Western Region Technical Attachment
No. 92-38
December 8, 1992

INTRODUCTION TO PCGRIDS DIAGNOSTICS

This Technical Attachment is intended to demonstrate the usefulness of gridded data as well as the capabilities of PCGRIDS. Gridded model output data provides a unique opportunity to manipulate base grids, such as temperature, heights, and winds, to compute a variety of diagnostic quantities which may provide insight into the forecast changes within a particular model.

Two such familiar diagnostic tools used to estimate quasi-geostrophic (QG) forcing for vertical velocity are: 1) vorticity advection by the thermal wind, which must be inferred on AFOS from plots of thickness overlaid on the 500 mb vorticity field; and 2) Q-vector divergence, which is not an available on AFOS. Using gridded data and PCGRIDS, these diagnostic quantities may be calculated explicitly, removing any ambiguity that may have existed with previously used methods. It also provides an opportunity to diagnose whether or not the predicted vertical velocity within the model is in response to QG forcing.

Vorticity advection by the thermal wind (see WRTA 91-48) using AFOS typically is done using the 1000-500 thickness overlaid onto the 500 mb vorticity field (Fig. 1a). Using this method may be difficult to properly interpret QG forcing for two reasons: 1) Determining where positive vorticity advection (PVA) changes to negative vorticity advection (NVA); and 2) using the 1000-500 mb thermal wind does not encompass the level on which the vorticity is calculated and, thus, does not correctly determine the advection occurring through a layer. Using PCGRIDS, a somewhat more representative field may be obtained by computing the advection of the 500 mb vorticity by the 300-700 mb thermal wind. The 300-700 mb thermal wind is more representative of the vorticity advection through that layer, using 500 mb vorticity. Figure 1b represents the results of such a computation, where positive (cyclonic) vorticity advection by the thermal wind is denoted by positive values. Note the actual computation (Fig. 1b) better defines the transition from PVA to NVA, whereas in Fig. 1a, it is more difficult to identify the transition.

Likewise, the divergence of the Q-vectors may also be computed at various levels. An important note: Viewing Q-vector divergence at a particular level may be dangerous and should always be viewed at two or three levels within the troposphere. Q-vectors assist in quantifying the contribution to the vertical motion field by quasi-geostrophic dynamics at a particular level within the atmosphere. The vertical integration of quasi-geostrophic forcing is an important consideration, not the amount of QG forcing at any one particular level. Thus, vertically consistent patterns of Q-vector divergence identify the large-scale vertical motion, while fluctuations between Q-vector convergence and divergence, from level to level, suggest the large-scale QG dynamics are not very consolidated in forcing vertical motions. Figure 2 illustrates the presentation of Q-vector divergence at three vertical levels, using PCGRIDS and gridded data, as well as the need for viewing multiple layers. Comparing the Q-vector divergence shown in Fig. 2 over an area from central California to southwestern Arizona, identifies Q-vector convergence at 300 and 700 mb with Q-vector divergence indicated at 500 mb. This pattern suggests the QG forcing over this region is not consolidated and, thus, probably weak. This does not suggest that vertical motion is absent, but more importantly the vertical velocity present is in response to mesoscale forcing. By comparing three levels within the troposphere, the combined effect of QG forcing may be inferred (see WRTA 90-07).

Thus, PCGRIDS and gridded data allow an in-depth interrogation of the model output through manipulation of the base gridded fields. This provides the forecaster more control and flexibility in choosing the diagnostic fields desired for a particular forecast problem. In the case of gridded data, the forecast problem will dictate the diagnostic fields chosen and not a limited list of available products. This will require creative development and knowledgeable choices of diagnostic fields relevant for each unique forecast problem.

References

Western Region Technical Attachment No. 91-48, Applying Trenberth's Approximation of the Omega Equation, December 10, 1992.

Western Region Technical Attachment No. 90-07, Evaluating Vertical Motion or Why is it Snowing, February 13, 1990.

