PACIFIC REGION TECHNICAL NOTES

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A Surprise Pacific Storm, April 1979

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INTRODUCTION

Last April an intense storm (central pressure 976 MB) presented itself off the B.C. Coast. The development was rapid and unexpected. Barely 24 hours elasped from the initial perturbation of the flow to the mature cyclone phase.

Both the Pacific Weather Centre (PWC) prognostician and the computer prognostic models had difficulty resolving the onset of the cyclogenesis and the subsequent strength of the cyclone. At present the state of the art still does allow for significant improvement (short term) over the computer prognostications. About 18 hours prior to the storm's maturity the PWC prognostician anticipated a much deeper development than recognized earlier. Neverless, likely due to poor initialization, the 12 hour LFM prognostic surface chart gave a 1000 MB low off the coast in contrast to the 976 MB actual low.

Satellite imagery is invaluable, but at present one of the limitations confronting the operational meteorologist is that one can not guage the absolute strength or rate of deepening of a developing system from the pictures. It would be of interest to initiate a study correlating cloud patterns with associated surface development.

(A) The Developmental State

In the beginning a broad ridge dominated the eastern pacific (see Figs. 1 and 2). A band of baroclinic zone cirrus clearly defines the ridge. Along 175W a large amplitude upper through is evident with an approaching disturbance just west of the trough.

At this time (00Z April 10) the numerical models (i.e. LFM, CMC spectral and PE Barotropic) developed a moderate low off the B.C. coast in 48 hours. But as yet no development was evident from the surface chart and satellite photographs.

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(b) First Phase, The Cirrus Wave Pattern

The numerical predictions were too fast. After 36 hours the satellite picture (Fig. 3) and the surface charts offered no concrete evidence of a developing wave. Upon a more discerning glance the 500 MB analysis and the satellite picture (Figs. 3 and 4) do offer some hints, namely

(1) The vigorous disturbance across the Aleutian Islands has continued to move eastward. Reducing the wavelength between it and the major through (now positively sloped) ahead to less than 1200 MI. wavelengths less than this are unstable and one would expect shortly the major trough to deform and a wave to move out.

(2) Further the baroclinic zone appears to have steepened and intensified. Compare figures 1 and 3. The baroclinic zone cirrus about the ridge and troughhas narrowed significantly.

(3) Relatively colder air is available within the trough for injection into a growing wave.

(4) Of importance as well perhaps is the subtle change in curvature of the cirrus edge (line AB in Fig. 3) which tends imperceptable to the concave (cyclonic).

Within the next six hours the curvature along line AB has accentuated and some development appears imminent (see Fig. 5). Further the curvature implies a relative speed maximum between points A and B on Fig. 5. The cloud edge XY has remained stationary, during the last six hours, indicating that the stream west of the trough is breaking through across the trough to establish a more westerly current.

(c) Second Phase, the Cross-Over Storm Comma Emerges

In figure 6 the vorticity comma has formed with the comma head (area H) well visible from under the cirrus deck. The dry slot or surge region just to the rear of the comma is now clearly defined. The cloud edges have become fairly distinct which is a reliable sign that the system is developing. The term cross-over comma signifies that the comma head (area H) is composed of lower cloud than the cloud immediately south of it. One is able to distinguish the difference by the cloud texture and brightness.

The accompanying 500 MB analysis (Fig. 7) confirms the presence of a strong vorticity centre placed nearby the location X (Fig. 8). In addition, the 500 MB analysis confirms that a westerly stream has been established between 45-50N.

At this point, note that even the LFM computer model (the CMC model was not that different). Based on the 00Z April 12 data, failed to deepen the system enough. The 12 hour prognostic surface chart (Fig. 10) for 12Z April 12 underestimated the central pressure by 24 MB! An accurate initial analysis is crucial. Compare the satellite picture (Fig. 8) and the 500 MB initial LFM analysis (Fig. 9). The vorticity centre from the LFM, associated with the system. Is clearly misplaced and its central value to weak for the strength of the comma system. Further the LFM has not emphasized the corresponding short wave through sufficently which again appears quite insipid to what one would expect from looking at the satellite picture. However computer models generally do not handle "Explosive" developments well.

(D) Third Phase, the Mature Comma (Cyclone)

The mature storm classic-cloud pattern is well illustrated in figures 11 and 13. The circulation has deepened and a closed low formed aloft (see fig. 12) with the surface and upper low almost coincidental. The dry slot now has wrapped itself about the circulation centre and the low has occluded. The comma cloud (fig. 13) is now behind the cirrus deck as the cirrus (area A) as moved faster than the middle level comma (area B). Of interest as well is the position of the cold front lying just to the rear of the comma tail and crossed the tail (at C) where the tail and rear edge of the cirrus deck intersect. The position of the cold front is verified in part by the surface chart (fig. 14). Lastly notice that the main flow has become quite zonal across the eastern Pacific with the bottom part of the original trough having been cut off to form a closed low.

