Western Region Technical Attachment
No. 92-02
January 14, 1992

COMMENTS ON WESTERN REGION TECHNICAL ATTACHMENT NO. 91-50, "DISCONTINUOUS VERTICAL MOTION DIAGNOSED THROUGH PIVA."

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The authors of Western Region Technical Attachment (TA) No. 91-50, presented a case study whereby vertical motion was diagnosed via simplified quasi-geostrophic (QG) numerical analysis. They demonstrated that QG forcings in some areas were different at various levels and showed that this seemed to coincide with areas where precipitation was less than one might have expected.

The satellite picture shown in Fig. 1 appears to have the coldest cloud tops in an anticyclonic band from east-central Nevada through western Montana. Figures 2a-c (Fig. 4 in the original TA) show only weak QG forcing in this area. Why is there apparently strong vertical motion in an area that QG forcing are weak?

One possibility is that there may be an interaction between two jet streaks. Although we do not have the data plots to support this claim, a typical position of jet streaks for such a pattern is illustrated in Fig. 3 by the thick arrows. The "left-front" quadrant of the jet streak rounding the bottom of the Nevada trough (southern branch), and the "right-rear" quadrant of the jet streak in the British Columbia/Saskatchewan trough (northern branch) are in the same general area. The combination of enhanced vertical motion may be producing enhanced vertical motion over eastern Idaho and Montana.

Another possibility is that there is a deformation zone in this area. There is a confluent area of flow between the flow around the Nevada trough and the flow around the Canadian trough. This is a deformation axis of dilatation, similar to the idealized schematic depicted in Fig. 4 [1]. Such a deformation zone that is increasing the temperature gradient (frontogenesis) would produce a secondary circulation with enhanced upward vertical motion south of the axis of dilatation. From Fig. 3, it appears that the deformation zone in this case would lie from western Idaho into extreme western Montana. This would support the enhanced vertical motion over eastern Idaho and Montana.

To some extent, the quasi-geostrophic system includes jet streaks and frontogenetical deformation zones, and thus includes the vertical circulations that they produce. However, these circulations can be much more intense if the quasi-geostrophic approximation is removed.

These comments are not intended to refute the claims made by the authors of TA 91-50. Rather, they are to point out that in some areas, vertical motions can be strong when QG forcings are weak. Many ways of diagnosing vertical motion may need to be considered to explain all areas of vertical motion.

[1] "Reverse" Deformation Zone, Western Region Technical Attachment No. 87-45.

