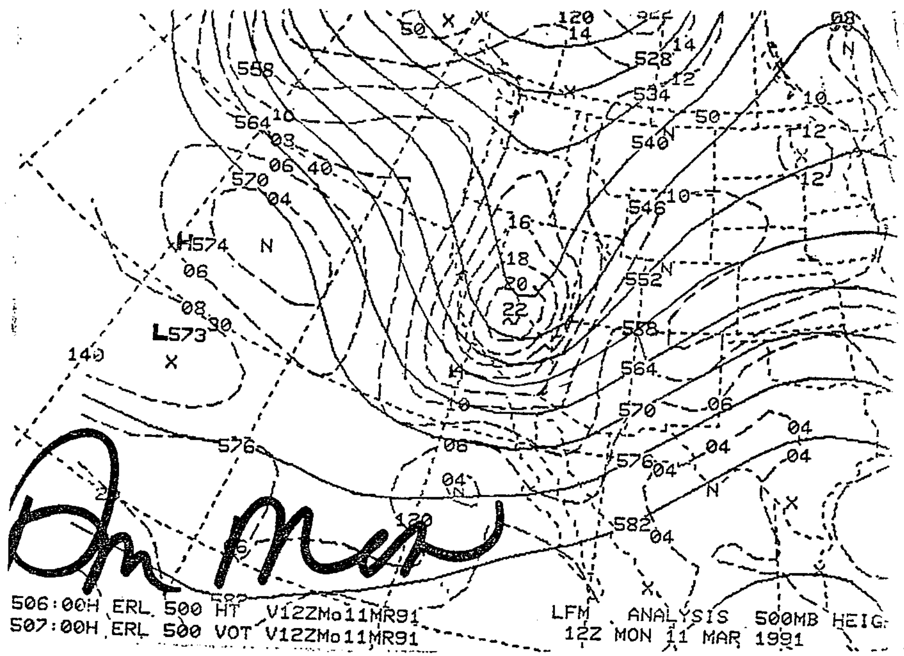



Fig. 4

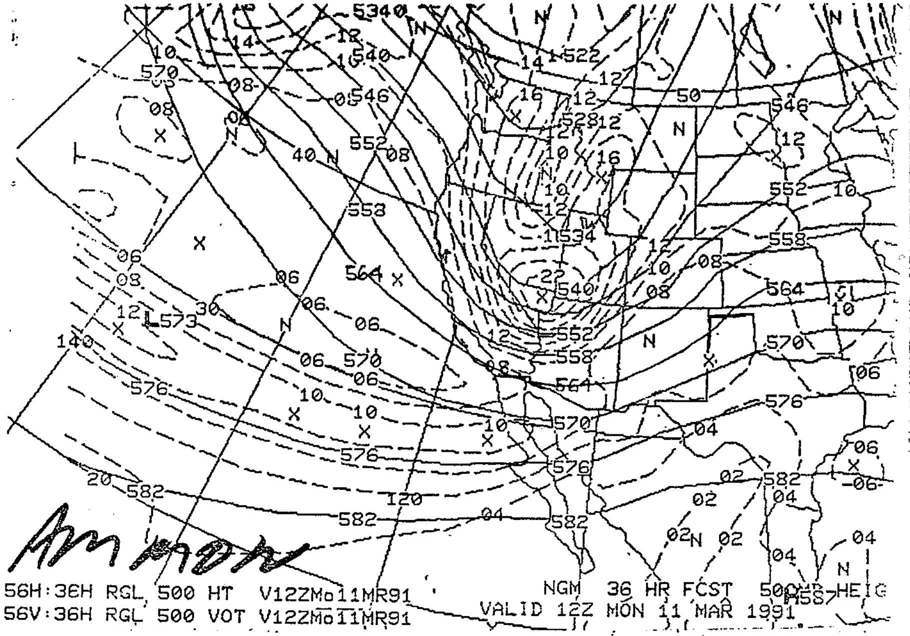



