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Examples of Wind Maxima Delta Cirrus

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INTRODUCTION

Last March, the author noted and preserved an interesting satellite picture (Fig. 1) which displayed a distinct cirrus formation (area B-C, Fig. 1) overrunning a frontal cloud band off the California coast.

Recently (Fig. 2) a similar pattern evolved and subsequent pictures (Figs. 3 and 6) give an excellent close-up of the cirrus configuration in question. As this pattern developed in much the same way as the previous example and seemed quite interesting, we decided to investigate further and to prepare a brief note on the subject.

The cirrus pattern documented has a distinct wedge (fan or delta) shape. Now Weldon (1975 and 1979) has discussed in some detail the formation and implications of this pattern. Here we simply wish to briefly elaborate on the two examples which will consolidate some of Weldon's ideas. In addition, I have made some tentative conclusions regarding the delta cirrus which may be of use in future occurrences.

SPEED MAXIMA CIRRUS

One of the basic cloud patterns often observed on satellite pictures has a general "T" shape, the stem being parallel to the wind speed maximum, and the cross bar lying along the stretching axis of the deformation zone ahead of the speed maximum. Referring to figure 4 we note the speed maximum (denoted max) and the associated stylized streamlines. Adjacent to the speed maximum are located the vorticity maximum and minimum centres together with the rotation of the air relative to adjacent air parcels. From this pattern note the formation of two confluent asymptotes of the deformation zone.

In advance of the speed maximum the flow becomes diffluent. The air slows down and some vertical motion is generated. The Region just in advance of the speed maximum is then favourable for cloud production and the cirrus will become stretched laterally along the confluent asymptote lying perpendicular to the speed maximum axis. The resultant cloud configuration would be triangularly constructed. The delta pattern is then roughly triangular with two well defined sides and one ragged edge. The two well marked edges being along the jet

or maximum wind axis and along the deformation confluent zone. The ragged edge is on the anticyclonic (or right hand) side of the speed maximum.

CONDITIONS FOR OBSERVING DELTA CIRRUS

Whereas delta cirrus may be associated with any wind maxima, we restrict ourselves to those cases where the delta pattern is a separate, distinct identity (as seen as Figs. 1 and 3), located somewhere just ahead of a ridge and to the rear of the upper trough. Using this criteria, we may set down two conditions under which a distinct delta configuration may form

1) preferably a high amplitude upper ridge in order to induce sufficient subsidence to eliminate any obscuring higher cloud west of the ridge line.

2) A substantial wind speed maximum which has either moved over the ridge, or formed or intensified east of the ridge. From the examples we may postulate a a speed maximum in excess of 100 knots.

CONCLUSIONS AND SUMMARY REGARDING DELTA CIRRUS

As some of the empirical conclusions are based on just two examples, caution must be exercised in the acceptance of them. However, the comments here will alert others to similar developments which may corroborate the conclusions drawn.

1) The cirrus forms just ahead of the core of strongest winds (note Figs. 5 and 8 showing the relation between the wind maximum and the cirrus pattern).

2) The delta pattern is associated with speed maxima in excess of 100 knots. This may imply that below speeds of 100 knots no delta pattern is formed.

3) The intense speed maxima has a strong vorticity maximum and minimum on either side (see Figs. 7 and 9).

4) The lower (southern) cirrus boundary is along the confluent deformation zone which is beautifully illustrated in Figures 3 and 6.

5) It seems evident that a cirrus wedge overruning the lower cloud in the bottom of the trough is indicative of the trough digging. The main energy in the flow is directed southerly as the delta axis is almost normal to the lower cloud band underneath and not stretched into a more easterly orientation. In both examples the trough did indeed dig, especially so in the March example. The digging aspect has, of course, the net result that the cloud system west of the trough has little or no eastwards motion. This is important for we may tend to prognosticate the system too far east, not recognizing the strong digging trend initially.