Concluding Remarks

This brief presentation underlines some of the problems linked with determining the when and where and if of the onset of significant syslogenesis. At present one can merely be alert to certain initial configurations favouring development. To summarize, the main conditions encountered for this development were:

(1) A large amplitude trough,
(2) An approaching significant wave further upstream,
(3) A strong baroclinic zone,
(4) Onset of concave (cyclonic) curvature of the baroclinic zone cirrus with subsequent emergence of the comma head.

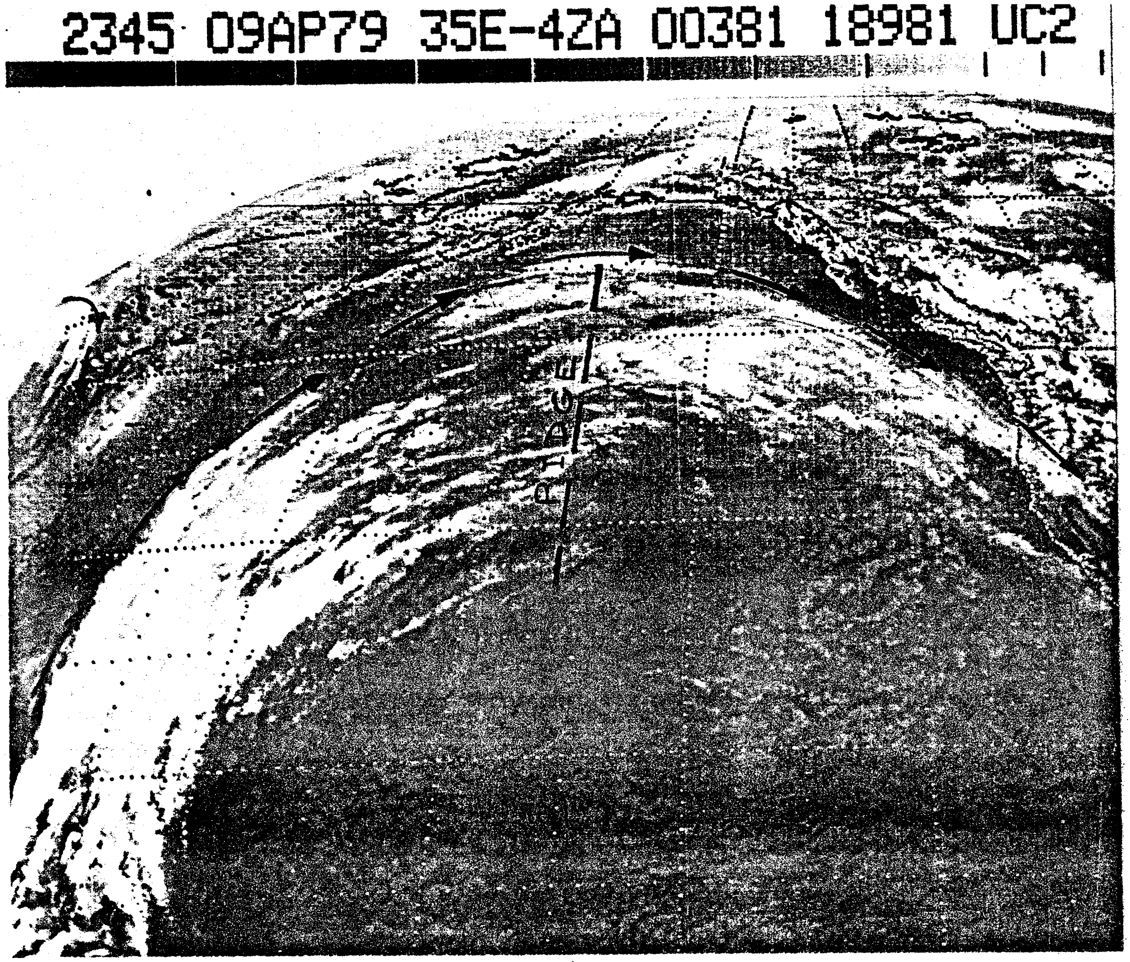

FIG. 1. SATELLITE PICTURE, 2345Z APRIL 9, 1979. AXIS OF MAXIMUM WINDS DENOTED BY ARROWS.

FIG. 2. THE CMC 500MB INITIAL ANALYSIS FOR 00Z APRIL 10, 1979. THE 500MB HEIGHT CONTOURS (SOLID LINES) AND VORTICITY ISOPLETHS (DASHED).

