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SATELLITE IMAGERY AND THE USE OF THE J.J. GEORGE TECHNIQUE FOR MARITIME CYCLONES OVER THE PACIFIC

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INTRODUCTION

The J.J. George (1960) method for predicting maritime cyclones is very familiar to Atlantic Coast forecasters; however this technique has never been used to any extent on the West Coast. This lack of popularity can probably be attributed to the poor surface data base over the Pacific Ocean. Nevertheless, now that GOES-W satellite pictures are routinely available, it appears that this method promises to be a very useful aid for Pacific storms.

The objectives of this paper are as follows:

(1) to review the J.J. George method;

(2) to abstract the satellite applications work done by W.J. Younker in Anchorage, Alaska;

(3) to present a Pacific deepening prediction graph for use with 1000-500 mb thickness instead of temperature; and

(4) to demonstrate the method with a case study.

The J.J. George Method

The three parameters used by George for cyclone intensity are its location at the surface with respect to the 500 mb pattern, the strength of the flow above the centre at 500 mb, and the temperature gradient 1000 miles northwest of the surface centre at 500 mb. Deepening cyclones favour regions under open contours in advance of the 500 mb trough. Of the lows which intensify, the deepening is associated with the stronger 500 mb contour and thermal gradients.

Two parameters are used to quantify the amount of deepening

(1) The difference in 500 mb height across (open contours only) a measuring unit of 15 degrees of latitude centered above the surface low and measured normal to the current.

(2) The difference between 500 mb temperature above the surface centre and the coldest temperature included in an arc extending 15^{o} latitude into the northwest quadrant from the low.

These two differences are entered on a deepening prediction graph which are labelled in model and maximum 24 hour deepening amounts.

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George found that for strong deepeness, i.e. for lows under open contours and in advance of the upper trough, the direction of motion of the cyclones was across the 500 mb contours towards lower heights. The angle across the contours varied from near zero degrees at the left hand edge of the upper jet stream to as much as 30 degrees at the right hand edge. The average angle of contour crossing under the centre of the stream is 7.5 degrees toward lower height.

Speeds of cyclones are also determined measuring 500 mb contour and thermal gradients above the sea level centre. The measuring interval is 3½ degrees of latitude in this case. Again, a graph is entered to determine the speed.

Snopkowski and Welch (1959) adopted the J.J. George deepening prediction graph for use over the Pacific Ocean.

W.J. Younker Satellite Application of the Technique

W.J. Younker (1981) has identified a particular satellite imagery cloud pattern associated with some rapidly developing cases of cyclogenesis over the Pacific. Surface low centre positions were correlated with these cloud circulation patterns and the Snopkowski and Welch deepening graphs were then applied to the low centres. The results of a number of cases studied were very encouraging. The technique significantly outperformed both the PE and LFM prognoses.

The particular cloud pattern which invariably always resulted in a rapidly deepening low is called an S-C system. These letters refer to the cloud shape on the cold side of the baroclinic zone. Sinking motion over or to the rear of a deep cloud circulation centre appears to be a timely clue for cyclogenesis over the North Pacific. There must be a gradual increase in brightness from the southern or lower portion of the S or C cloud structure to the northern or upper portion (L to U on figure 2) without a leaf or layered appearance. Also, clouds in the L and U band of the S pattern are colder towards the western edge.

The S pattern is an early indication of low level (open isobar) circulation while the C cloud is a later stage likely associated with a closed isobar surface low. In winter, surface lows will be about one degree of latitude to the left of the direction of motion of significant lower cloud circulation centres (X in figure 2) at 30 knots and within 2 degrees at 60 knots.

Experience at Anchorage indicated that tracking the systems for at least 8 hours yielded the best results for speed and direction of motion of the storm.

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The Deepening Prediction Graph for the Canadian Upper Air 500 mb Chart

Temperature fields at 500 mb are not analysed on the Canadian 500 mb chart. Instead, thermal gradients are depicted as 1000 - 500 mb thickness contours. In order to use the deepening graph over the Pacific, the temperature gradient at 500 mb was assumed to be equal to the 1000-500 mb layer mean temperature gradient. Temperature difference values on the Snopkowski and Welch graph were then simply converted to changes in the 1000-500 mb layer thickness values (see figure 1).

A Case Study - February 15, 1981

The S cloud patterns as described by Younker is clearly identifiable on the satellite picture at 0545Z on February 15, 1981 (figure 3). At 1245Z (figure 4) the S pattern still exists although the C type cloud configuration is clearly evolving.

Using the cloud circulation centre position identified on the 1245Z satellite picture and the appropriate 500 mb chart (figure 5), the deepening technique yields a 24 hour deepening rate of 20 mb. The surface analysis for 1200Z (figure 6a) indicates an initial pressure of approximately 1004 mb where a surface low should be located.