6) Most likely, the instantaneous direction of the flow is governed by the orientation of the cirrus edge to the left of the wind maximum, i.e. from example (Fig. 1) of March the edge is oriented south south-east with the southern cloud edge almost non-existent. This would imply a very strong flow southward. On the other hand, the example of June (Fig. 2, 3 and 4) suggests a nearly symmetrical diffluent flow with the primary push in a more southeasterly direction than the earlier case.

In conclusion then, when a cirrus wedge or delta is observed, east of the ridge, one should associate it with a possible intensifying speed maximum and be alert to the trough east of the ridge digging, the shape, orientation and texture of the cloud formation giving some additional hints as to the associated flow pattern.

REFERENCE

Weldon, R.B. NWS Satellite Training Course notes of April 1975 and January 1979.

FIG. 1. SATELLITE PICTURE, 0515Z MARCH 1 1979. AXIS OF MAXIMUM WINDS → →, WIND MAXIMUM J X AND WIND MAX. CIRRUS BETWEEN B-C.

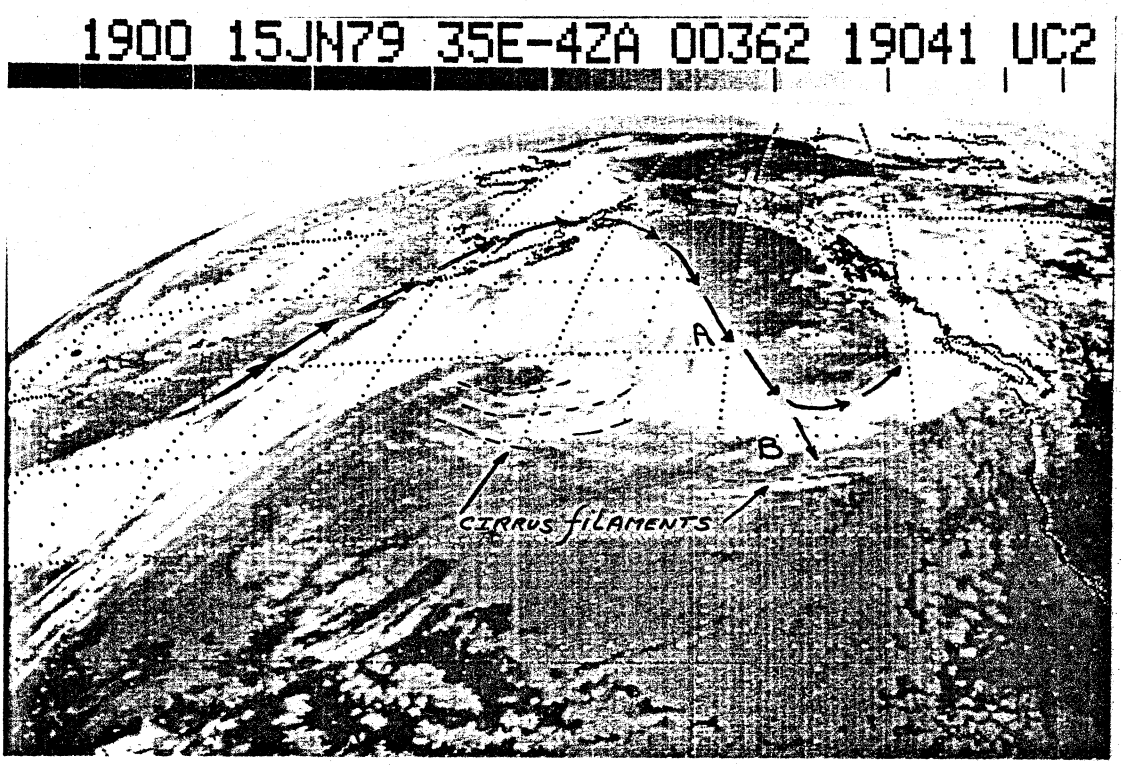

FIG. 2. SATELLITE PICTURE, 1900Z JUNE 15 1979. AXIS OF MAXIMUM WINDS → → AND WIND MAX. CIRRUS BETWEEN A-B.