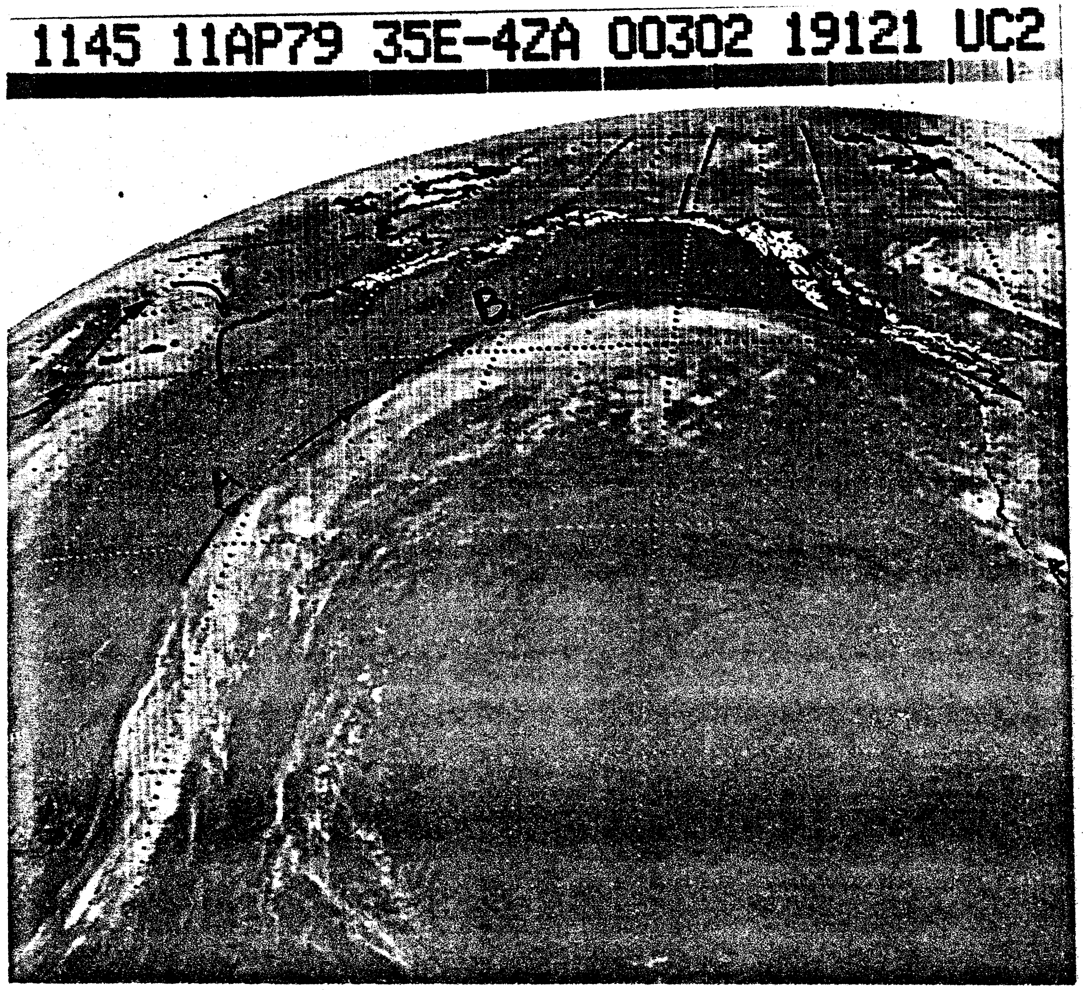

FIG. 3. SATELLITE PICTURE, 1145Z APRIL 11, 1979. AXIS OF MAXIMUM WINDS DENOTED BY ARROWS. LINE AB INDICATES CHANGE IN CURVATURE.

