PACIFIC REGION TECHNICAL NOTES

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EXAMPLES OF DEFORMATION OF BOUNDARIES

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PROMINENT METEOROLOGISTS, PETTERSSEN, PALMEN AND NEWTON INVESTIGATED THEORETICALLY THE ROLE OF DEFORMATION AND DIVERGENCE IN PRODUCING FRONTOGENESIS AND FRONTOLYSIS. IT WAS GENERALLY AGREED THAT FRONTOGENESIS WAS THE SUM RESULT OF FOUR PROCESSES:

(A) THE DIABATIC EFFECT
(B) THE ACTION OF THE DEFORMATION FIELD
(C) THE ACTION OF THE DIVERGENCE FIELD
(D) THE ACTION OF THE VERTICAL MOTION FIELD.

THE LAST THREE ARE INTERRELATED.

OVER A FAIRLY UNIFORM UNDERLYING SENSIBLE HEAT SOURCE SUCH AS THE PACIFIC OCEAN, THE DIABATIC EFFECT MAY BE NEGLECTED IN COMPARISON TO THE EFFECT OF THE WIND FIELD.

BEFORE THE ADVENT OF SATELLITE PICTURES, SYNOPTIC MAPS WERE MAINLY CONSTRUCTED FROM GROUND OBSERVATIONS WHICH VARIED GREATLY IN QUALITY AND FREQUENCY. DISTINCT CLOUD BOUNDARIES WERE NOT DISCERNIBLE BECAUSE OF THE LACK OF SPATIAL RESOLUTION IN THE OBSERVING NETWORK. THEREFORE, ANALYSIS WAS BASED ON PRECONCEIVED MODELS (USUALLY THE CLASSICAL WAVE MODEL). SUCH CONCEPTS AS DEFORMATION AND DIVERGENCE AND THEIR ROLE IN PRODUCING DISTINCT CLOUD BOUNDARIES BECAME ACADEMIC.

RECENTLY, SATELLITE PICTURES BECAME AVAILABLE ON A HALF HOURLY BASIS. DISTINCT CLOUD BOUNDARIES AND THE EVOLUTION OF CLOUD PATTERNS BECAME MORE OBSERVABLE. GREATER EMPHASIS WAS NEEDED ON THE DYNAMICS OF THE WIND FIELD IN THE ANALYLIS AND INTERPRETATION OF CLOUD PATTERNS. UNFORTUNATELY, THIS HAS BEEN AT THE EXPENSE OF THE OLDER FRONTAL MODELS.

ROGER WELDON OF NESS* APPLICATIONS GROUP, NOAA**, COMPOSED A SERIES OF NWS*** SATELLITE PICTURE INTERPRETATION NOTES. HE PLACED RENEWED EMPHASIS ON THE DEFORMATION FIELD AND ITS ROLE IN PRODUCING CLOUD BOUNDARIES. THESE NEW (OR RENEWED) CONCEPTS HAVE GAINED SUBSTANTIAL ACCEPTANCE IN THE NWS FORECAST OFFICES.

WELDON WAS RESPONSIBLE FOR COINING THE TERMS HIGH LEVEL DEFORMATION BOUNDARY AND SUBSIDENCE SURGE BOUNDARY. (SEE FIGURE 1) THE HIGH LEVEL DEFORMATION BOUNDARY DEFINES THE NORTHERN LIMIT OF THE CIRRUS CLOUD. THE SUBSIDENCE SURGE BOUNDARY DEFINES THE BACK EDGE OF THE COMMA TAIL (MOSTLY LOWER AND MIDDLE CONVECTIVE CLOUD). THESE TERMS WILL BE ADOPTED HERE.