Assuming a constant historical speed and constant deepening rate, the developing cyclone could be predicted as indicated in figure 5. The George track is based on a 7.5 degree cross contour track towards lower heights as suggested for lows located along or near the upper stream.

The final positions verify quite well with the analysed position on the surface chart 24 hours later (see figure 6f). However, the storm's central pressure dropped approximately 8 mb more than the deepening graph indicated. In comparison to the numerical prognoses (see figure 6), the prediction based on this technique was excellent.

Conclusions

An old technique for the prediction of deepening cyclones appears to work well for specific satellite cloud systems. The method has been applied to a number of cases during the late winter of 1980 at the Pacific Weather Centre. The cases have not been documented, but the results suggest that the technique usually out performs the numerical prognoses in the early detection and prediction of some rapidly deepening Pacific storms.

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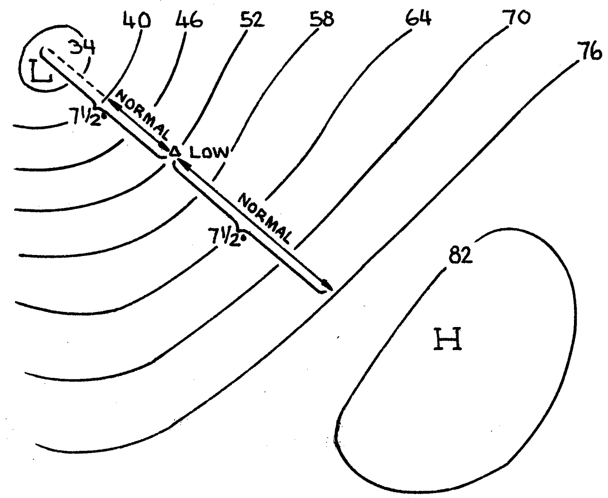
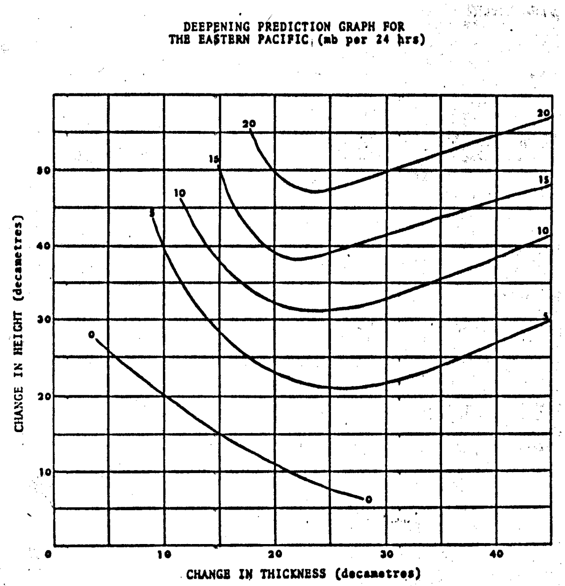
References

1. GEORGE, J.J., 1960, Weather Forecasting for Aeronautics, Academic Press, London, pp. 133-155.

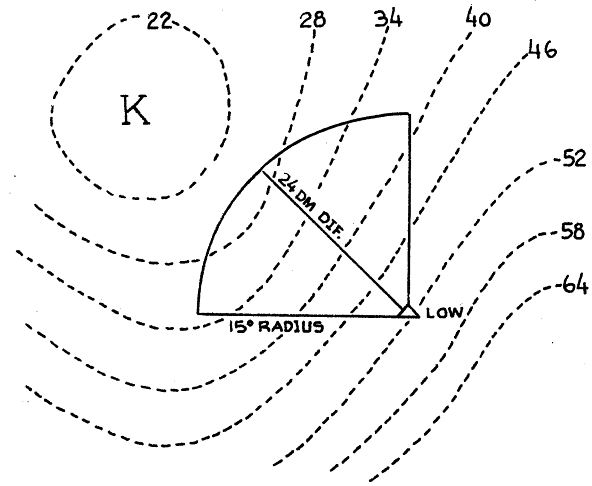
2. SNOPKOWSKI, Edward L. and Paul R. Welch, July 1959, "Evaluation of an Objective Method for the Prediction of Central Pressures of North Pacific Cyclones", Bulletin of the American Meteorological Society, Vo. 40 No. 7, pp. 336-339.

3. YOUNKER, Waldo J., February 1981, "Satellite Intensity Predictions of North Pacific Cyclogenesis", National Weather Digest, Vol. 6 No. 1, pp. 40-47.





STEP 1. Determine the 500mb height difference for deepening computation. Measure normal to current between points 7.5 deg of lat. on each side of surface low. When closed contours lie in this range, measure only to the last open contour.



STEP 2. Determine the 1000-500mb thickness difference for deepening computation. Measure between the thickness over surface low and coldest thickness within sector extending 15 deg of lat. northwest of low.

