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UTILIZATION OF SATELLITE IMAGERY DEFORMATION ZONE CONCEPT IN REFINING MEDIUM RANGE CLOUD FORECASTS

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A series of earlier PWC Tech Notes[1] discussed techniques to relate cloud edges and areas observed on satellite imagery to features on NWP charts.

It was shown by WELDON[2] and substantiated in PWC studies that cloud edges could often be defined by using a pseudo streamline field. Vorticity isolines were treated as streamlines of cloud elements with respect to the cloud field. The inherent deformation zones were found to correspond closely to the cloud deformation zones evident on satellite imagery.

The intent of this follow-up paper is to demonstrate the usefullness and validity of this concept in the preporation of medium range cloud forecasts.

A case study is presented to show:

- the deformation zone - cloud edge relationship;
- the continuity of this relationship through a series of analysis and progs;
- how the concept works over land, ocean and under different type flow patterns.

The following case study March 26-28, 1981 includes:

- GOES west imagery (UC 2 Sector)
- Spectral (CMC) 500mb/vorticity analysis and 24 hour progs.
- Limited fine MESH (NMC) 500mb/vorticity analysis and 24 hour progs.
- Pseudo streamlines are marked to outline deformation zones, i.e. ↗. These streamlines are in fact vorticity isolines.
- Deformation zones are denoted by a "stretching" line ⟷ .

The imagery, analysis and 24 hour progs valid 12Z March 27, 00Z March 28 12Z March 28 are used to show the usefullness and continuity of the deformation zone cloud edge relationship.

Please refer to the examples.

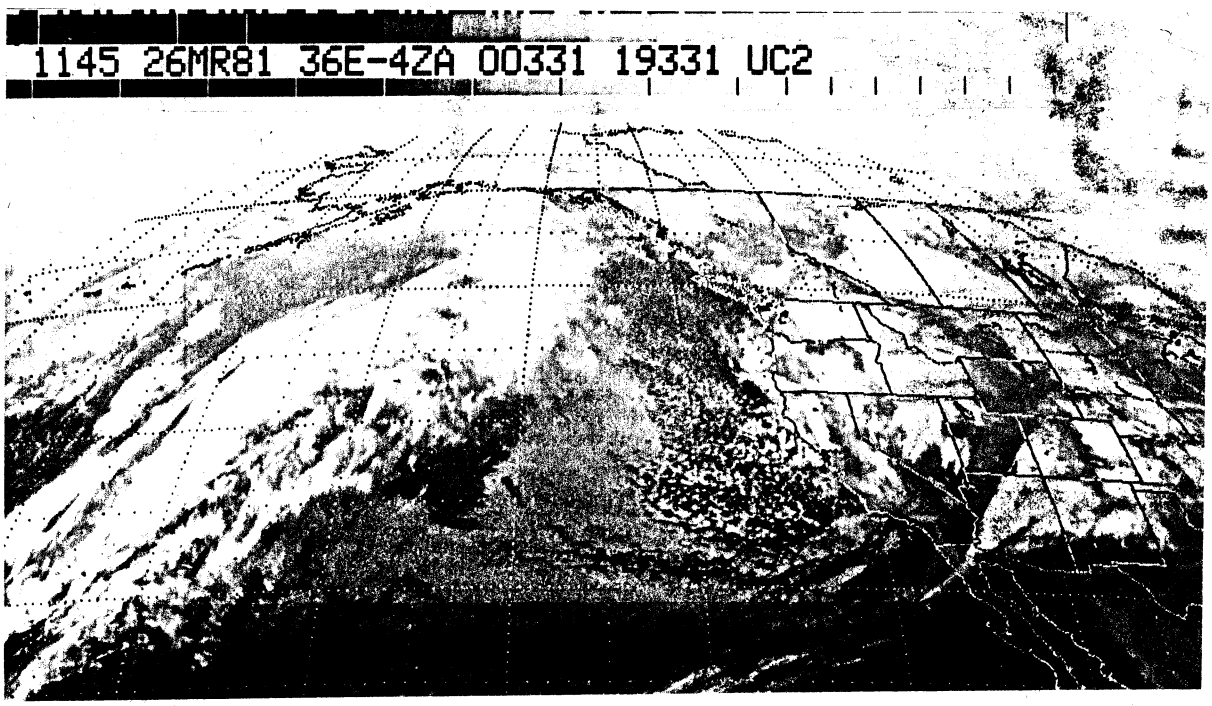


Figure 1A 12Z 26 March 1981

Observe the position of the leading cloud edge approaching the Alaskan Panhandle and Charlottes (Figure 1A). Note how the cloud edge fits the deformation zones of Figure 1B and 1C and overruns the short wave ridge along 140W.

Also note the break cloud across the northwestern U.S.A. extending from southeastern B.C. to south central Montana (Figure 1A). The deformation zones on 1B and 1C fit the pattern quite well. The zone is displaced a little too far south over Washington, however the vorticity minima appears to be too intense on both analysis.

As well the back edge of the cloud shield over Alberta lies north of associated deformation zone shown on the analysis. The 24 hour progs (valid 12Z 27 March 81) will show this error to be carried on.