THE SATELLITE PICTURES OF FEBRUARY 24 CLEARLY DEMONSTRATED BOTH BOUNDARIES. A QUASI-STATIONARY VORTEX NEAR 45N 128W. THE HIGH LEVEL DEFORMATION BOUNDARY LIES EAST-WEST VICINTY OF 50N OVER SOUTHERN BC. THE SUBSIDENCE SURGE BOUNDARY LIES ALONG THE NORTHWEST AMERICAN COAST TO NORTHERN CALIFORNIA THEN SOUTHWESTWARD TO ABOUT 30N 140W. (SEE FIGURE 2)

THERE ARE TWO IMPORTANT FEATURES ASSOCIATED WITH THE SUBSDIENCE SURGE BOUNDARY. FIRSTLY, NOTE THE CLEAR ZONE BEHIND THE BOUNDARY. THIS CLEARLY INDICATES THAT STRONG SUBSIDENCE IS OCCURING SINCE THE CONVECTION IS BEING SUPPRESSED. SECONDLY, IF STREAMLINES ARE DRAWN ALONG THE LINES OF CUMULUS CLOUDS, THE DEFORMATION THAT IS OCCURING BEHIND AND ALONG THE BOUNDARY IS READILY OBSERVABLE. THIS IS SHOWN SCHEMATICALLY IN FIGURE 3 (WHICH IS DIRECTLY COMPARABLE WITH FIGURE 2B).

THE HIGH LEVEL DEFORMATION BOUNDARY IS NOT WELL DEFINED ON ANY OF THE VISUAL PICTUES OF FIGURES 2 AND 5. THIS IS MOSTLY DUE TO THE TRANSPARENCY OF THE CIRRUS. THE ENHANCED IR PICTURE (FIGURE 4) SHOWS THE BOUNDARY MUCH BETTER. THE ANALYSIS OF THE WIND FIELD IS DIFFICULT FROM SATELLITE IMAGERY ALONE FOR THIS BOUNDARY. FILM LOOPS OR SOME KIND OF ANIMATED MOTION OF THE CLOUD SYSTEM IS NECESSARY TO DEMONSTRATE THE EFFECT OF THE WIND FIELD NEAR THIS BOUNDARY. ALTERNATIVELY, THE WIND FIELD CAN BE INFERRED BY USING AN UPPER AIR ANALYSIS, A SERIES OF STILL PICTURES AND SOME EXPERIENCE. THE SUM RESULT IS SHOWN IN FIGURE 3. THIS PATTERN IS DIRECTLY COMPARABLE WITH THE WELDON MODEL OF FIGURE 1. WEST OF 125W THE WIND IS WESTERLY AND EAST OF 123W THE WIND IS EASTERLY AT 1815Z. THIS RESULTS IN THE SHARP BOUNDARY IN THE CIRRUS SHIELD.

*NESS - NATIONAL ENVIRONMENTAL SATELLITE SERVICE
**NOAA - NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
***NWS - NATIONAL WEATHER SERVICE
THE ABOVE ARE AGENCIES OF THE UNITED STATES.

cc. Pacific Region WO4's, YQQ, METOC Esquimalt, PAWC, Pacific Region H.Q.

