Western Region Technical Attachment
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MODEL VERIFICATION OF AN UPPER-LEVEL LOW

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Introduction

On Friday, January 29, 1993, an upper-level low developed over southern Idaho. This weather system evolved into a major winter storm for much of southern and eastern Utah, producing 3 to 4 feet of snow in western Wayne County during the 3-day period from 29 January through 1 February.

When short-wave troughs develop into closed lows over the Great Basin, moisture is often deficient during the incipient stage. As the upper-level low closes off and winds become evenly balanced around the circulation, moisture frequently increases on the east side of the system. The upper-level low in this case became nearly stationary over the desert Southwest, and moisture was injected into the circulation from the subtropical Pacific Ocean. Southerly flow drove the moisture into southern Utah, resulting in heavy precipitation.

The NMC forecast models often struggle with timing, location, and intensity of these upper-level systems. The intention of this Technical Attachment is to show which of the NMC models most accurately predicted the initial development of the upper-level low and vorticity maxima in this case. Particular attention is paid to the ETA-X model which has received little documented verification.

Results

The models were compared and verified with the 1200 UTC 29 January analyses from the ETA-X and RAFS (Figs. 1a and 1b). Both models have a similar analysis with a digging vorticity maximum located along the border area of southeast Oregon and northwest Nevada.

The 24-hour forecast charts of 500 mb heights and vorticity for three of the NMC models (ETA-X, RAFS, and AVN) from the 1200 UTC 28 January forecast cycle, valid at 1200 UTC 29 January, are shown in Figs. 2a-c. All three models were similar in locating the main vorticity maximum on the back side of the developing low. Comparing the forecasts with the analysis in Fig. 1, all the forecasts were a little slow with the position of the vorticity maximum. The RAFS verified best on the location, but the differences between models were slight. The ETA-X generated a positive vorticity lobe over southwest Utah, which never materialized. The RAFS also developed this lobe, but did not define a vorticity maximum along the southern Utah border. The AVN provided the best forecast in this area, ignoring this spurious feature and emphasizing the main vorticity maximum on the back side of the low.

Significant model differences were apparent on the 48-hour forecast of 500 mb heights and vorticity, generated from the 1200 27 January model run. Figures 3a-c show the 48-hour forecast of 500 mb heights and vorticity for the ETA-X, RAFS, and AVN, respectively. The best forecast position of the digging vorticity maxima was produced by the ETA-X model, while the closed low circulation was best depicted by the RAFS model. The RAFS model was too far east on the digging vorticity maxima, and the AVN verified even further from the observed. If the AVN had verified correctly, the stormiest weather would have occurred over northern Utah. Instead, the most significant weather occurred over southern Utah.

Summary and Conclusion

The ETA-X model outperformed the other models on the 48-hour forecast of the developing vorticity maximum. Once the NGM and AVN converged on the ETA-X solution of a stronger digging system (24-hour forecast), they verified well. The NGM generated the best 24-hour forecast of the vorticity maximum and 500 mb circulation pattern.

In several undocumented cases during the fall season of 1992, the ETA-X model verified better than the other NMC models. It has been noted that during split flow patterns, the ETA-X often follows the early NMC model (LFM) and is first to dig short-wave troughs further south and west. The NGM and AVN models often "under-forecast" the strength of digging short-wave troughs in split flow.

The forecaster should be aware of the potential for error with the NGM and AVN, particularly in cases of split flow with a digging short-wave trough. The ETA-X and LFM may provide a better forecast of these events beyond the 24-hour time frame. The findings in this study are not conclusive, but provide the forecaster a little more confidence in the ETA-X model solution in split flow regimes.

