WESTERN REGION TECHNICAL ATTACHMENT
November 18, 1975
No. 75-31

WILL THE REAL LOW CENTER PLEASE STAND UP?

Pinpointing low centers based strictly on apparent centers of circulations observed on satellite pictures can at times be rather difficult. However, for oceanic and other data-sparse regions, satellite pictures are perhaps the only reliable aid at our disposal. If the storm in question is in the mature stage and moving slowly, the system will be quite vertical, and locating the low center will not be a problem. However, during the developing stage of a storm, the apparent center of rotation, as seen on satellite pictures, may not coincide with the low center, particularly if the system is moving rapidly. For instance, where would you put the low center in Figure 1a (IR) and 1b (Vis.)? Point A?

For a developing system, the apparent center of rotation that is shown on the satellite pictures is dependent upon the rotation of the air with respect to itself--not with respect to the surface of the earth. These rotations, which depend upon air motion with respect to itself, are known as vorticity comma clouds. The apparent rotation that we see on the satellite pictures is associated with the vorticity pattern.

To represent this, Figure 2a [1] shows a cyclonically rotating solid disc that is also translating (V_t). Point R is the center of rotation and also the center of vorticity of the disc. However, if we determine the instantaneous velocity with respect to the paper (or surface of the earth) of each point on the disc (adding the rotational and translational velocities for each point), and then draw the streamlines through the resultant vector field, we get Figure 2b [1]. Point C becomes the apparent center of circulation--the VORTEX center. This is where the translational velocity is equal and opposite to the tangential velocity. And point R remains, as before, the center of vorticity.

Therefore, if you chose point A in Figure 1 as the low center, you lose. Figure 3 shows this apparent rotation (vorticity comma (shaded)) and the actual location of the low center at the 50 kPa level (500 mb). The vorticity pattern associated with the comma is also shown, as well as the comma positions four hours prior and after. The comma circulation is embedded in and moves with the flow.

Figure 4 is an example of what happens when V_t approaches zero. System W (Figure 4a, IR) was warm core in nature and was moving at a very rapid pace toward the east-northeast. Only a small reflection of this system was analyzed at the 50 kPa level. However, between 24 and 36 hours later, the system began to slow as it moved into the long-wave trough position and as cold air fed into it, and thereafter a rapid transition toward a mature coldcore system took place. Figure 4b (IR) and Figure 5 show that the vortex and vorticity centers with this system nearly coincided at 1200Z.

To sum: In the atmosphere, when an area of clouds is rotating and translating, the center of rotation with respect to the air (the center of vorticity) does not coincide with the low center depicted on a synoptic map.

The distance between points R and C will vary according to the ratio of translational velocity to the rotational velocity. If the translational velocity is zero, points R and C will coincide.

If the rotational velocity is everywhere smaller than the translational velocity, there will be no closed vortex on the synoptic map depiction of the system (there will be no easterly winds).

Reference:

[1] R. B. Weldon, NWS Satellite Training Course Notes, Part I, NESS, April 1975.