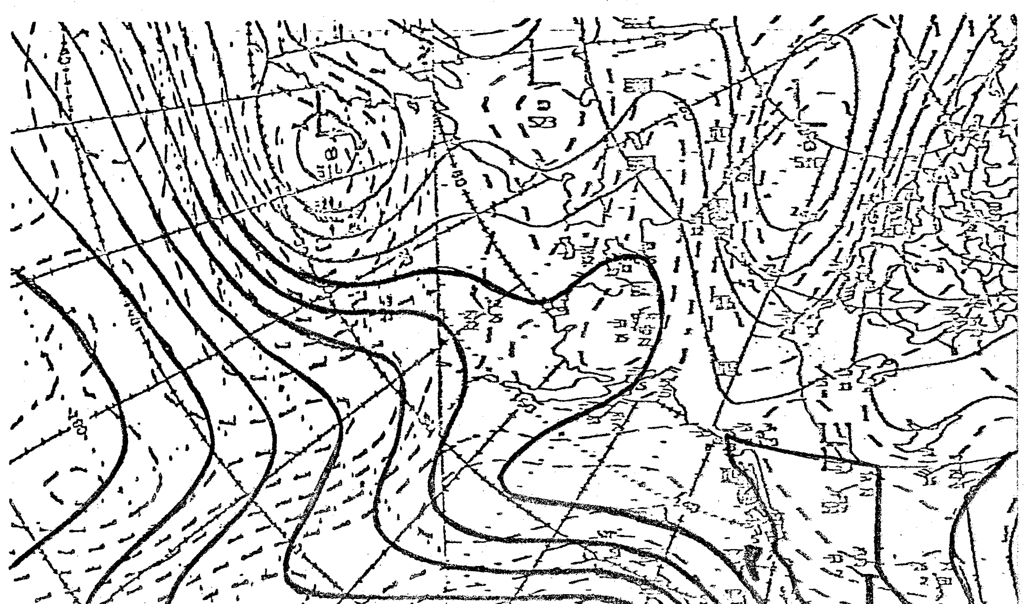

FIG. 4. THE CMC 500MB INITIAL ANALYSIS FOR 12Z APRIL 11, 1979. THE 500MB HEIGHT CONTOURS (SOLID LINES) AND VORTICITY ISOPLETHS (DASHES).

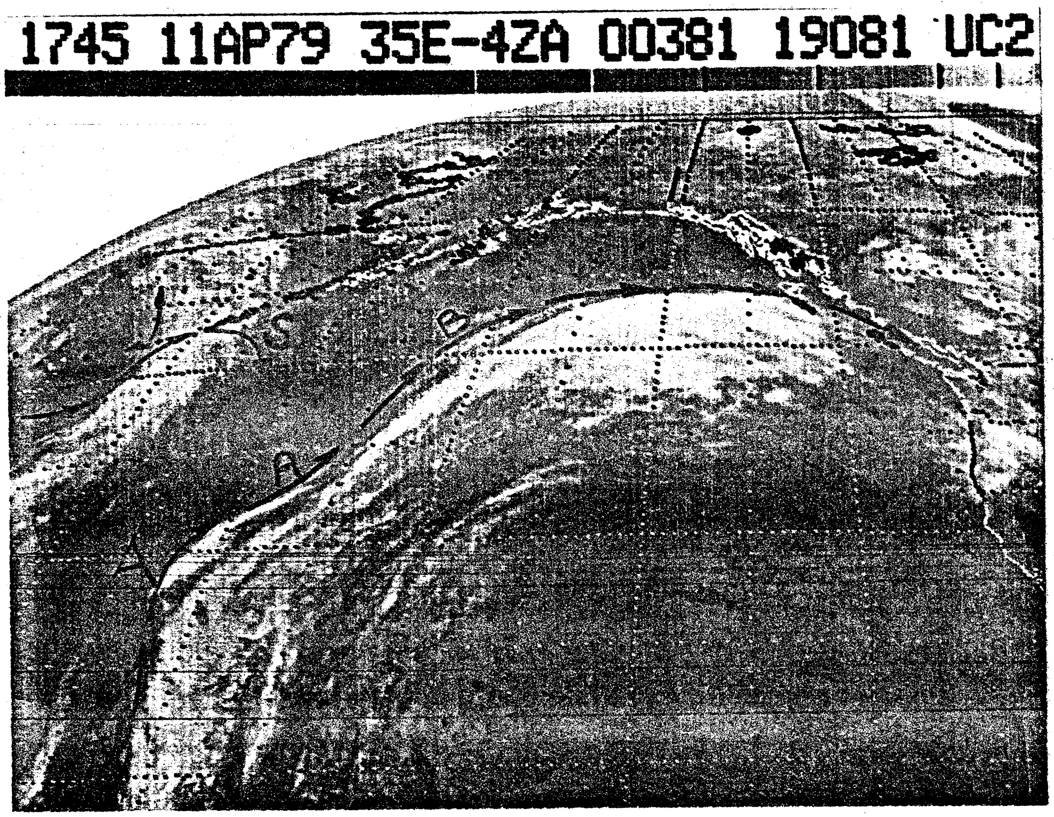

FIG. 5. SATELLITE PICTURE, 1745Z APRIL 11, 1979. AXIS OF MAXIMUM WINDS DENOTED BY ARROWS. CONCAVE (CYCLONIC) CURVATURE BETWEEN AB. CLOUD EDGE XY QUASISTATIONARY.