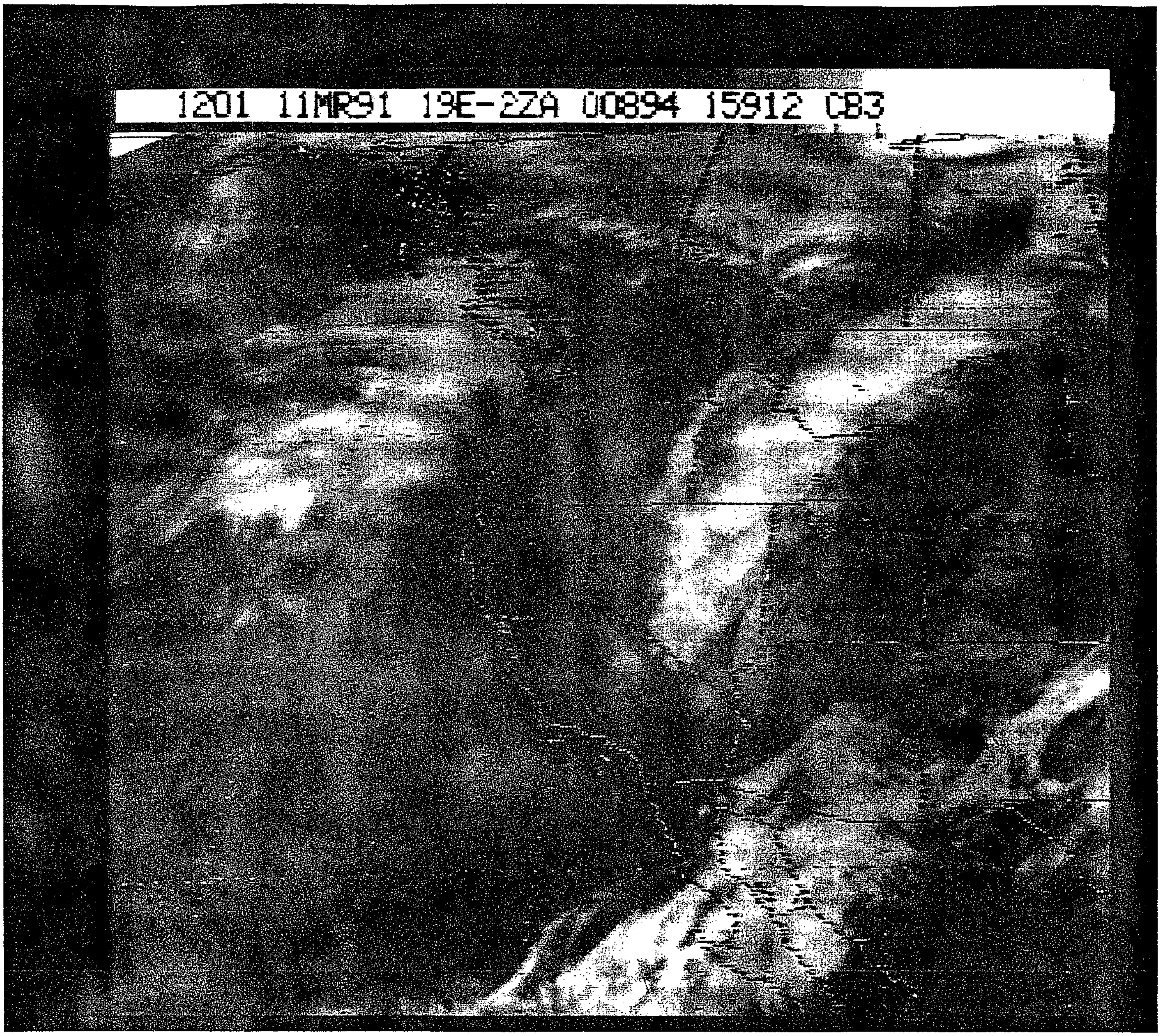


Fig. 1

RHS PIVA 850–700–500 MB 3/11/91 12Z

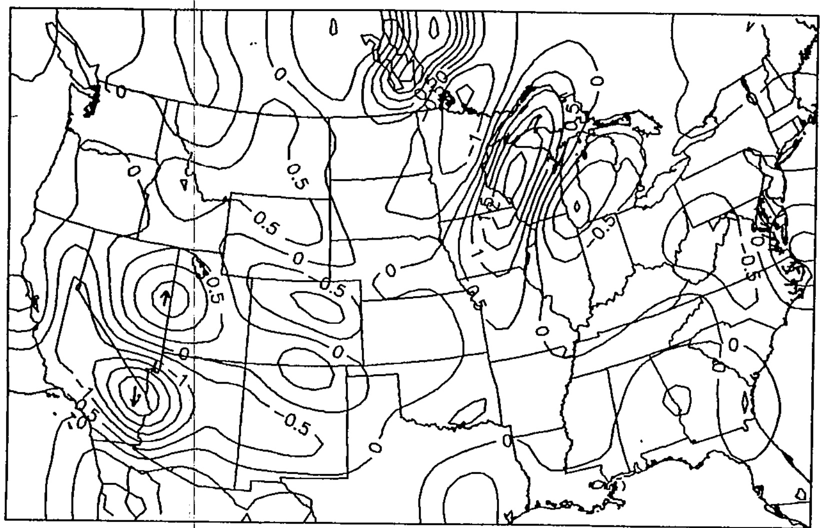


Fig. 2 (a)