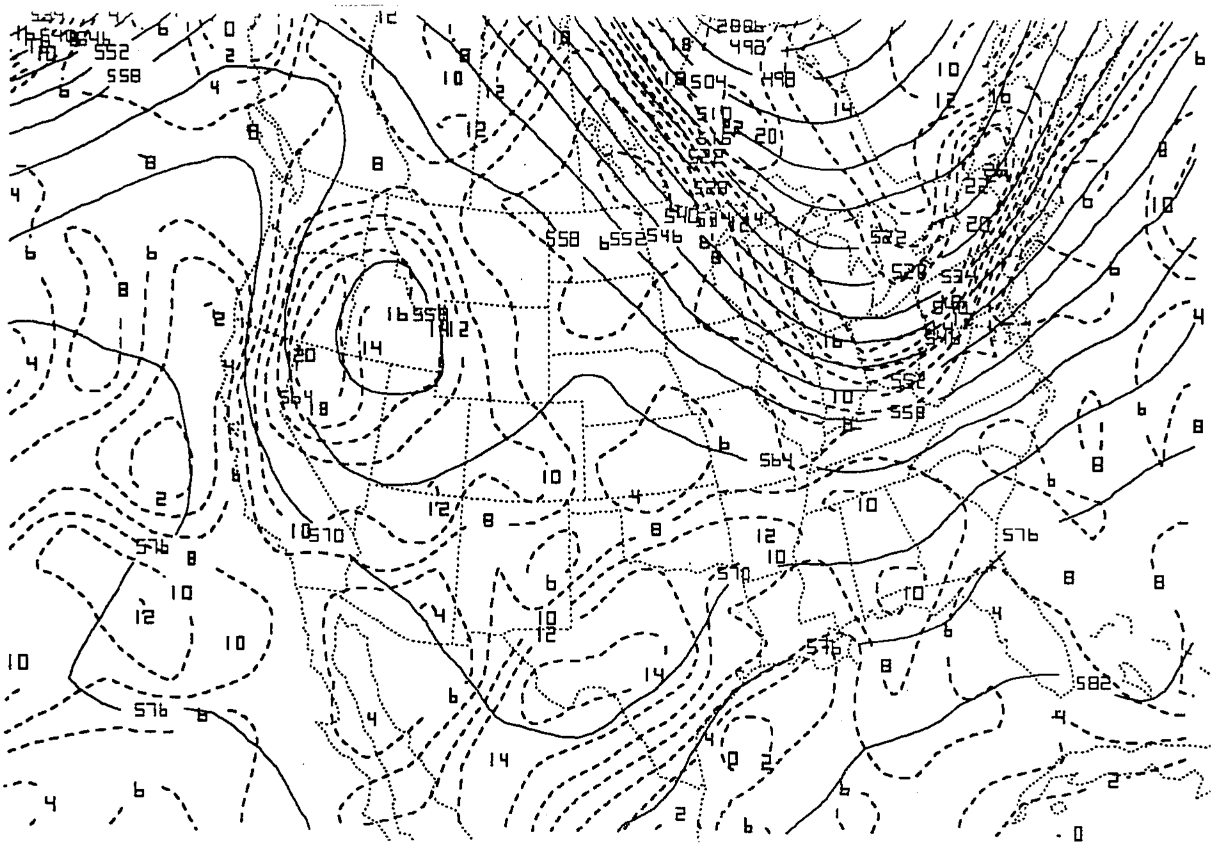

Fig. 1a 500 mb height (dm) & absolute vorticity ($x10^{-5}$ s^{-1}) from ETA-X analysis valid 1200 UTC 29 January 1993.