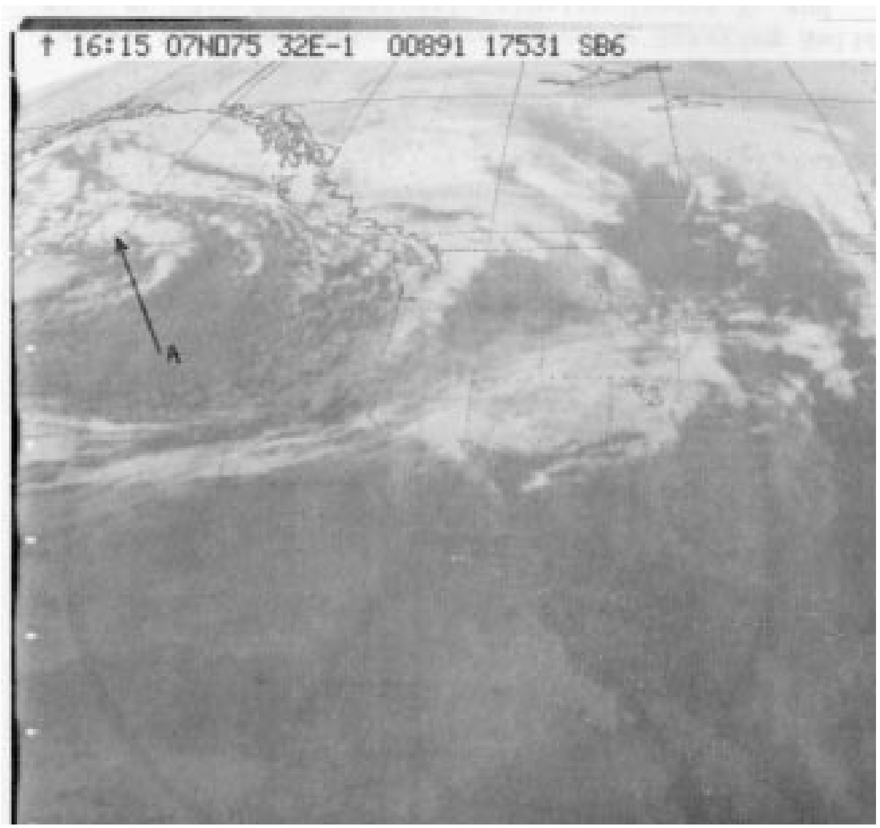

Figure 1a. IR SMS-2 PICTURE FOR 1615 GMT SHOWING APPARENT CENTER OF CIRCULATION IN THE GULF OF ALASKA.

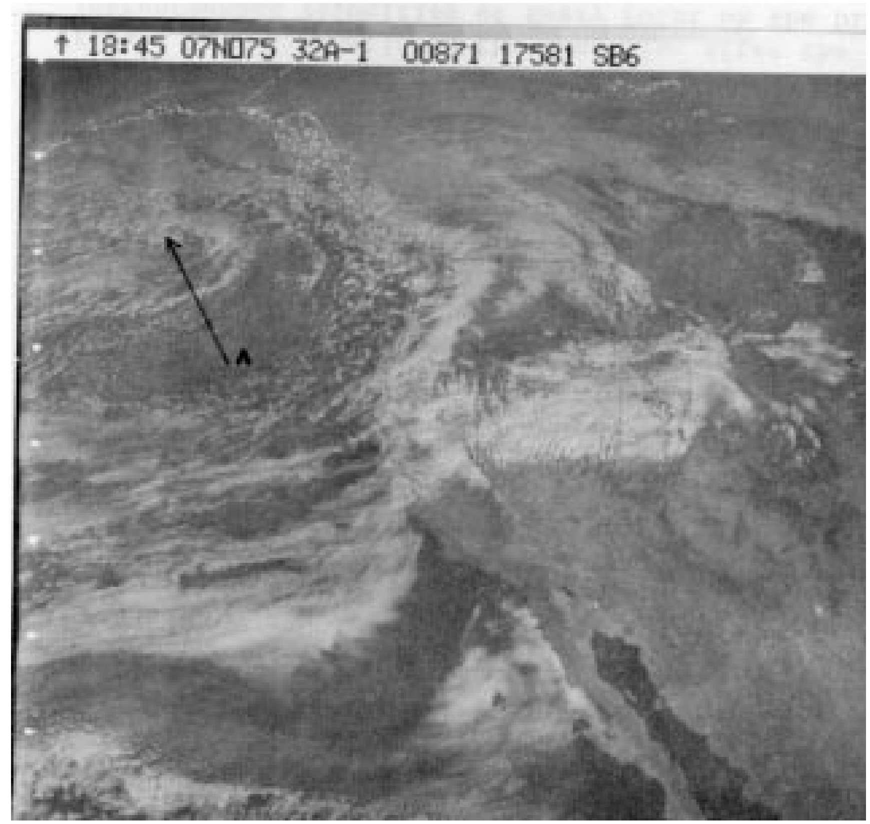

Figure 1b. VISUAL SMS-2 PICTURE FOR 1845 GMT SHOWING APPARENT CENTERJ OF CIRCULATION IN THE GULF OF ALASKA.