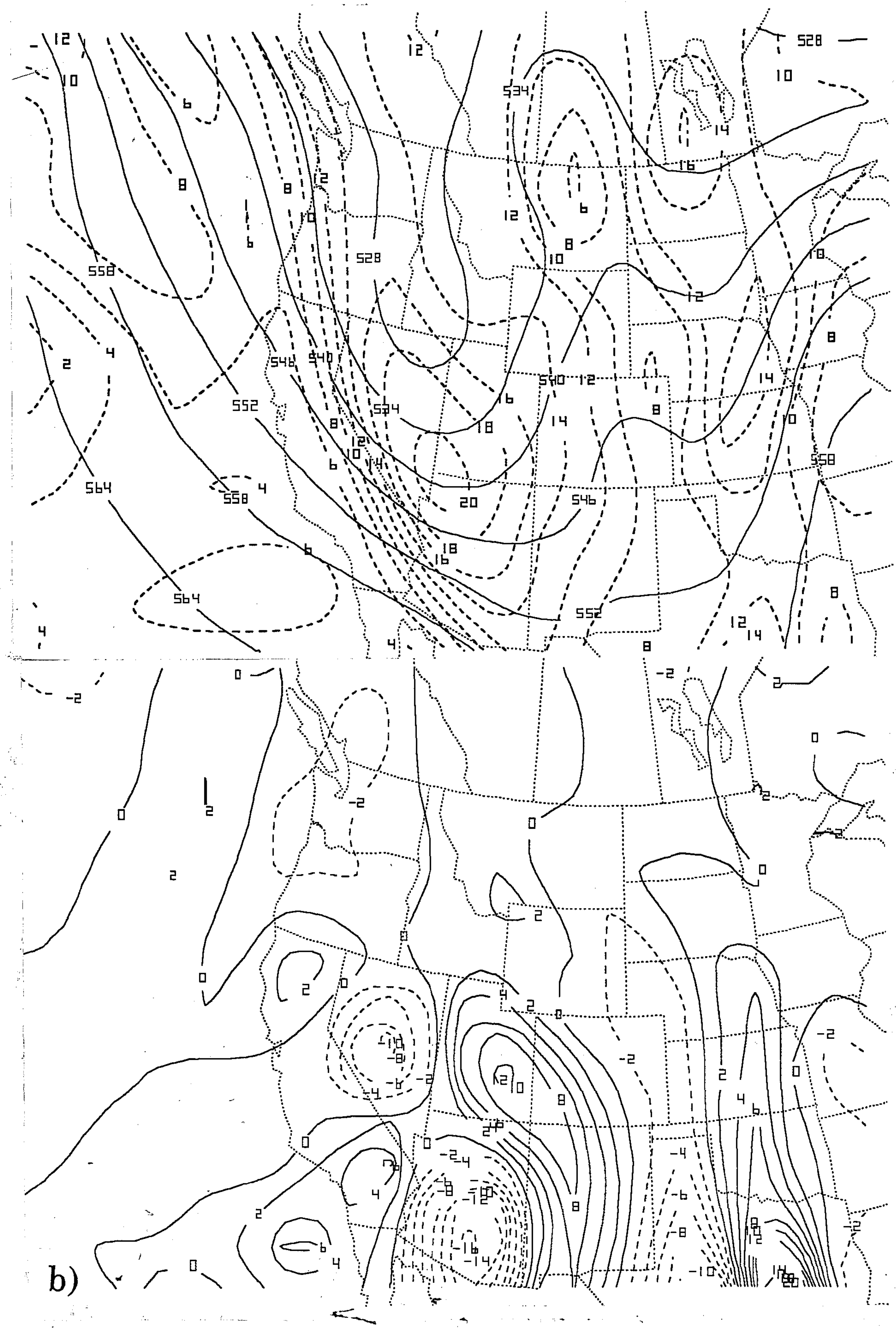

Fig. 1 a) 1000-500 mb thickness (solid) and 500 mb absolute vorticity; b) 500 mb absolute vorticity advection by the 300-700 mb thermal wind. Contour interval of $2x10^{-9}$ s^{-2}.

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Fig. 2 Q-vector divergence at a) 300 mb (contour interval 4x10^{-10} C m^{-2} s^{-1}); b) 500 mb (contour interval 1x10^{-9} C m^{-2} s^{-1}); 700 mb (contour interval 2x10^{-10} C m^{-2} s^{-1}).