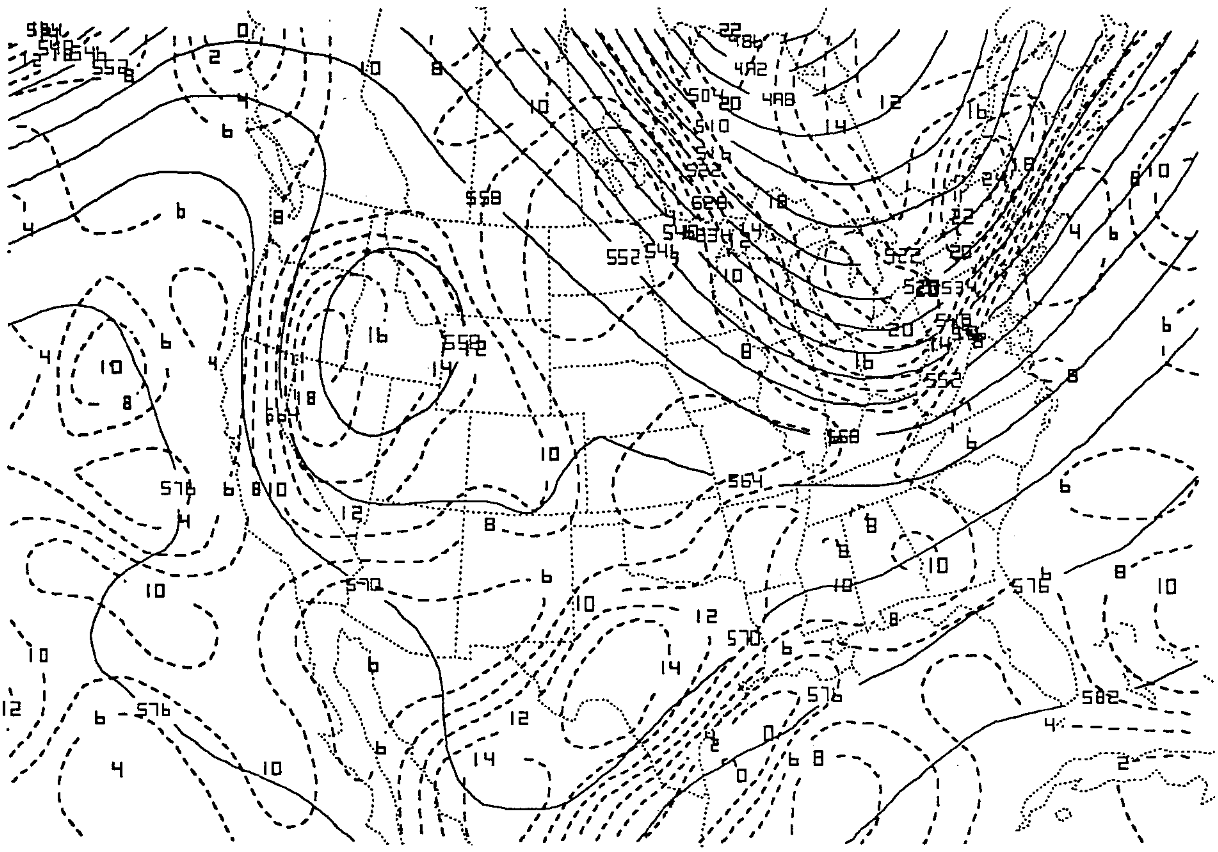

Fig. 1b 500 mb height (dm) & absolute vorticity ($x10^{-5}$ s^{-1}) from NGM analysis valid 1200 UTC 29 January 1993.

