PACIFIC REGION TECHNICAL NOTES

80-039
November 24, 1980

SATELLITE OBSERVED CLOUD FIELDS AND THEIR RELATIONSHIP TO FLOW PATTERNS

- Part B -

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INTRODUCTION

This note describes a technique for locating and forecasting synoptic scale cloud areas and edges using the 500mb vorticity field and satellite imagery.

Weldon (A) has found that cloud edges often correspond closer to vorticity fields than to actual streamlines. This is especially evident if one uses the vorticity isolines as relative streamlines. This conclusion has been reaffirmed in day to day observations and special studies by PWC satellite meteorologists. Using Weldon's findings and these day to day observations, an attempt has been made to systematically isolate significant likely cloud areas and edges on the 500mb vorticity field. These areas are then compared to the satellite imagery for "goodness" of fit. The purpose of this article is to outline the method and show the type of vorticity-cloud fit that is characteristically achieved.

TOOLS

- 500mb vorticity field. (Relative if possible. Absolute a reasonable substitute and used at PWC because of availability.)
- Satellite photo at chart time.
- Vorticity prognosis.

ANALYSIS OF THE VORTICITY FIELD

- Outline or abstract the vorticity isolines from the 500mb analysis.
- Mark on ridges and troughs.
- Mark vorticity maxima and minima.
- Show positions of local wind maxima. (Using Weldon's placement with regard to vorticity centres.)
- Show the deformation zones (cols) within the vorticity isolines.

STEPS FOR CLOUD PLACEMENT

- Use the vorticity ridge for the first guess positioning for the back edge of a cloud system. Keep this edge only across the tubular flow area*.
- Extend the cloud downstream within the tubular flow area until it encounters one of the following:

* Tubular flow area: Region of tight and nearly parallel vorticity isolines.

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- a deformation zone;
- a significant vorticity ridge;
- a split flow.

Note the right hand edge of the tubular flow area defines the bottom of the cloud.

- In the case of a deformation zone abruptly end the cloud just in advance of the zone.

- In the case of a vorticity minima axis thin out the cloud along it.

- In the case of a split continue the cloud along the main stream and a streamer of cloud along the weak branch. Terminate the cloud at the next deformation zone or vorticity minima axis.

- Fill in the leading half of a closed vorticity maximum with cloud.

- Show a dry slot in the back of the cloud edge in association with the local wind maximum. The stronger the wind maximum, the greater the indentation.

- Join the cloud edges to form the cloud system.

This subjectively produced cloud picture is then compared to the satellite imagery to establish a degree of fit.

Some additional modelling may have to be done to account for moisture, scaling, resolution and error in method or vorticity analysis.

If the fit is good, the technique might be applied to the 12 and 24 hour vorticity prognosis. From day to day application and familiarization with the technique realistic cloud fields can be depicted.

The following example for 24 September, 1200Z is meant to illustrate the technique.

CASE STUDY

The case documented is for the 24th of September, 1200Z. The 500mb CMC Spectral contour and vorticity chart is shown in Figure 1.

THE ANALYSIS OF THE VORTICITY FIELD

Figure II shows the abstracted vorticity field with vorticity maxima, minima, ridges and troughs marked. Pseudo streamlines are marked with the flow counter-clockwise about vorticity maxima and clockwise about minima.

Figure III shows the positioning of the local wind maxima (as defined by Weldon) illustrated.

Figure IV shows the significant deformation zones or cols within the vorticity streamline field.

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Figure V shows the completed analysis of significant features.

DETERMINATION OF PROBABLE CLOUD AREAS AND EDGES

Figure VI shows the cloud areas and edges outlines by using the first three steps.

Figure VII shows the cloud and back edge indentation by the local wind maxima.

COMMENTS

- Considering the coarseness of grid and lack of data over the Pacific the fit is quite good.
- It is interesting to note that with the well developed system 30-50 degrees N 150-160W, the CMC moisture analysis would show little or no associated mid level moisture. Figure IX.

REFERENCE

A. Weldon, Roger - 1979
Cloud Patterns and the Upper Wind Field Satellite Training Course Notes NESS/NOAA.

RECOMMENDATIONS

- Since vorticity isolines are useful in outlining significant synoptic scale areas and edges, it should be possible to construct a subjective vorticity field from satellite cloud fields.

- Progged cloud fields using methods outlined in this study should be verified against moisture and RH prog packages.

- Since deformation zones, within the vorticity field, are such good cloud dissipaters, these zones should be closely watched. This is especially critical when dealing with the troublesome northern edge of California cut off lows and also when dealing with frontal zones approaching the B.C. coast from the Pacific.

