PACIFIC REGION TECHNICAL NOTES

81-010

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THE USE OF SATELLITE PHOTOGRAPHS IN DETERMINING THE BEST NUMERICAL GUIDANCE IN A CRITICAL WEATHER SITUATION - THE HEAVY RAINFALL OF BOXING DAY 1980

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INTRODUCTION

The synoptic events that contributed to the heavy rainfall and flooding which occurred on December 26, 1980 over southwestern B.C. have already been documented in a previous paper (81-003).

This paper reviews the guidance material and satellite photographs that were available prior to this event, in an effort to enhance the experience in dealing with heavy rains along the B.C. coast and to recognize the need for warnings well in advance.

SYNOPTIC EVENTS PRIOR TO THE DEVELOPMENT

On December 21st an upper ridge which had been aligned from western Alaska southeastward to off the California coast, flattened and moved inland, allowing short waves to affect the coast from California to southern B.C.

Meanwhile upstream, a broad upper trough slowly deepened east of the dateline in the southern stream between 30°N and 40°N latitude. This southern stream at such low latitudes involved a warm and very moist sub-tropical air mass.

By the 24th, a broad southwesterly flow had extended onto the northern California, Oregon and southern Washington coasts, with a series of rapidly-moving short waves spreading heavy rain to these areas. Only light rain was reported northward into southwestern B.C. The satellite photograph for 1215Z December 24, 1980 (Figure 1) and the satellite analysis chart for 1145Z December 24th (Figure 2) show the typical pattern which is associated with heavy rainfalls on the coast. A broad baroclinic zone of extensive cloud with very cold tops extends from

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Washington/northern California westsouthwestward to the long wave trough position near 160°W longitude, just north of the Hawaiian Islands. Short waves of relatively low amplitude were moving very rapidly (of the order of 55 to 65 knots) in the strong southwesterly flow. Heavy rainfalls and flooding were occurring in the Pacific Northwest U.S. states and flood warnings were issued for these regions.

Twenty-four hours later the satellite analysis chart for 1145Z December 25th (Figure 3) and the satellite photograph for 25/1515Z (Figure 4) show three short waves in the stream. Two of these were embedded in the strong baroclinic zone and, similarly to those of the 24th, were moving very rapidly at about 65 knots. Another short wave had just moved out of the base of the broad trough near 160° west longitude, and was moving a little slower than previous troughs had done. At 1515Z this developing short wave was located at 148° W and a large increasing area of cloud with very cold tops had formed ahead of it. This suggested that a new baroclinic zone had formed to the west of the old one from 24 hours earlier, and a slightly westward shift of the jet axis had taken place. It was also evident that this was a more vigorous, larger amplitude and slower-moving short wave trough, and a different type of system than its many predecessors. It was building a short wave ridge ahead of it with the baroclinic zone shifting northward with time.

The satellite picture for 25/2345Z (Figure 5) shows a strong well-developed short wave trough along 144°W longitude and a large area of cloud with very cold tops extending northeastward to 130°W. This trough had an average speed of about 45 knots in the previous 18 hours, markedly slower than the 55 to 70 knot speeds of earlier systems.

By 26/1215Z the satellite photograph (Figure 6) and the satellite analysis chart of this photo (Figure 7) show the short wave trough along 138°W longitude, still moving northeast at 45 knots. The cloud downstream has now moved northward and extends well into southwestern B.C. About twelve hours later the satellite picture for 26/2145Z (Figure 8) shows the trough just west of 130°W, which represents a slight decrease in speed to 40 knots, with the downstream cloud system covering all of B.C. northward to 60°N latitude.

500 MB CHARTS, SURFACE FEATURES AND PROGNOSTIC CHARTS

The CMC 500 mb analysis for 12Z December 25th (Figure 9) shows the broad southwesterly flow with the main stream extending into Washington and Oregon. The rapidly-moving short wave troughs in this flow had not been well analyzed or progged, which was usual in a zonal flow pattern. A short wave trough was located at 158°W longitude, and was quite well placed in comparison to the satellite analysis. The surface analysis for 25/12Z (Figure 10) shows a series of frontal waves moving rapidly eastnortheast towards Oregon and northern California.

The prognostic packages available on the day shift on December 25th showed a marked disagreement. The LFM and U.S. spectral progs both indicated little change in the baroclinic stream impinging on the coast, and maintained the precipitation pattern over Washington and Oregon

and well south of B.C. through the 26th.

The 24 hour LFM 500 mb. prog valid 26/12Z (Figure 11) and the U.S. spectral prog for the same time (Figure 12) showed almost no height changes on the B.C. coast. This was reflected in the precipitation pattern, also forecast to remain over Washington and Oregon. The 24 hour LFM precipitation prog (Figure 13) has the heaviest precipitation (> 1 inch) forecast over western Oregon and extreme southwestern Washington. The 36 hour LFM precipitation prog valid 27/00Z (Figure 14) showed only a slight northward movement into western Washington. The 24 hour U.S. spectral RH/VV prog valid 26/12Z (Figure 15) shows a similar pattern.

The CMC progs were rather different over southwestern B.C. The 24 hour CMC spectral 500 mb. prog (Figure 16) indicated a more intense short wave trough near 140° W longitude which resulted in more downstream ridging, with the main flow being deflected north into southwestern B.C. This resulted in the CMC precipitation forecast showing the heaviest rainfall pattern also being deflected northward into southwestern B.C. (Figure 17), although the amounts were less than half of the actual amounts.

A comparison of the 500 mb. heights at YZT and UIL through 36 hours indicates the much better CMC forecast on this particular development as shown in Figure 18.

The 500 mb. charts for 26/12Z and 27/00Z (Figures 19 and 20 respectively) show how closely the CMC spectral prog verified.

THE QPF MESSAGES AS GUIDANCE

The FOUS 76 issued at 251200Z called for a 24 hour rainfall at Vancouver of 0.58 inches and a 36 hour rainfall of 1.60 inches. The FXCN3 CWA01 QPF message issued at 1200Z forecast 41 mm. in 24 hours at the 1820 grid point (Comox) and 70 mm. in 36 hours. Again the CMC output was better, although it must be recognized that the FXCN3 CWA01 message almost always vastly over-forecasts precipitation amounts and coverage along the B.C. coast and is generally regarded as poor guidance by Vancouver meteorologists.