Figure 1B

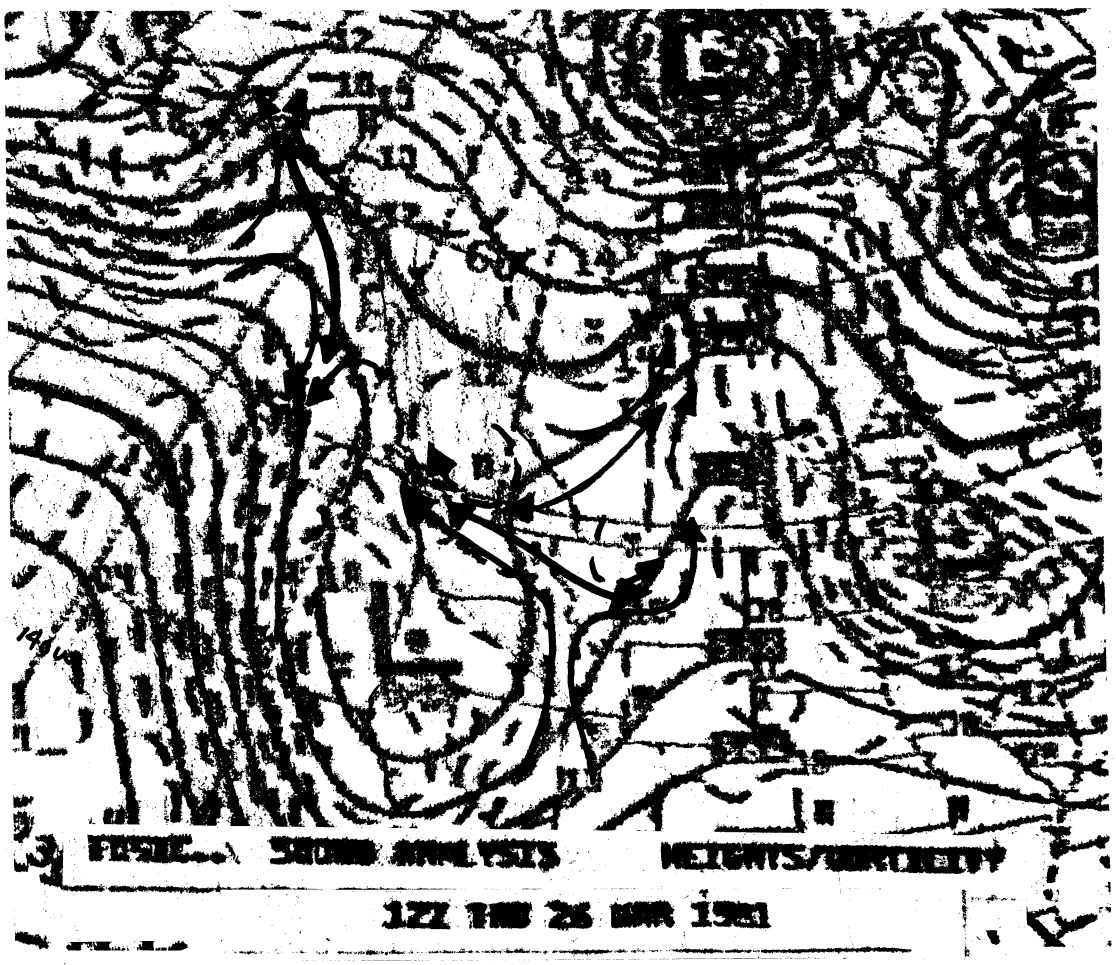
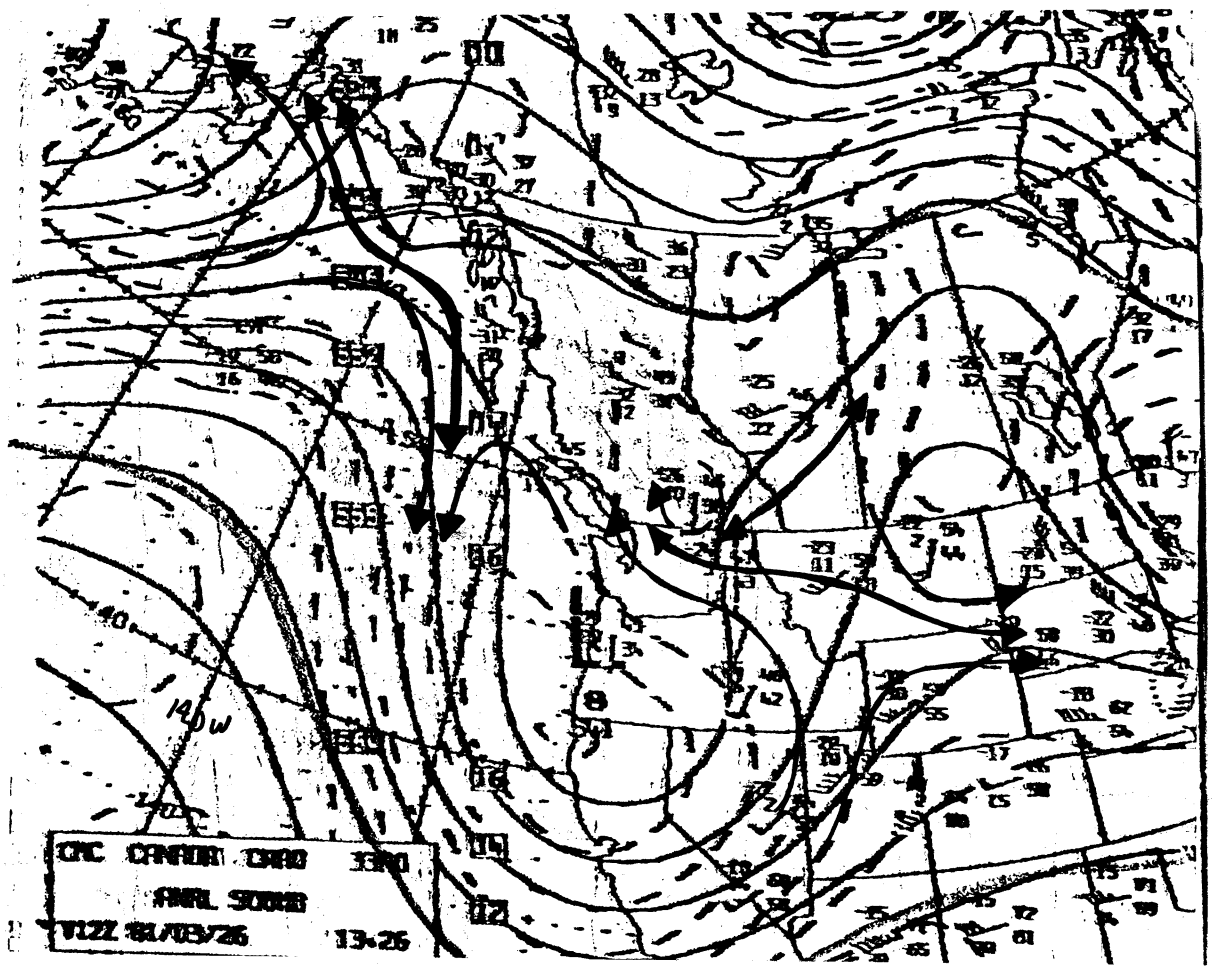


Figure 1C



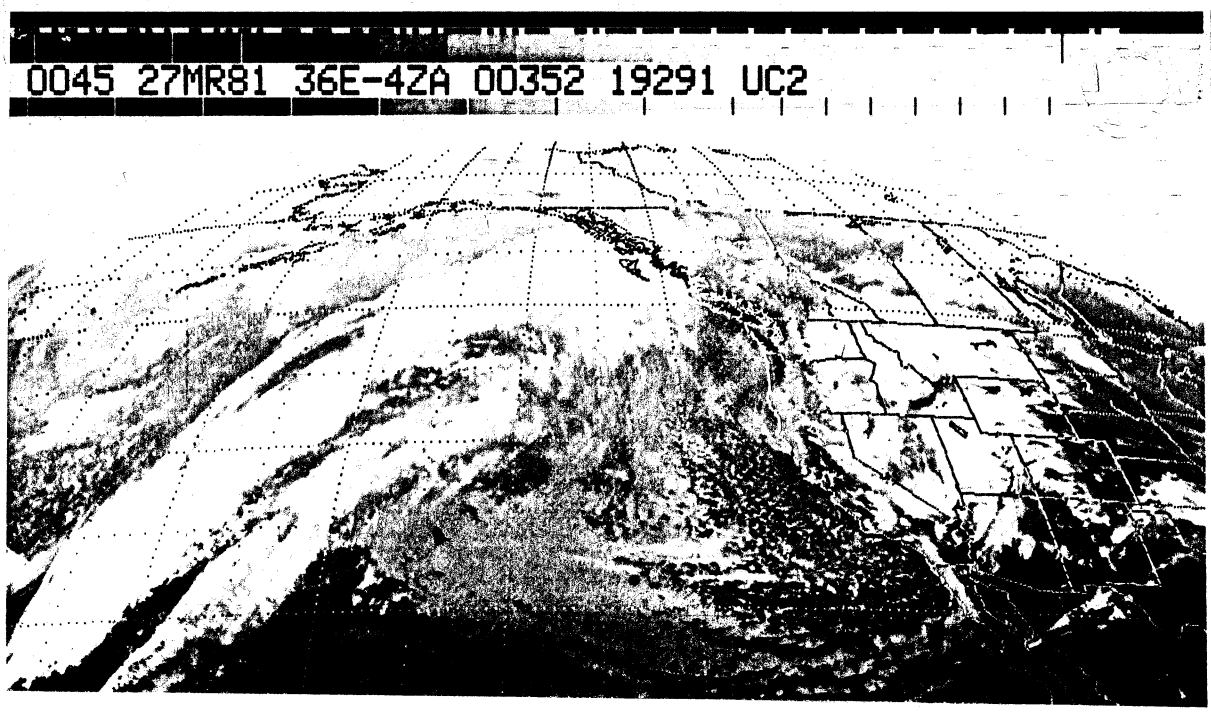


Figure 2A 00Z 27 March 1981

The deformation zone over the northeastern Pacific of Figure 1 has pushed east over northwestern B.C. (Figure 2A). Both analysis show this well. (Figure 2B, 2C).