FIGURE 1. Deepening Prediction Technique

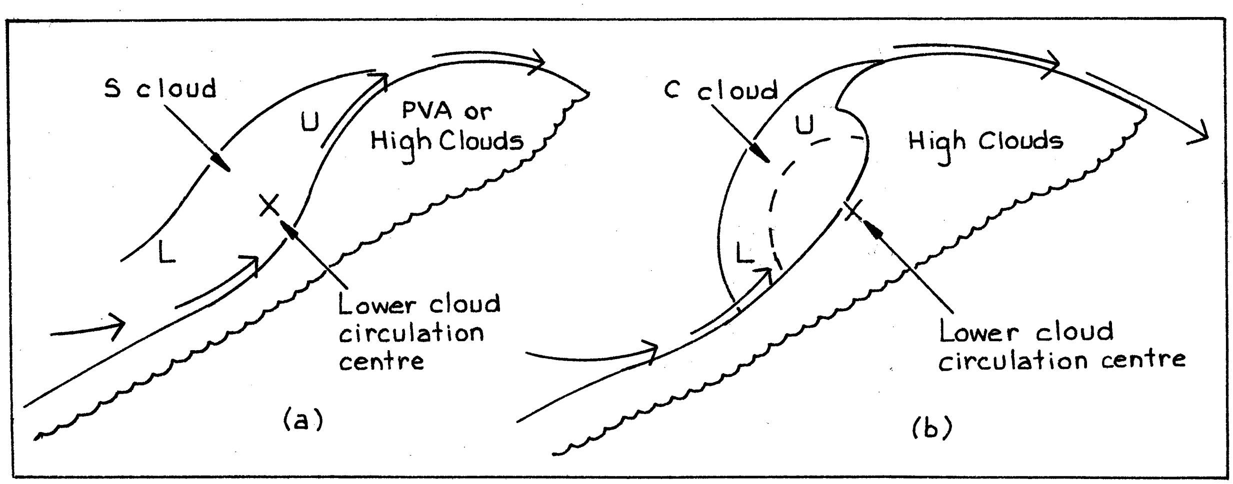


FIGURE 2. Schematic showing "S" and "C" cloud patterns.