THE FORECAST PROBLEM ON DECEMBER 25th

We were faced with a quandary. Would the flow buckle and push the heavy rains from Oregon and southern Washington northward into B.C. as the CMC progs suggested, thereby requiring heavy rain warnings

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for southwestern B.C.? The other alternative as depicted by both the LFM and U.S. Spectral progs, called for the main stream and strong baroclinic zone to remain south, leaving southern B.C. in only relatively light precipitation.

We seriously considered issuing the warnings on the afternoon of the 25th, after an examination of the microfilm record of the December 25, 1972 storm which set the 24 hour rainfall record of 92.7 mm. of rain at Vancouver Airport. Although the basic pattern across the Pacific Ocean was more zonal in the 1972 case, it was obvious that the pattern was such that if the flow buckled as the CMC progs suggested, there would certainly be heavy rainfalls over southwestern B.C.

Since we were not sure that the main stream would deflect to the north, and two of the progs were against a heavy rainfall, we held off on the heavy rain warnings until after the 00Z raobs were available.

CONCLUSIONS

A more intelligent interpretation of the satellite photographs should have revealed the importance of the strong short wave trough that developed on the 25th. We should have recognized that this trough was strong enough to cause significant short wave ridging ahead of it, which would deflect the strong baroclinic zone and heavy precipiation northward into southwestern B.C. This would have resulted in an acceptance of the CMC guidance over the other two prognostic packages, and an issuing of the heavy rain warning on the afternoon of the 25th, when it would have been much more useful, rather than the actual issue time on the early morning of the 26th.

FIGURE 1.

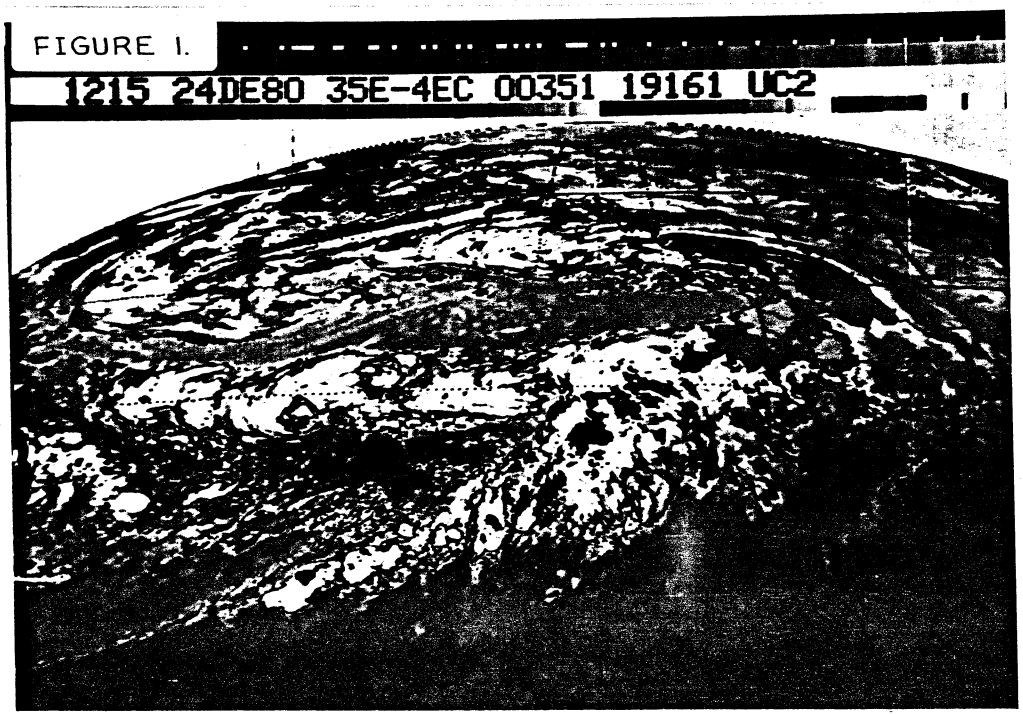


FIGURE 2.

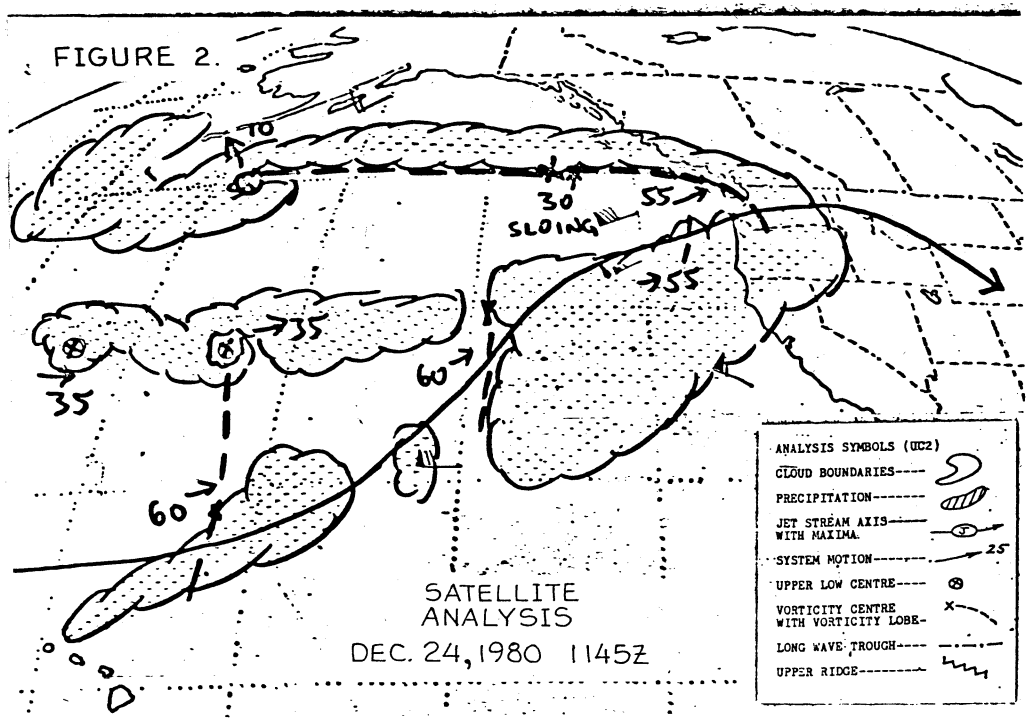


FIGURE 3.