- The vorticity streamline concept is not presented as the ultimate answer. With the addition of other parameters the method could be further improved.

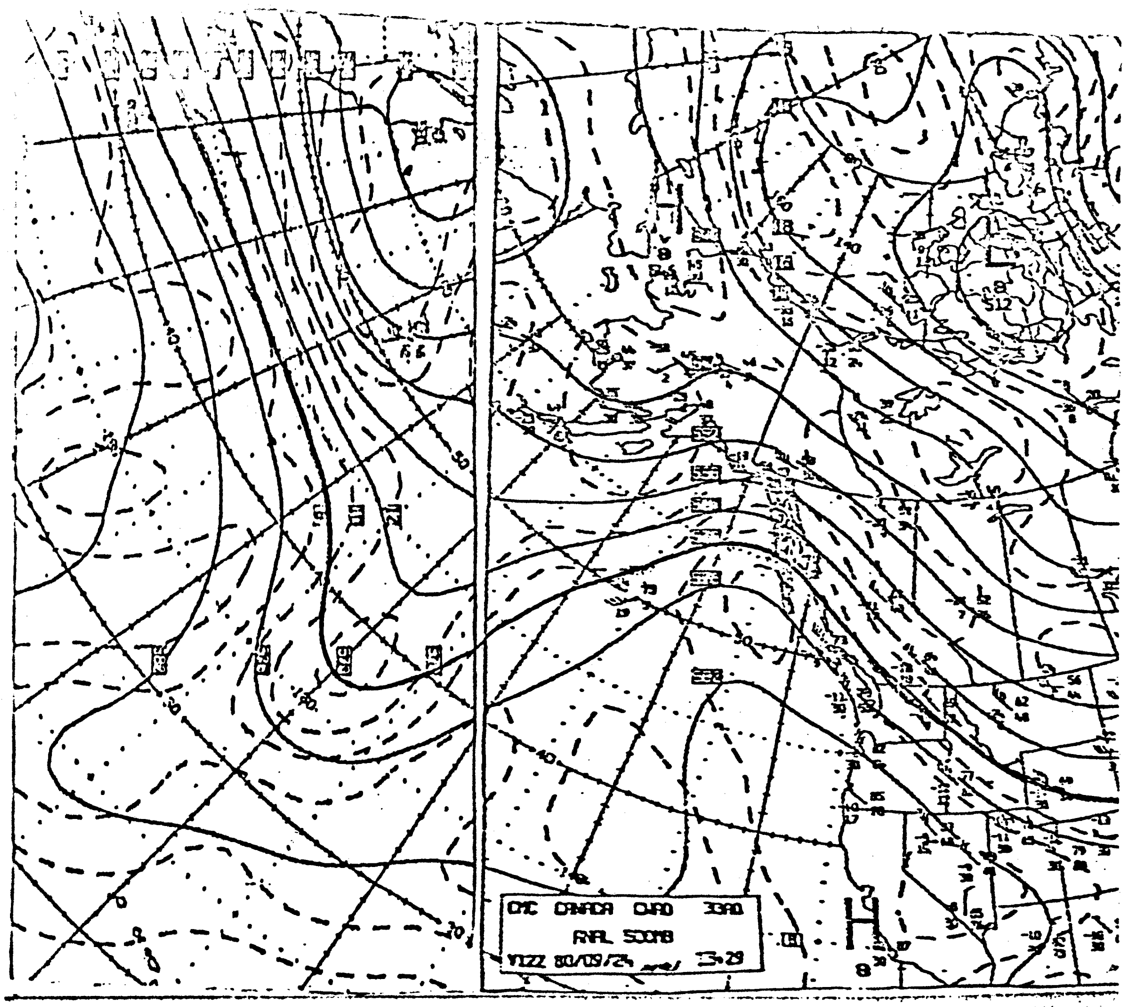


FIGURE I
500mb CMC SPECTRAL
CONTOUR AND VORTICITY