The deformation zone extending from southeastern B.C. to central Oregon marks the back edge of the cloud associated with the cold low over the U.S. southwest. This zone has rotated westward above the low since 12Z 26 March.

The deformation zone northeast to southwest across the southern Prairies is still analyzed too far south of the actual cloud edge by both models (Figure 2B, 2C). The 24 hour prog based on data at this time will show the same bias. (Prognosis discussion Figure 4.) Note data sparsity over the area.

Figure 2B

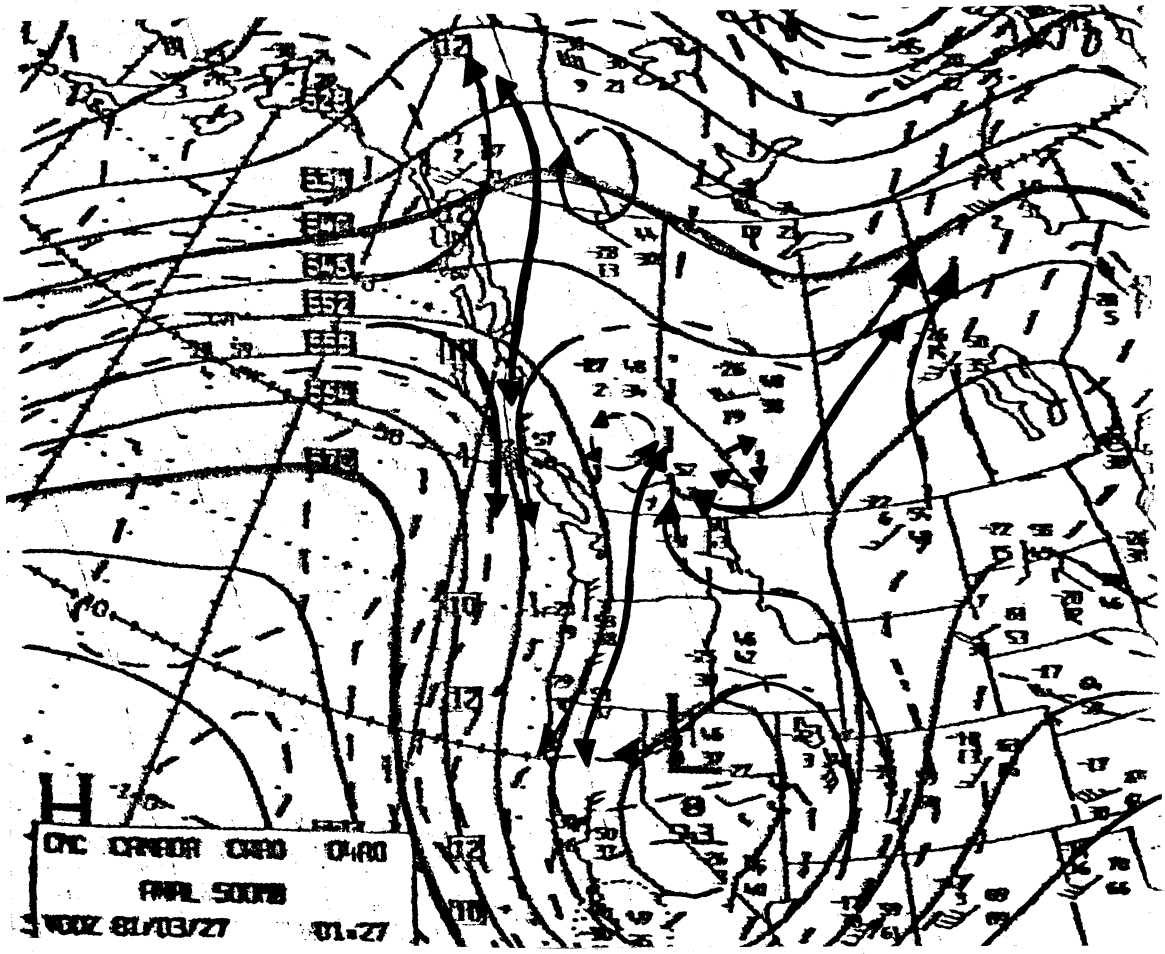
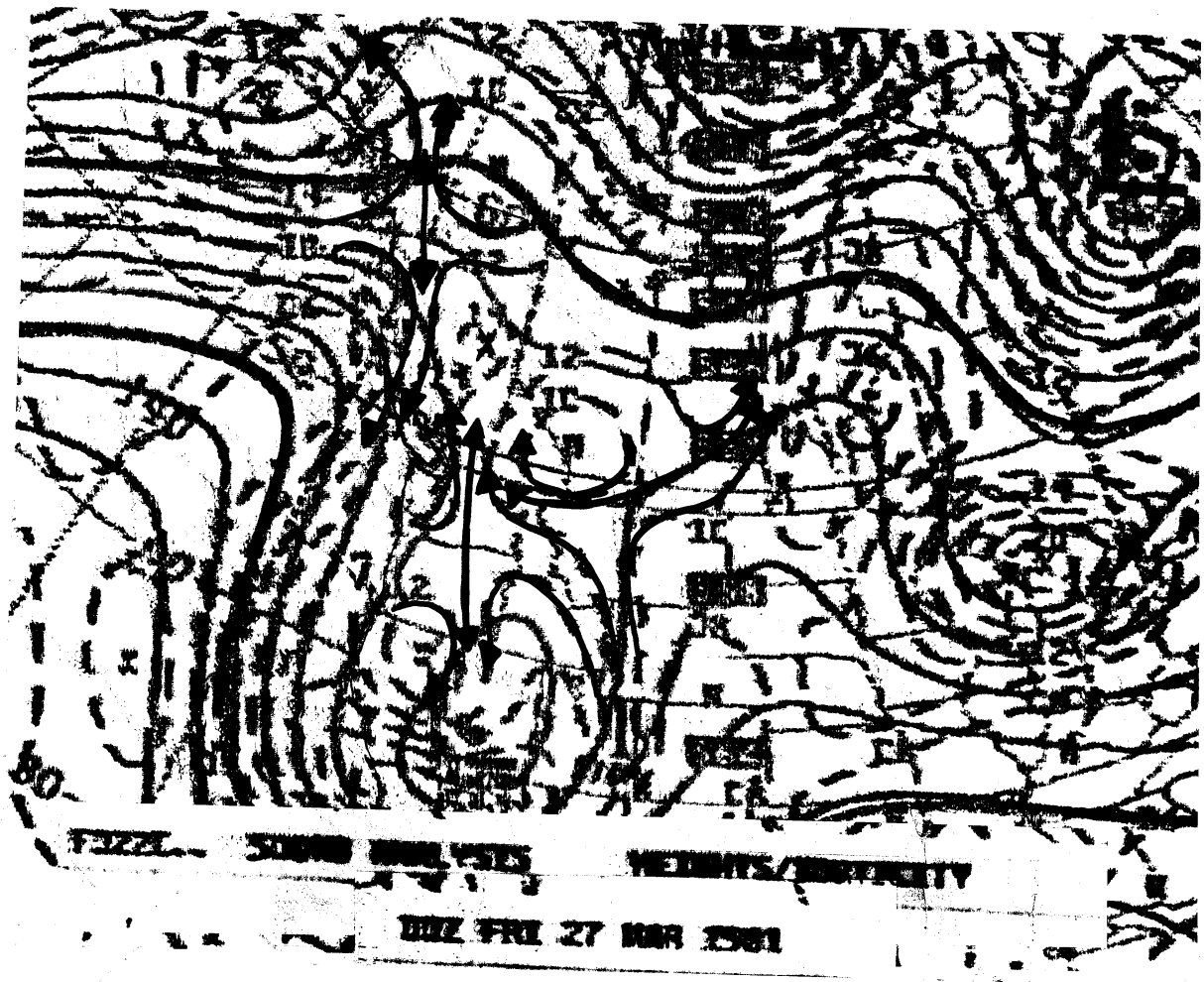