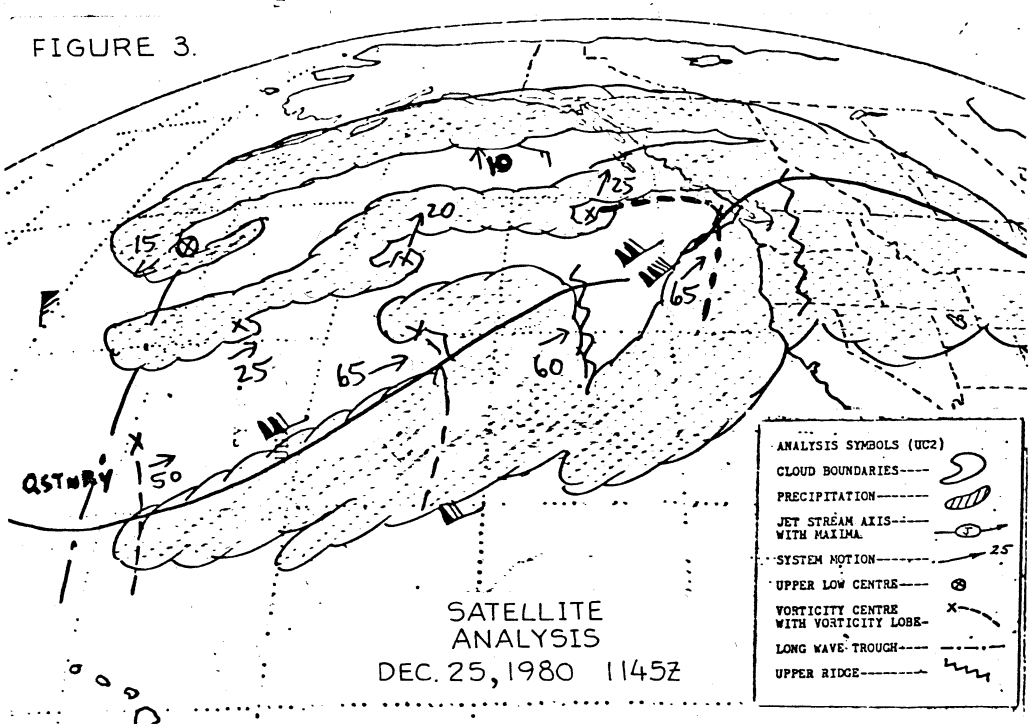


FIGURE 4.

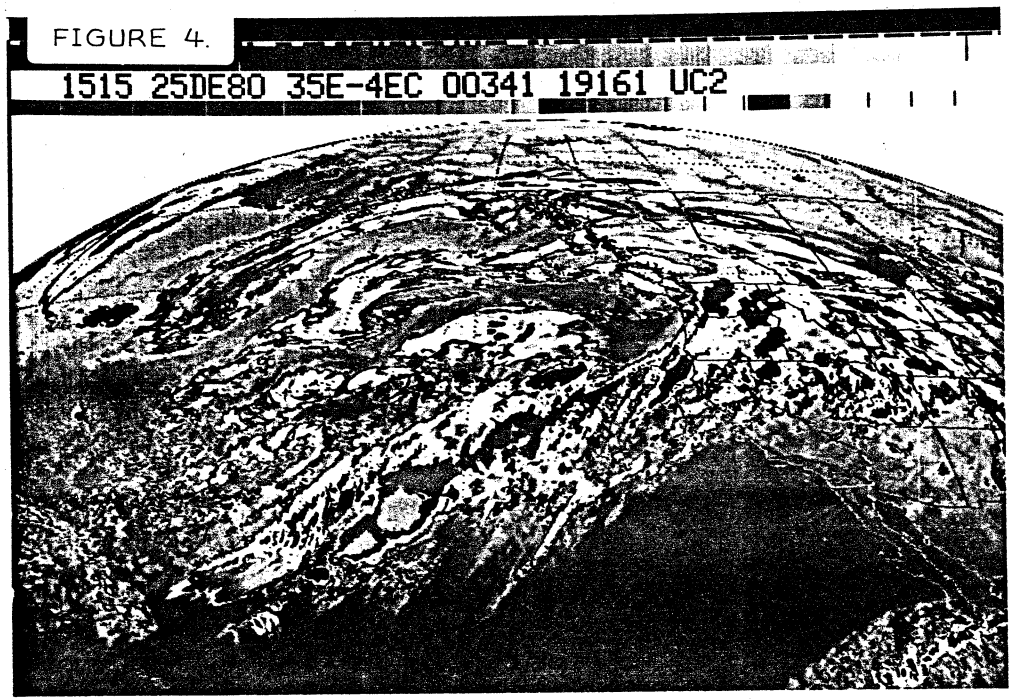


FIGURE 5.

