PACIFIC REGION TECHNICAL NOTES

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A DEEPENING PACIFIC STORM - JANUARY 10-12, 1980

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INTRODUCTION

January 10, 11 and 12, 1980 proved to be three very interesting days at the Pacific Weather Centre. During this period, two low pressure areas; one from the Gulf of Alaska and one from the southwest (40N 155W) moved together, combining and intensifying into one 946MB centre.

This case study will examine how well the numerical models handled the situation. It will also look at factors to consider in making a physical assessment of the situation.

THE CASE

The case involves two separate low centres, one from the Gulf of Alaska and one from 40N 155W. As the upper trough began digging out over the Gulf of Alaska it began feeding very cold air southward from Alaska. Meanwhile, the southern stream was feeding warm air westnorthwestward. Eventually, there was interaction between the northern and the southern streams resulting in a very strong baroclinic zone. On 12 January 0000Z C7P reported a 500mb temperature of -37° while the warmer air associated with the southern low was of the -10 to -15C. variety.

The low reached its maximum depth of 946mb at 12 January 0600Z. See figures 1, 2 and 3, the surface maps for 10 January, 1200Z through 12 January, 0000Z.

Precipitation over the south coast began as snow as the system intensified and then turned to rain as the warmer Pacific air eroded the Arctic air. In the Interior, snow spread in as the system deepened and eventually turned to freezing rain and then rain over the southern regions.

HOW DID THE NUMERICAL MODELS HANDLE THE DEVELOPMENT?

Both of the low pressure areas were well established for at least 24 hours prior to the rapid development. Because of this the numerical models should have had a good handle on the development.

In fact, the numerical models were very good in handling the development for the Gulf of Alaska low. See figures 4 and 5, the 48 hour CMC and LFM surface prognosis. The southern low was not handled too well by either the LFM or the CMC spectral. However, as the southern low

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eventually was absorbed into the Gulf low, the 48 hour numerical progs appeared fine.

Handling interaction between two streams seems to be one of the weaknesses of the numerical models. Perhaps if this had been better taken into account, the numericals would have shown a slightly deeper development, and slightly farther south. The numericals were very similar in depth and position. Both were about 10mb not deep enough and about 4^{o} too far northeast.

FACTORS TO CONSIDER IN MAKING A PHYSICAL ASSESSMENT OF THE CASE

A. For the Gulf of Alaska low

1. The first important clue to development was the jet maximum over Alaska. See figures 6 through 17 which give the upper air charts for 10 January, 0000Z through 11 January, 0000Z. Note the 500mb and 250mb maps. The jet maximum of 100kts plus was located on the west side of the Alaska trough.

2. The direction of the jet was backing with time indicating a southwesterly transport of momentum and hence digging for the Gulf of Alaska trough.

3. The thickness field lags the contour field. There was a strong concentrated thermal gradient over southern Alaska in the region approaching the low centre. This, of course, is also indicative of development.

4. There was a good cold low level injection. As pointed out by J.J. George, this usually precedes development by 18 hours or less. Note the 850mb charts for 10 January, 0000Z through 11 January, 0000Z.

5. Latent heat release probably played a role in the development to some extent but this was difficult to gauge. The number of ship reports present was limited so area and rate of precipitation was hard to determine.

6. Diabatic effects and stability:
The diabatic effect was an influence enhancing the cyclonic curvature as the cold air streamed off Alaska over the relatively warm Gulf waters. The upper air temperatures at Yakutat at 10 January, 1200Z were as follows: 850mb -10^{o}C.
700mb -20^{o}C.
500mb -45^{o}C.
Considering this air is moving over 5^{o}C. water there is certainly a strong diabatic effect and induced instability around the low.

7. There was a good vorticity trough approaching from Alaska bringing an area of strong positive vorticity advection over the Gulf of Alaska.

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B. For the southern low:

1. Remember the models are not the best at handling the opening of lows into the northern stream.

2. Remember Henry's Rule "When a significant shortwave appears upstream and comes to within 1200 n m of the old low, the acceleration of the old low will begin".

3. Gardiner states that "Development of the cutoff low appears to be related to the intensity of the temperature contrast associated with the vortex and with the strength of the circulation. A temperature contrast of 10°C. at 500mb and maximum winds of 100kts at 300mb are both required before significant development occurs. As the temperature contrast and maximum winds exceed these limits the probability of surface development increases rapidly. The temperature contrast is difficult to estimate without upper air data, however, the jet maximum associated with the low exceeds 120kts.

SUMMARY

In this particular case the numerical models did a good job of predicting the development of the Gulf of Alaska low even 48 hours in advance. They did not, however, handle the development of the southern low very well and hence the interaction between the two lows and streams was underestimated. This seems to be a weakness of the numerical models and should be anticipated in these situations. For this reason the degree of intensification may have been a bit underestimated.

By approaching the prognostic problem from the physical assessment point of view as recommended by D. Gardiner in his paper on "Isobaric Prognosis - Principles and Techniques", the prognostician would not only realize the potential for development of the Gulf of Alaska low but also become aware of the low to the southwest and of the resulting intensification of the overall system as a result of this interaction. The physical assessment method allows the prognostician to incorporate on a subjective basis, significant changes that can be observed in the data. For example, such things as changes in the wind speed and direction that may be observed by pilot reports or satellite imagery between the main numerical models runs can thus be incorporated into the forecast.