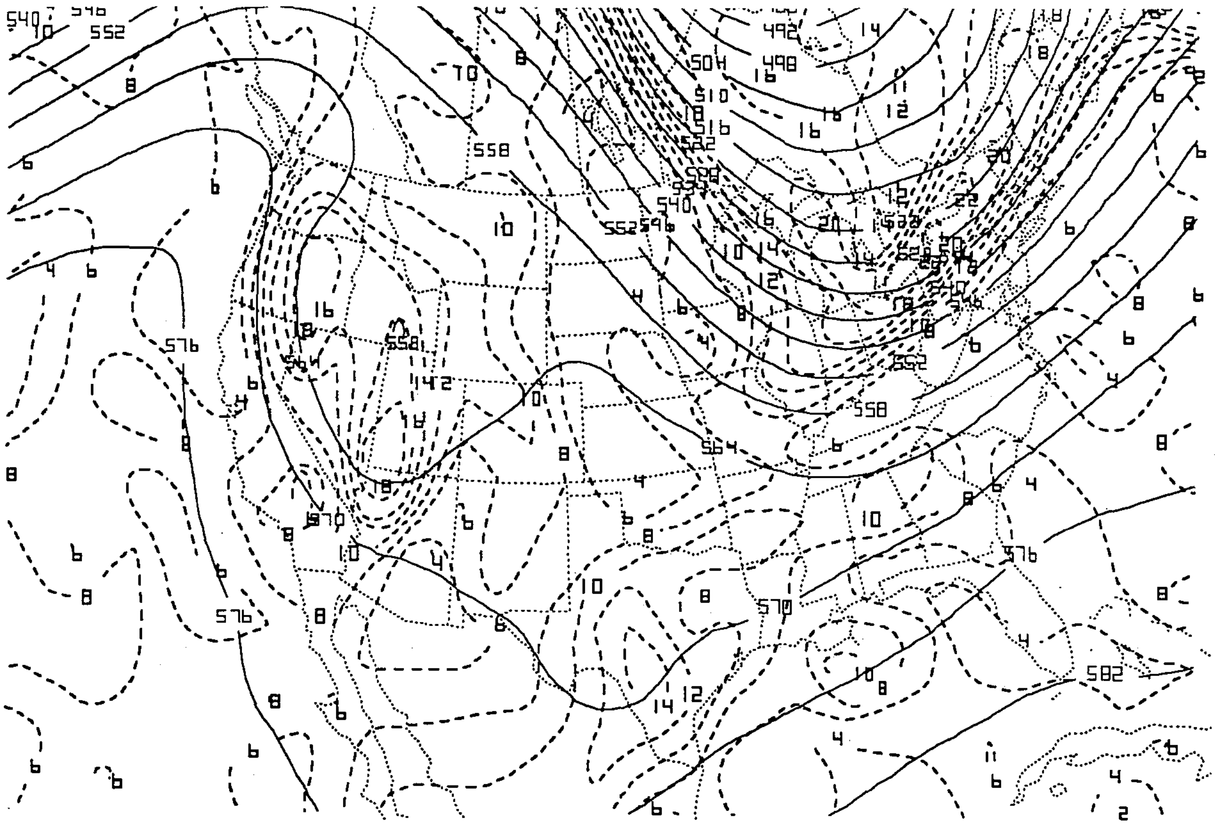

Fig. 2a 500 mb height (dm) & absolute vorticity ($x10^{-5}$ s^{-1}) from ETA-X 24h forecast valid 1200 UTC 29 January 1993.