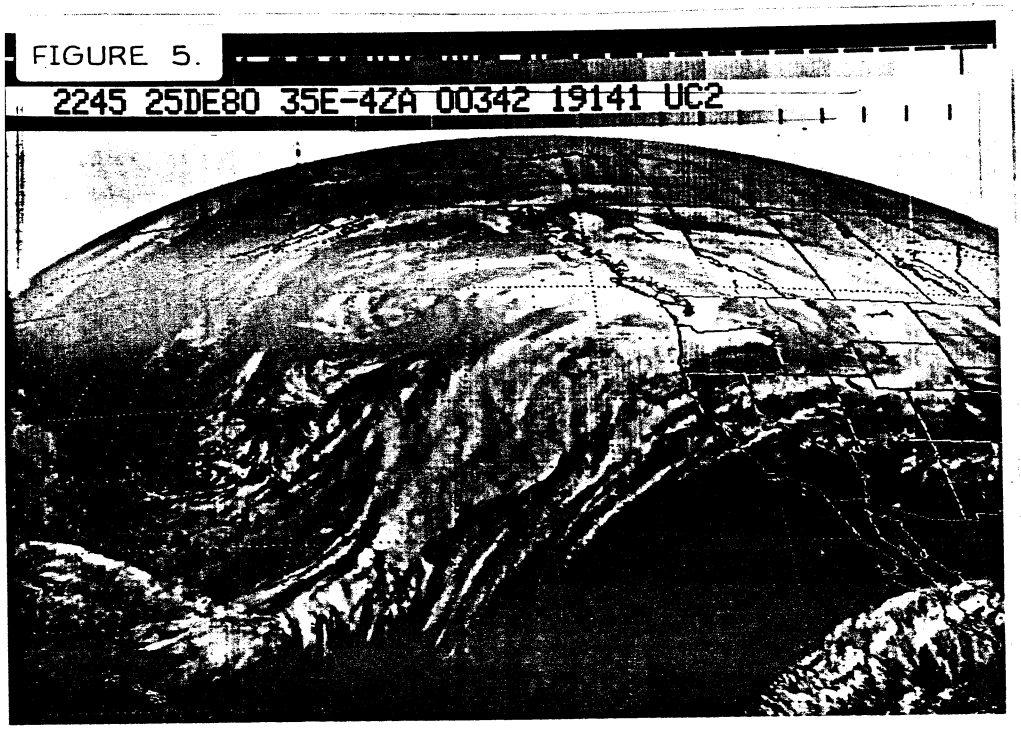
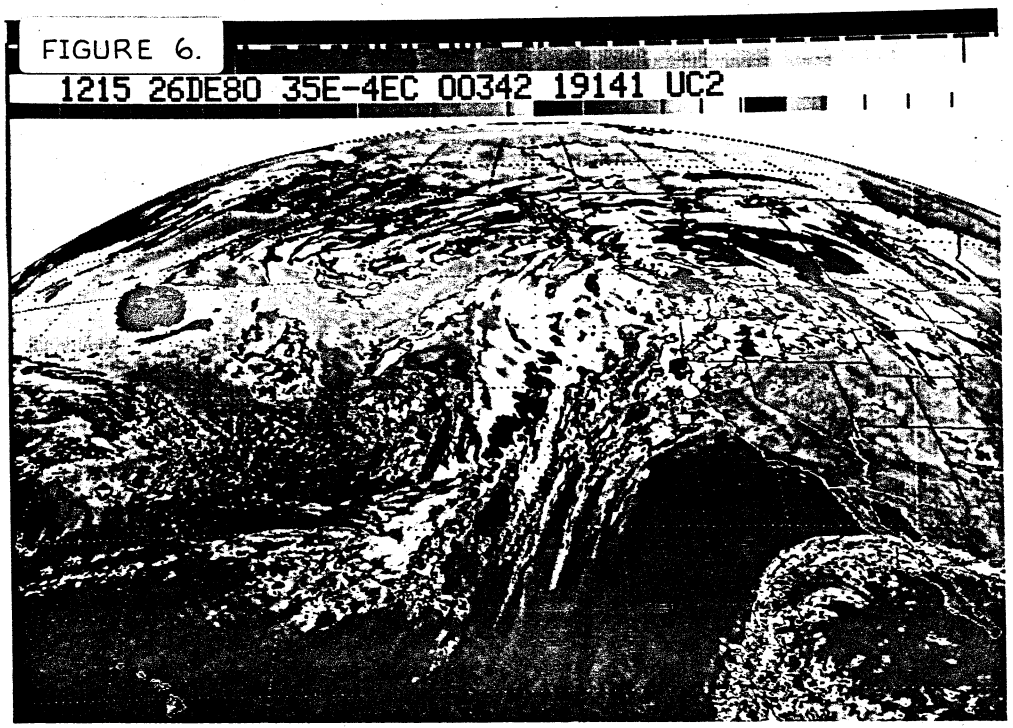


FIGURE 6.



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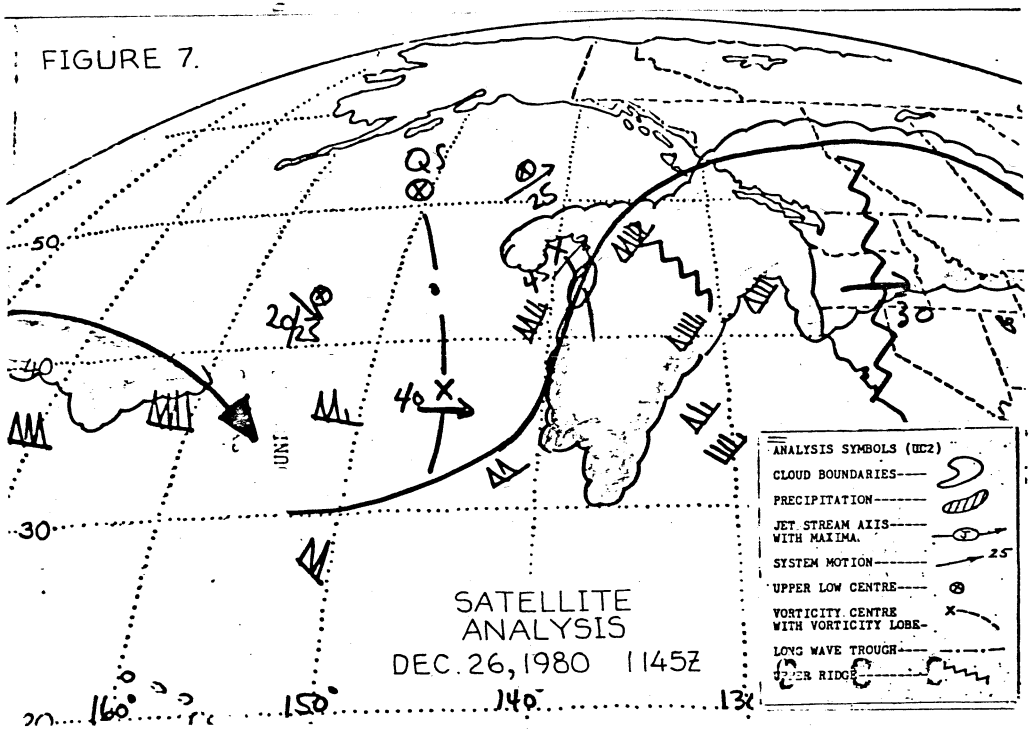