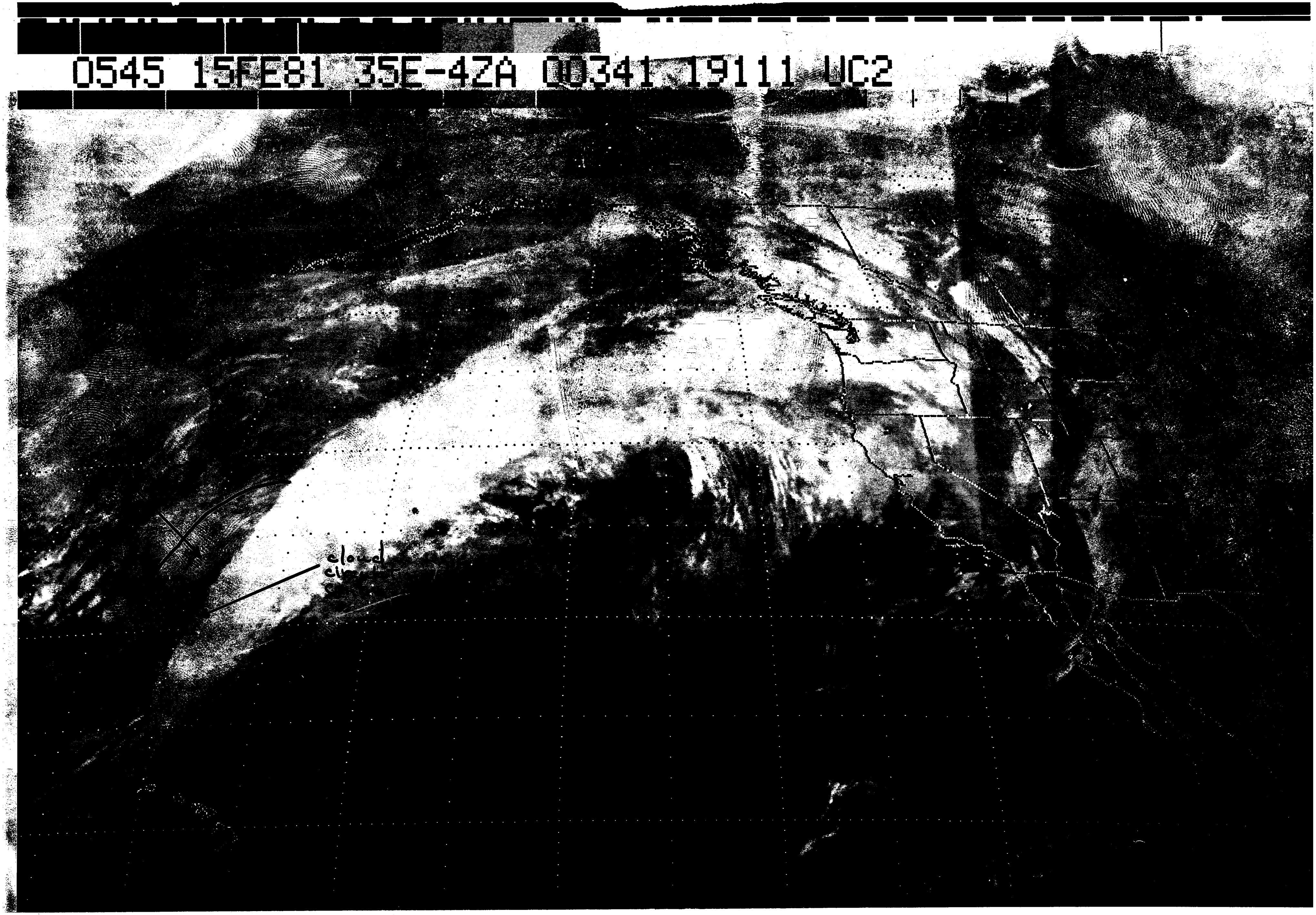


Figure 3

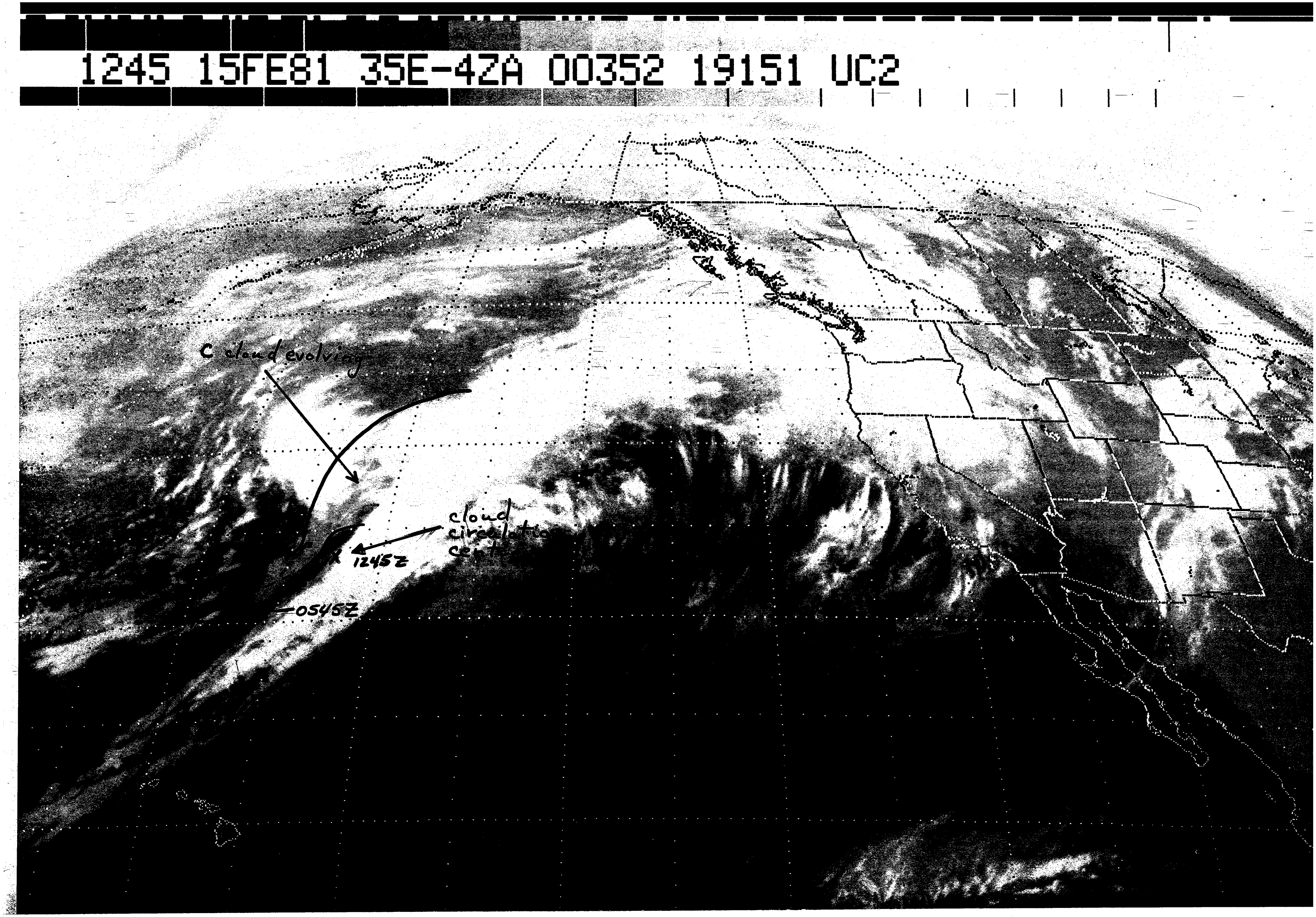

1245 15FE81 35E-4ZA 00352 19151 UC2