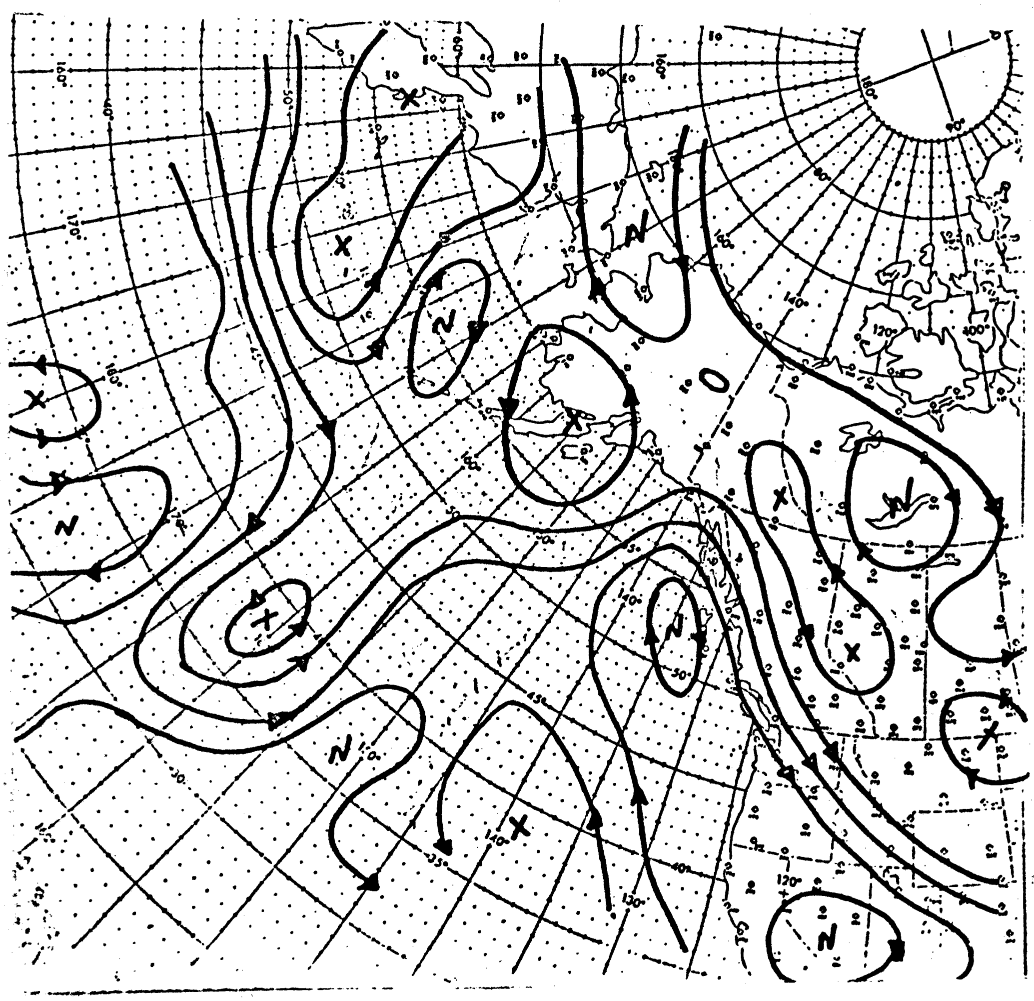


FIGURE II
ABSTRACTED VORTICITY
FIELD
- MAXIMA, MINIMA,
MAXIMA AXIS, MINIMA AXIS
MARKED.
- EMPIRICAL STREAMLINES
(VORTICITY ISOLINES) RUN
COUNTER-CLOCKWISE ABOUT
VORTICITY MAXIMA AND
CLOCKWISE ABOUT MINIMA.