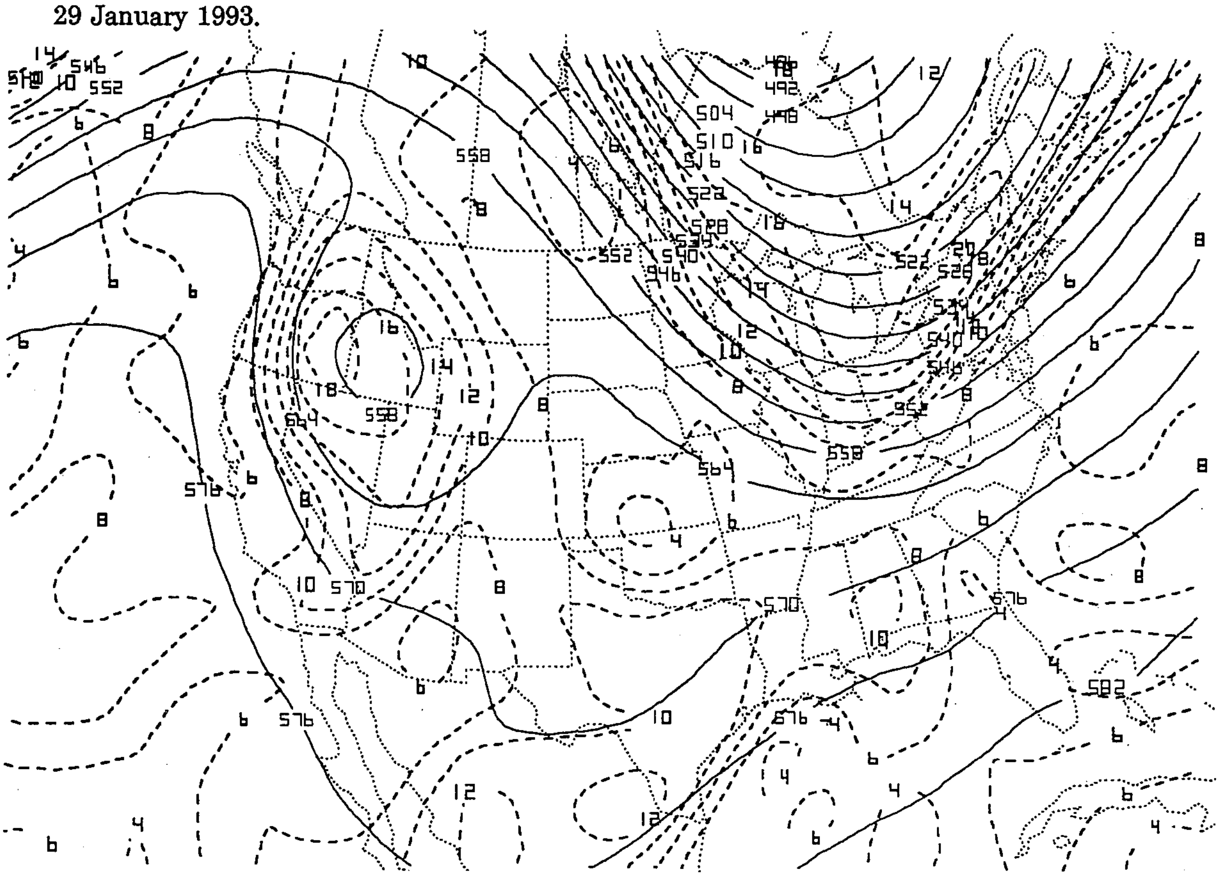

Fig. 2b 500 mb height (dm) & absolute vorticity ($x10^{-5}$ s^{-1}) from NGM 24h forecast valid 1200 UTC 29 January 1993.