REFERENCE

D. Gardiner - Isobaric Prognosis - Principles and Techniques

Course Training Notes (unpublished)
Training Branch AES Headquarters Downsview, Ont.

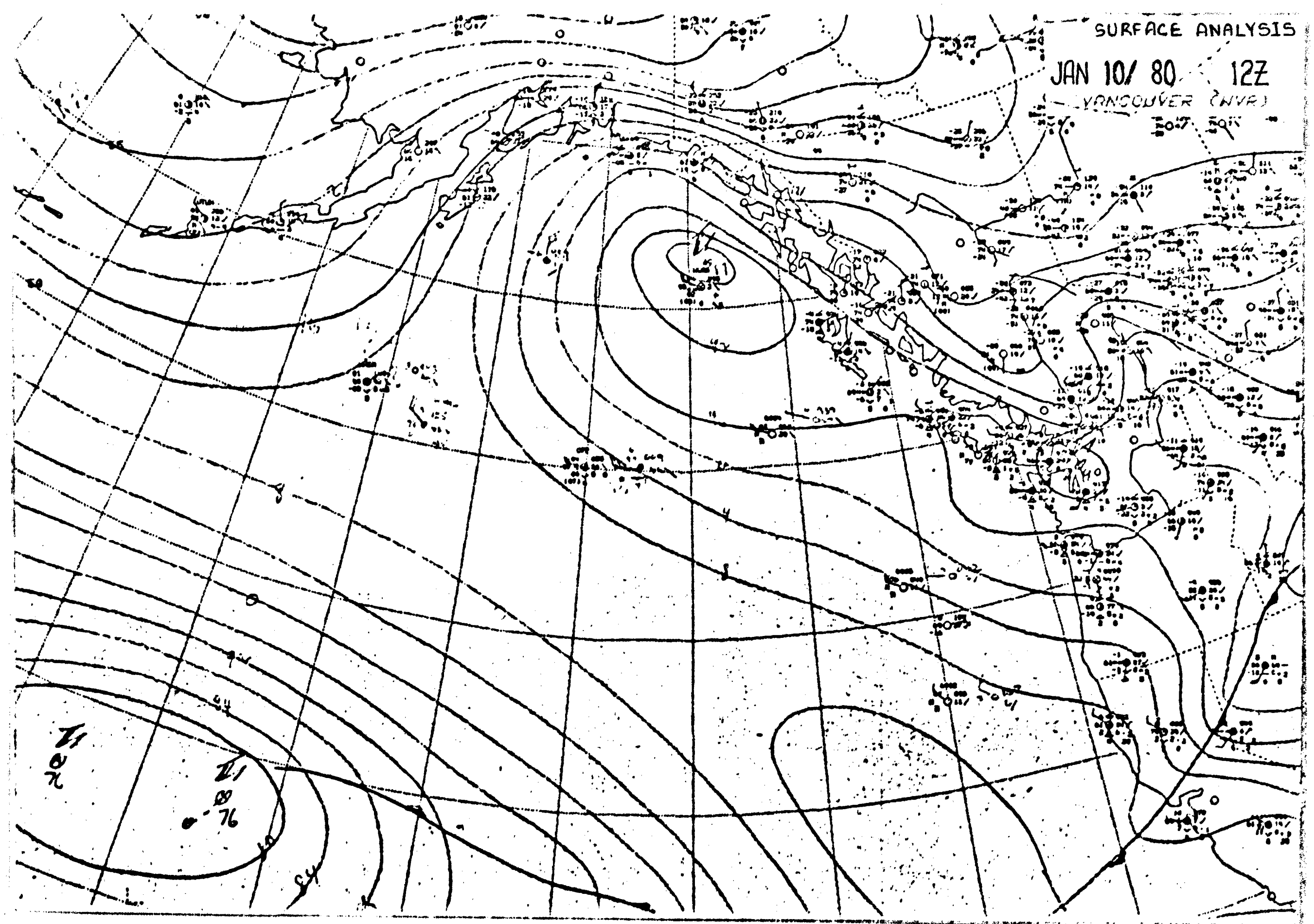
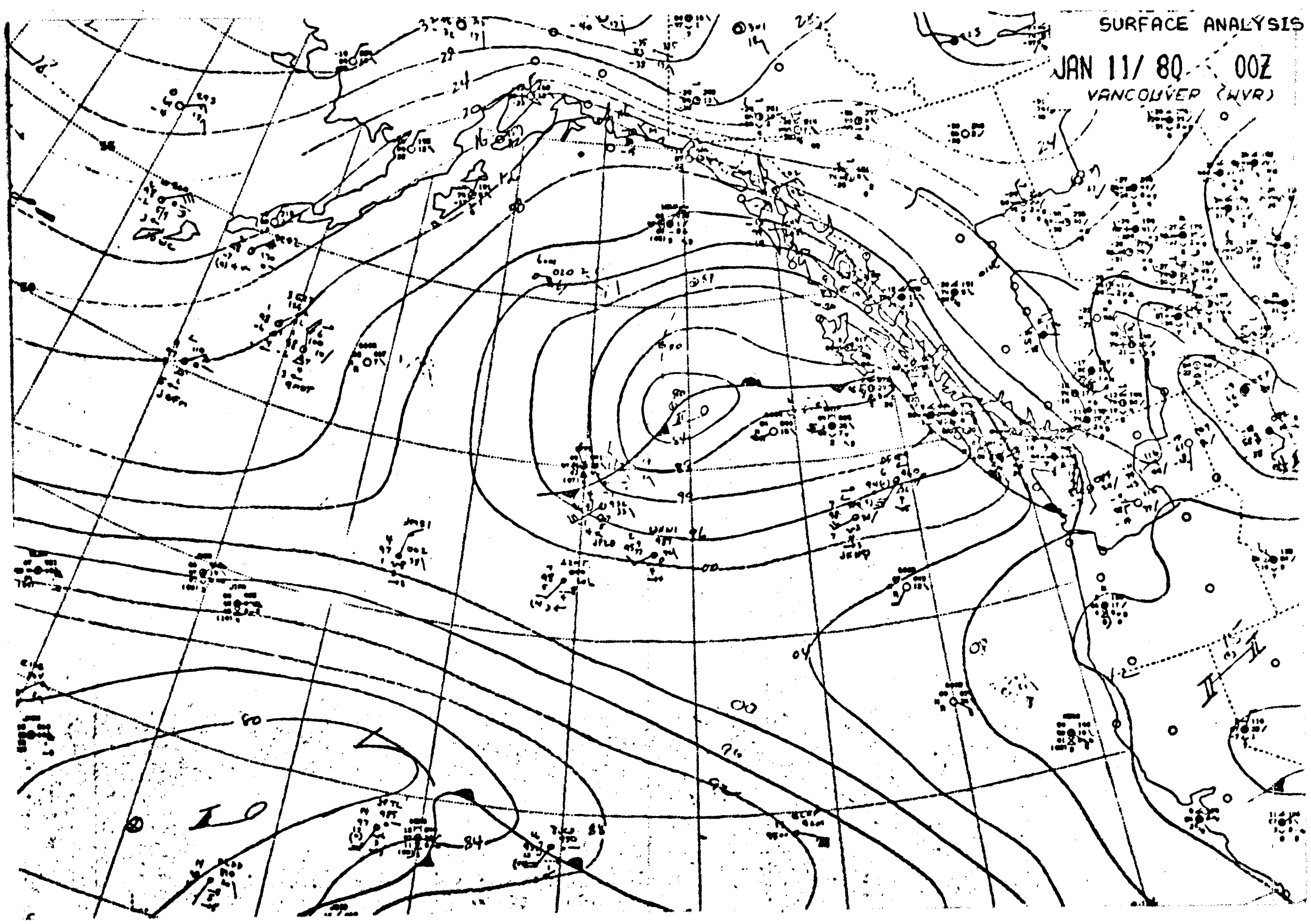