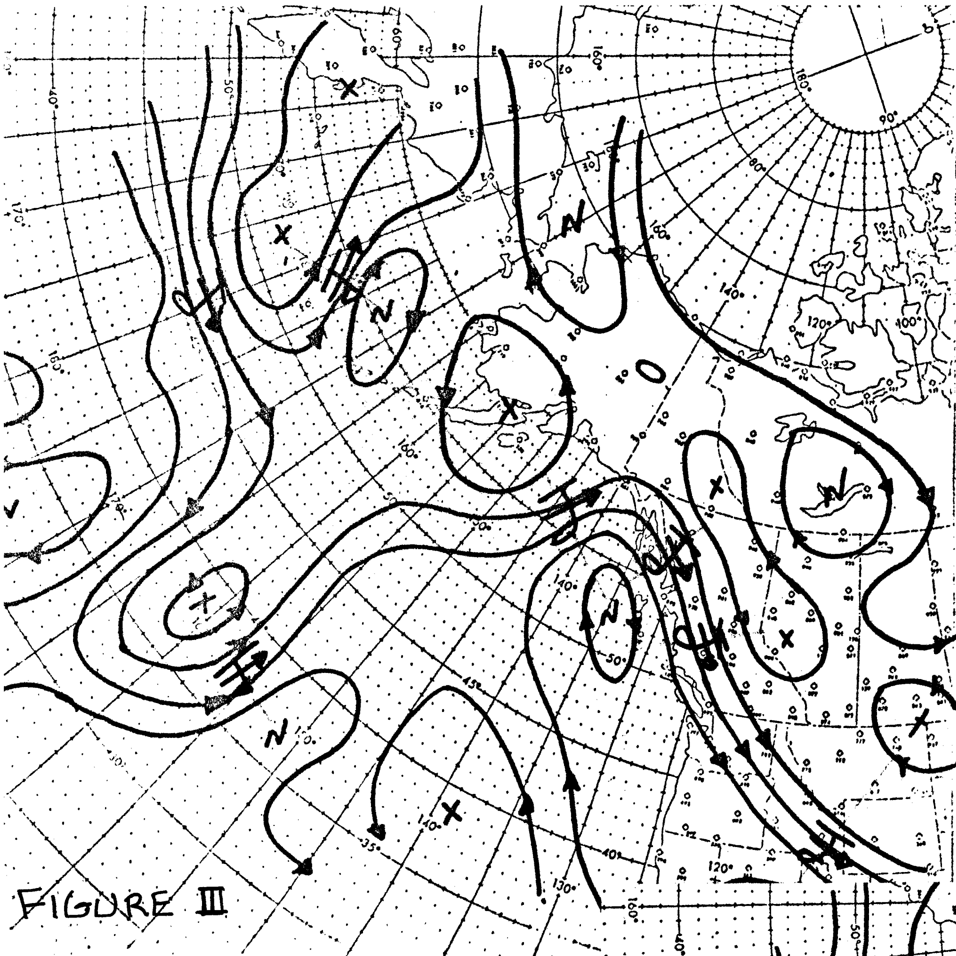
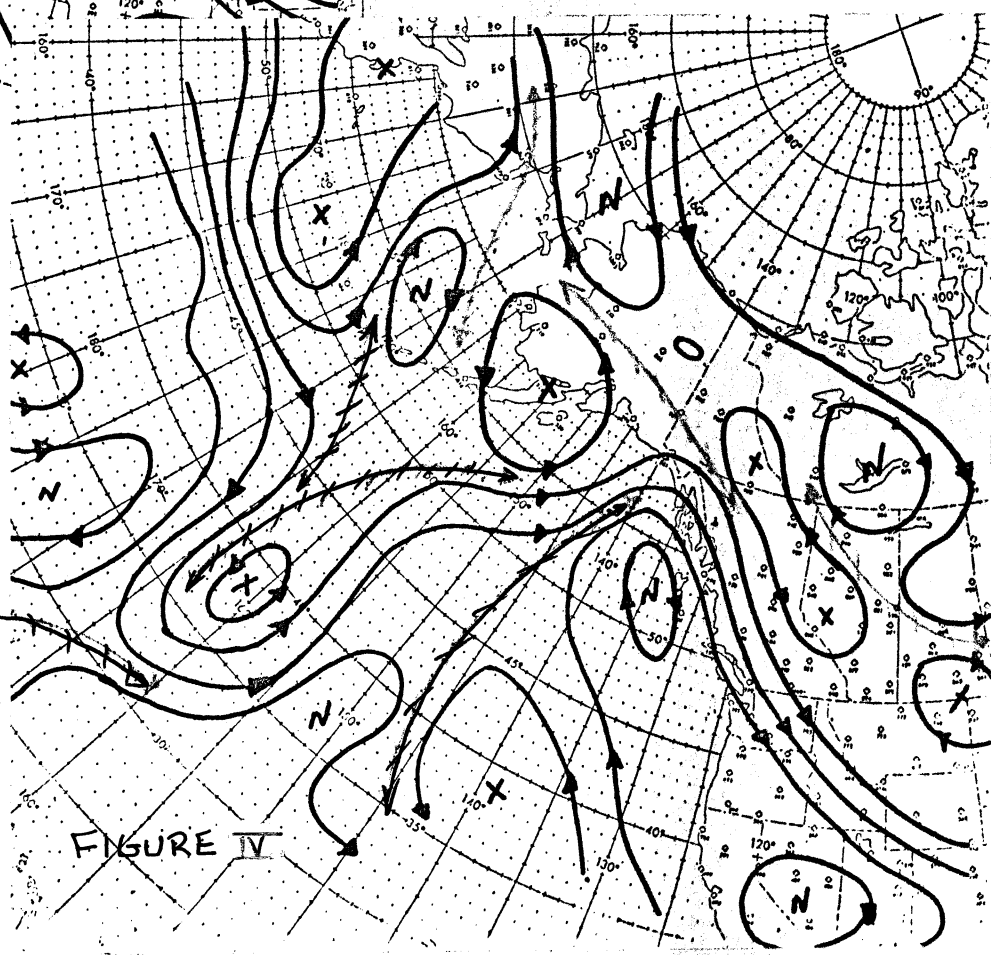