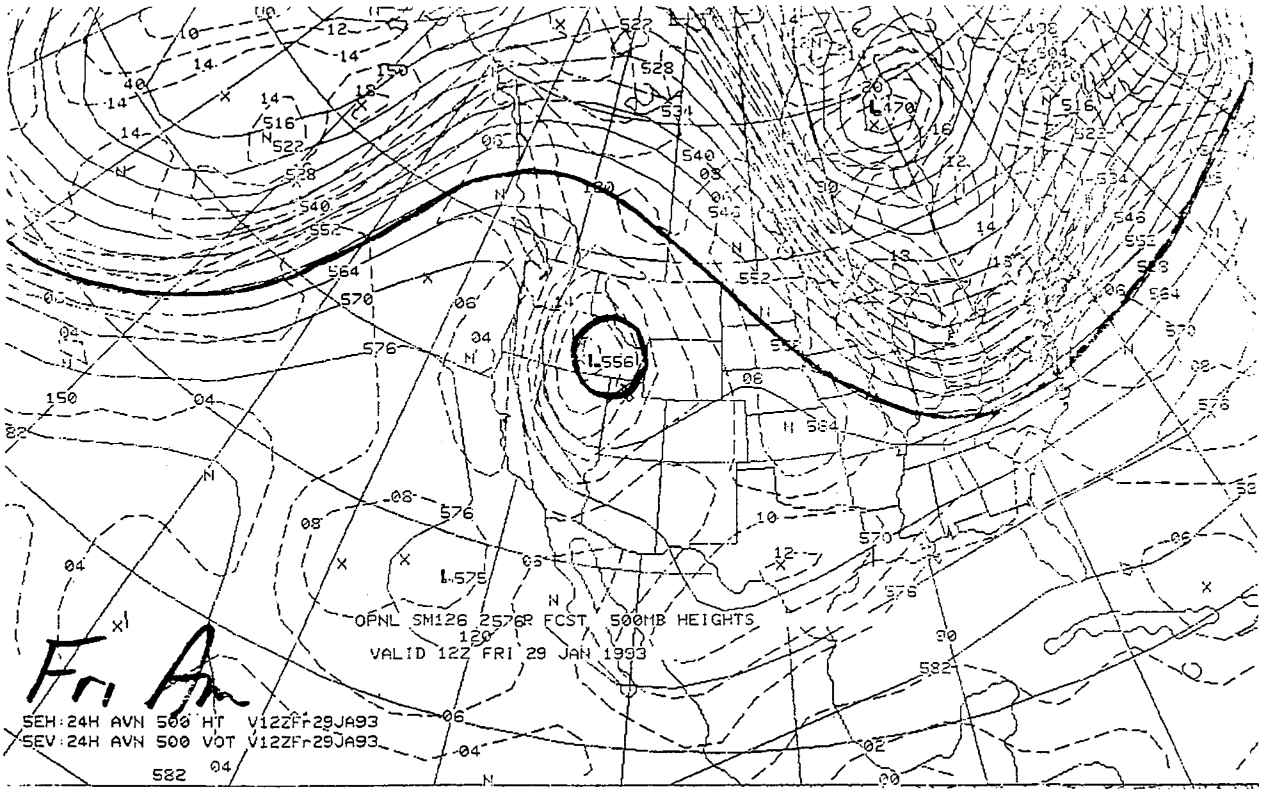

Fig. 2c 500 mb height (dm) & absolute vorticity ($x10^{-5}$ s^{-1}) from AVN 24h forecast valid 1200 UTC 29 January 1993.