Figure 2C



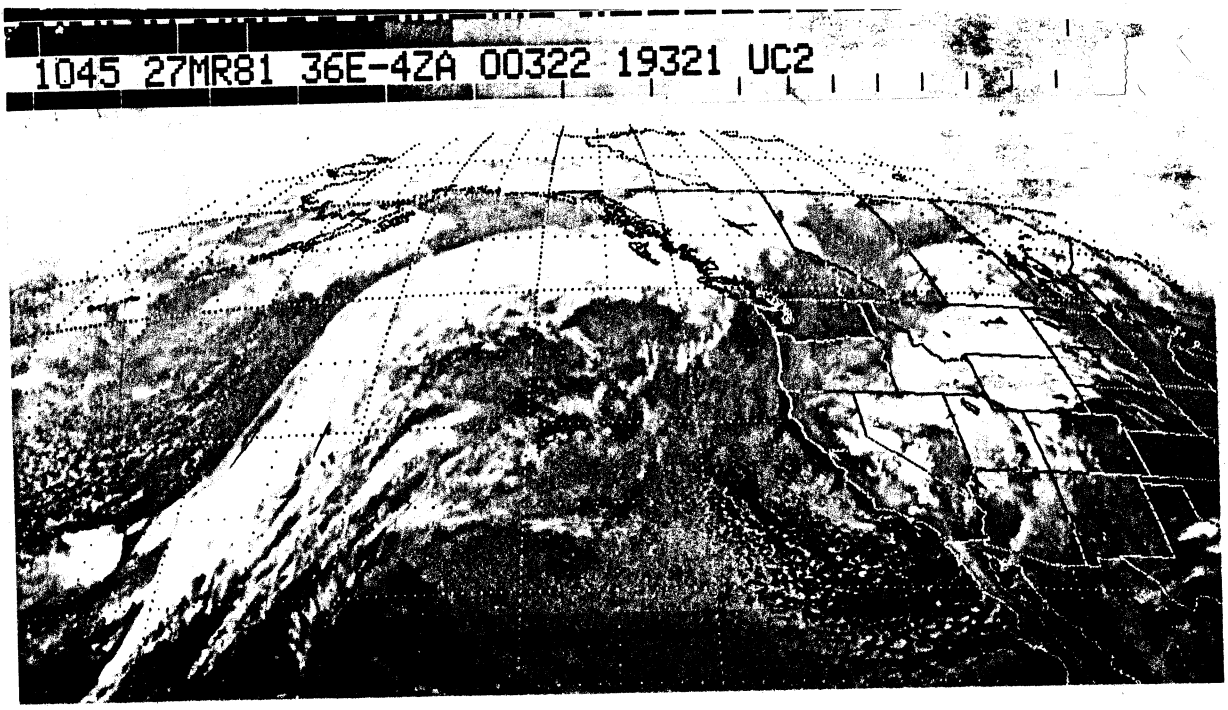


Figure 3A 12Z March 27, 1981

ANALYSIS (Figure 3B, 3C)

Both CMC and LFM analysis show the leading cloud edge of the Pacific system now pushing into western Alberta. The LFM has the best fit.

The two deformation zones that made up the back edge of the cloud system extending from the western Prairies to the southwestern U.S.A. have organized into one elongated zone. In this area the spectral appears to correlate better than the LFM . Both had carried the zone too far south the past 24 hours.

24 HR PROGS VALID 12Z MARCH 27, 1981 (BASED ON 12Z MARCH 26) Figures 3D, 3E.

Over northwestern B.C. the progged deformation zones agree well with those on the analysis (Figure 3D, 3E). The CMC spectral (Figure 3E) vorticity pattern is quite diffuse. However the LFM (Figure 3D) is sharp and agrees with the imagery.

Both progs caught the merging of deformation zones northeast of the cold low. The initial analysis (12Z March 26) were too far south with the deformation zone relative to the cloud edge. The progs suffer the same fate.

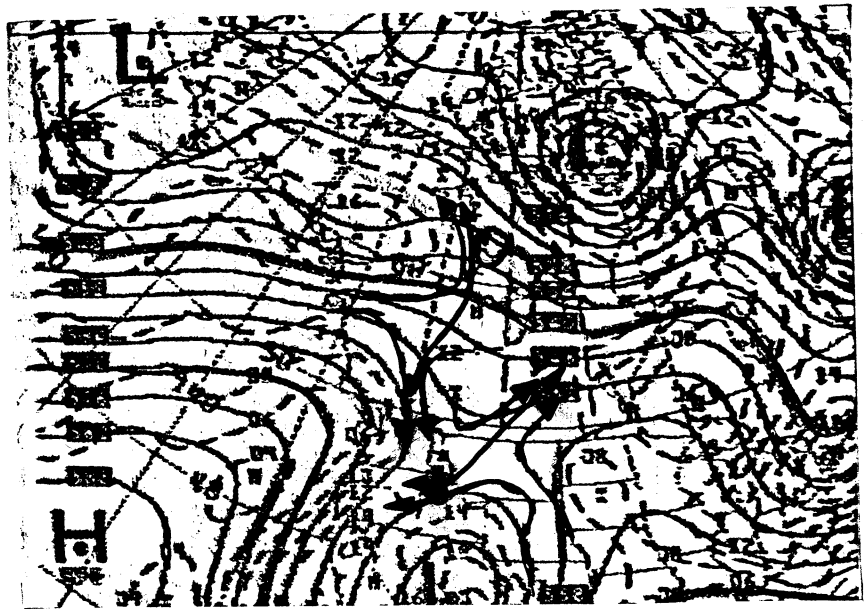
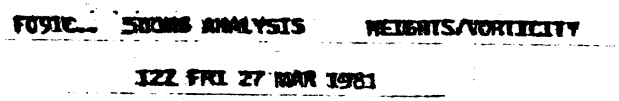