FIGURE III

- POSITION OF LOCAL WIND MAXIMA AS DEFINED BY VORTICITY MINIMA-MAXIMA PAIRS ACROSS THE STREAM. (WELDON)

FIGURE IV

SIGNIFICANT DEFORMATION ZONES OR COLS WITHIN THE VORTICITY FIELD.



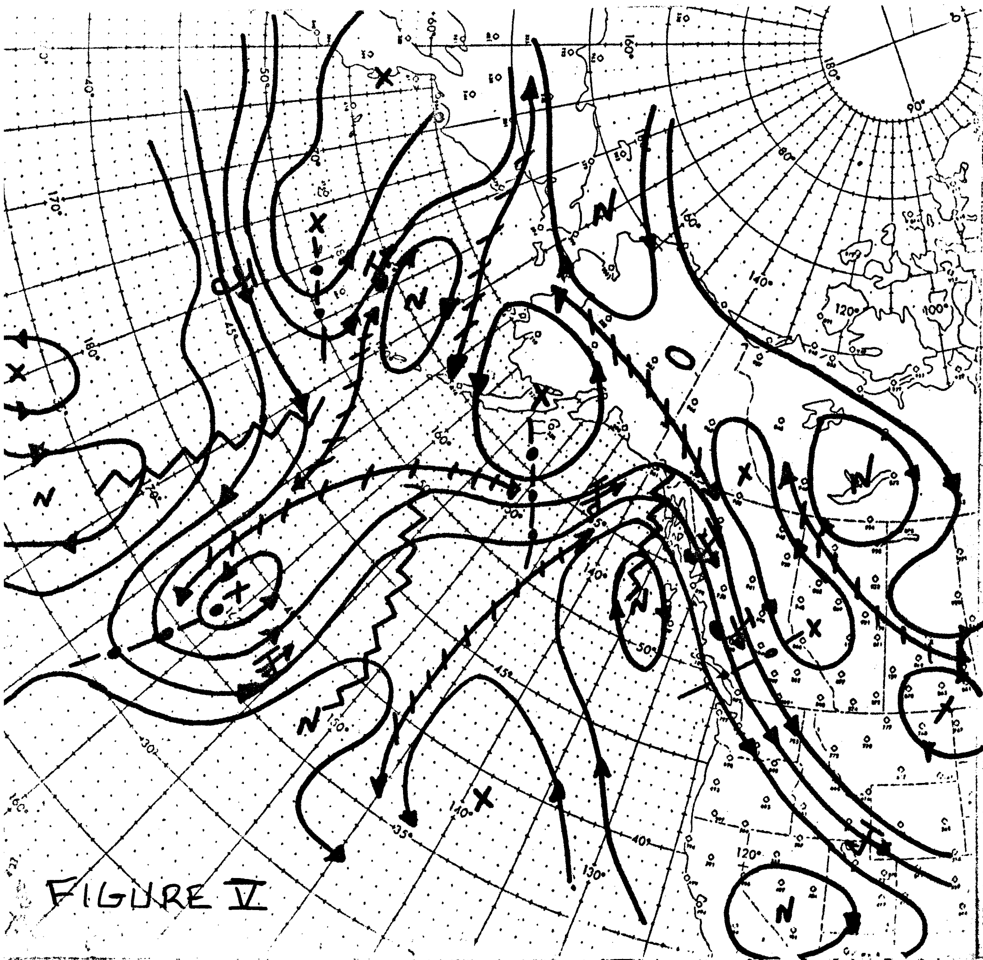


FIGURE V

- COMPOSITE OF FIGURES II, III AND IV. DETERMINATION OF PROBABLE CLOUD AREAS AND EDGES.