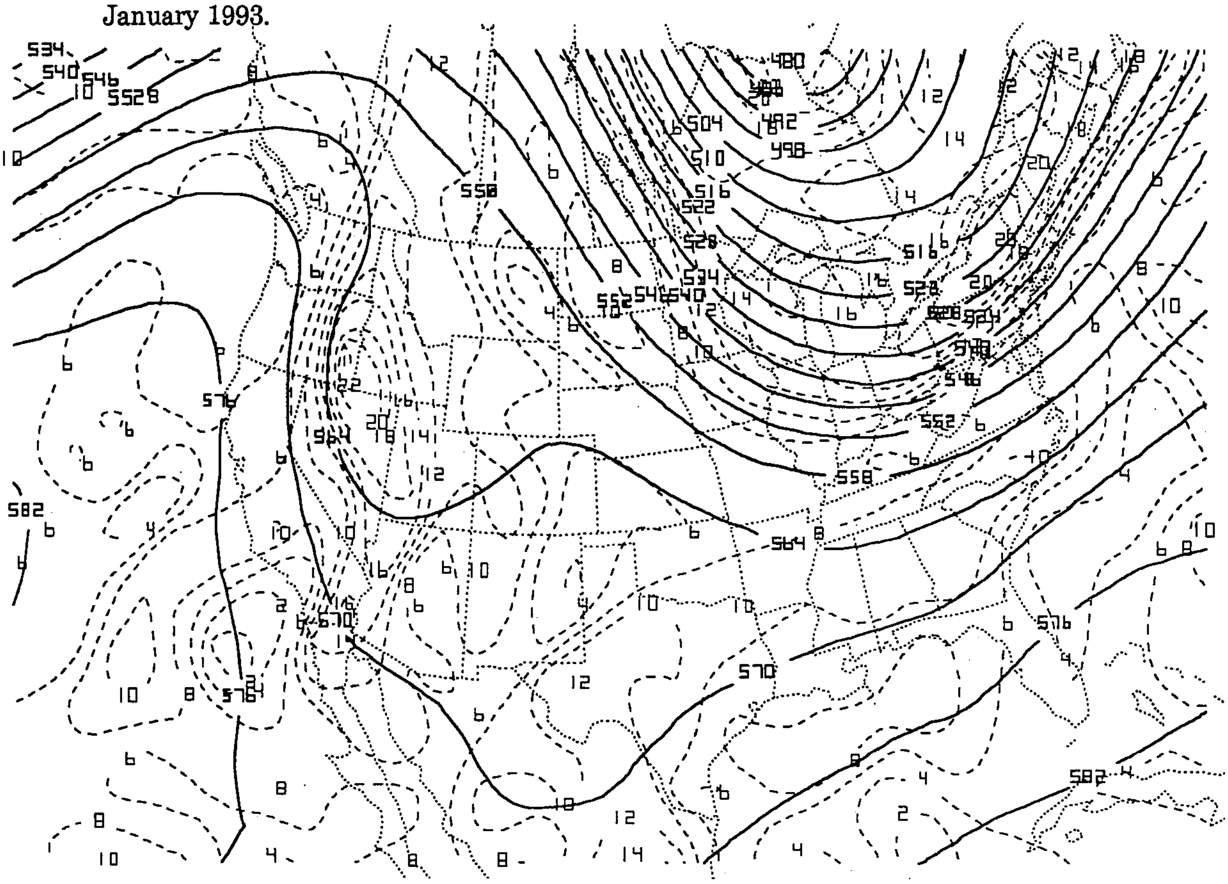

Fig. 3a 500 mb height (dm) & absolute vorticity ($x10^{-5}$ s^{-1}) from ETA-X 48h forecast valid 1200 UTC 29 January 1993.

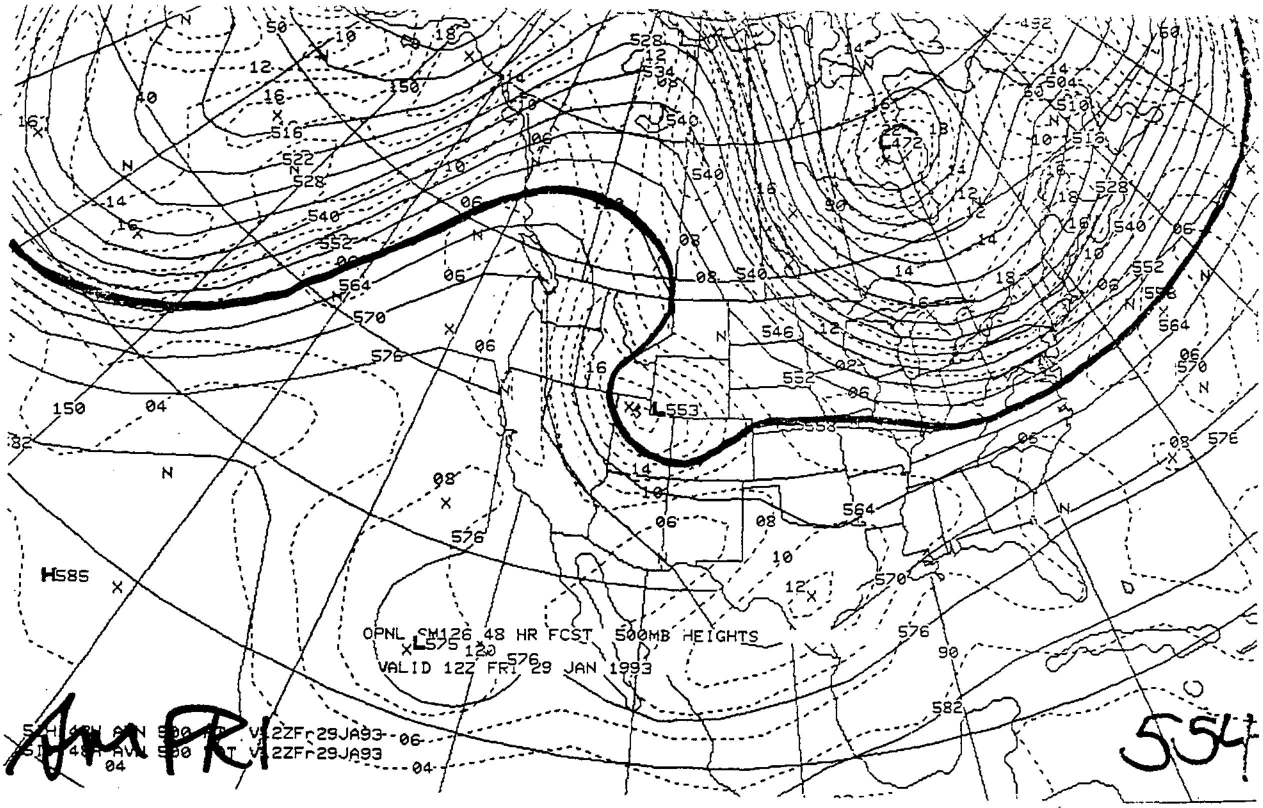

Fig. 3b 500 mb height (dm) & absolute vorticity ($x10^{-5}$ s^{-1}) from NGM 48h forecast valid 1200 UTC 29 January 1993.