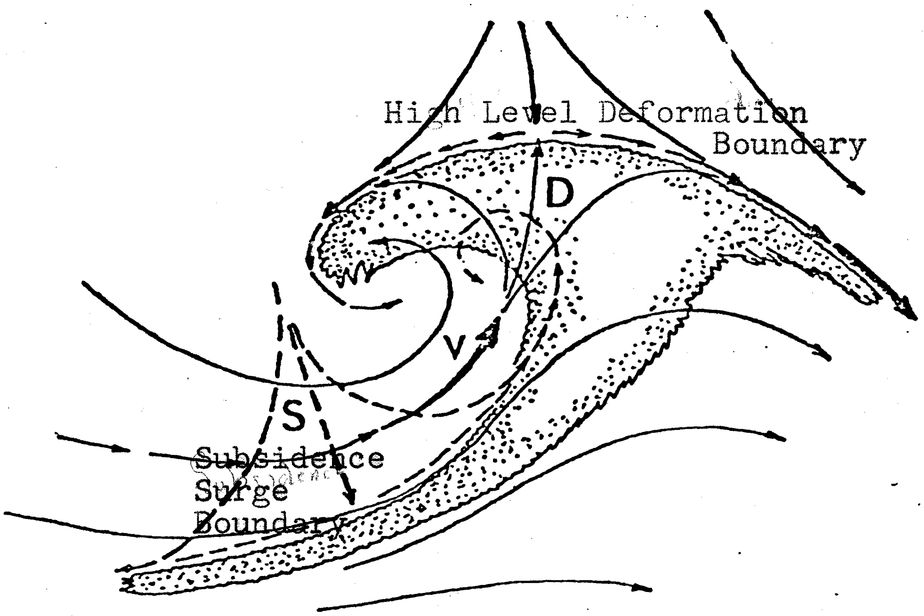

Figure 1. Model of a comma shaped cloud. Note the upper level flow (solid lines) and associated high level deformation boundary. Also note the low level flow (dashed lines) and the subsidence surge boundary.