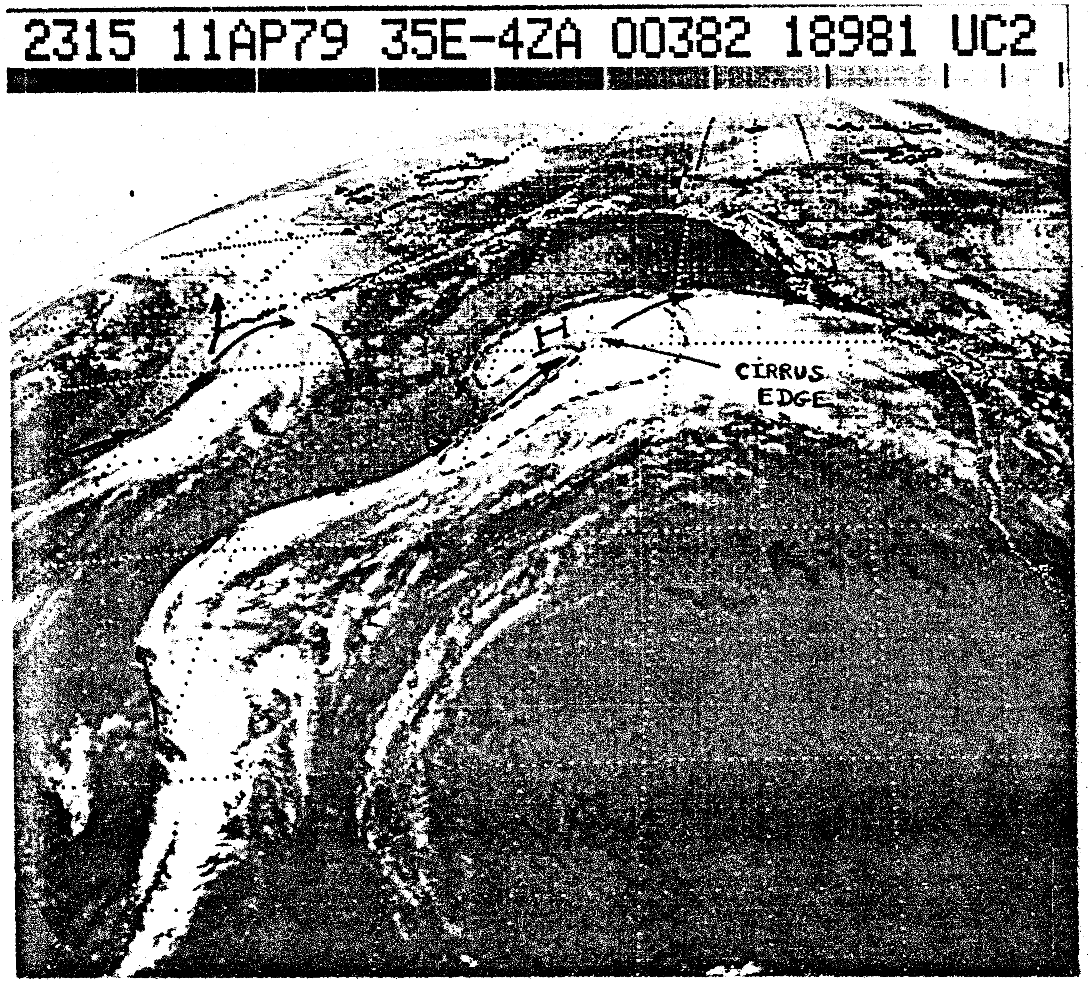

FIG. 6. SATELLITE PICTURE, 2315Z APRIL 11, 1979. AXIS OF MAXIMUM WINDS (ARROW), VORTICITY COMMA HEAD (H), VORTICITY CENTRE (X).