Figure 3B



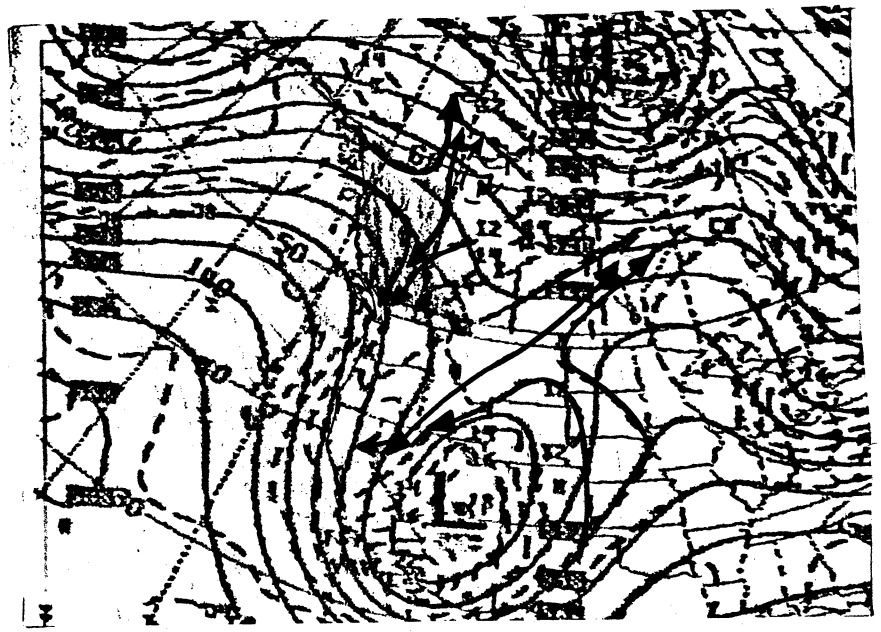


Figure 3D

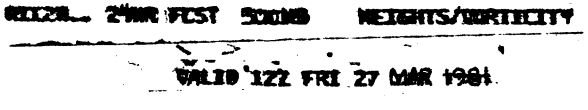


Figure 3E

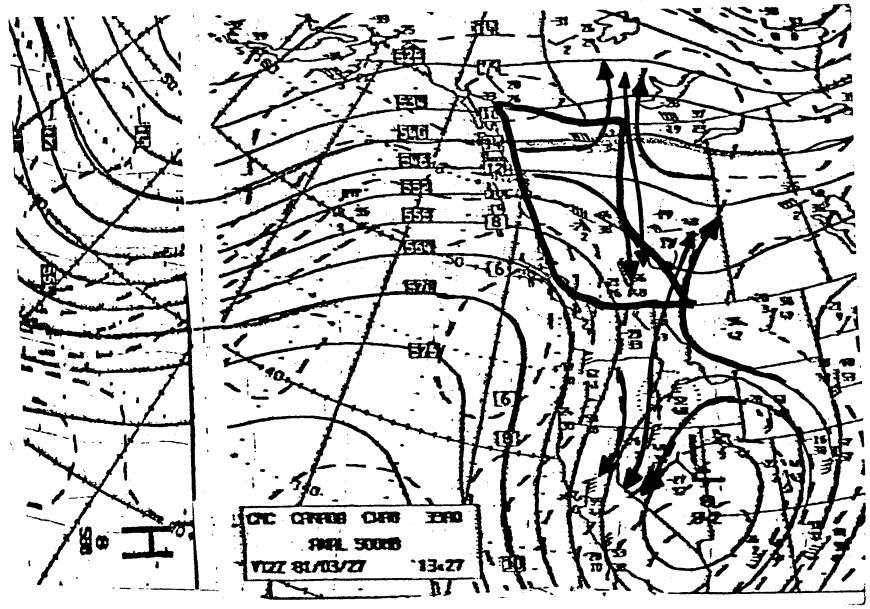
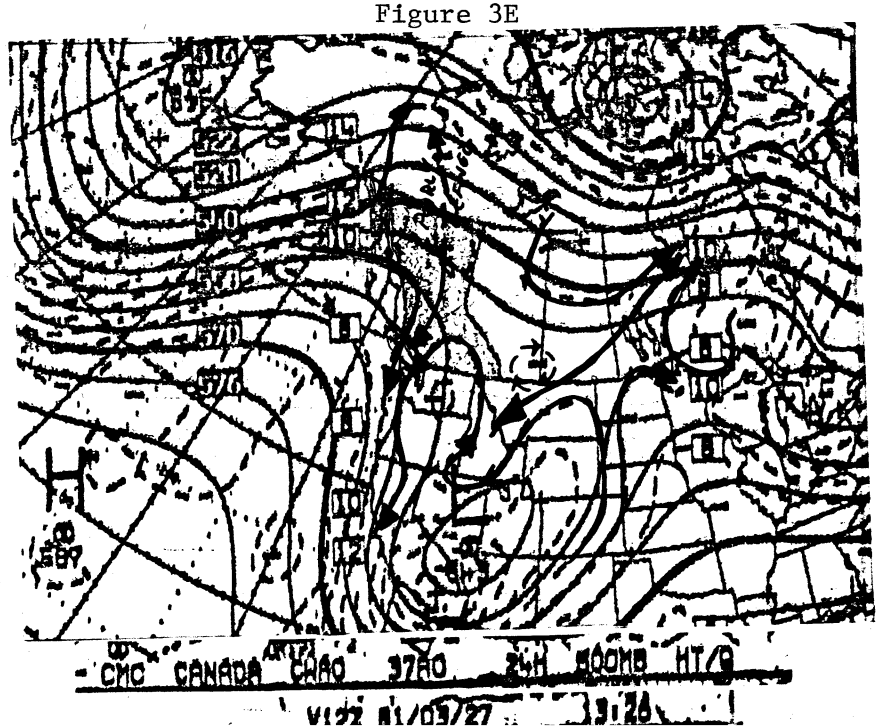