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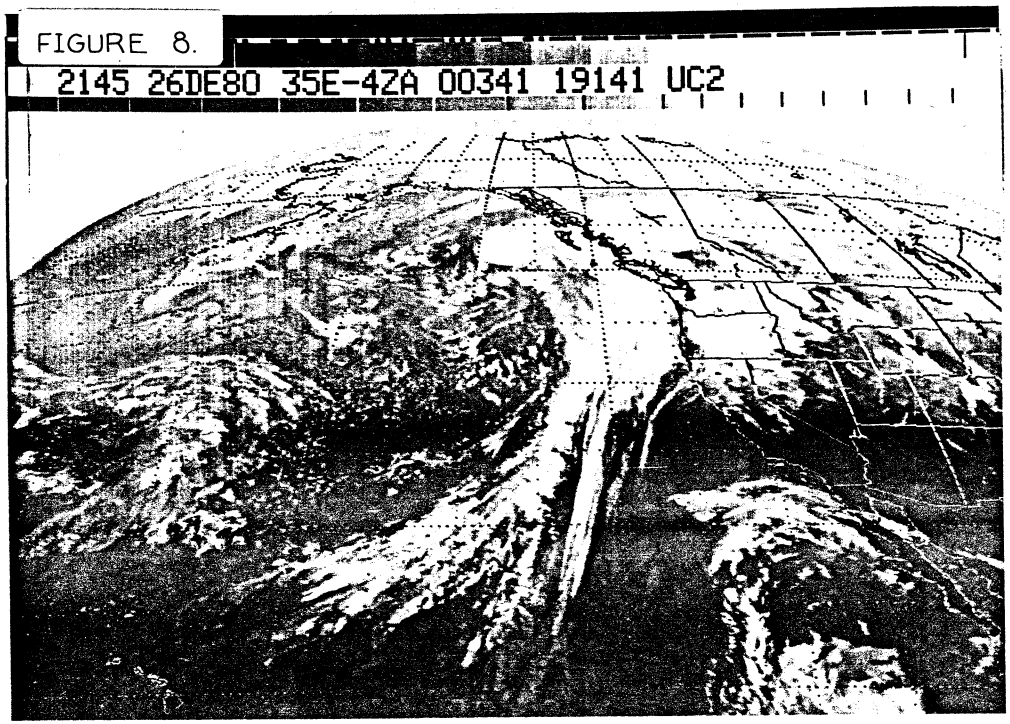
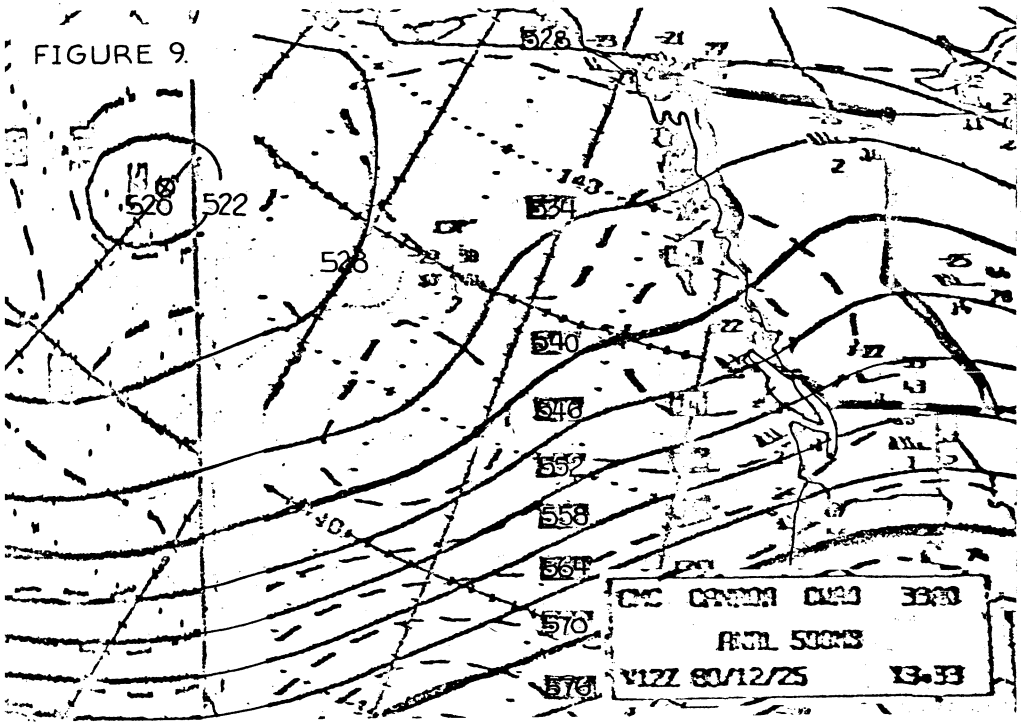


FIGURE 9.



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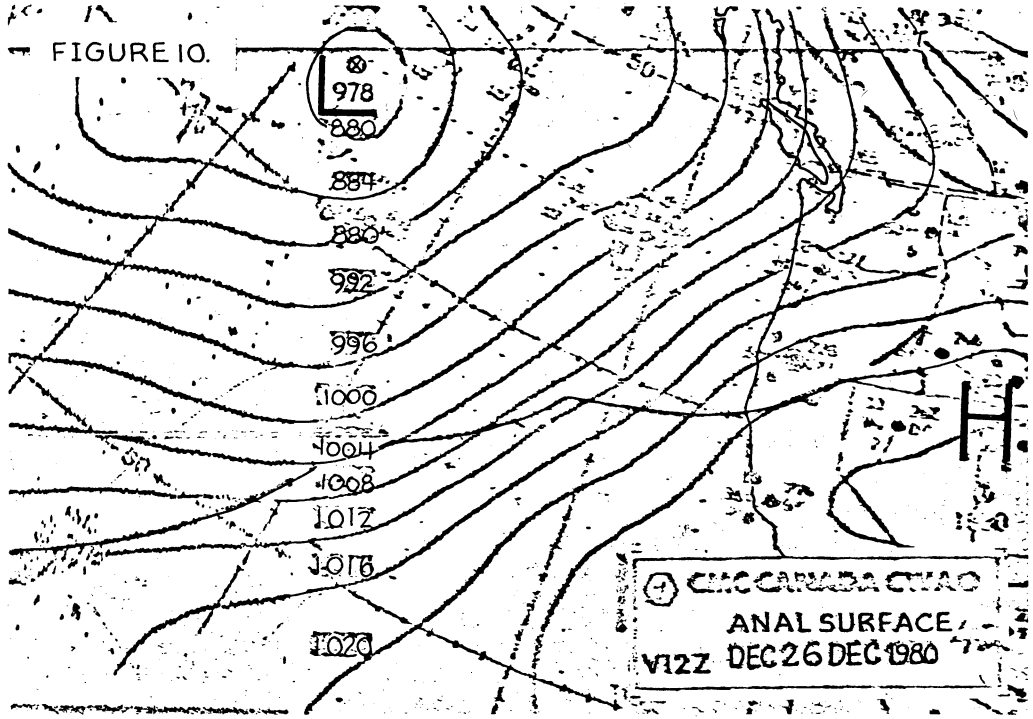
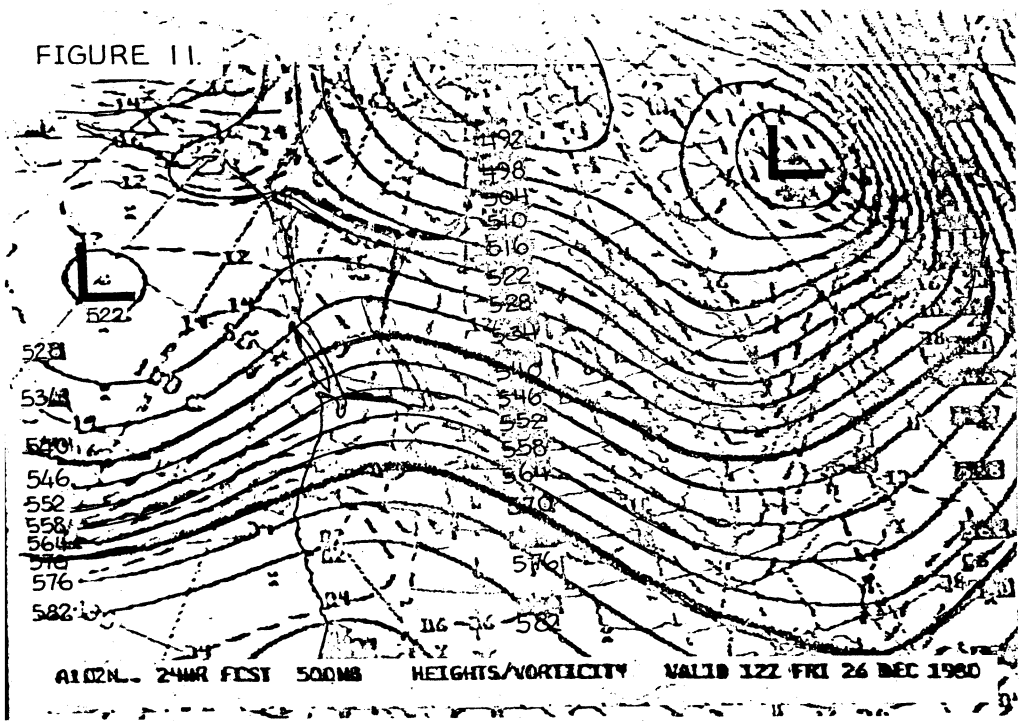