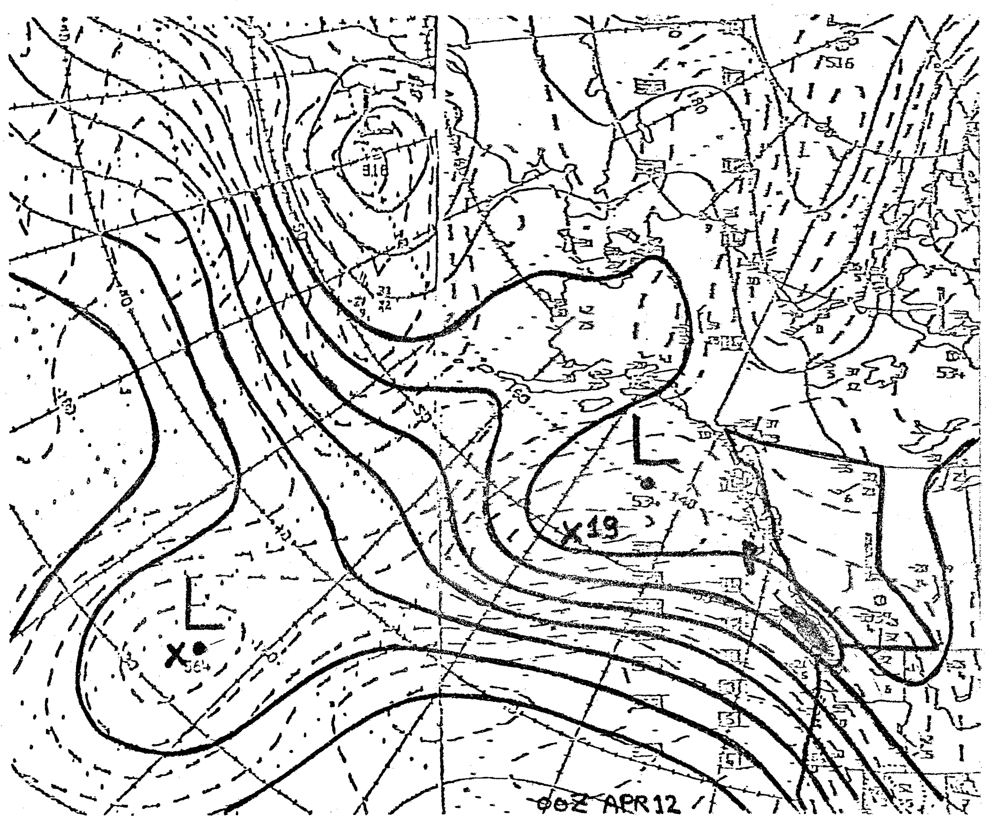

FIG. 7. THE CMC 500MB INITIAL ANALYSIS FOR 00Z APRIL 12, 1979. THE 500MB HEIGHT CONTOURS (SOLID LINES) AND VORTICITY ISOPLETHS (DASHES).

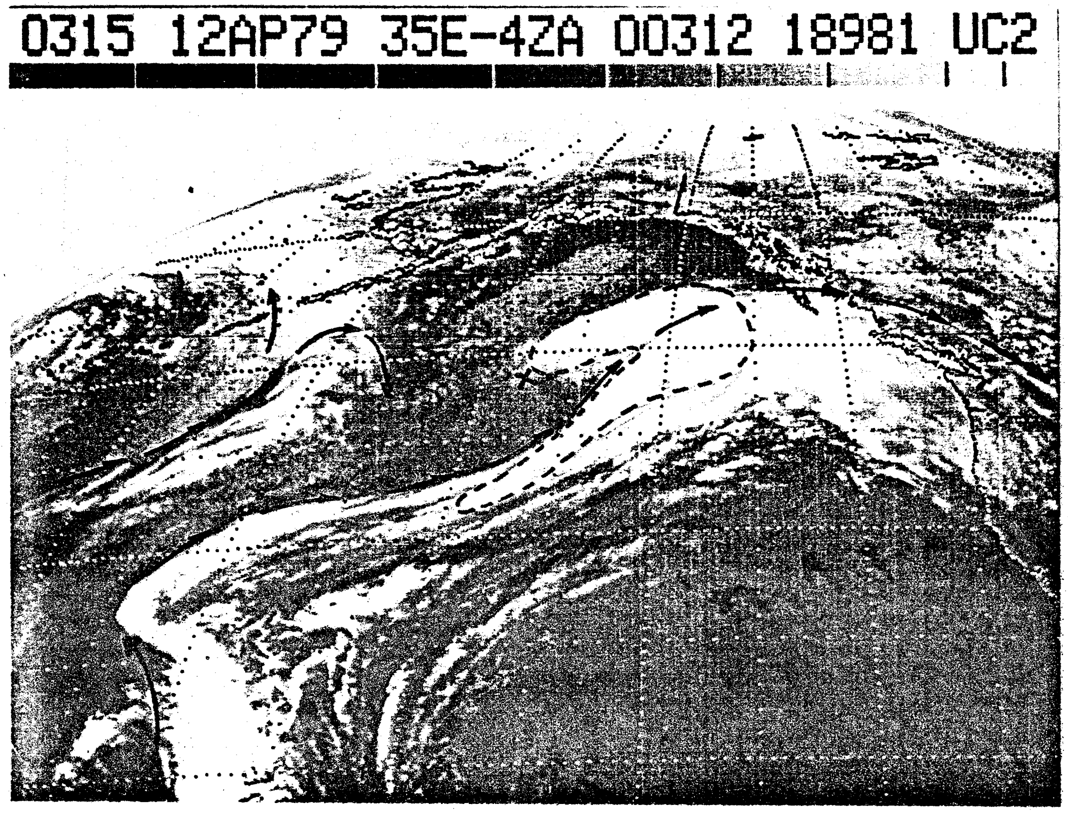

FIG. 8. SATELLITE PICTURE FOR 0315Z APRIL 12, 1979. AXIS OF MAXIMUM WINDS (ARROWS) AND VORTICITY CENTRE (X) AND COMMA CLOUD OUTLINED BY DASHED LINES.