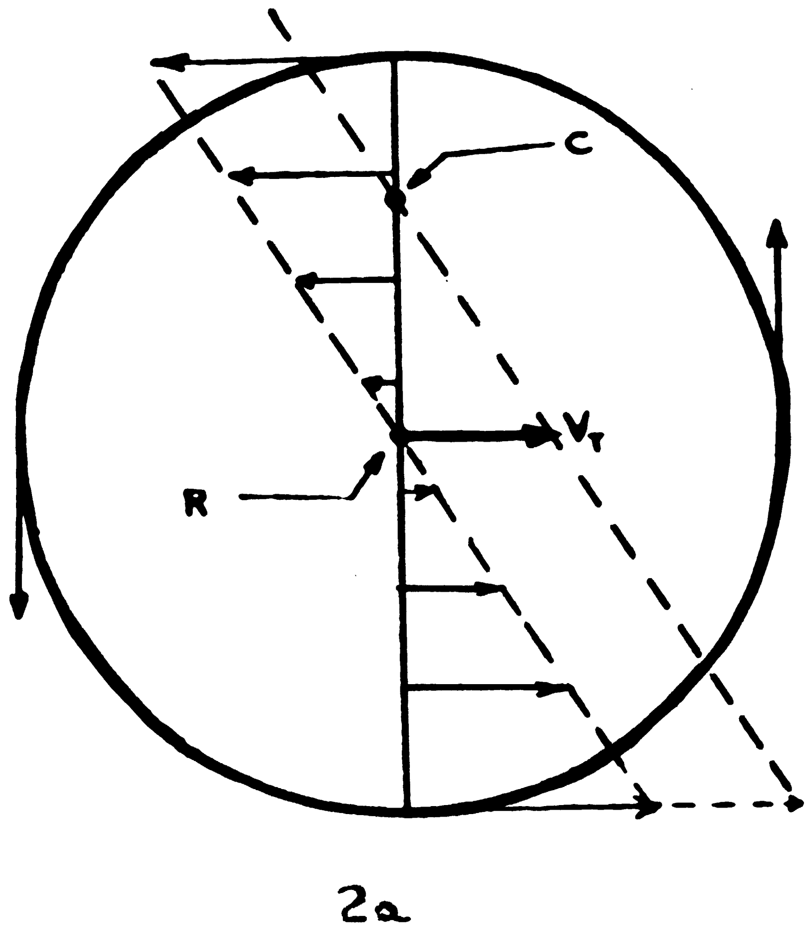

Figure 2a. Schematic of Cyclonically Rotating Solid Disc Showing Translational Velocity Vector V_t and the Tangential Velocities Due to the Rotation.