Fig. 5

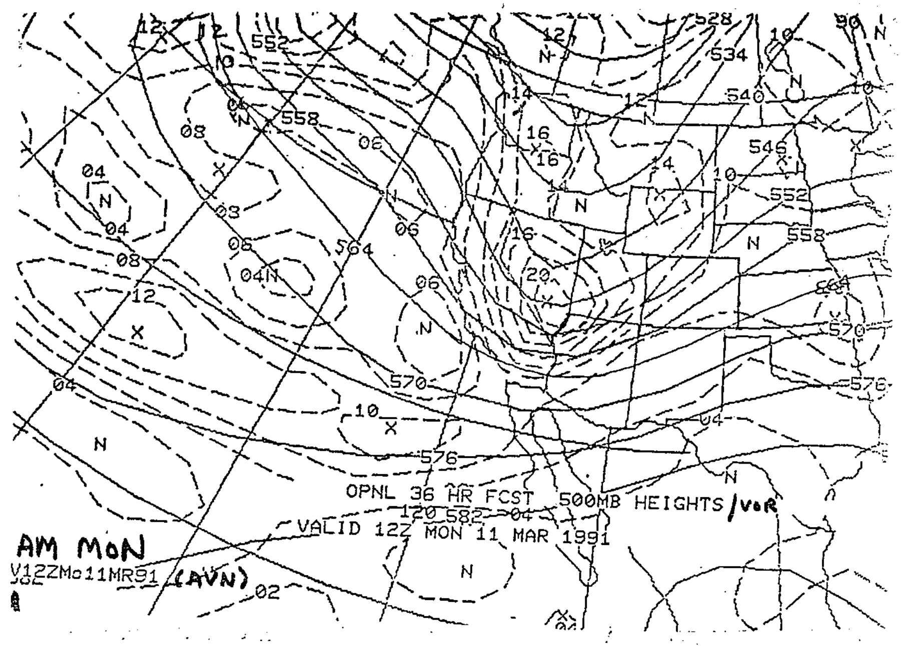
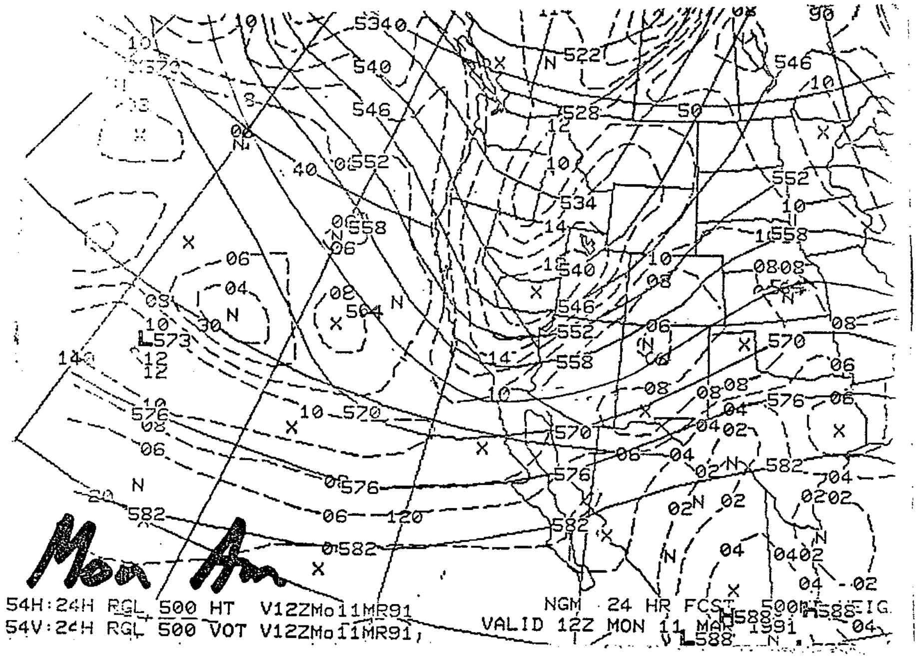