C cloud evolving
cloud
1245Z
0545Z

Figure 4

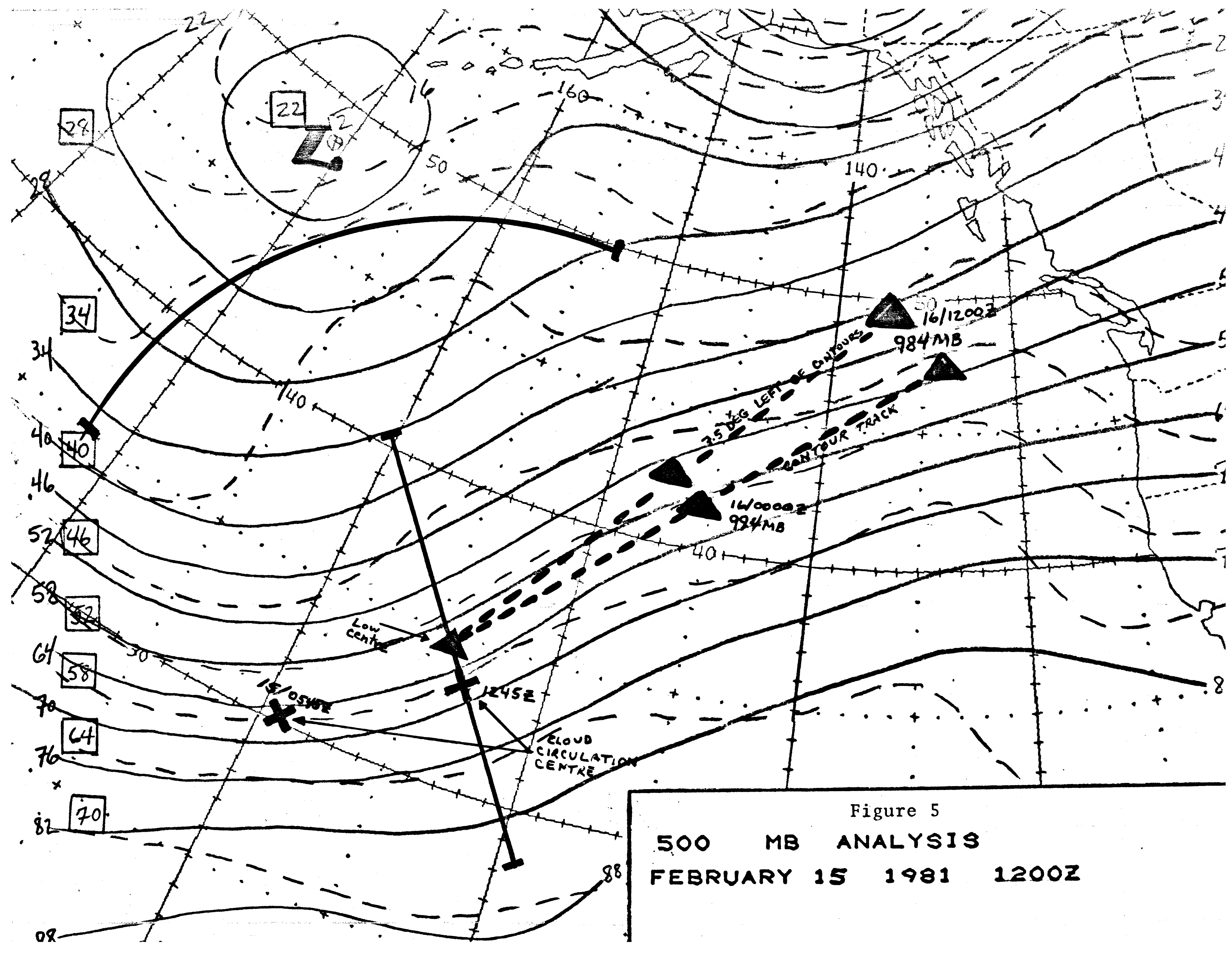


Figure 5

500 MB ANALYSIS

FEBRUARY 15 1981 1200Z