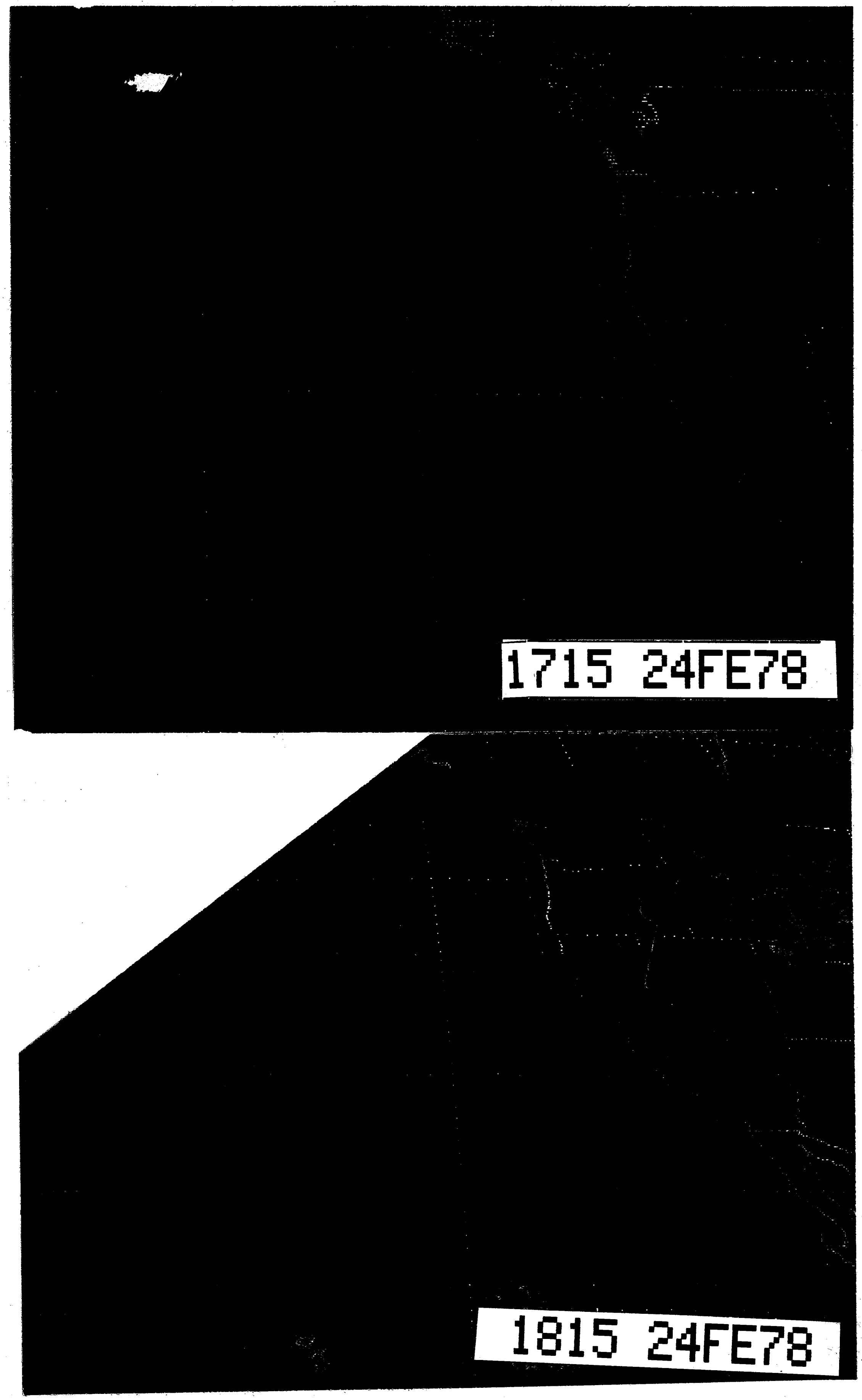

Figure 2. (a) Visual picture of a comma cloud system, 1715z, Feb 24. (b) Visual picture at 1815Z.