FIGURE 1.



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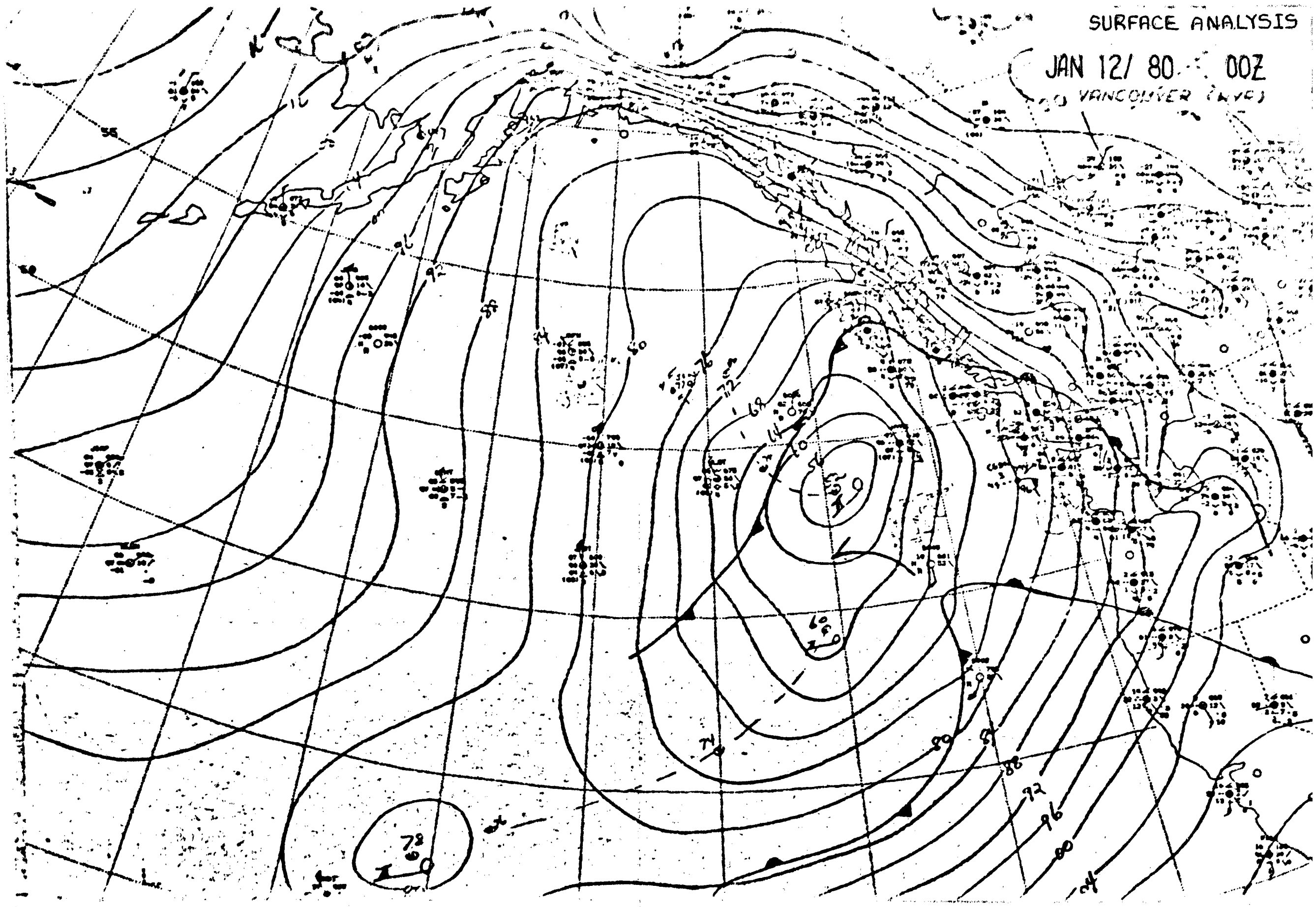