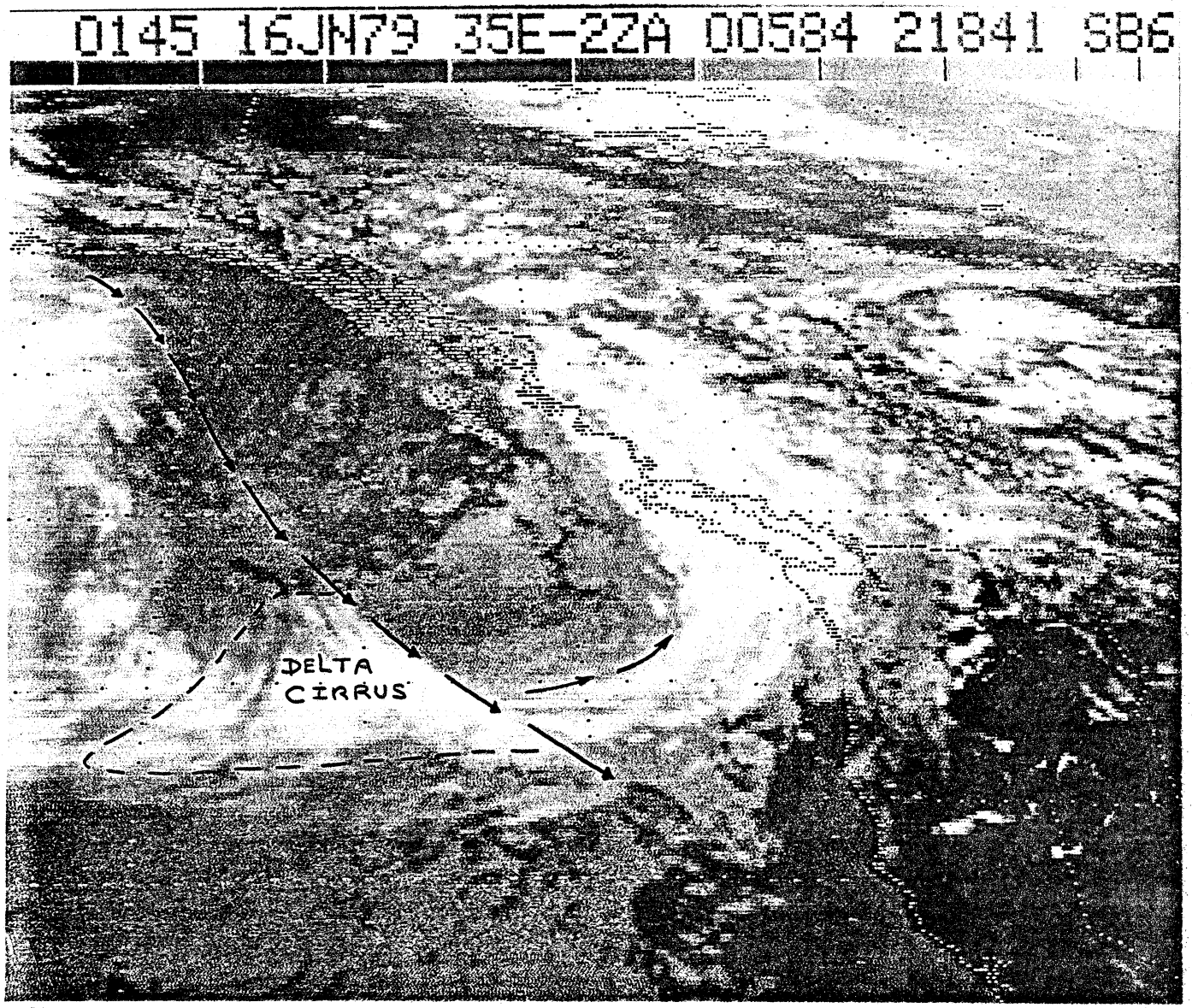

FIG. 3. SATELLITE PICTURE 0145Z JUNE 16 1979. AXIS OF MAXIMUM WINDS →→ AND WIND MAX. CIRRUS OR DELTA CIRRUS OUTLINED BY ---.
(DIAGRAM. FIG. 4 FROM WELDON, 1975)