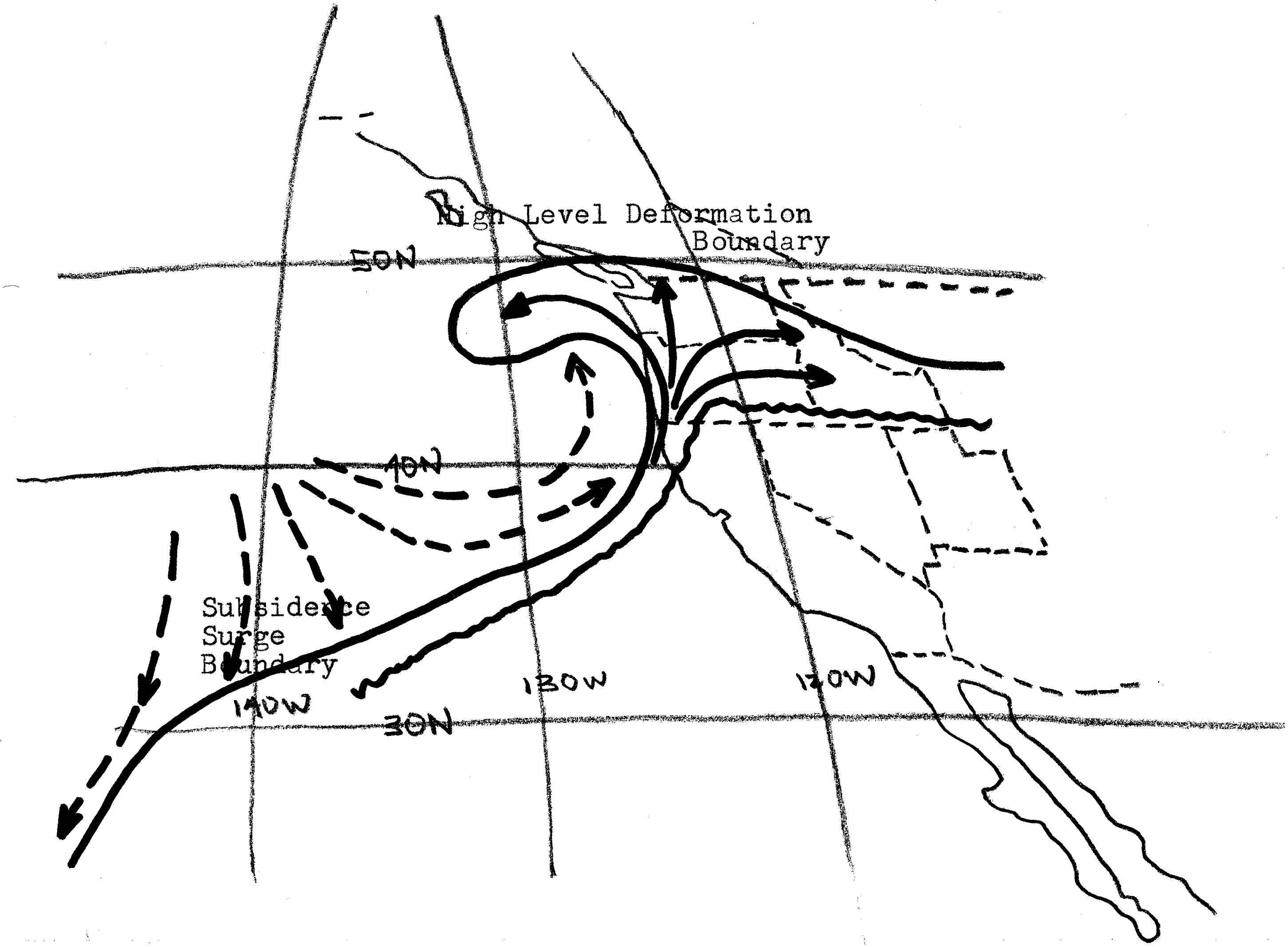

Figure 3. Inferred wind flow and deformation boundaries taken from Figure 2b.

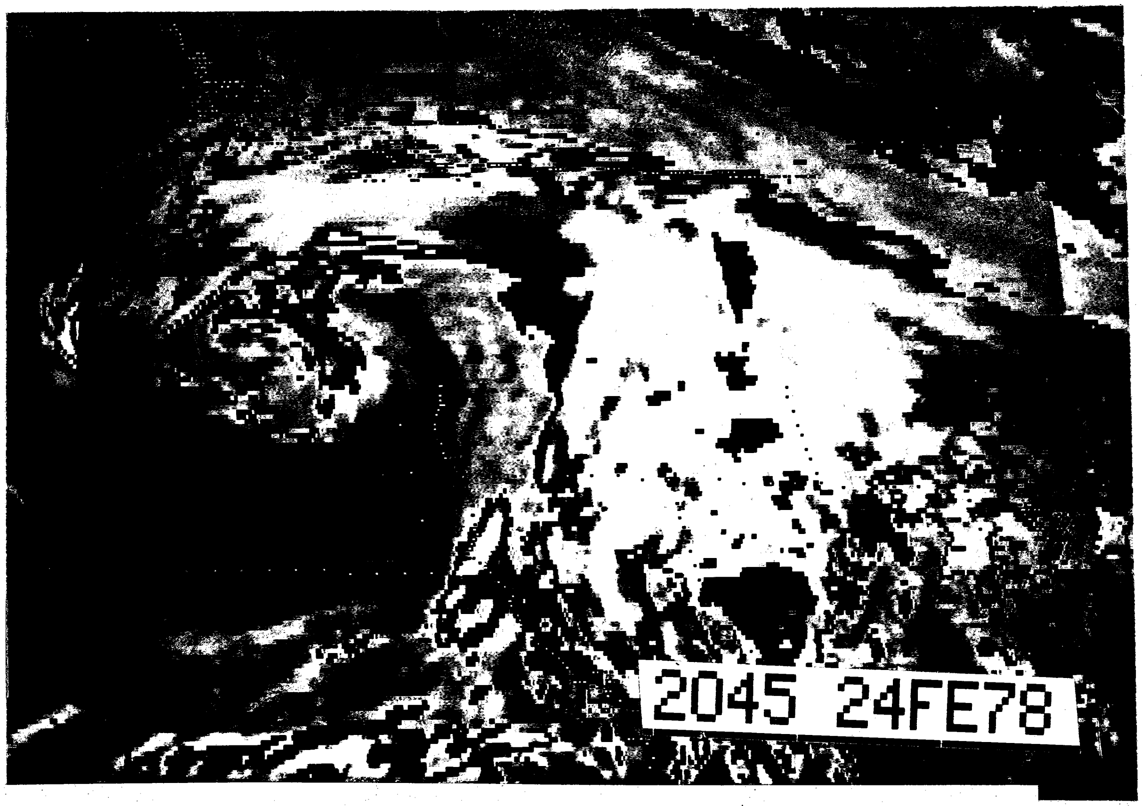

Figure 4. IR picture (EC enhancement) taken at 2045Z, Feb 24. Note the high level deformation boundary along 49-50N

Figure 5. Visual picture taken at 2215Z, Feb 24. Note the transparency of the cirrus. Lower cloud, snow covered mountains and valleys are visible through it. Also note the convective cloud in the comma head.