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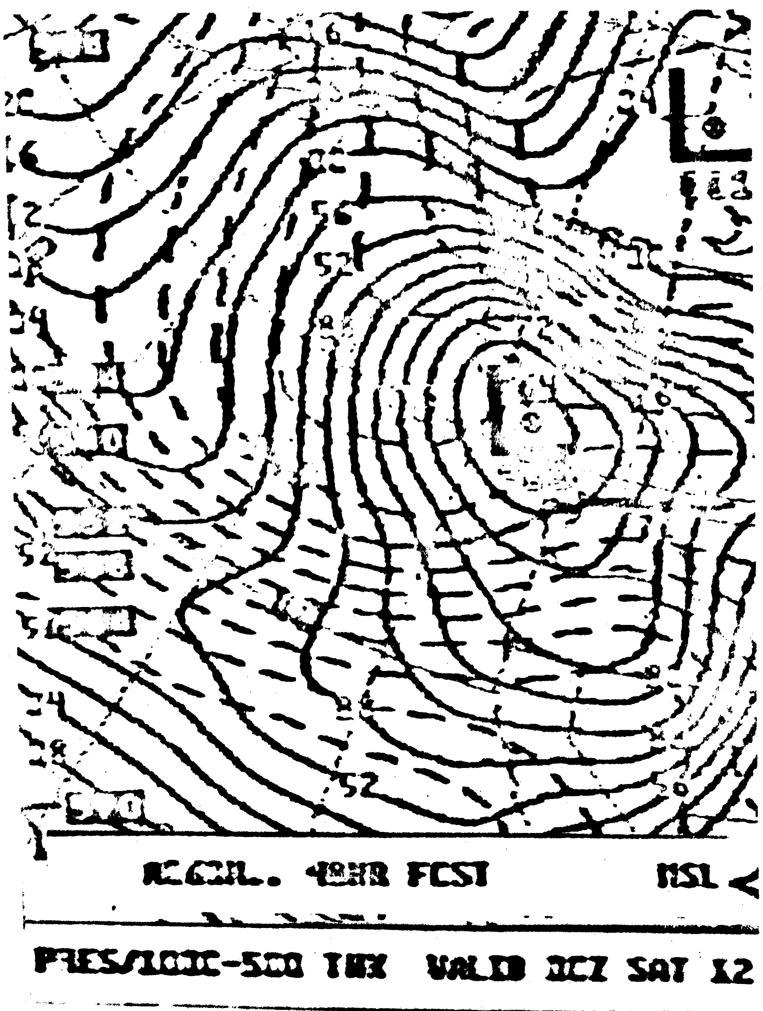