Fig. 6

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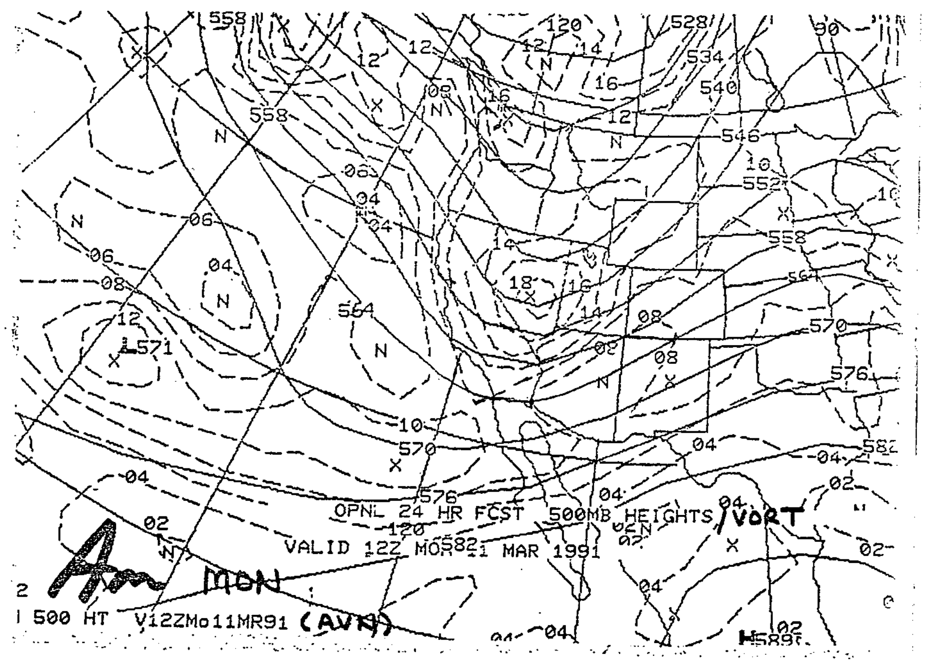


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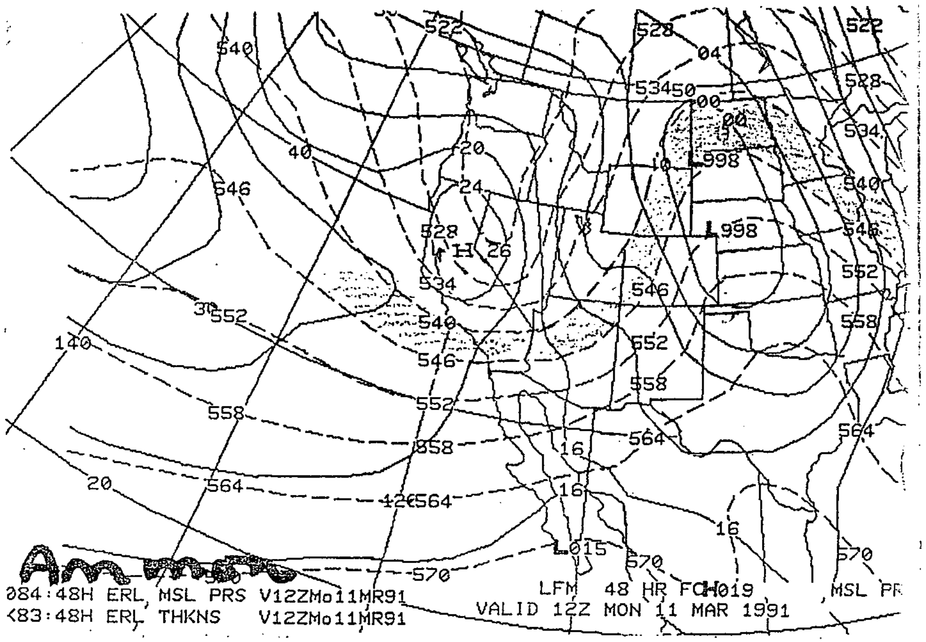
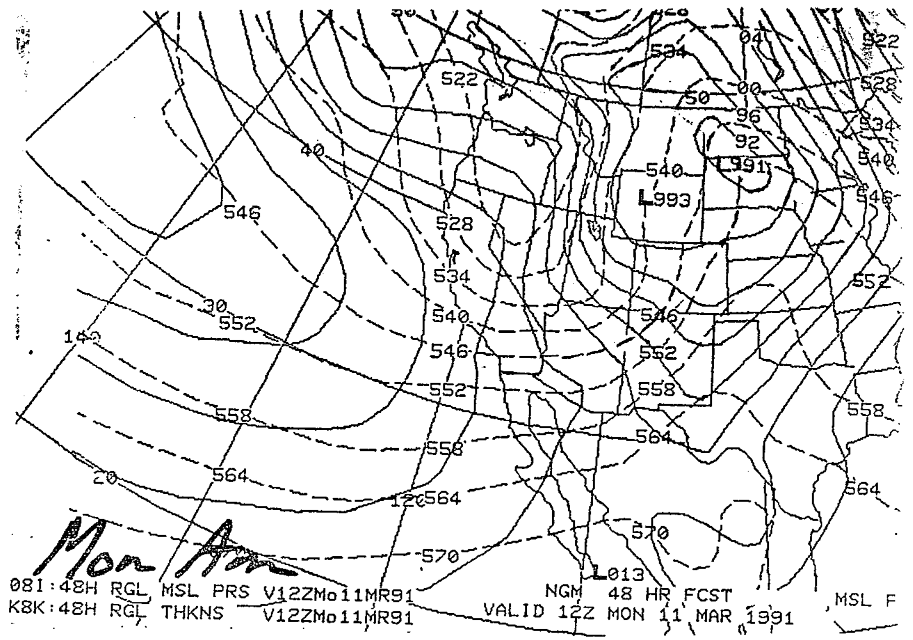