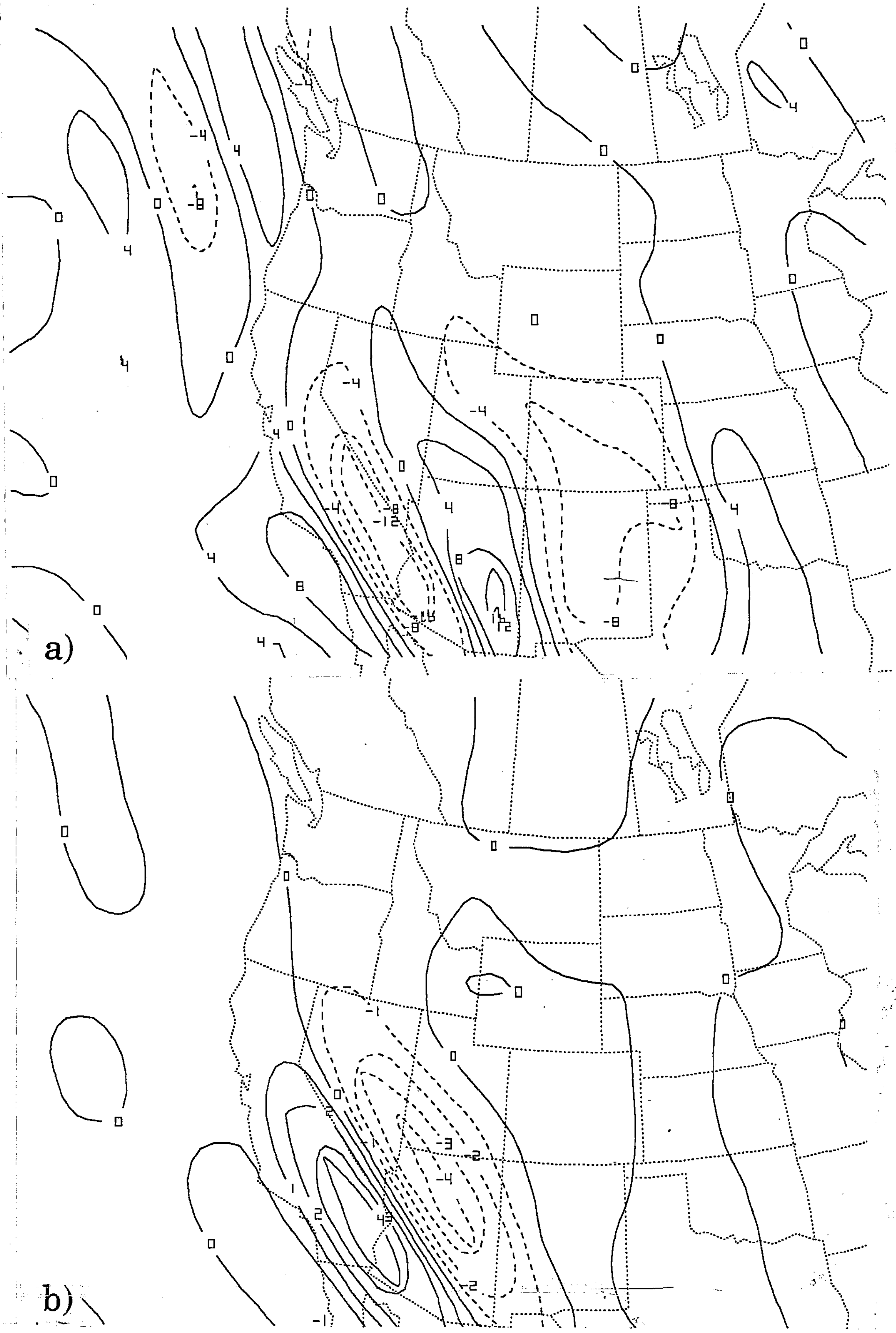

Fig. 2 Q-vector divergence at: a) 300 mb (contour interval of $4x10^{-10}$ C m^{-2} s^{-1}); b) 500 mb (contour interval of $1x10^{-9}$ C m^{-2} s^{-1}); c) 700 mb (contour interval of $2x10^{-10}$ C m^{-2} s^{-1}).