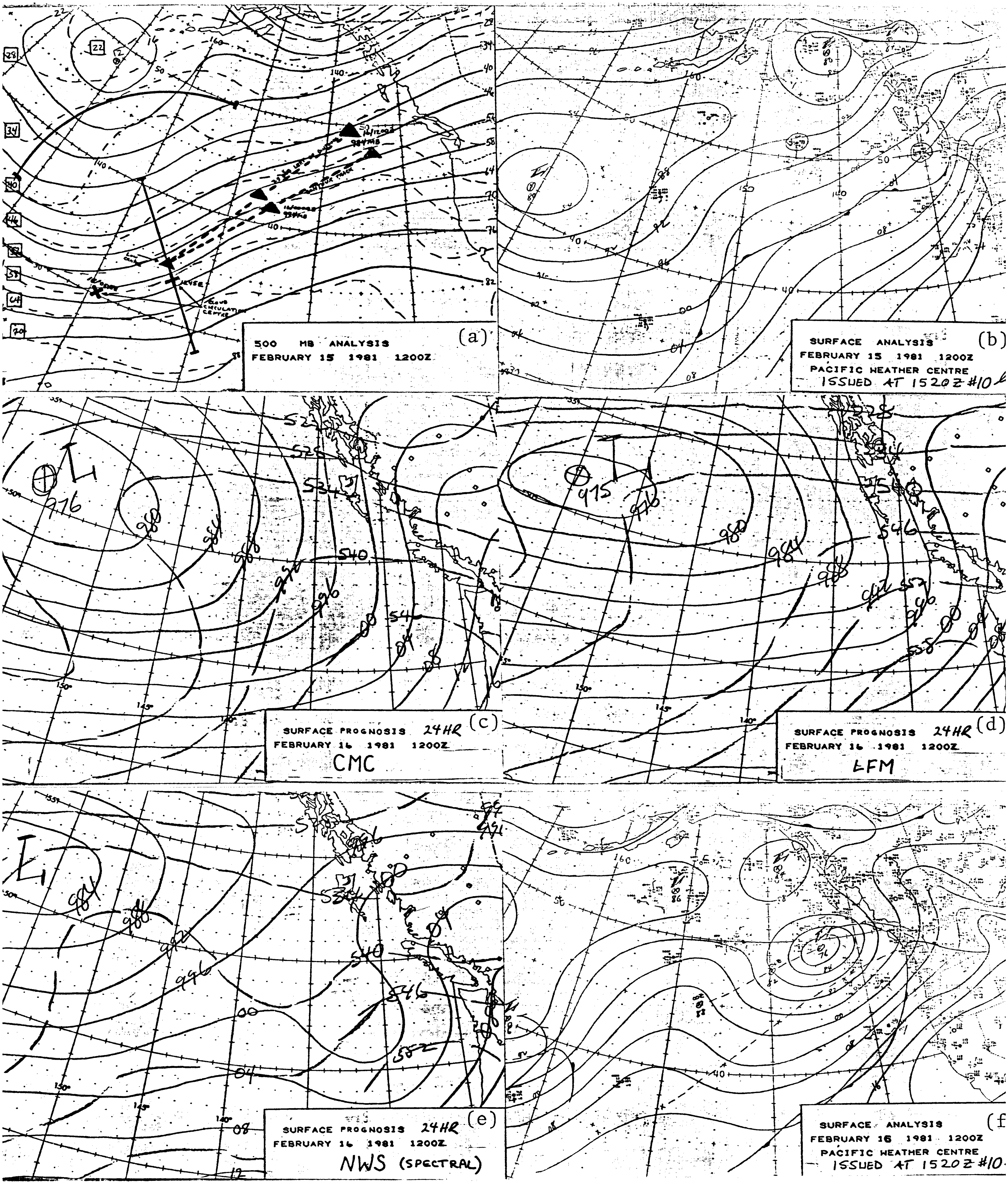
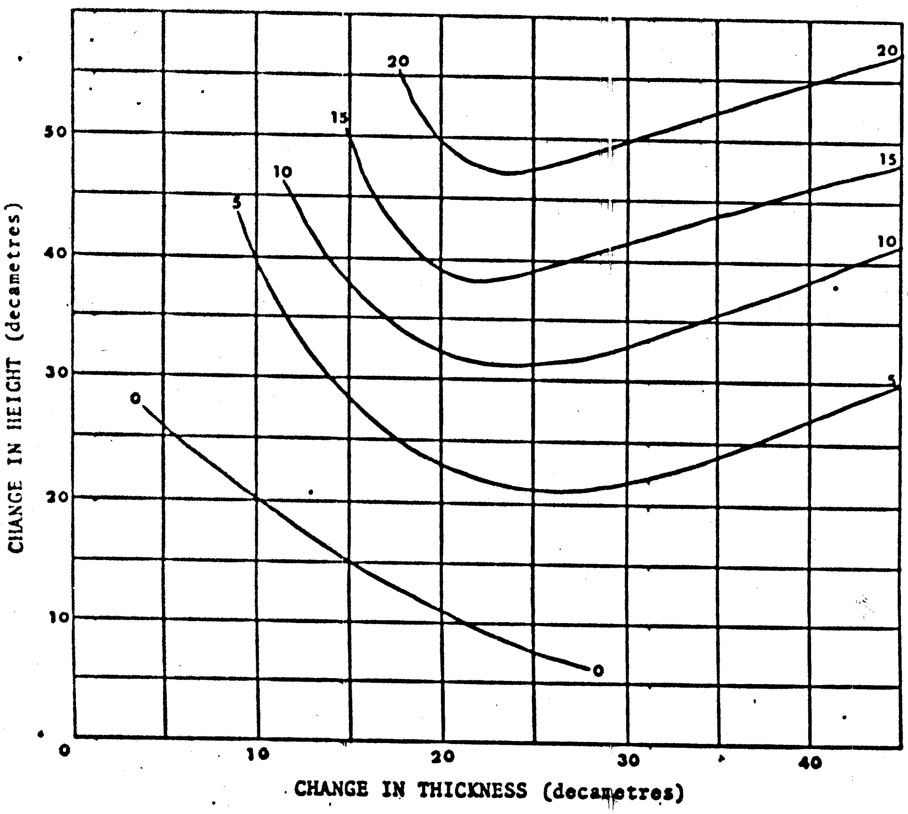
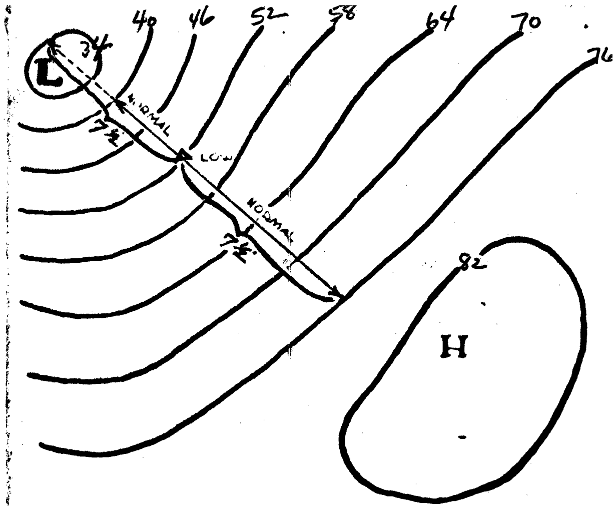