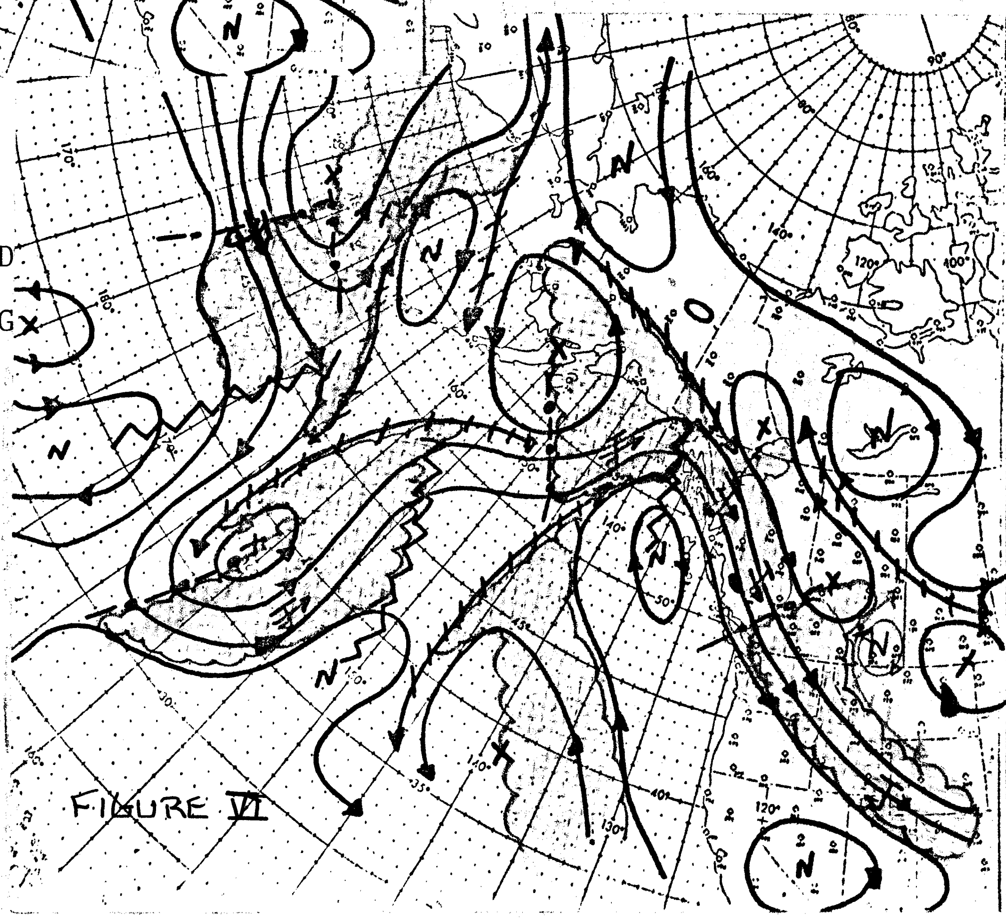


FIGURE VI

- SHOWS THE CLOUD AREAS AND EDGES OUTLINED BY FOLLOWING THE STEPS FOR CLOUD PLACEMENT.