Fig. 1 a) 1000-500 mb thickness (solid) and 500 mb absolute vorticity; b) 500 mb absolute vorticity advection by the 300-700 mb thermal wind. Contour interval $2\text{x}10^{-9}0\ s^{-2}$.

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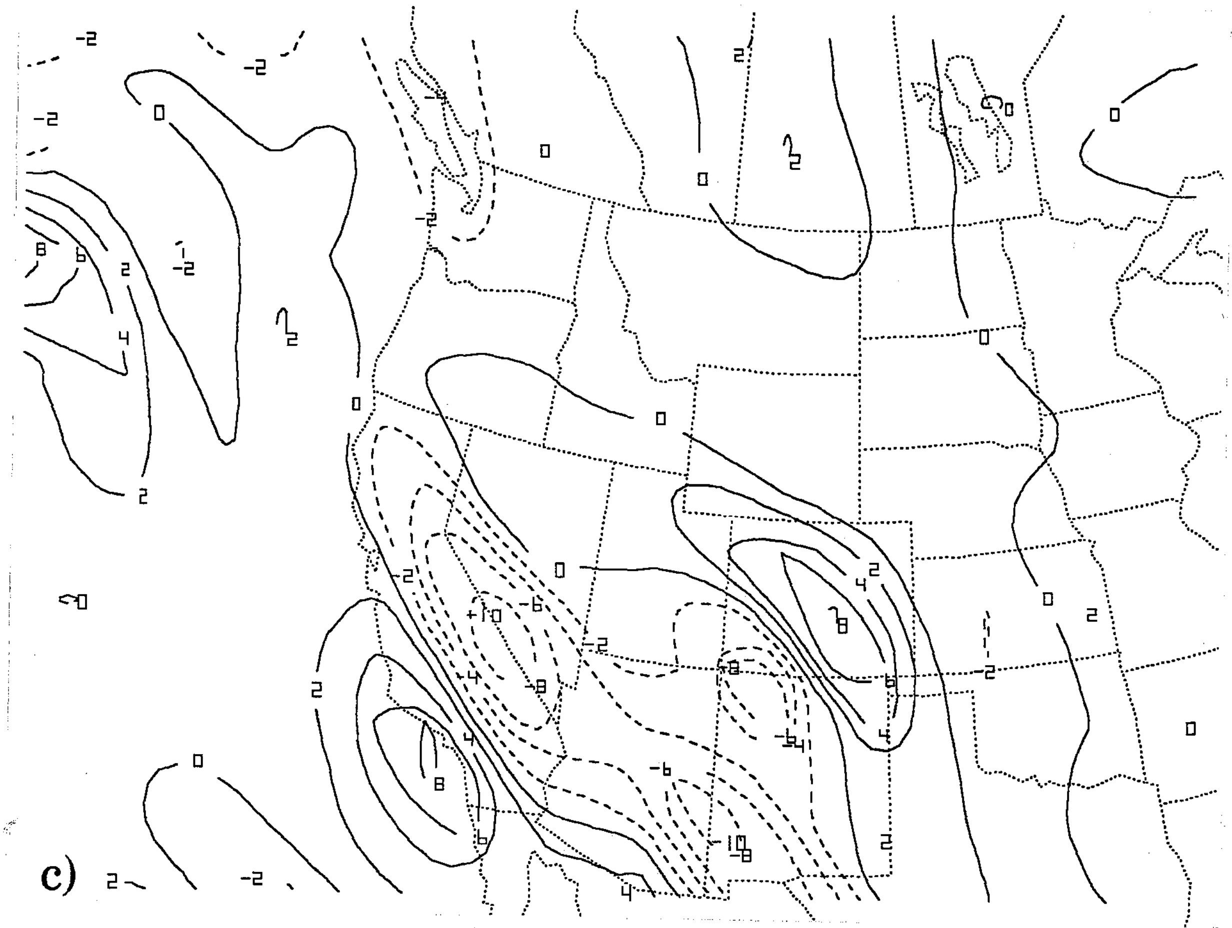

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