FIGURE 11.



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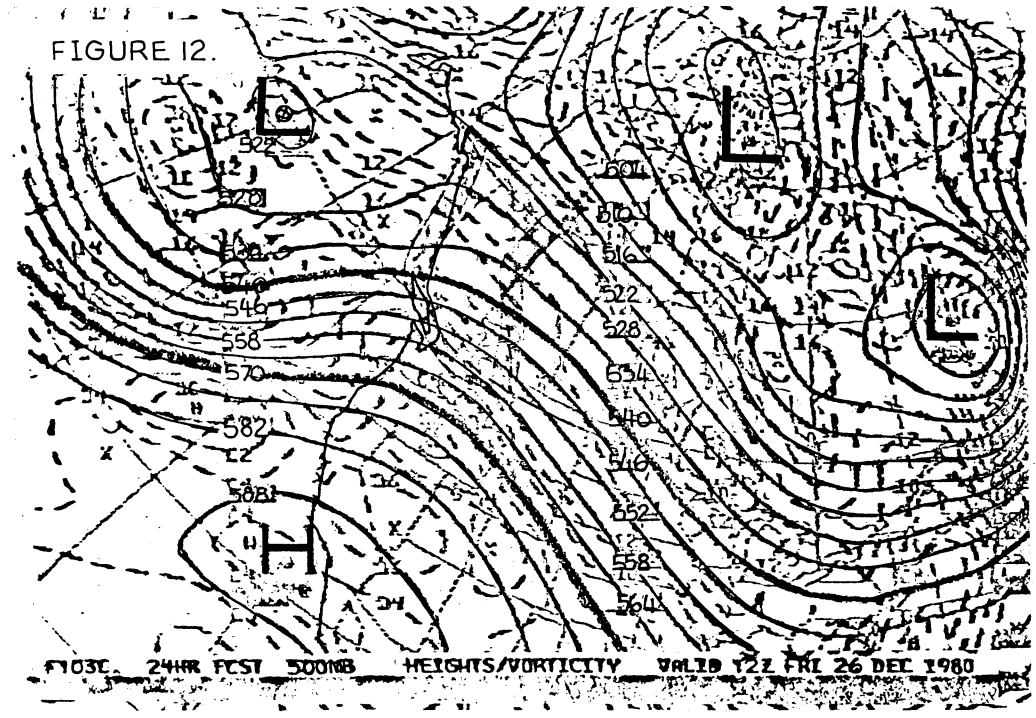
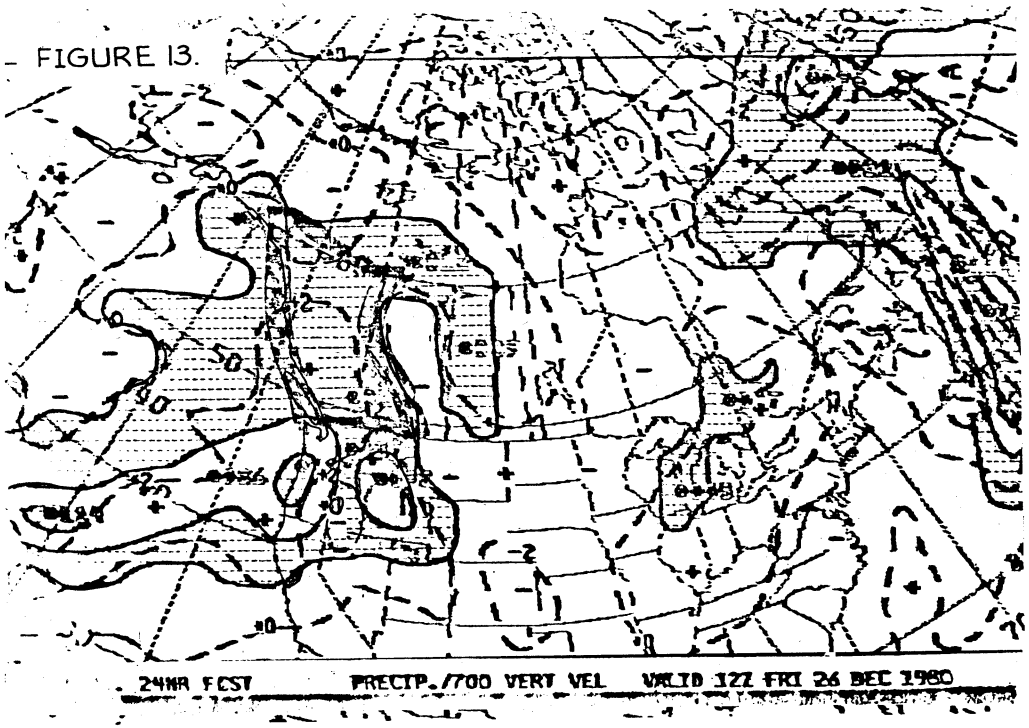


FIGURE 13.