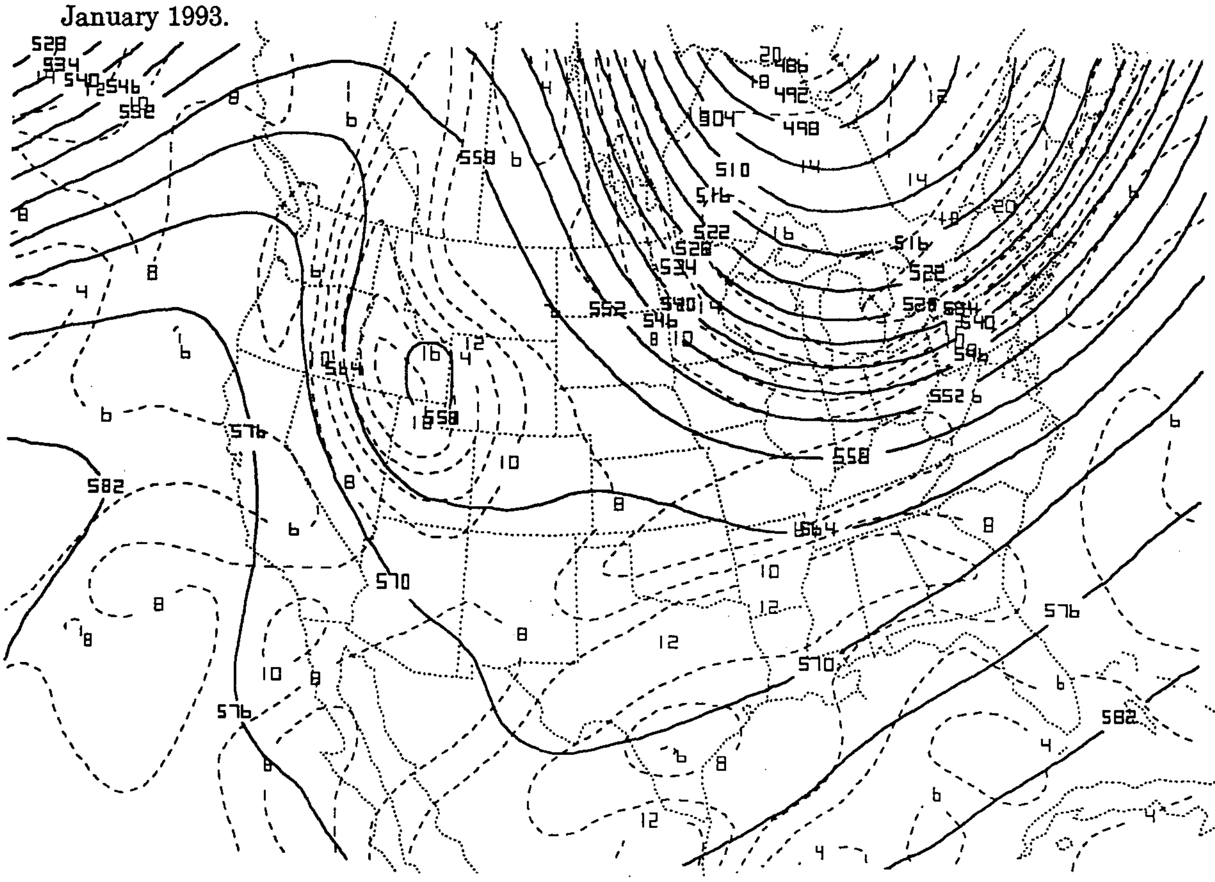

Fig. 3c 500 mb height (dm) & absolute vorticity ($x10^{-5}$ s^{-1}) from AVN 48h forecast valid 1200 UTC 29 January 1993.