Fig. 9

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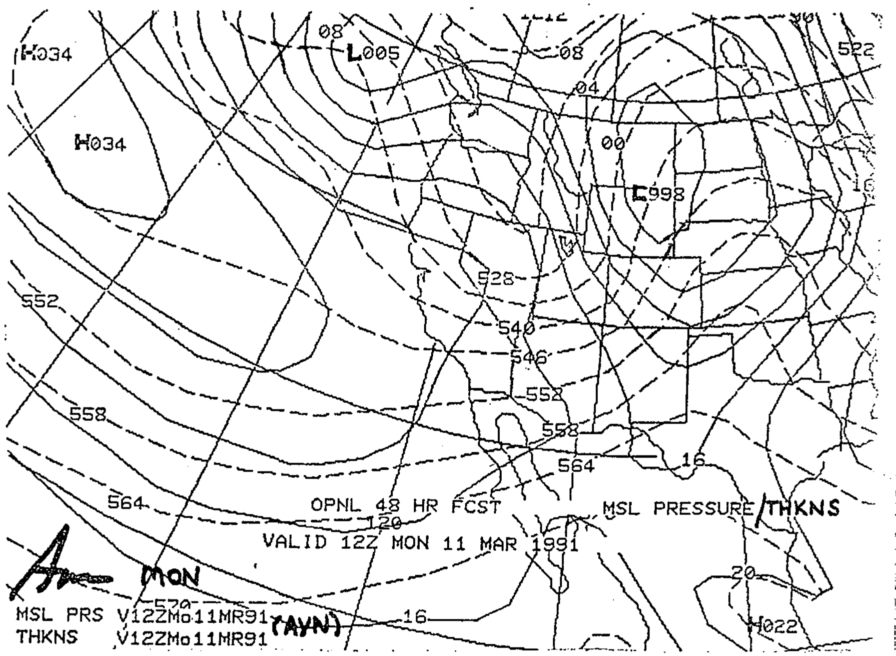