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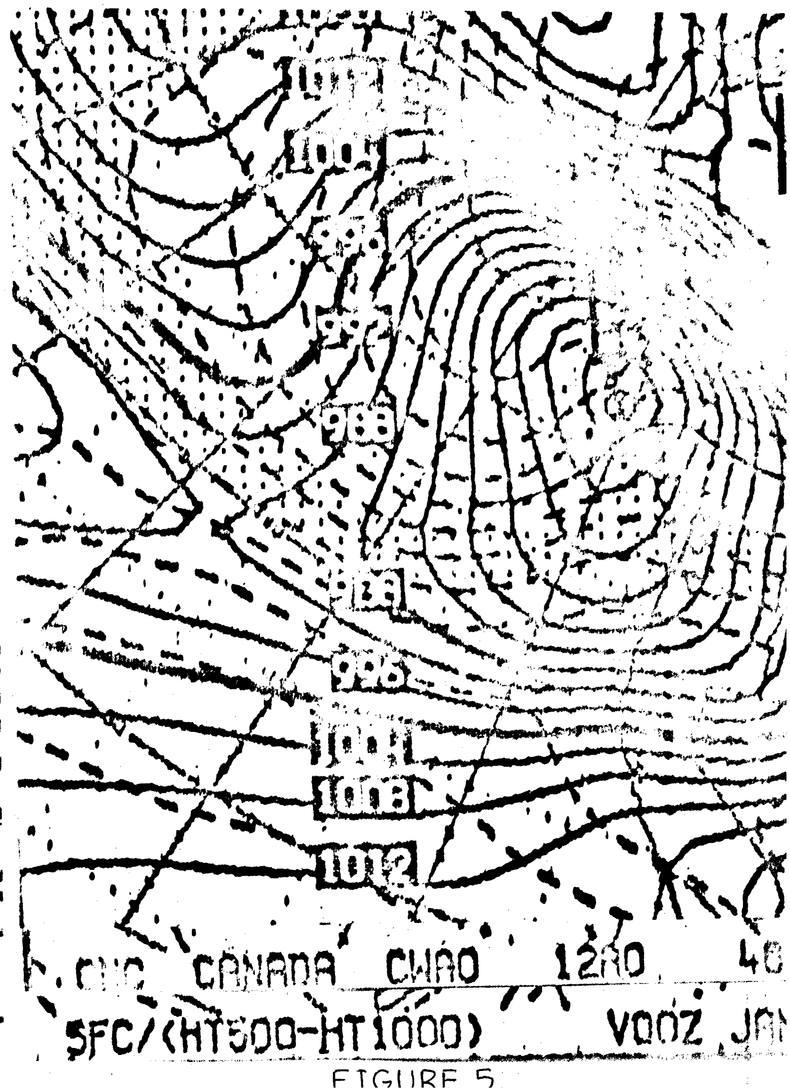

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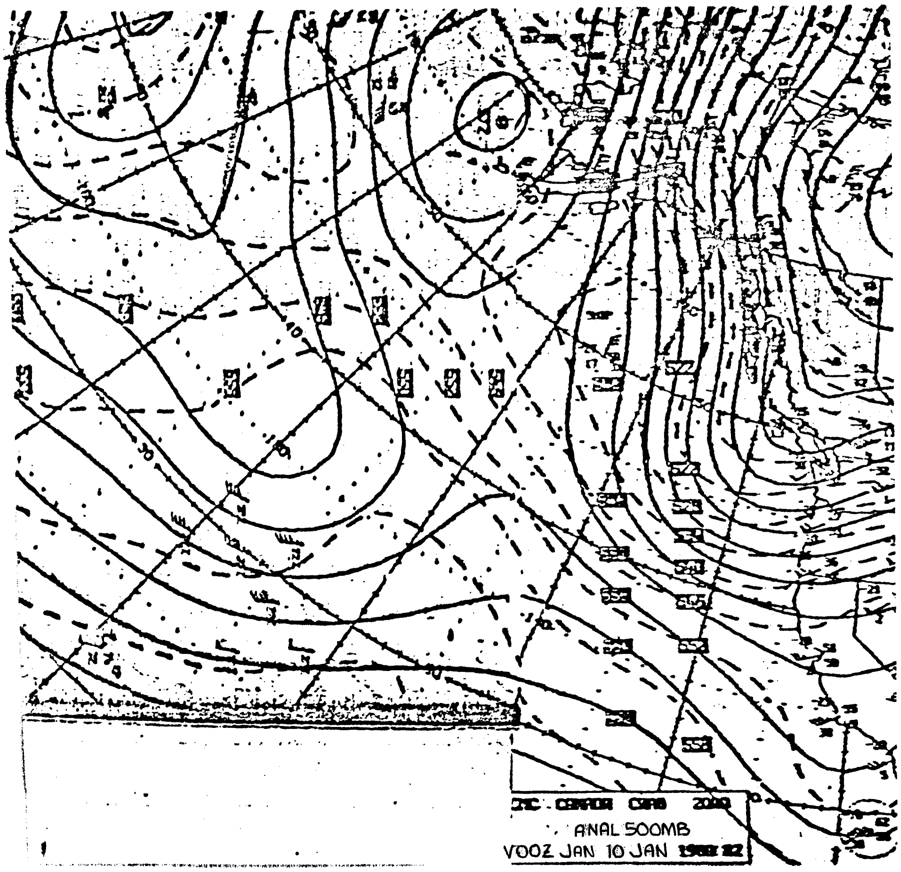