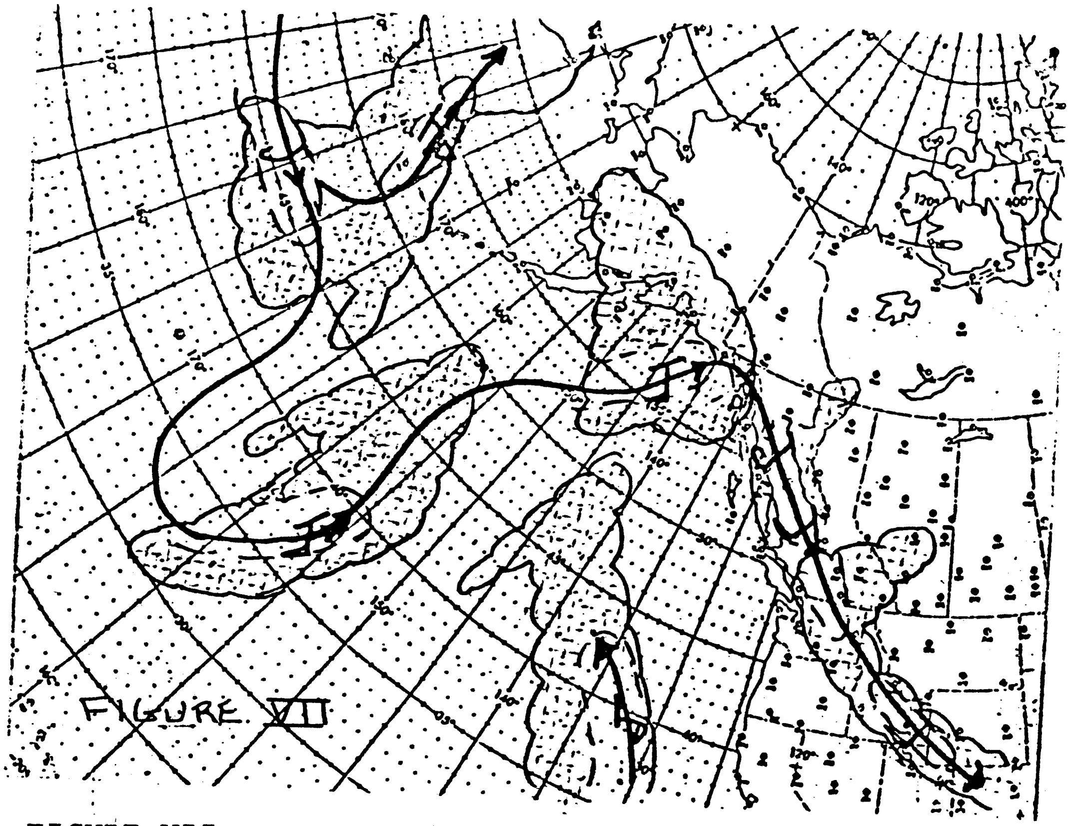


FIGURE VII

- SHOWS THE CLOUD AREAS AND BACK EDGE INDENTATION BY THE LOCAL WIND MAXIMA.

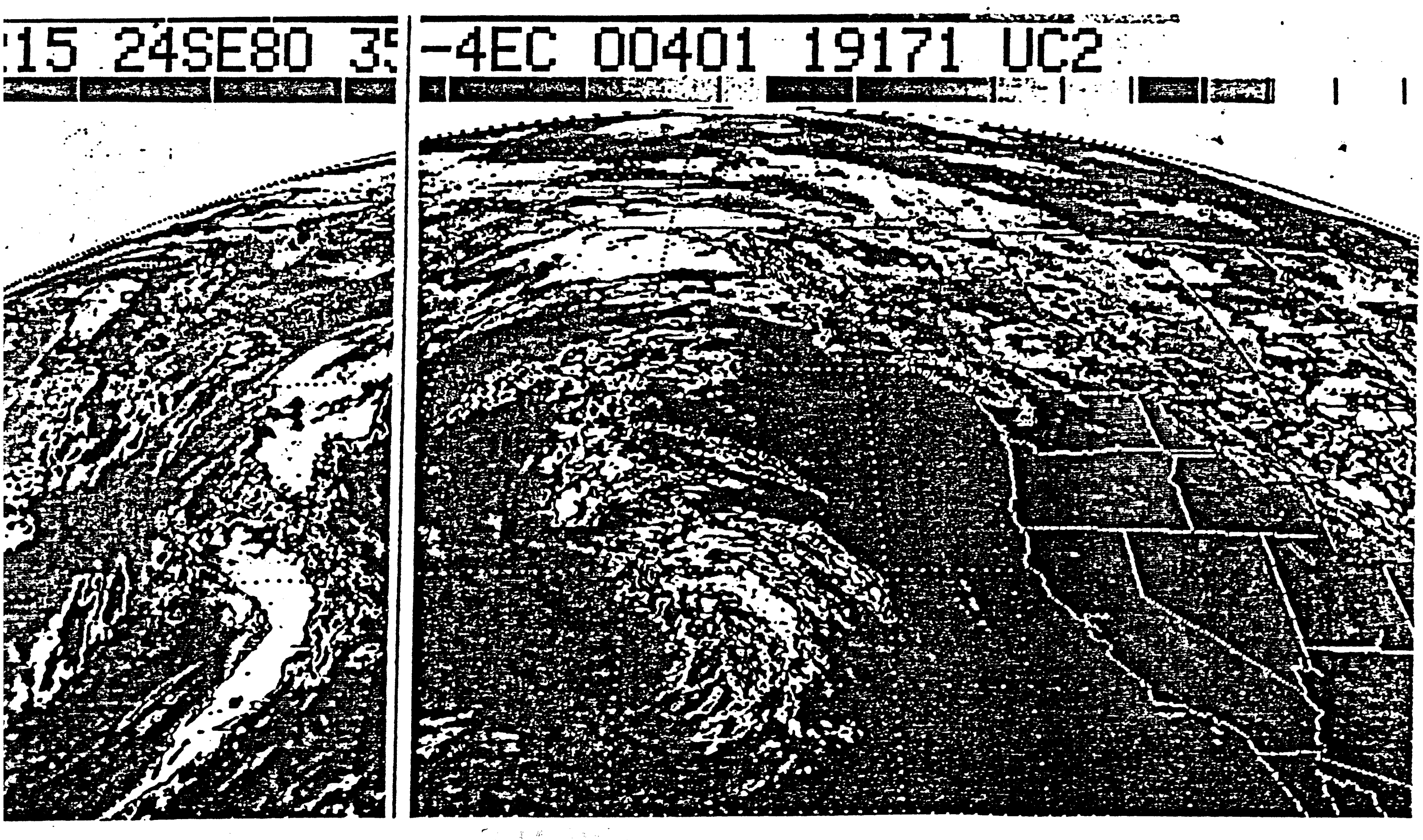


FIGURE VIII - COMPARISON OF CLOUD AREAS DETERMINED WITH SATELLITE IMAGERY.