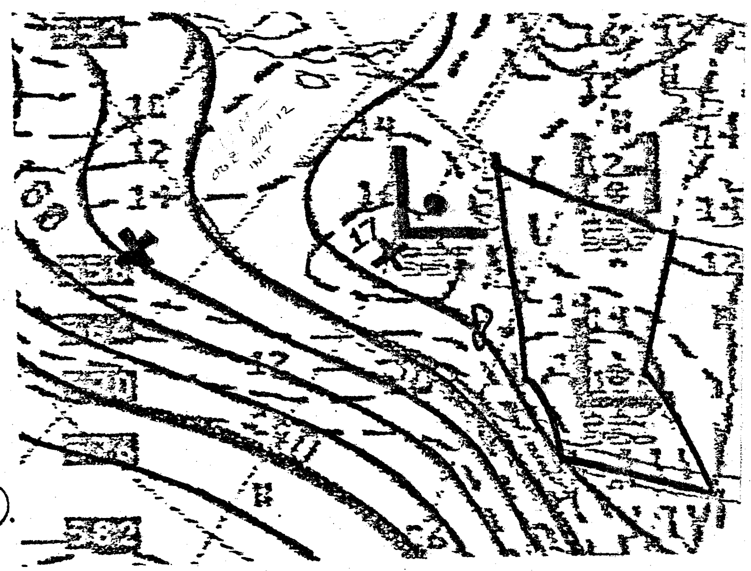

FIG. 9. THE LFM 500MB INITIAL ANALYSIS FOR 00Z APRIL 12, 1979. THE 500MB HEIGHT CONTOURS AND VORTICITY ISOPLETHS (SOLID AND DASHED LINES).

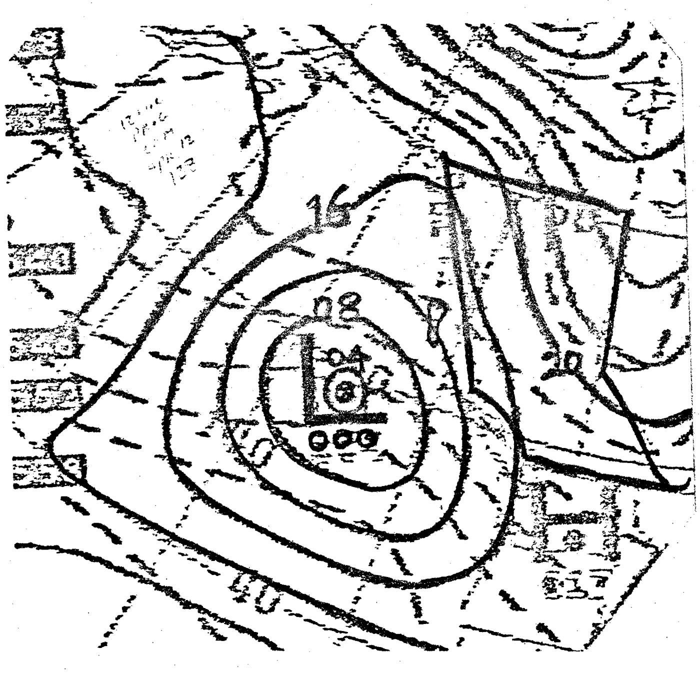

FIG. 10. THE LFM 12HR SURFACE PROG. FOR 12Z APRIL 12, 1979. SURFACE ISOBARS (SOLID LINES) AND THICKNESS CONTOURS (DASHED LINES).

FIG. 11. SATELLITE PICTURE 1315Z APRIL 12, 1979. AXIS OF MAXIMUM WIND MARKED BY ARROWS. VORTICITY CENTRE X. STORM CONFIGURATION OUTLINED BY DASHED LINE.