Figure 3C



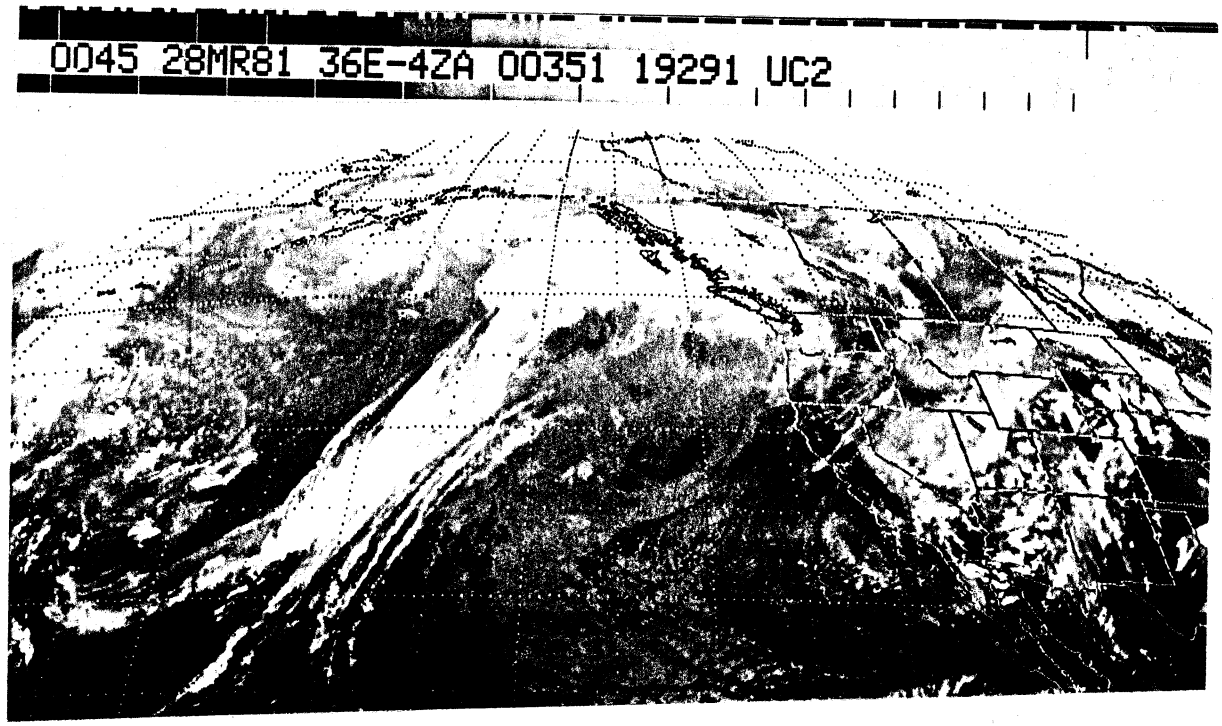


Figure 4A

ANALYSIS

Valid 0Z 28 March 1981. Both LFM (Figure 4B) and CMC (Figure 4C) analysis show the deformation zone that crossed the rockies pushing towards and starting to interact with the zone north of the cold low.

The LFM vorticity analysis (Figure 4B) is quite complex but if intermediate isolines are drawn in the zones can be defined. The cloud crossing the western Prairies has developed a subsidence break behind the leading edge and this is implied on the analysis. The CMC spectral (Figure 4C) with its coarser resolution has already merged the deformation zones from central Saskatchewan to southern Idaho. It still manages to keep them separate entities over northern Saskatchewan.

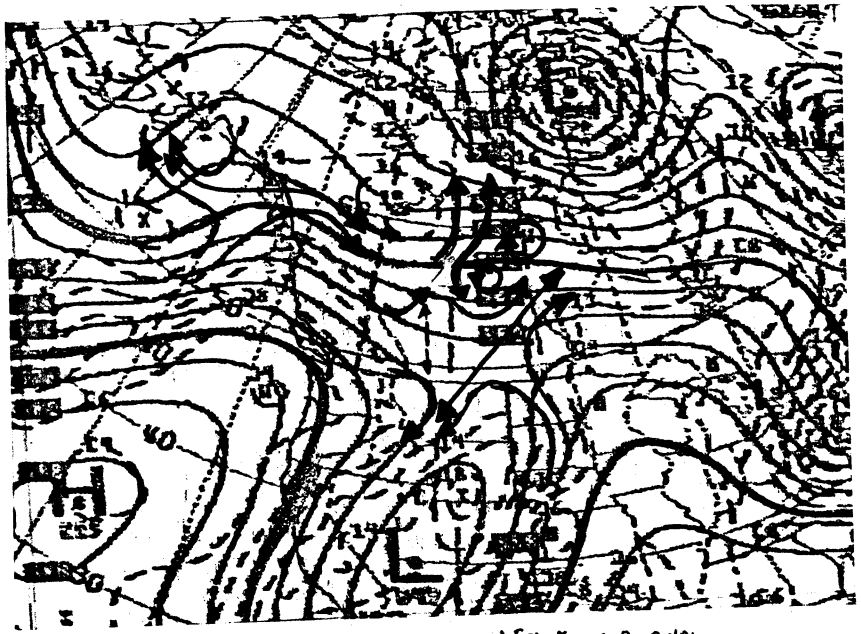
The deformation zone northeast of the cold low fits the northern cloud edge on imagery quite well.

PROG valid 00Z 28 March 1981 (Based on 00Z 27 March data).

The CMC 24 hour prog 4E has merged the two major deformation zones into one. This zone roughly edges the northern edge of the cloud associated with the cold low and the leading edge of the cloud moving across the Prairies.

The 24 hour LFM Prog (Figure 4D) is interesting in that it actually captures the two major deformation zones and cloud relationship better than the analysis for the same time. Both zones fit their associated cloud edges quite well. The zone associated with the cold low cloud is placed a little far south, however the analysis on which the prog was based suffered similarly.

As an aside note the relationship between the deformation zone extending from the eastern Gulf of Alaska through northern B.C.



LFM 500MB ANAL

Figure 4B VALID 00Z 01/03/28

Figure 4C

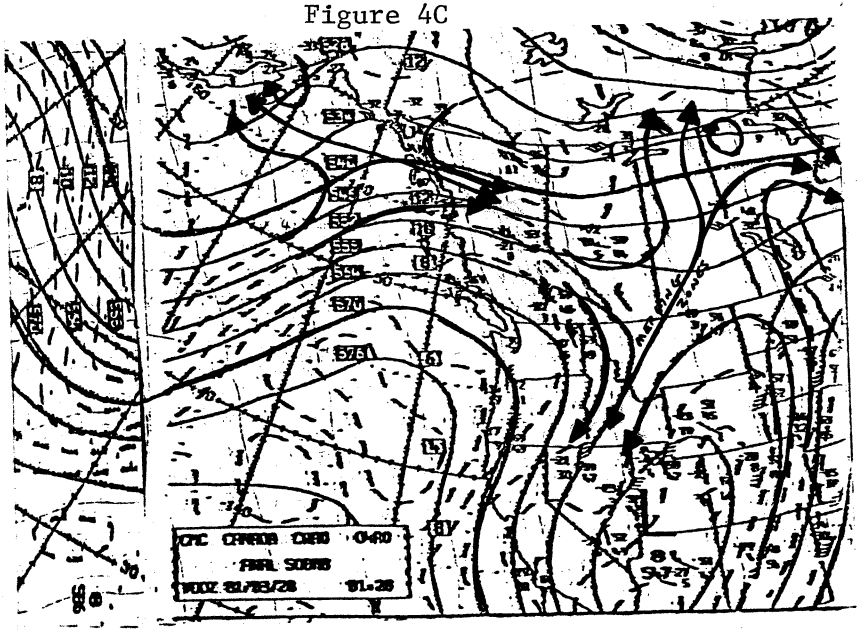
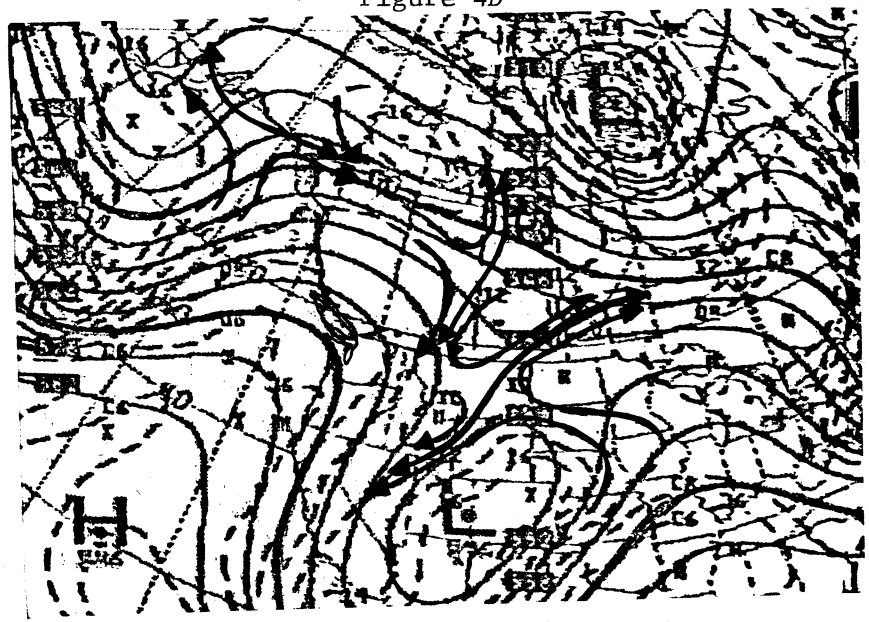