RHS PIVA 700–500–300 MB 3/11/91 12Z

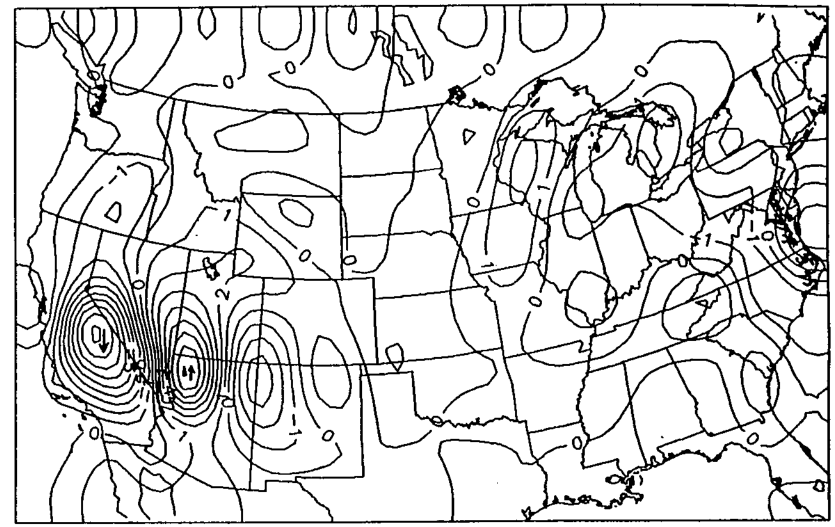


Fig. 2 (b)