500 MB ANALYSIS
FEBRUARY 15 1981 1200Z
(a)
SURFACE ANALYSIS
FEBRUARY 15 1981 1200Z
PACIFIC WEATHER CENTRE
ISSUED AT 1520Z #10
(b)
SURFACE PROGNOSIS 24HR
FEBRUARY 16 1981 1200Z
CMC
(c)
SURFACE PROGNOSIS 24HR
FEBRUARY 16 1981 1200Z
LFM
(d)
SURFACE PROGNOSIS 24HR
FEBRUARY 16 1981 1200Z
NWS (SPECTRAL)
(e)
SURFACE ANALYSIS
FEBRUARY 16 1981 1200Z
PACIFIC WEATHER CENTRE
ISSUED AT 1520Z #10
(f

Figure 6

DEEPENING PREDICTION GRAPH FOR
THE EASTERN PACIFIC (mb per 24 hrs)





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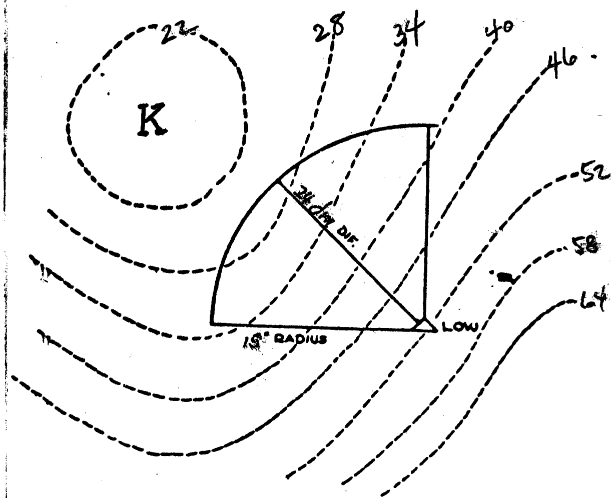

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Figure 1. Deepening prediction technique