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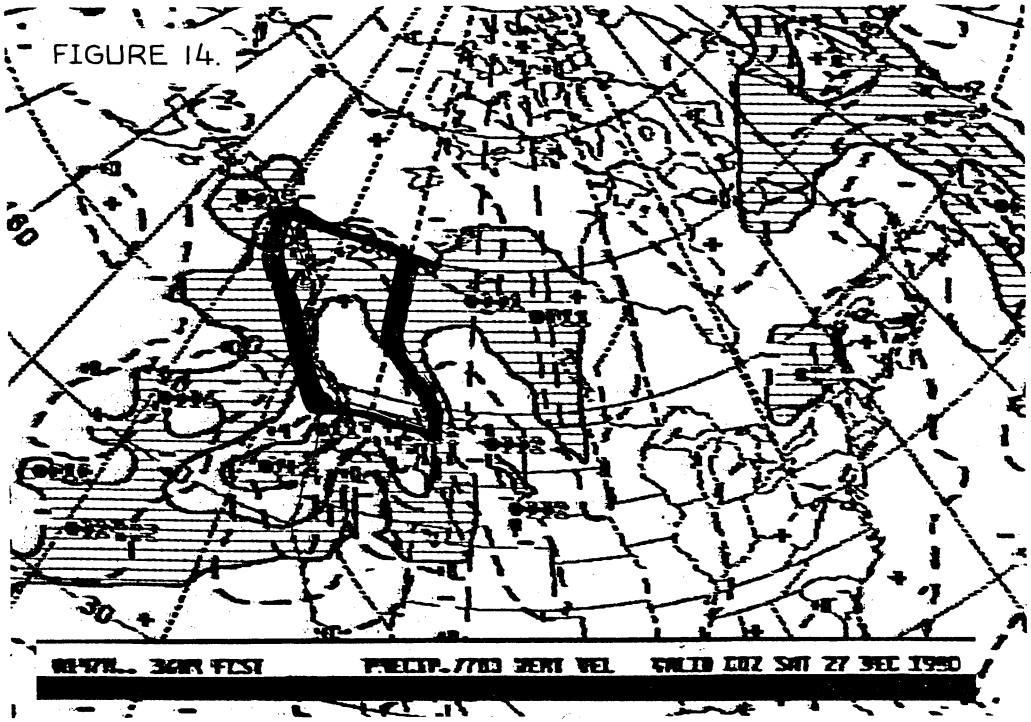

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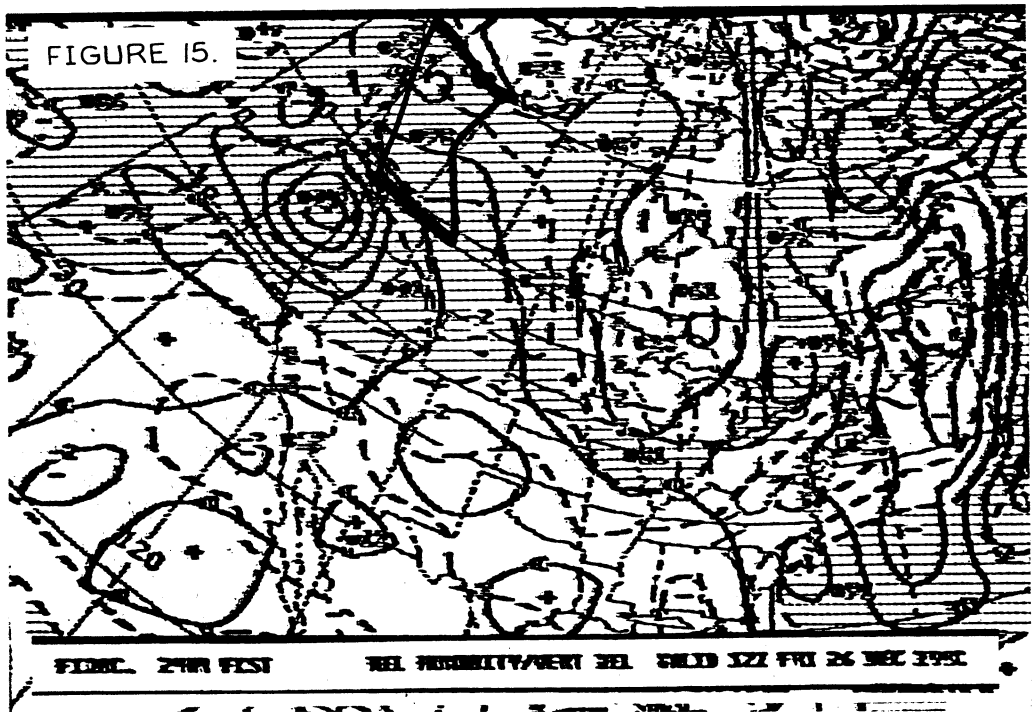

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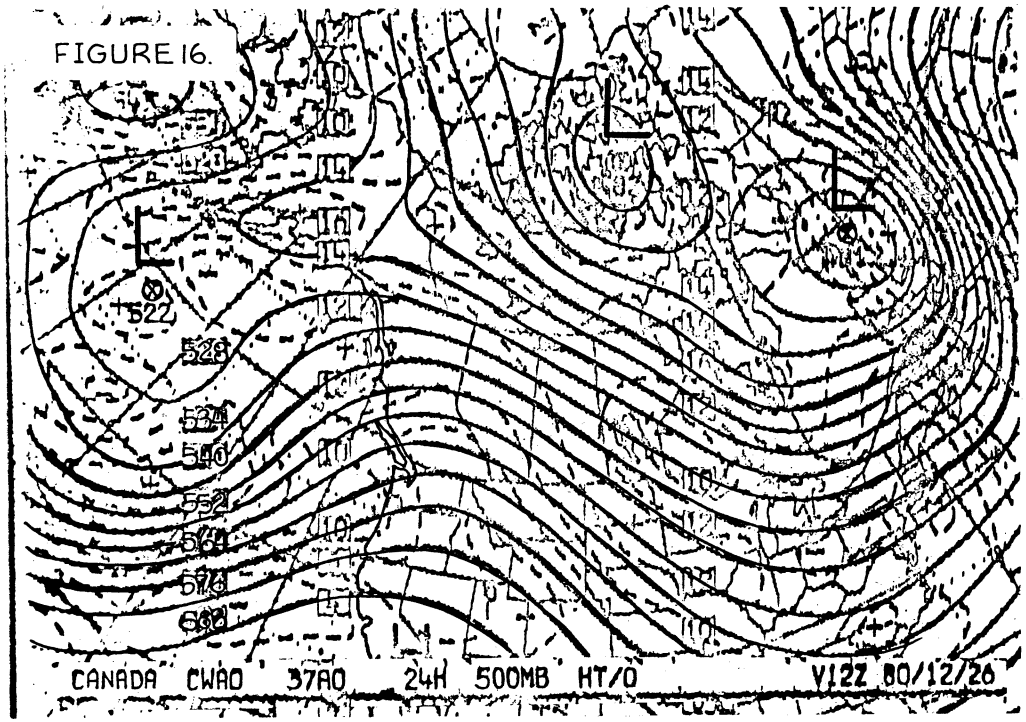