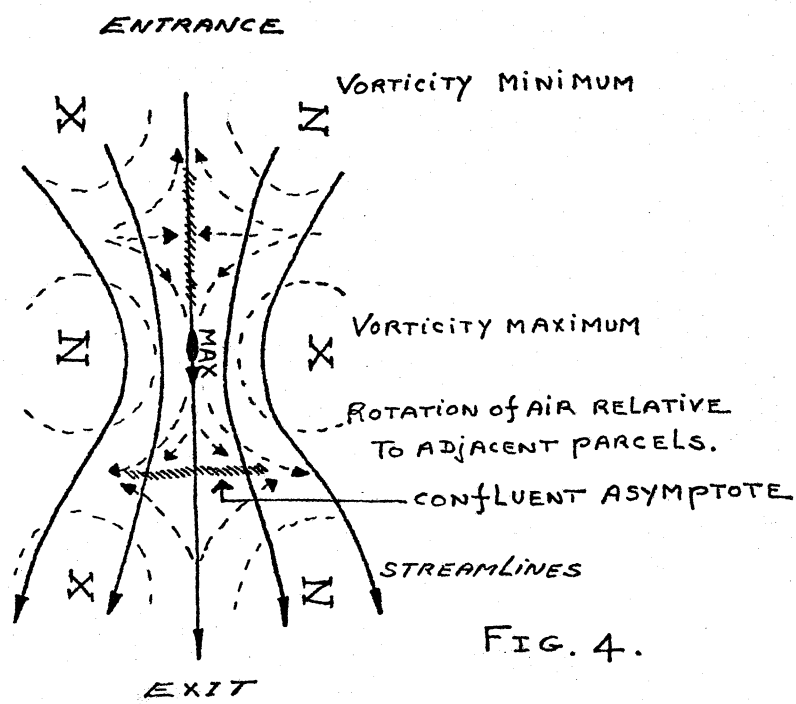

FIG. 4.