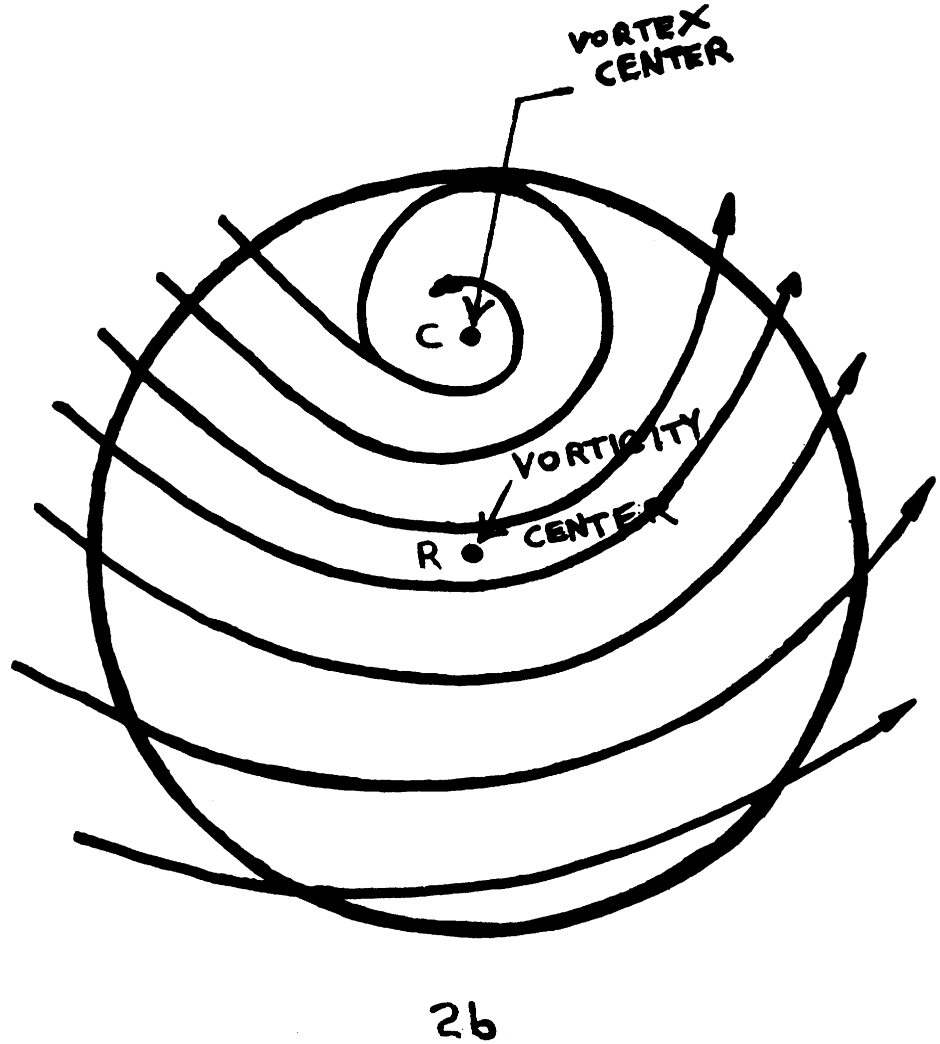

Figure 2b. Schematic of the Same Disc after the Instantaneous Velocities of Every Point on the Disc are Determined and Streamlines Drawn through the Resultant Vector Field.