FIGURE 17.

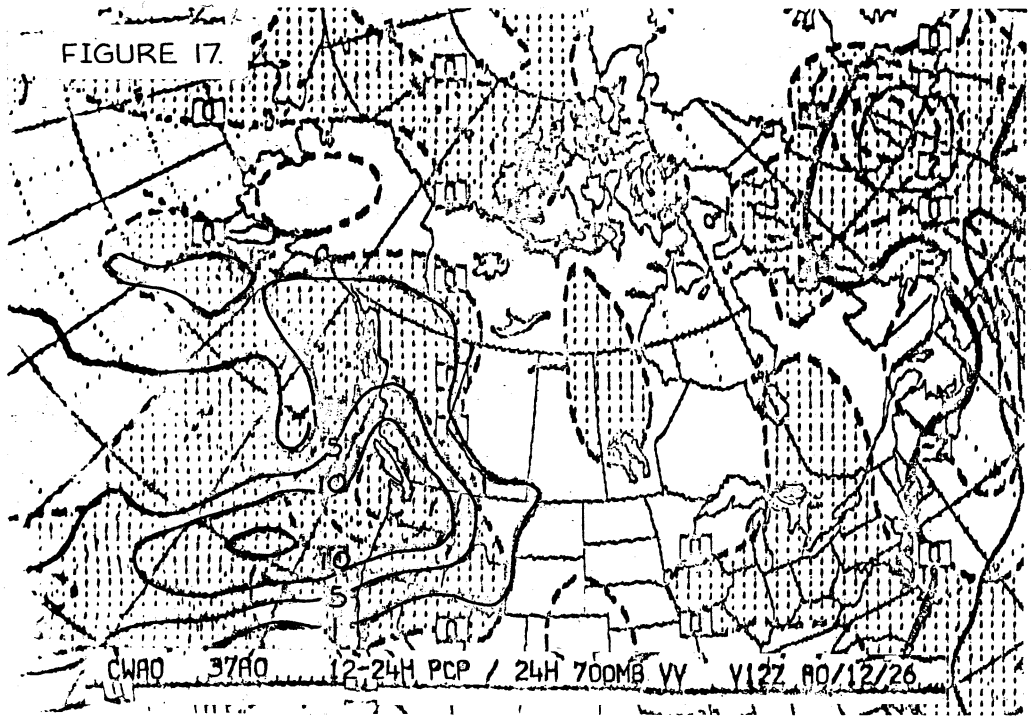

FIGURE 18.						
FCST PERIOD	DATE/TIME	STN.	ACTUAL	CMC FCST	NWS SPEC FCST	LFM FCST
	DEC 25 / 12Z	YZT UIL	42 56			
12 HOUR	DEC 26 / 00Z	YZT UIL	48 61	52 61	41 52	41 52
24 HOUR	DEC 26 / 12Z	YZT UIL	54 65	54 63	41 55	40 52
36 HOUR	DEC 27 / 00Z	YZT UIL	48 58	46 58	36 46	33 45

FIGURE 19.

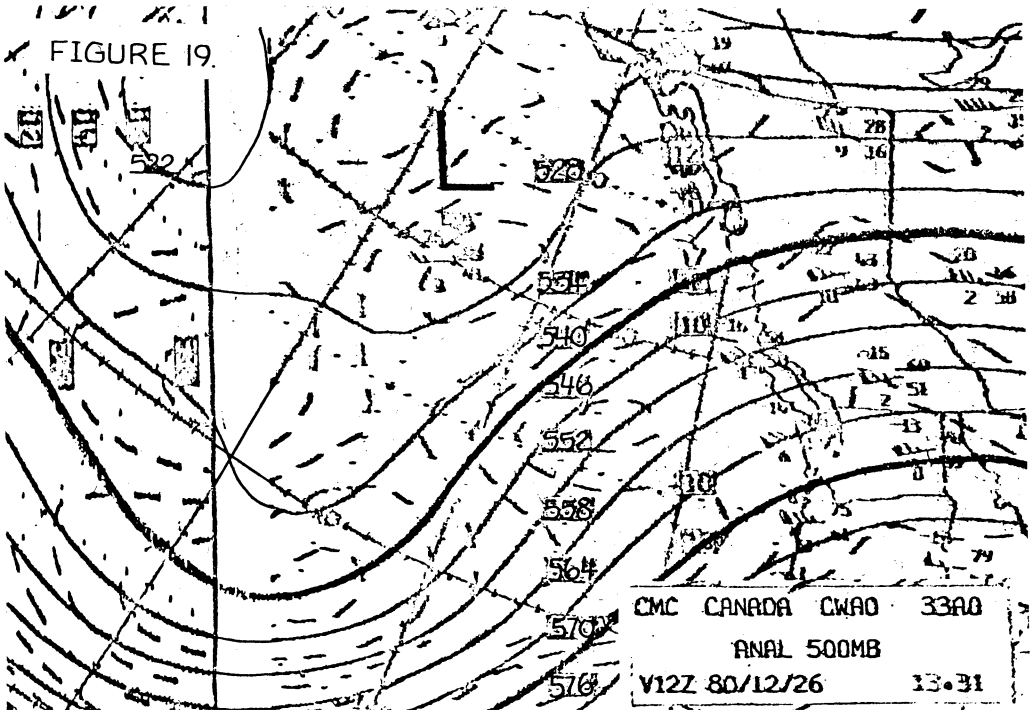

FIGURE 20.