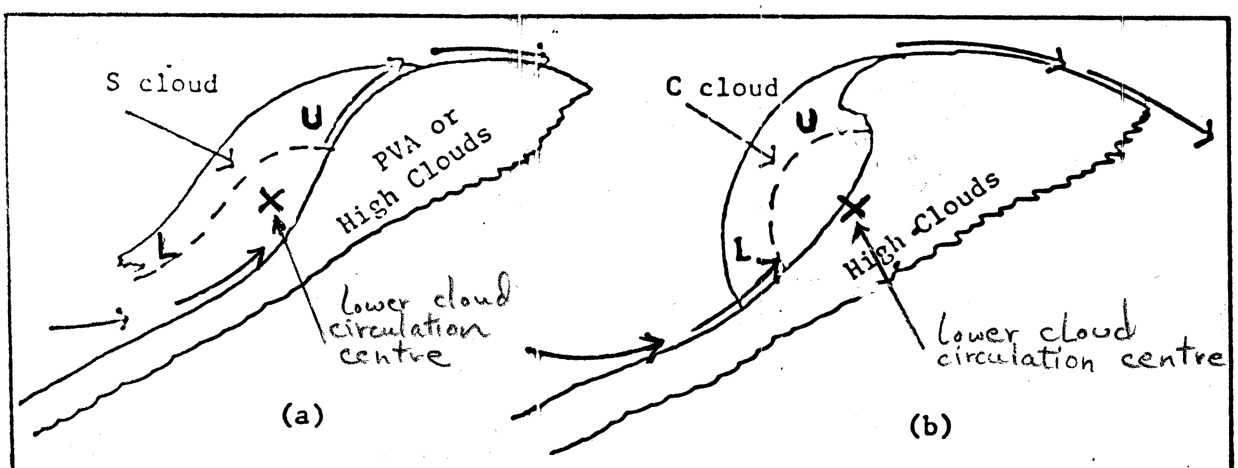
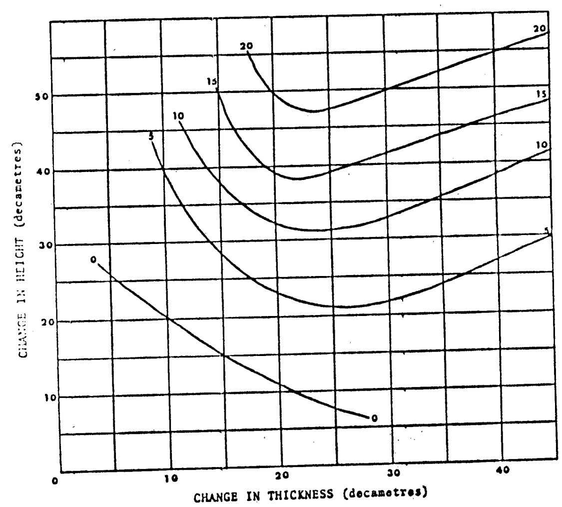
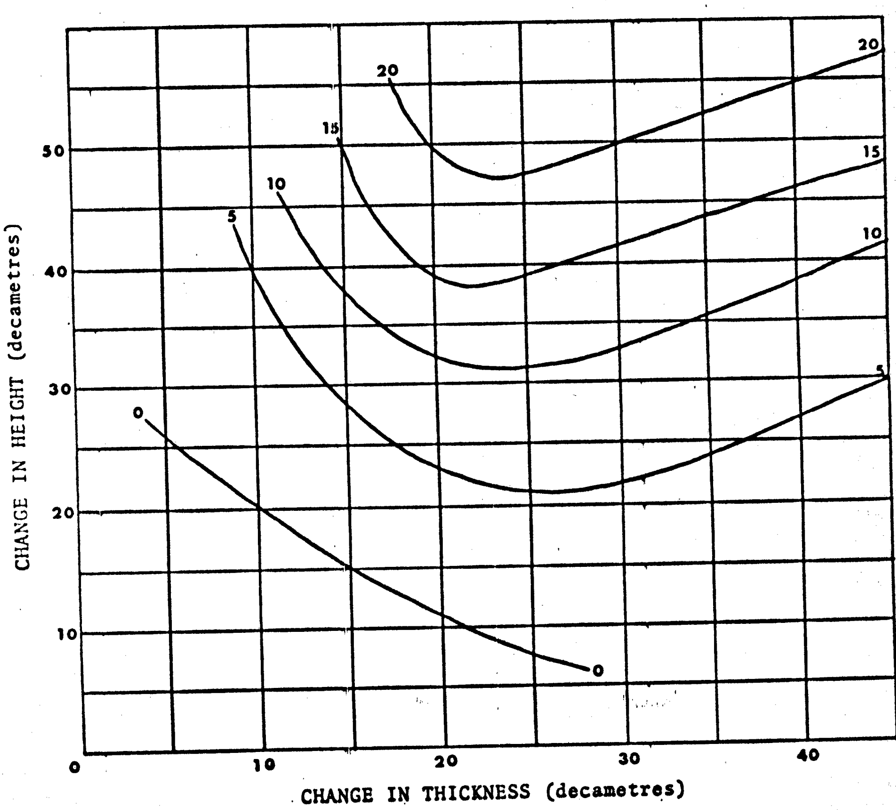


Figure 2. Schematic showing "S" and "C" cloud patterns.

DEEPENING PREDICTION GRAPH FOR THE EASTERN PACIFIC. (mb per 24 hrs)



DEEPENING PREDICTION GRAPH FOR
THE EASTERN PACIFIC (mb per 24 hrs)



DEEPENING PREDICTION GRAPH FOR
THE EASTERN PACIFIC (mb per 24 hrs)