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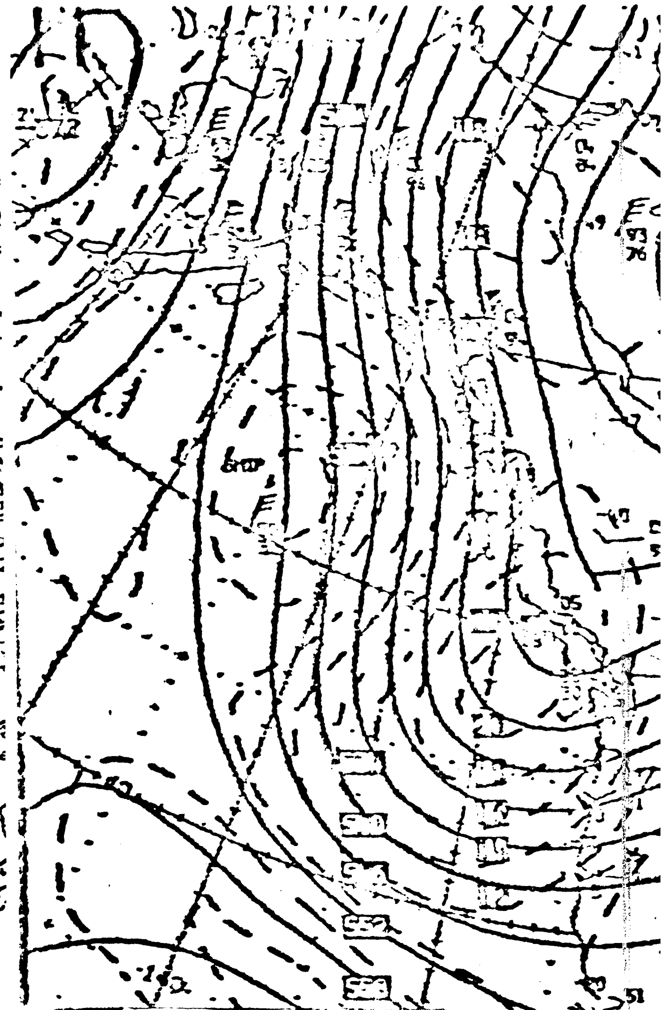

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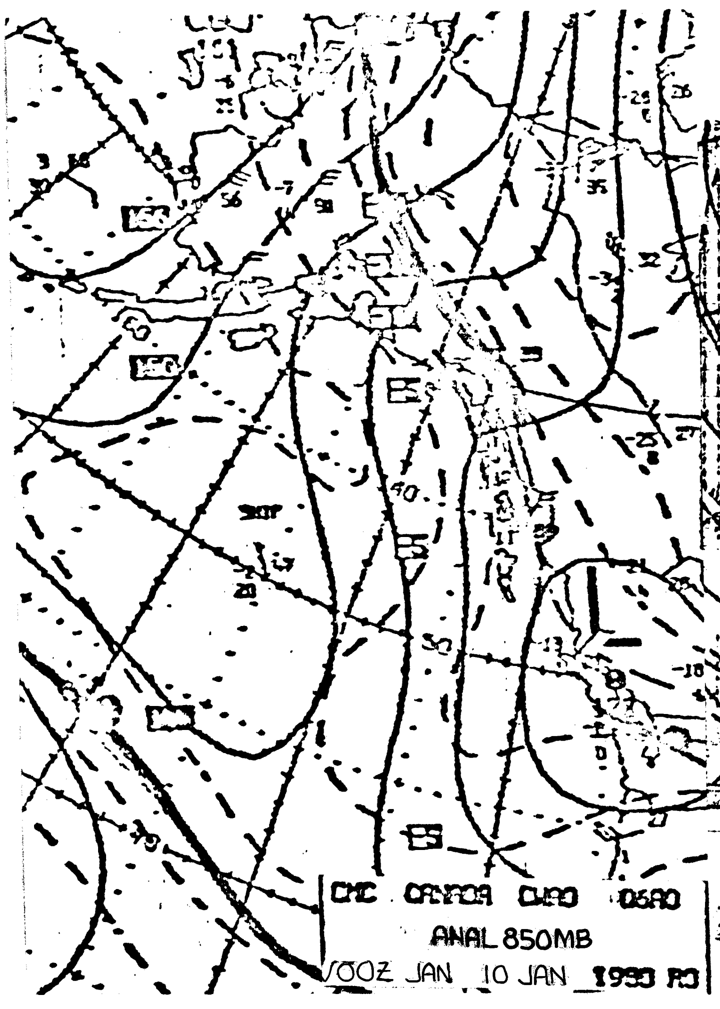
FIGURE 7



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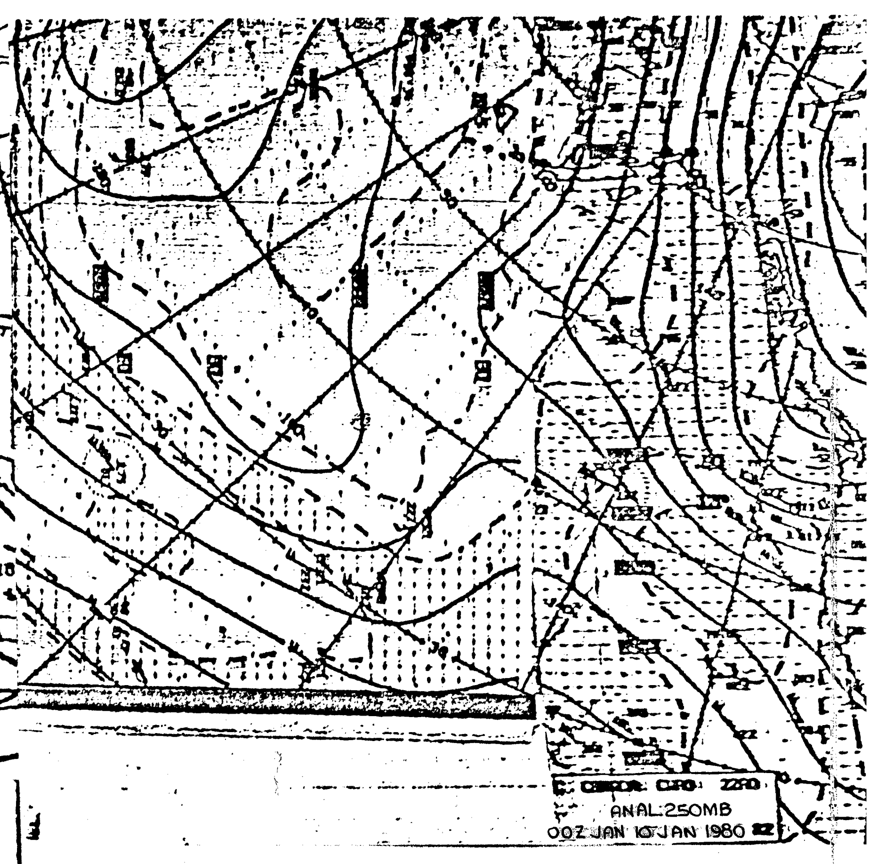