Fig. 11

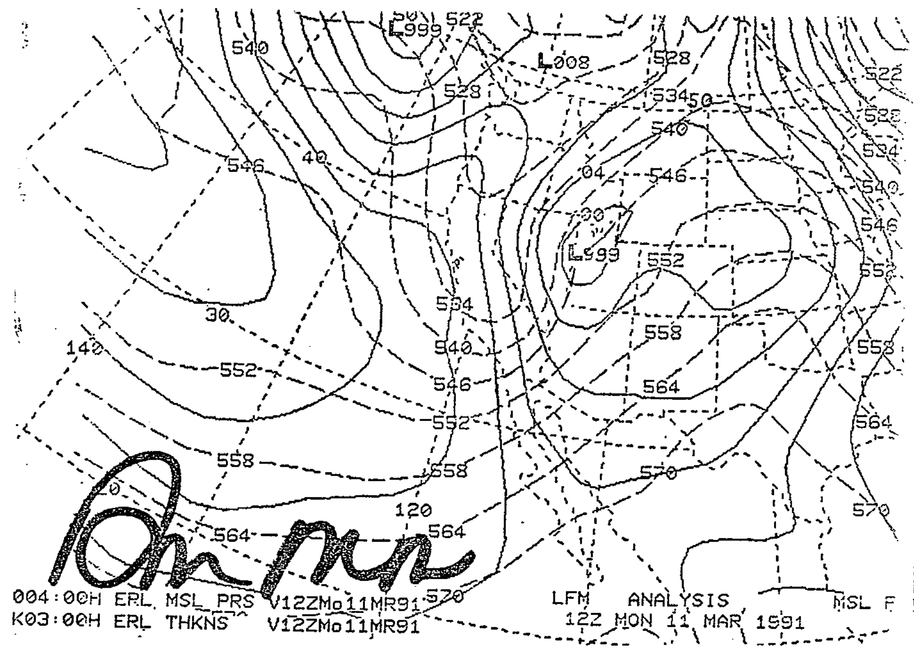


Fig. 12

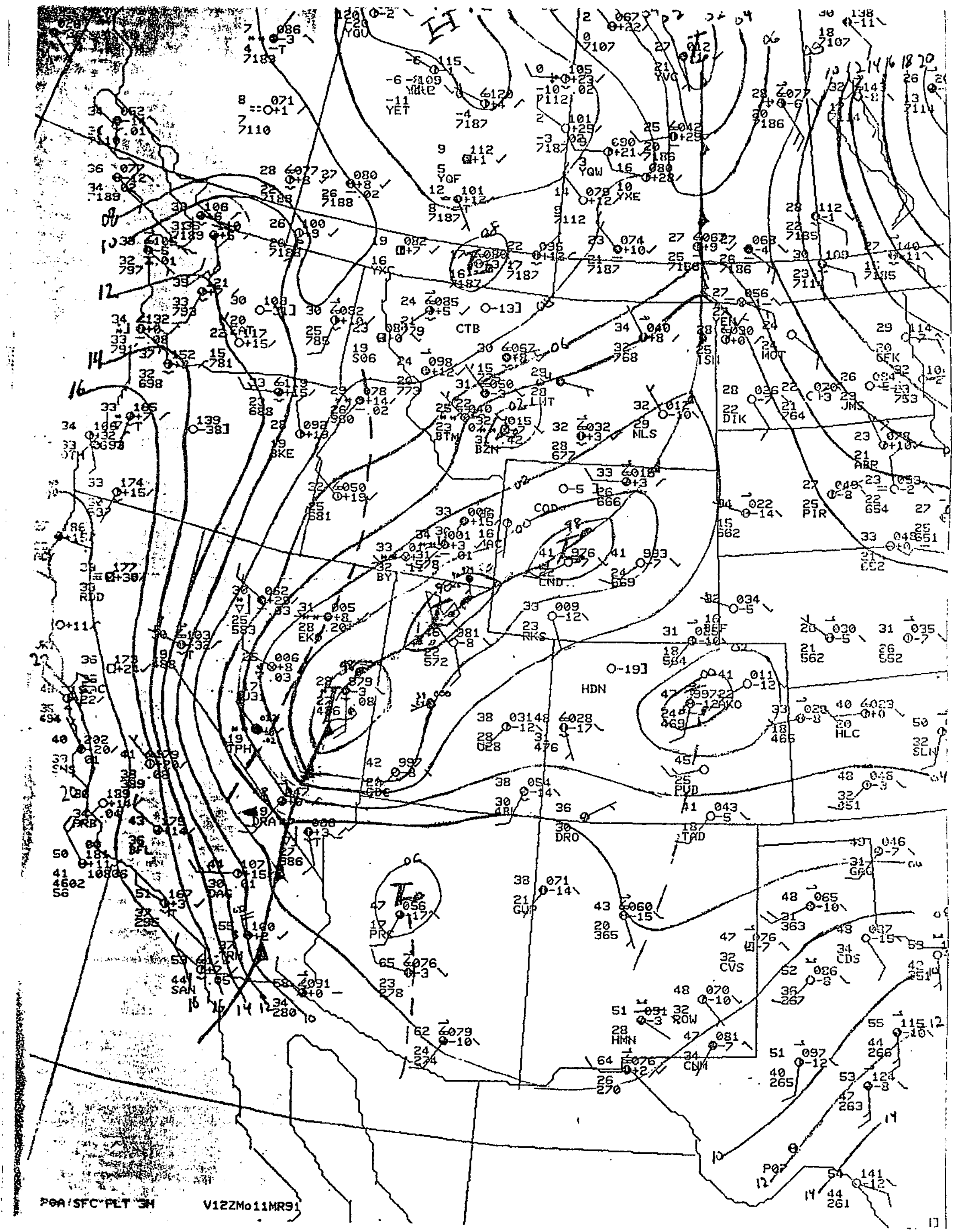