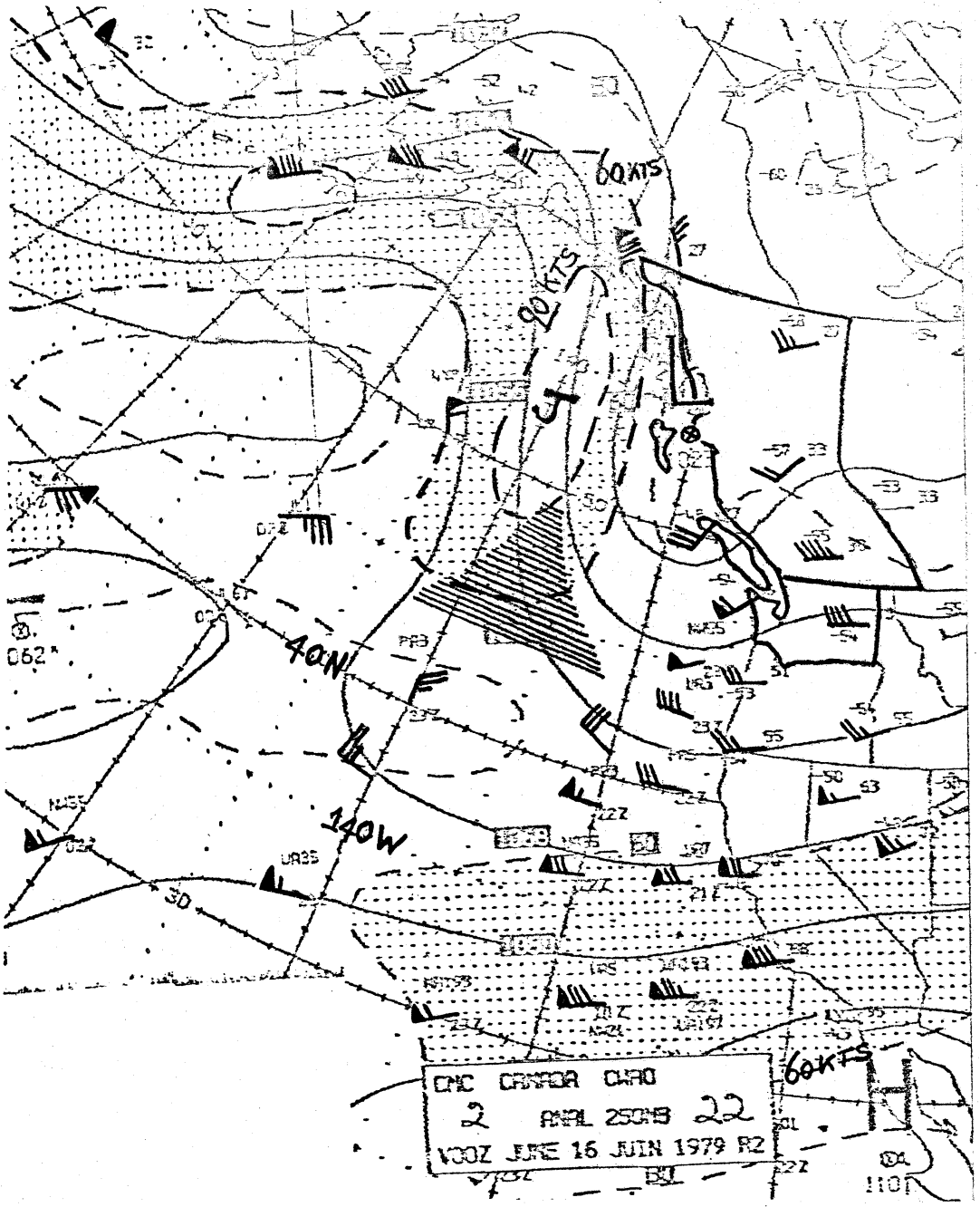

FIG. 5. THE 250 MB ANALYSIS FOR 00 Z JUNE 16 1979. SOLID LINES ARE THE HEIGHT CONTOURS OF THE 250 MB SURFACE. DASHED LINES ARE ISOTACHS, TOGETHER WITH WIND VECTORS. J REPRESENTS LOCATION OF THE JET STREAM WIND MAXIMUM AND THE ASSOCIATED CIRRUS CONFIGURATION.