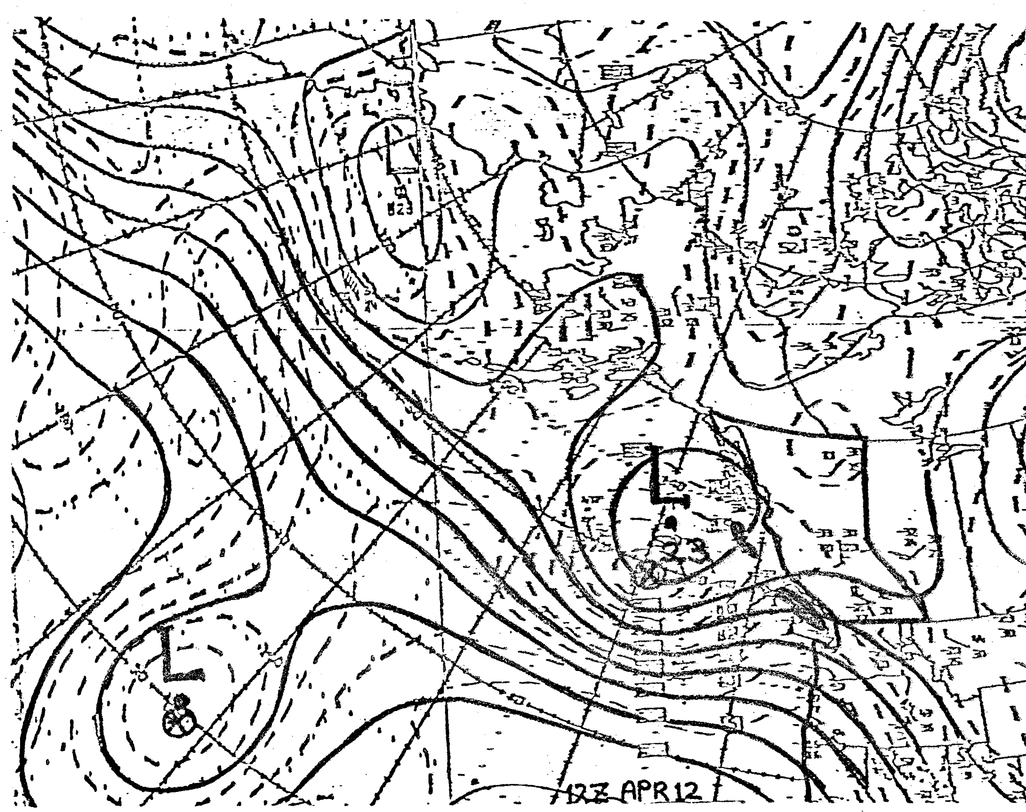

FIG. 12. THE CMC 500MB INITIAL ANALYSIS FOR 12Z APRIL 12, 1979. THE 500MB HEIGHT CONTOURS AND VORTICITY ISOPLETHS ARE THE SOLID AND DASHED LINES RESPECTIVELY.

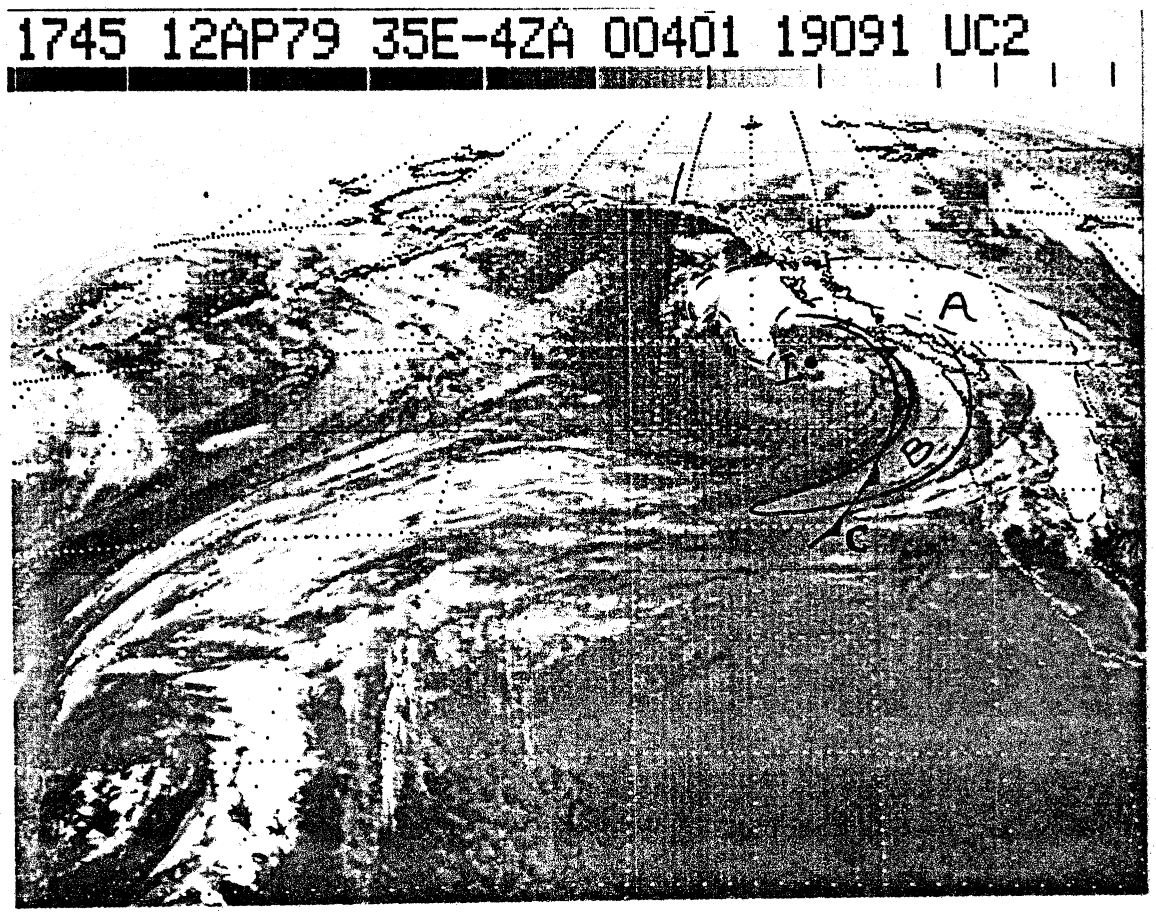

FiG. 13. SATELLITE PICTURE 1745Z APRIL 12, 1979, SHOWING MATURE CYCLONE. CIRRUS DECK OUTLINED BY DASHES AND LOWER CLOUD COMMA TAIL SOLID LINE (AREA B).

FiG. 14. SURFACE CHART FOR 18Z APRIL 12, 1979. MATURE STORM CENTRE (I,•) WITH ISOBARS AND CENTRAL PRESSURE 976 MB.