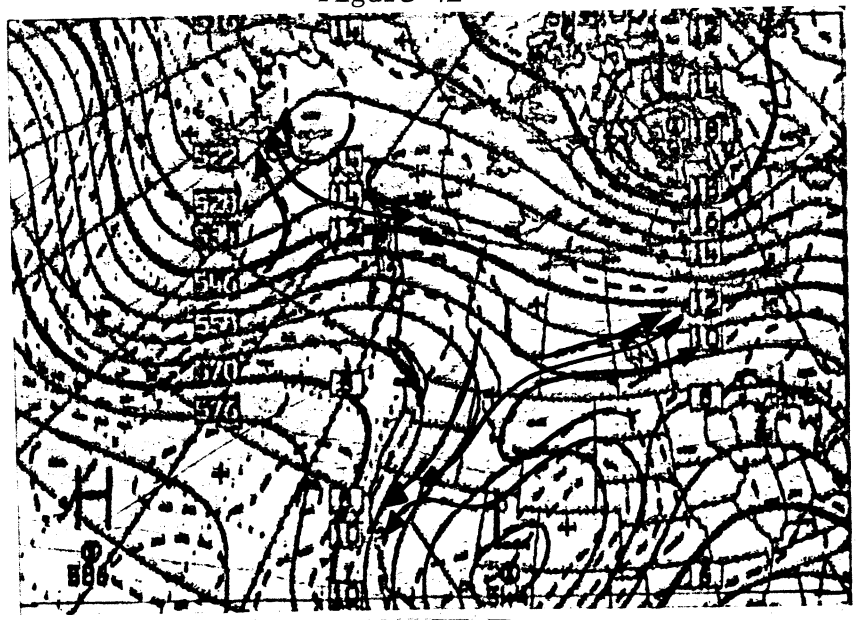
Figure 4D



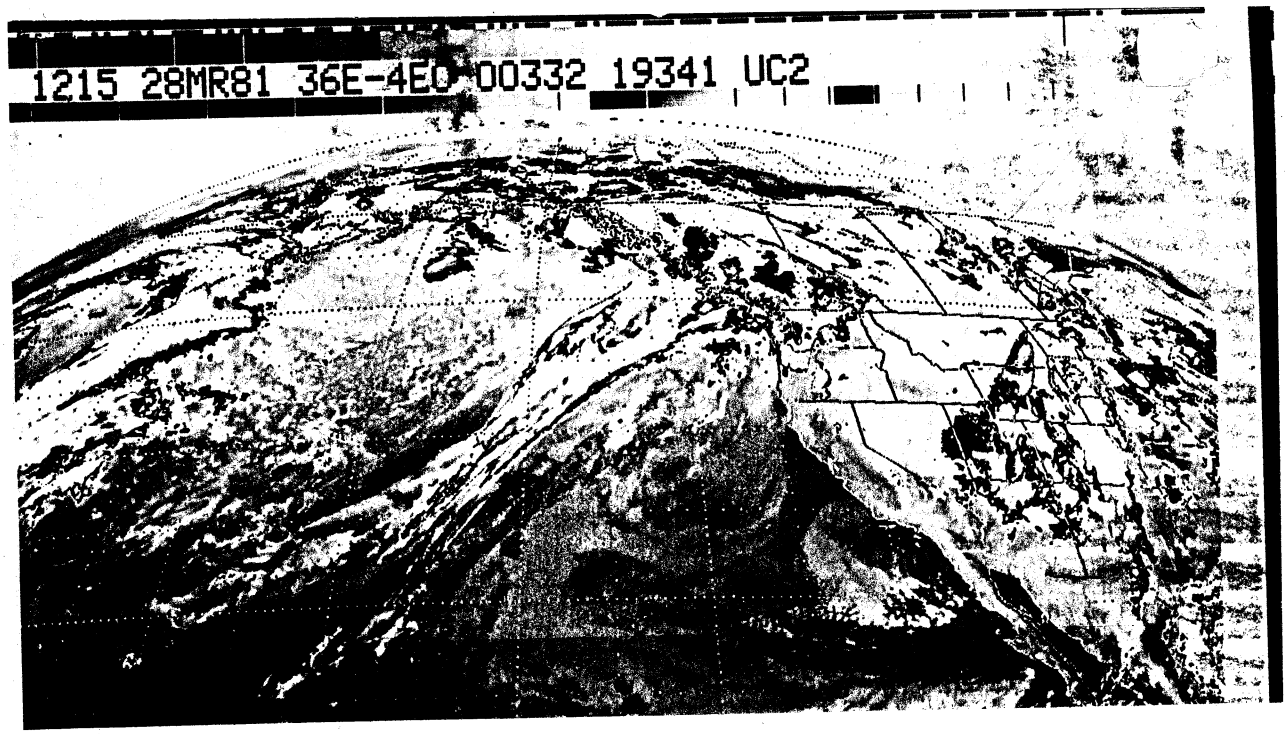
NMC... 24HR FCST 500MB HEIGHTS/VORTICITY

VALID 00Z SAT 28 MAR 1981

Figure 4E



CMC CANADA CMAO 0000 24H 500MB HT/VO



EC SECTOR

Figure 5

ANALYSIS 12Z 38 March 1981

The deformation zone crossing the western Prairies has now merged into one elongated zone. It still marks the northern edge of the cloud associated with the cold low and the leading edge of the cloud system moving in the westerlies across the northern Prairies. Analysis (Figure 5B, 5C) and cloud edges on the imagery show good agreement.

24 HR PROGNOSIS valid 12Z 28 March 1981 (Based on 12Z 27 March data)

Forecast position of the above deformation zone is well represented on the 24 hour progs.

ASIDE: note the basic agreement of deformation zone extending from southern Yukon to western Alberta on the analysis Figure 5B, 5C as well as the cloud edge on the imagery.