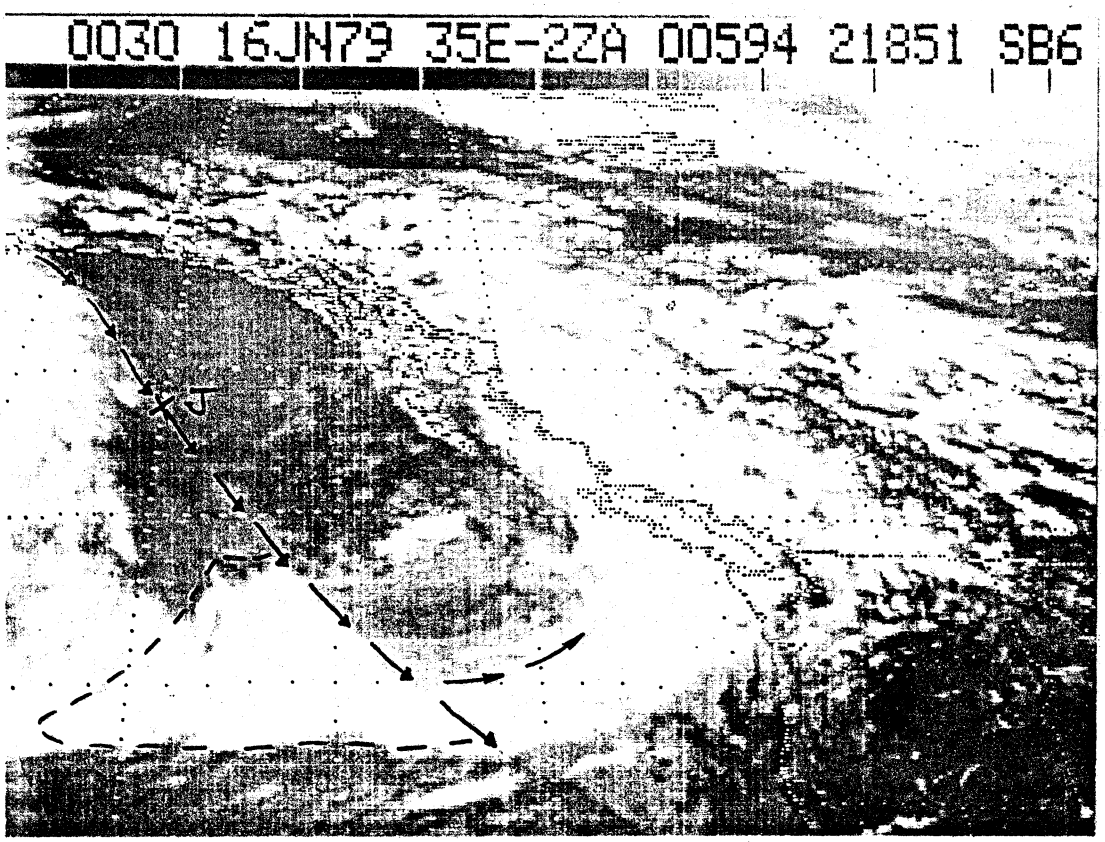

FIG. 6. SATELLITE PICTURE 0030Z JUNE 16 1979. AXIS OF MAXIMUM WINDS →→ AND x J THE LOCATION OF WIND MAXIMUM. DELTA CIRRUS CONFIGURATION OUTLINED BY DASHED LINE.

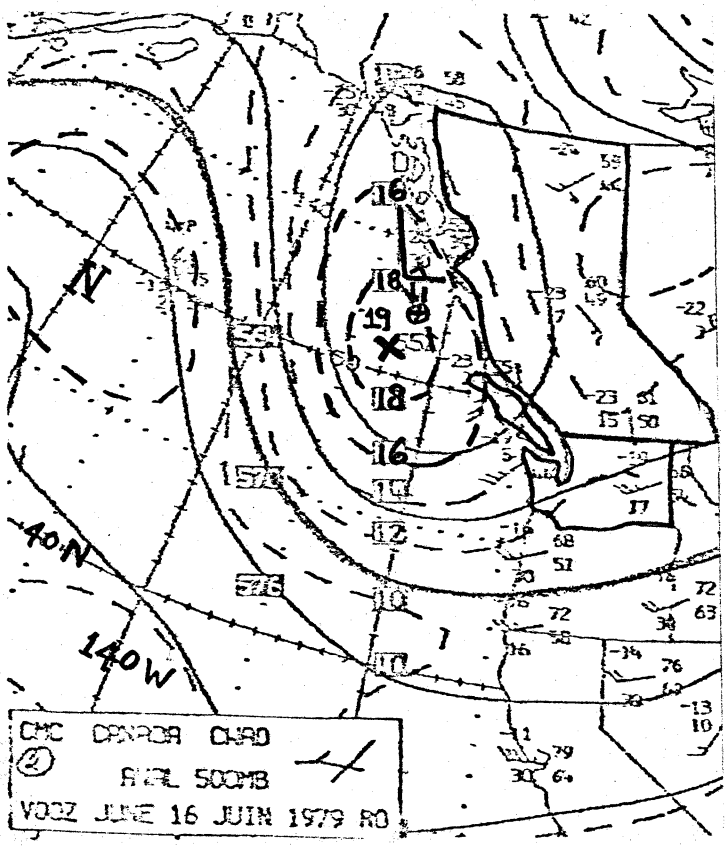

FIG. 7. THE 500MB ANALYSIS FOR 00Z JUNE 16 1979. SOLID LINES LINES ARE THE HEIGHT CONTOURS OF THE 500MB SURFACE AND THE DASHED LINES THE VORTICITY *ISOPLETHS*. X AND N THE VORTICITY MAXIMUM AND MINIMUM CENTRES RESPECTIVELY.