RHS PIVA 500–300–200 MB 3/11/91 12Z

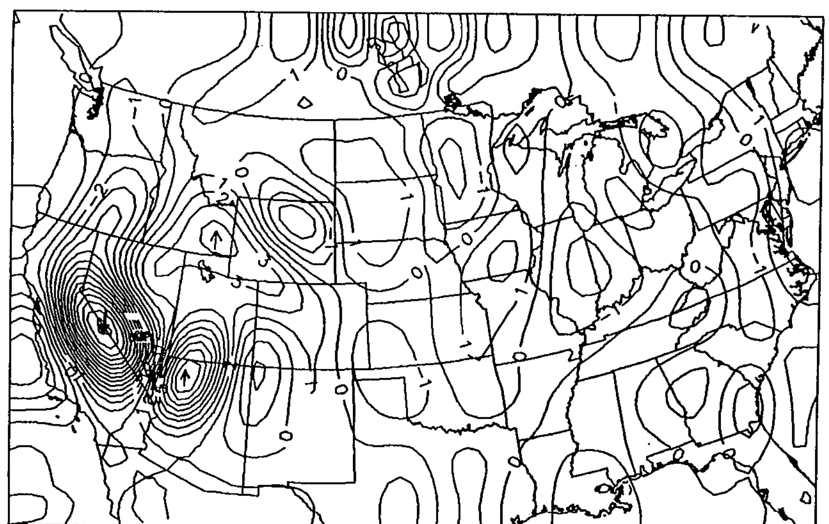
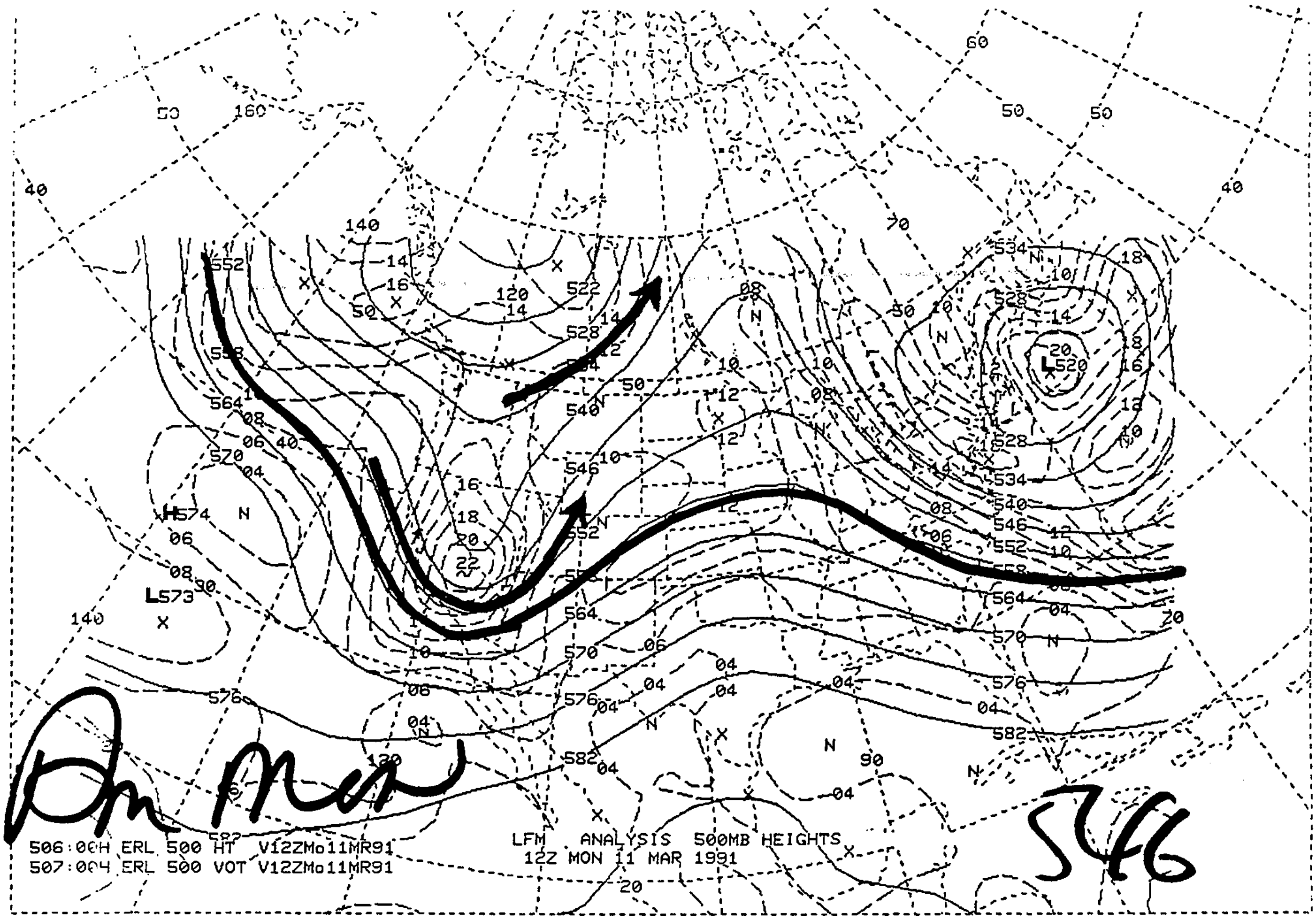


Fig. 2 (c)

FIG. 2 PIVA (x 10^{-17} m kg^{-1} s^{-1}) or the right-hand side of equation (1). Positive/negative values imply upward/downward vertical motion. (a) 700 mb vorticity advected by the 850-500 mb thermal wind (lower level), (b) 500 mb vorticity advected by the 700-300 mb thermal wind (mid level), and (c) 300 mb vorticity advected by the 500-200 mb thermal wind (upper level).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507:004 ERL 500 VOT V12ZMo11MR91
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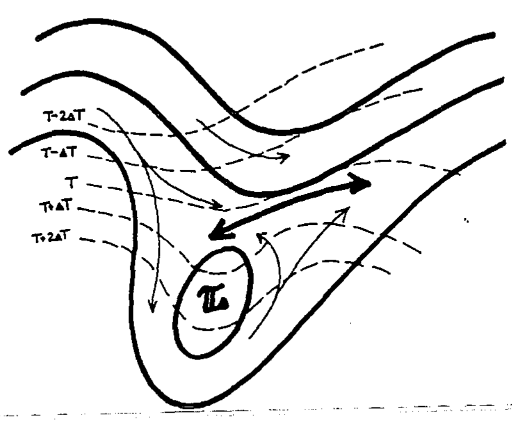
Fig. 3


T-2ΔT
T-ΔT
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T+ΔT
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Fig. 4