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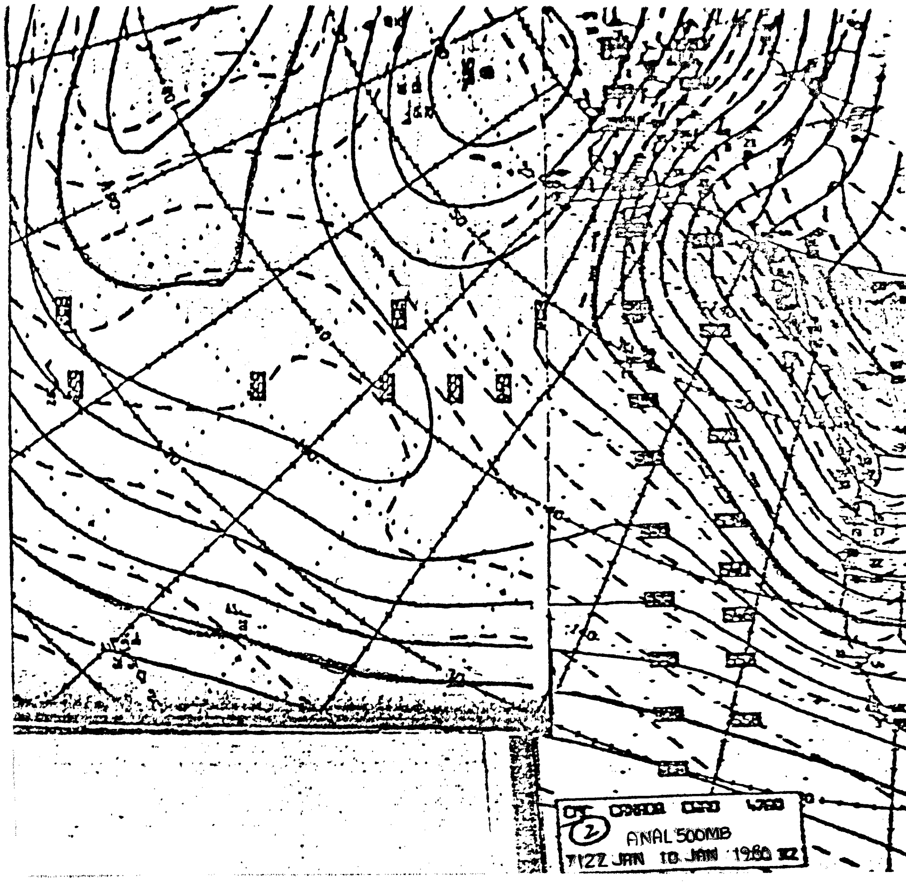

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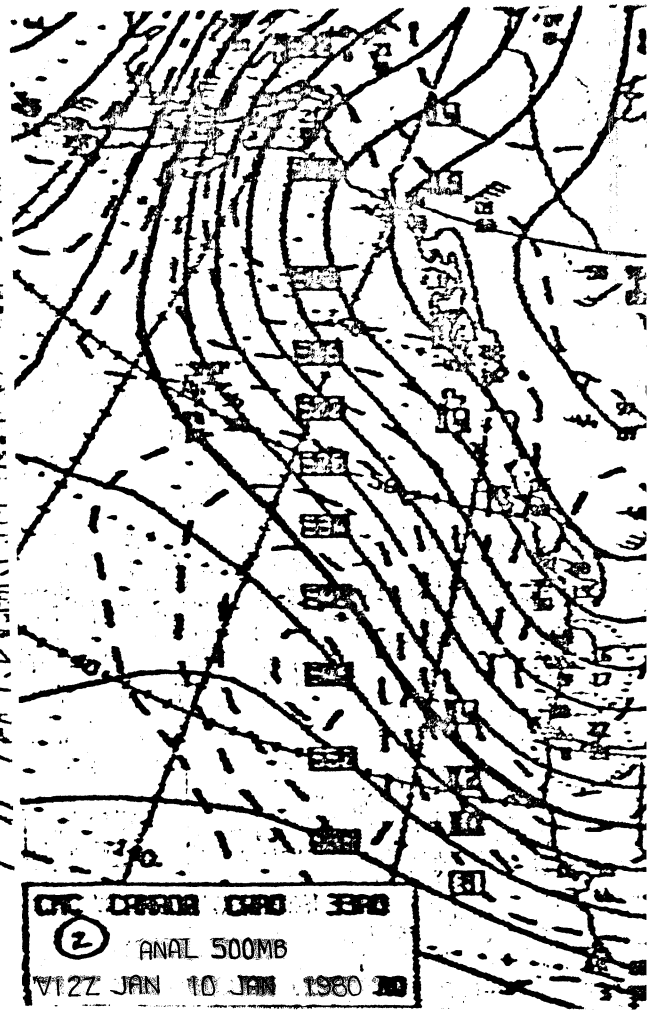