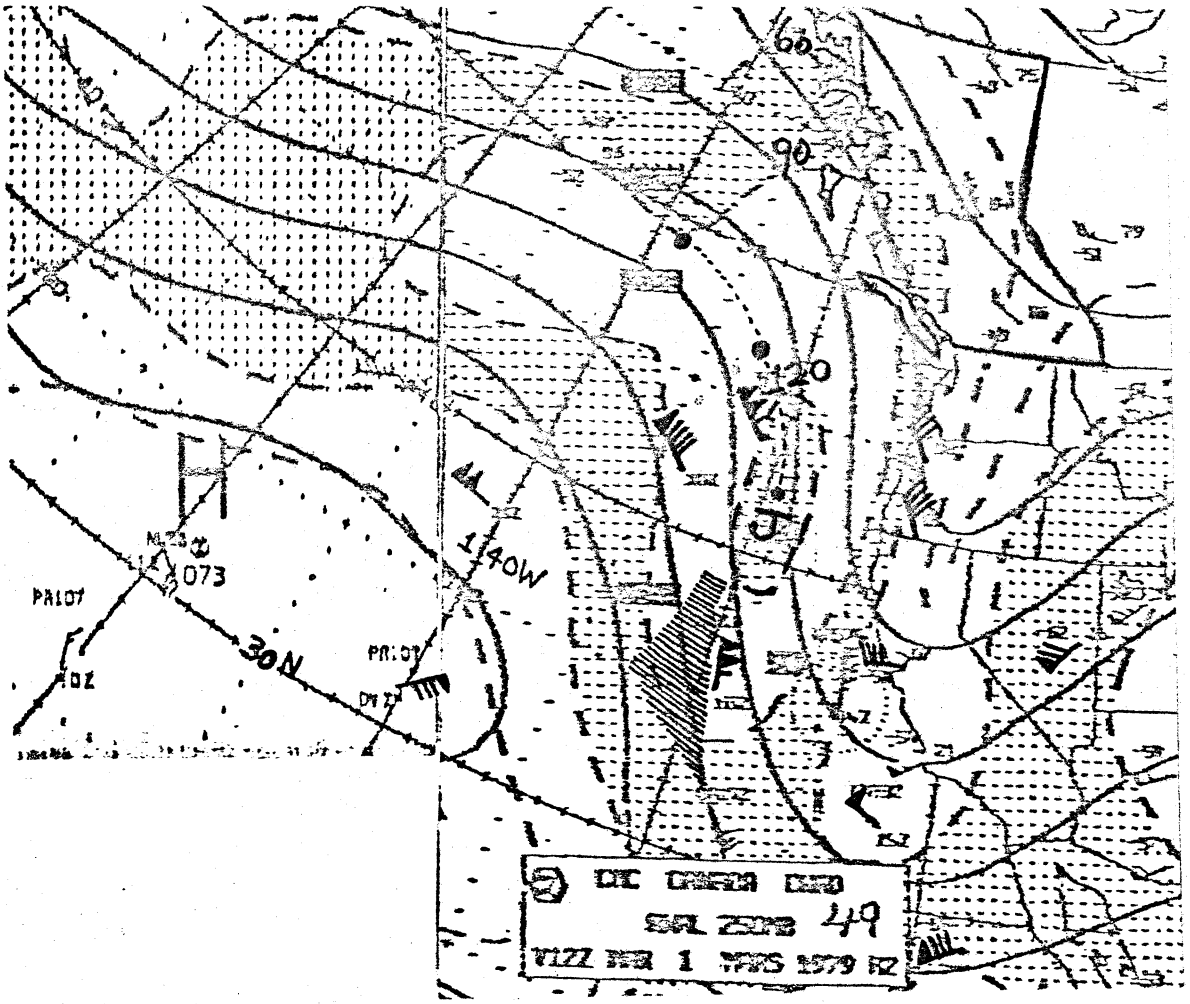

FIG. 8. THE 250 MB ANALYSIS FOR 12Z MARCH 1 1979. PARAMETERS DEPICTED ARE SAME AS FOR FIG. 5. THE •----• LINE REPRESENTS THE PATH OF WIND MAX. WITH HEAVY DOTS THE POSITION 06 AND 12 HRS AG