Fig. 13

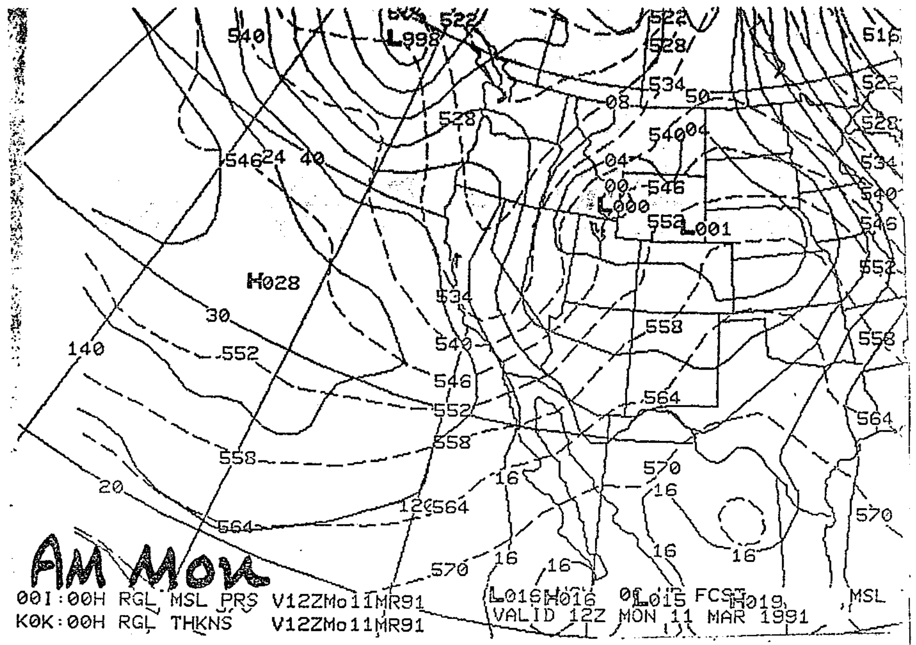


Fig. 14

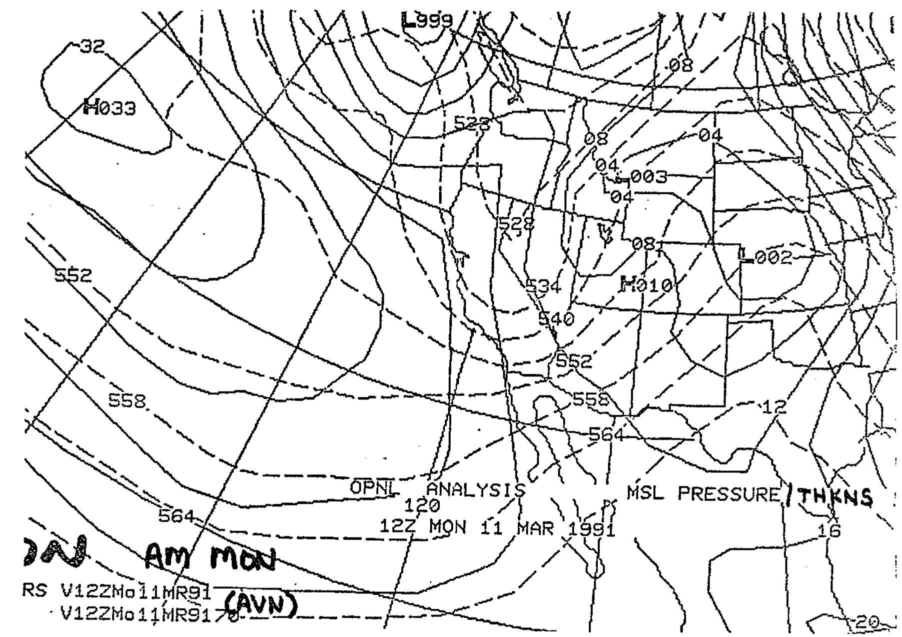


Fig. 15