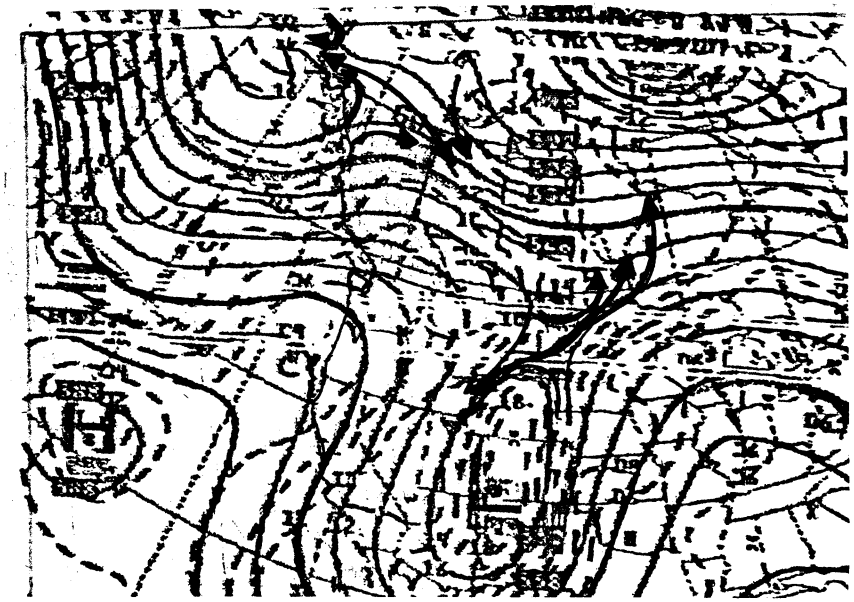
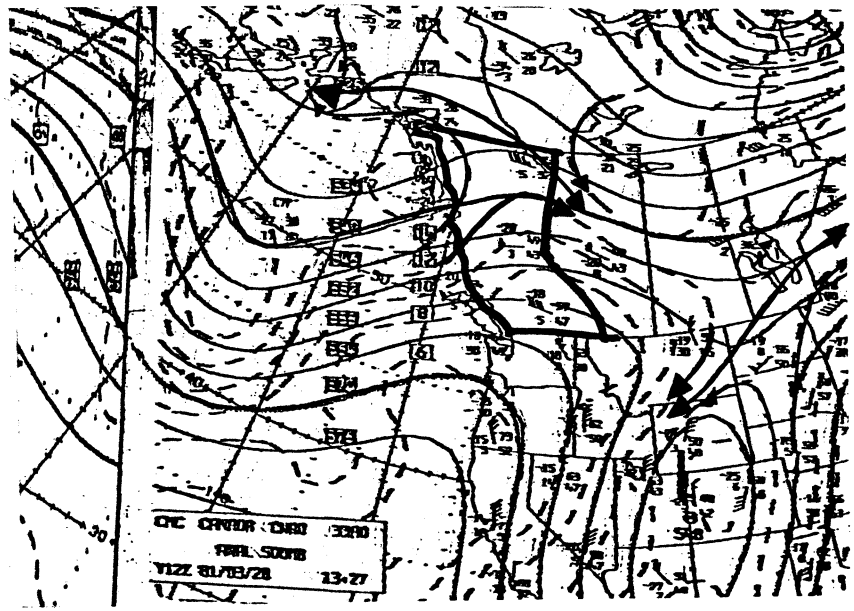


Figure 5B

Figure 5C



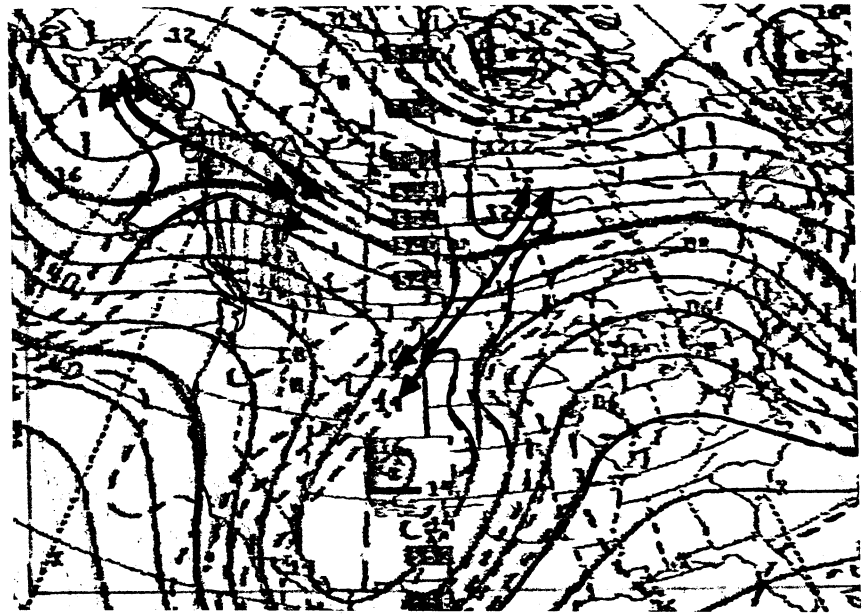
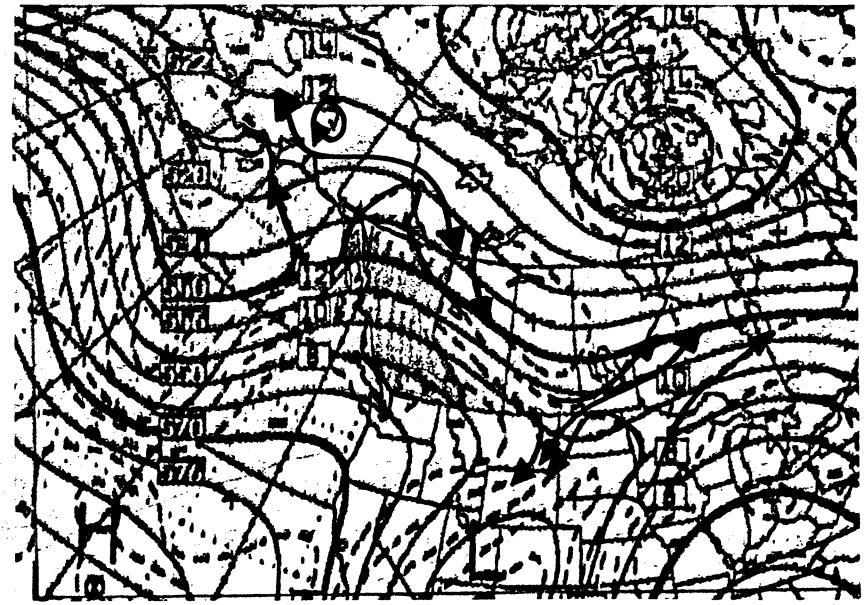


Figure 5D

Figure 5E



SUMMARY

The deformation zones determined from vorticity isoline streamlines correlate well with cloud edges as viewed from satellite imagery. These zones can be extrapolated in time and space. In fact progged zones may in fact be more representative than the analysis. This is especially true in data sparse areas. (See figure 4. Discussion.)

The case presented shows that the concept can be quite reliably used with different flow patterns. In this case with a cold low and also with a cloud system embedded within the westerlies.

Initially the deformation zone - cloud edge correlation concept can be used as a tool to verify the initial analysis. Often the finer resolution of the LFM gives sharper edges.

With good vorticity analysis and prognosis, the operational forecaster can use the deformation zones to better outline forecast cloud shields on medium range weather depiction forecasts. Where on the initial analysis, the deformation zone and imagery are at odds, then an adjustment to both will produce a better result. For example, if the 12Z 26 March deformation zone north of the cold low had been adjusted northward to fit the cloud, the 24 hour prog adjusted by the same amount would show good correlation with the imagery.

FOLLOW UP PROJECTS

- Plot PCPN reports on NOAH imagery over Pacific Region. Prepare a study of results with regard to positions relative to deformation zone.
- Verify 24 - 36 hour prog cloud edge based on DEF zone (I.E. vs PWC, CWAO).

REFERENCES

1. Pacific Region Technical Notes

   80-038B November 14, 1980
   Satellite observed cloud fields and their relationship to flow patterns - Part A

   80-039B November 25, 1980
   Satellite observed cloud fields and their relationship to flow patterns - Part B.

   Funk, Larry, Satellite Meteorologist
   Pacific Weather Centre, Vancouver.

2. Weldon, Roger - 1979
   Cloud patterns and the upper wind field.
   Satellite Training Course Notes NESS/NDAA.