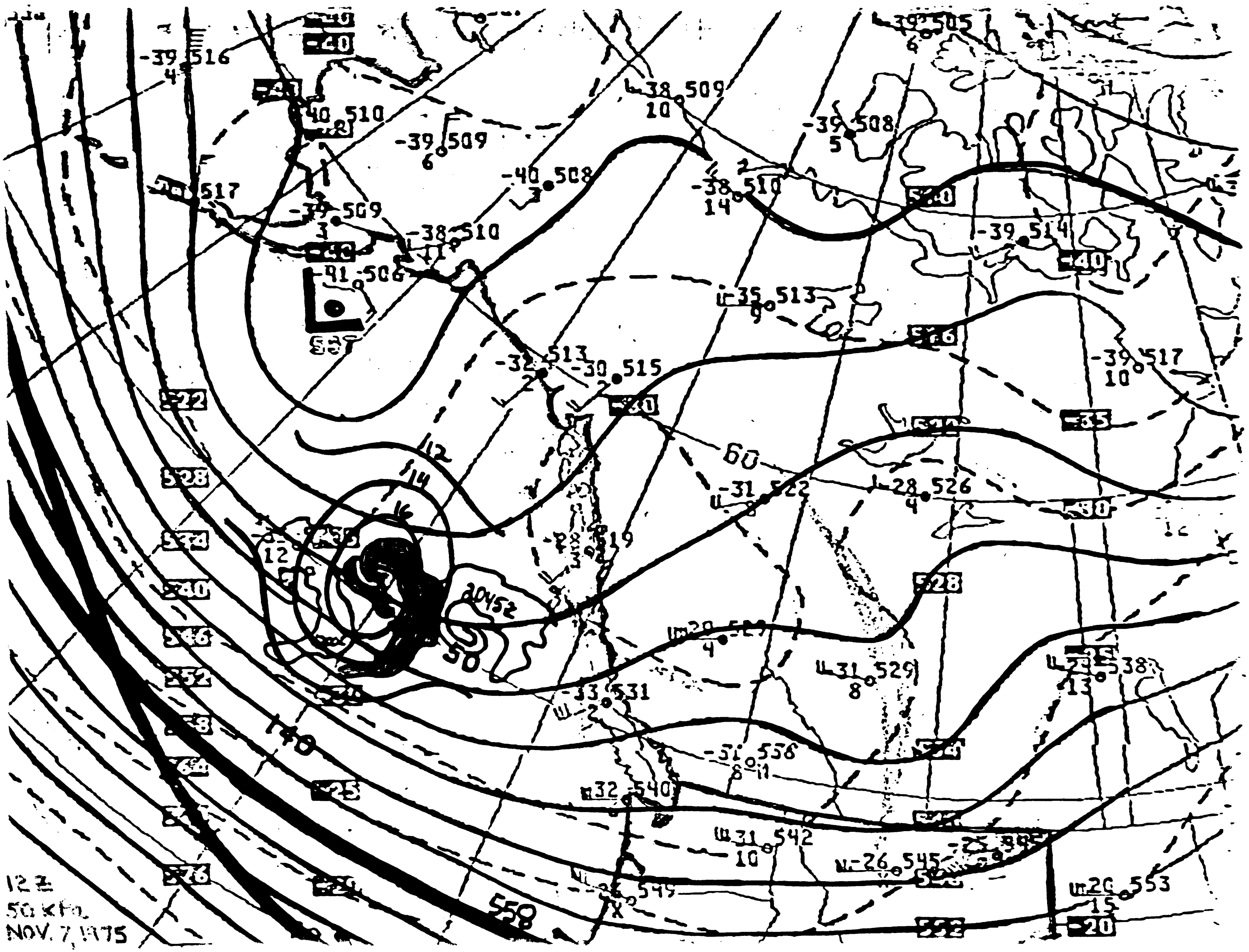

FIGURE 3. 1200 GMT NOVEMBER 7, 1975, 50 kPa CHART SHOWING BOTH THE LOCATION OF THE APPARENT CENTER OF CIRCULATION AT 1615 GMT (SHADED) AND ASSOCIATED VORTICITY PATTERN WITH RESPECT TO REAL VORTEX CENTER.

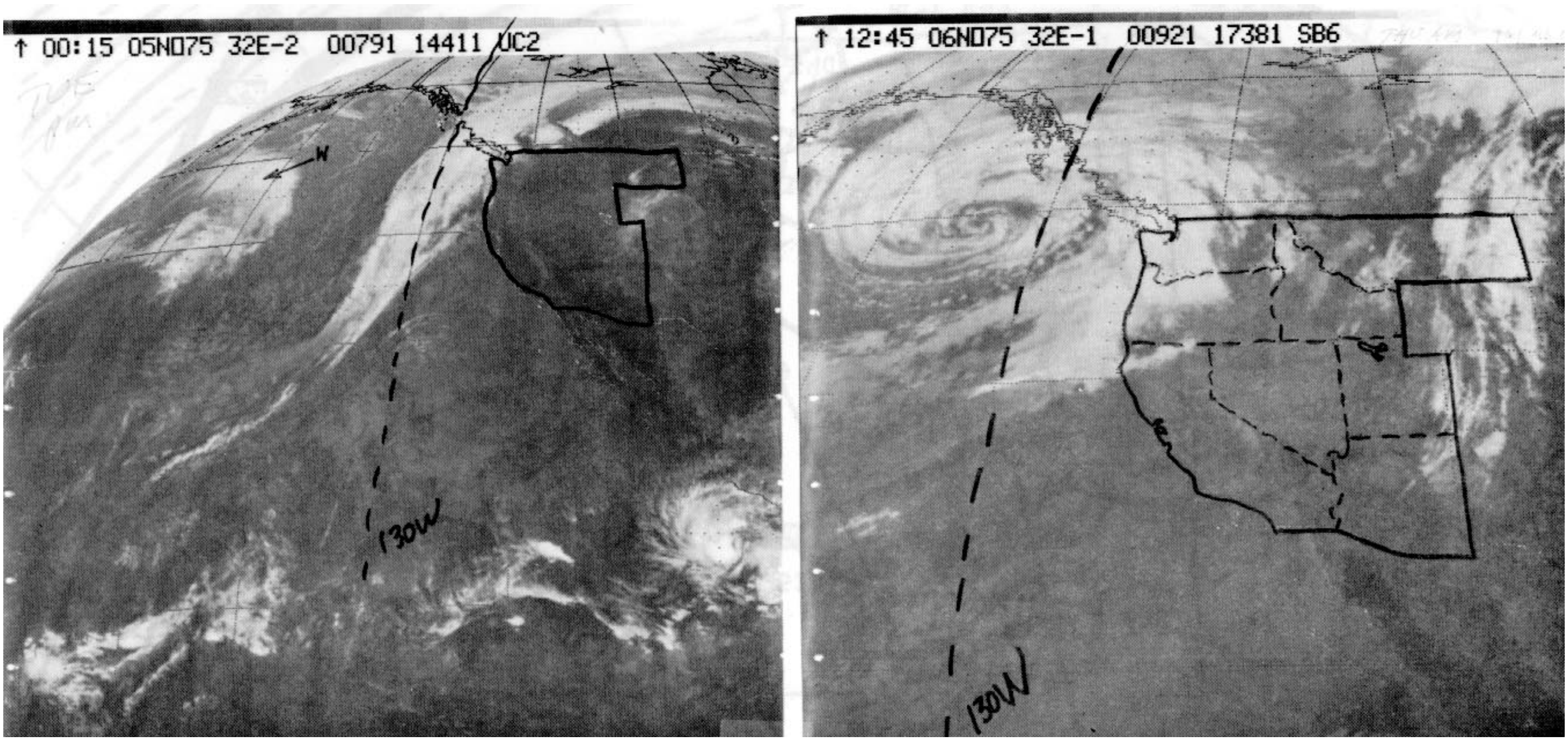

FIGURE 4. A) SMS-2 IR PICTURE OF WARM CORE SYSTEM (W) BECOMING B) COLD-CORE SYSTEM IN GULF OF ALASKA.