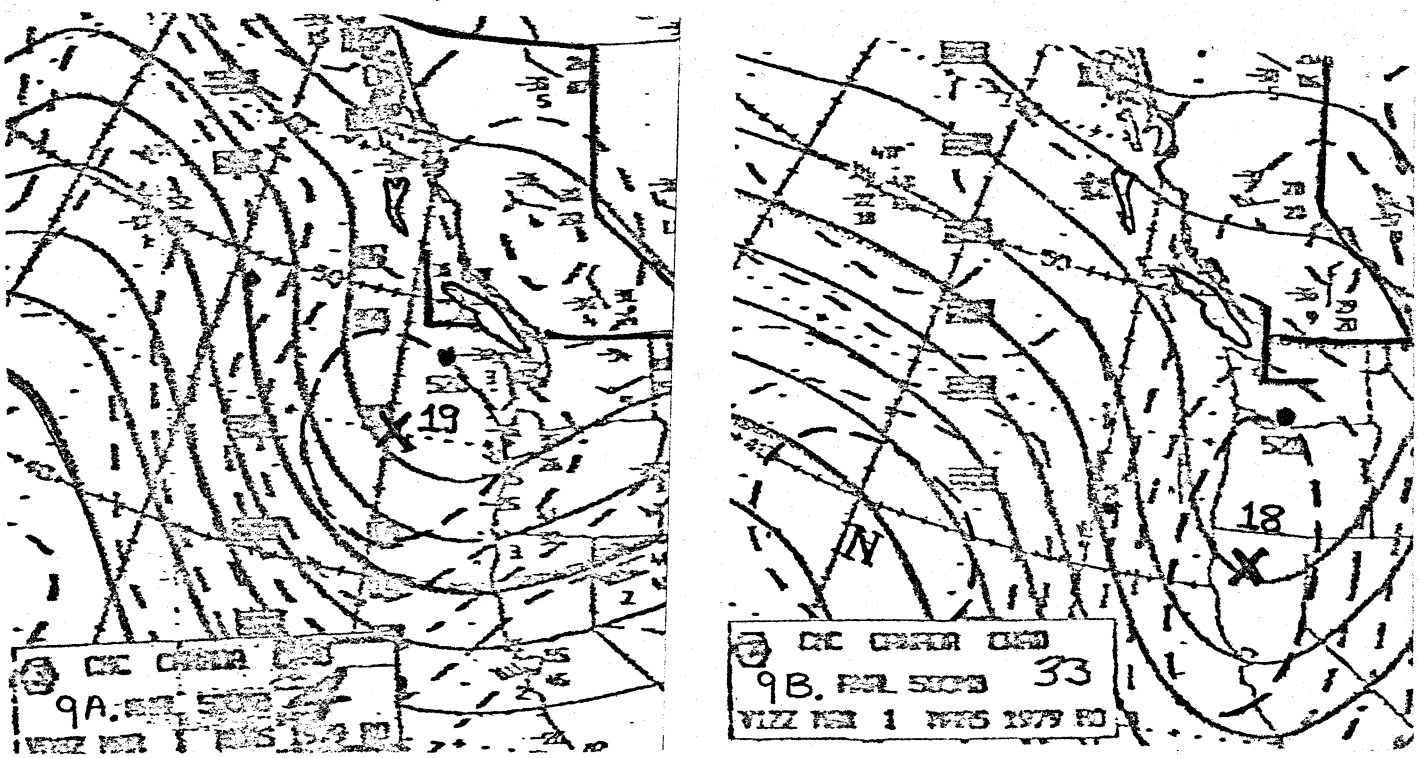

FIG. 9A AND 9B. THE 500 MB ANALYSIS FOR 00Z AND 12Z RESPECTIVELY MARCH 1 1979. PARAMETERS SHOWN ARE THE SAME AS FOR FIG. 7.