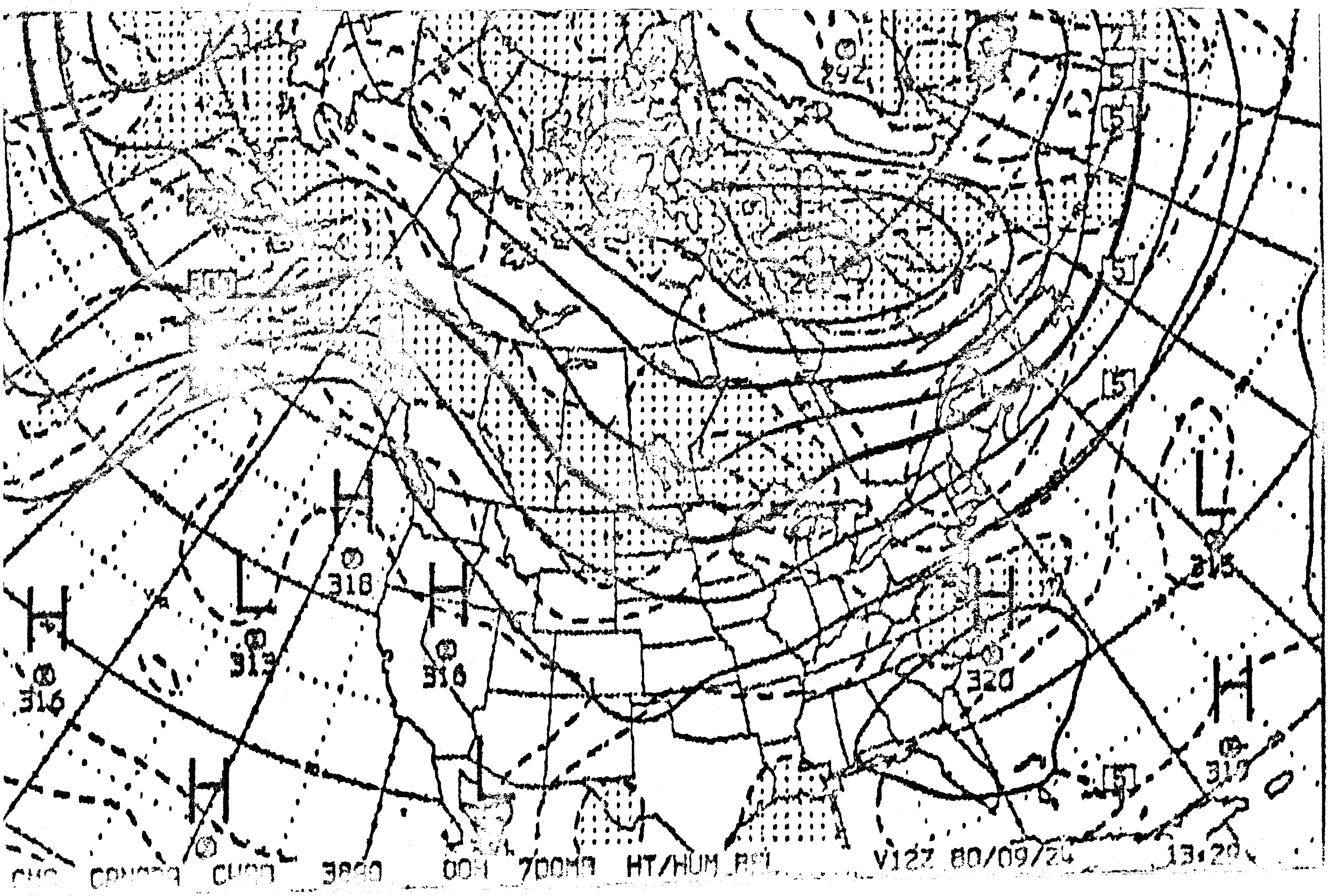

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FIGURE IX