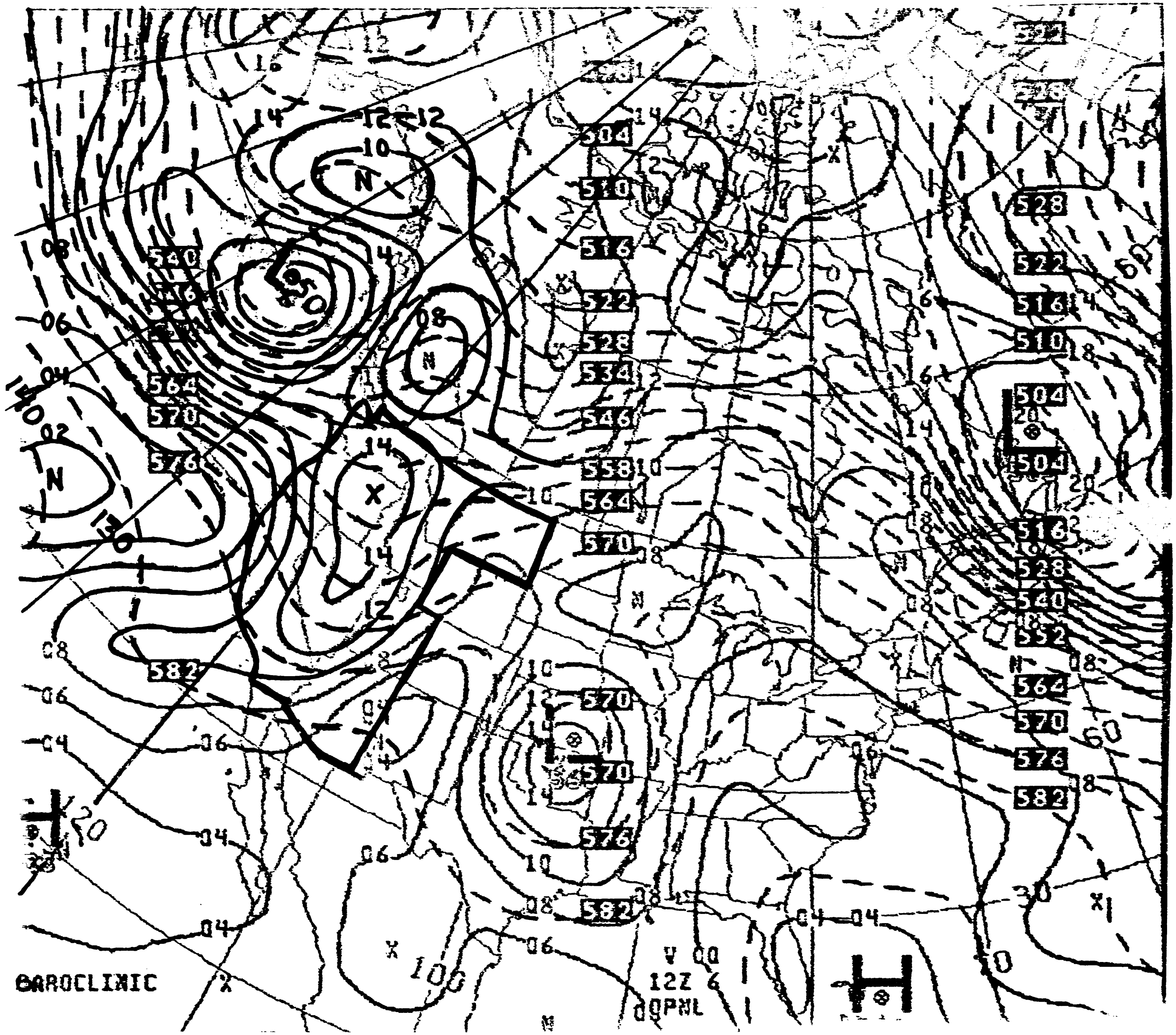

Figure 5. Initial PE Vorticity Analysis for 1200Z November 6, 1975.