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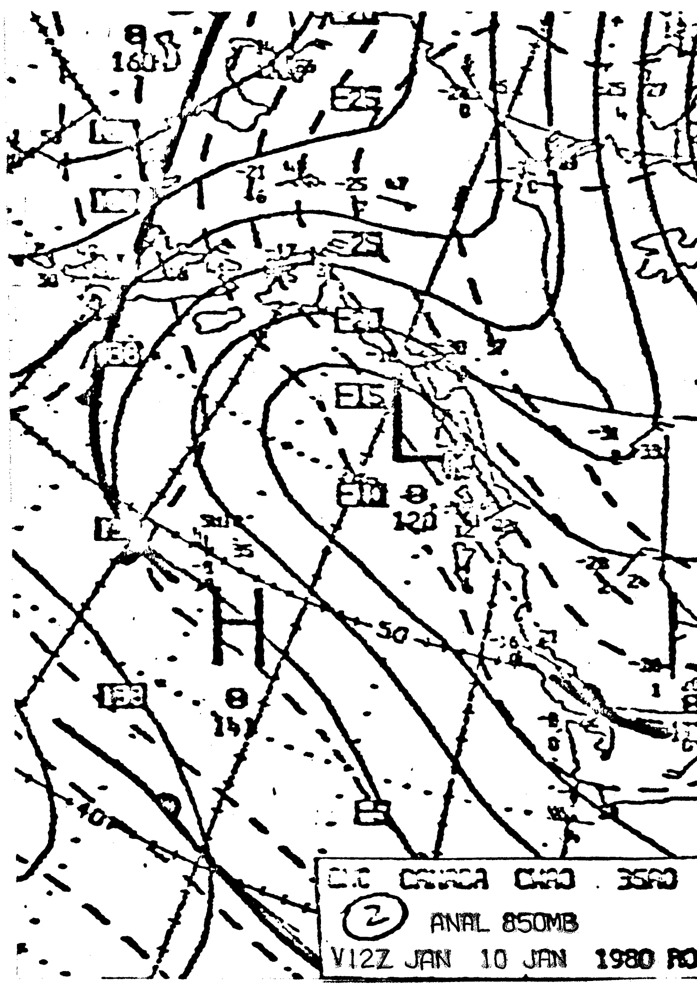

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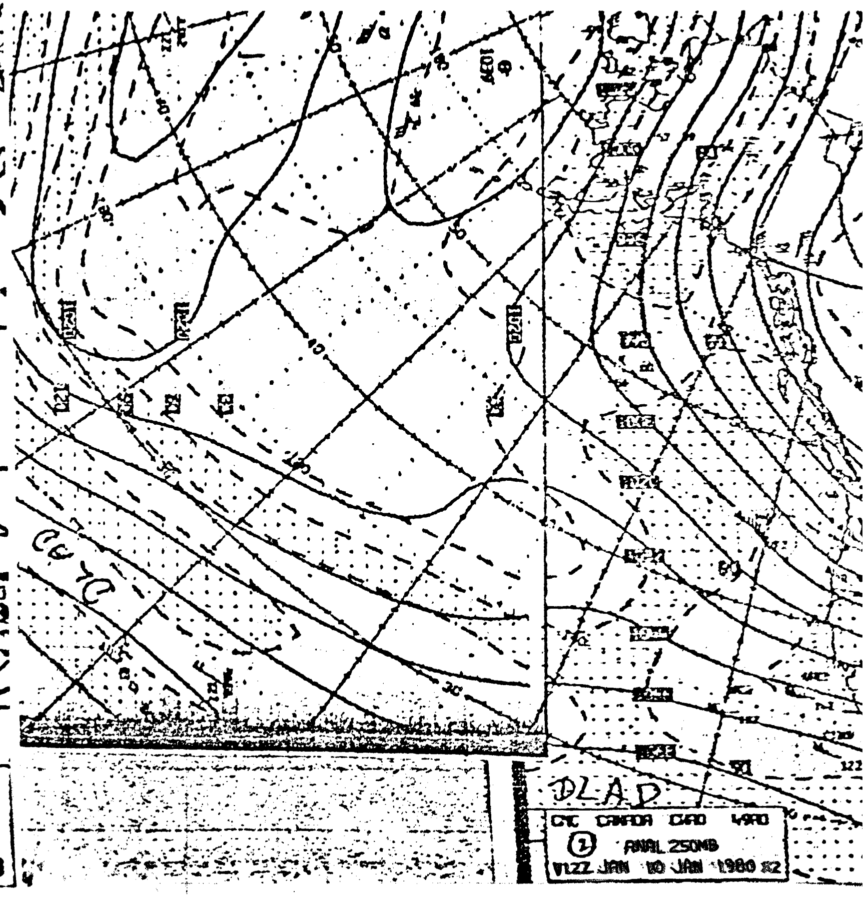

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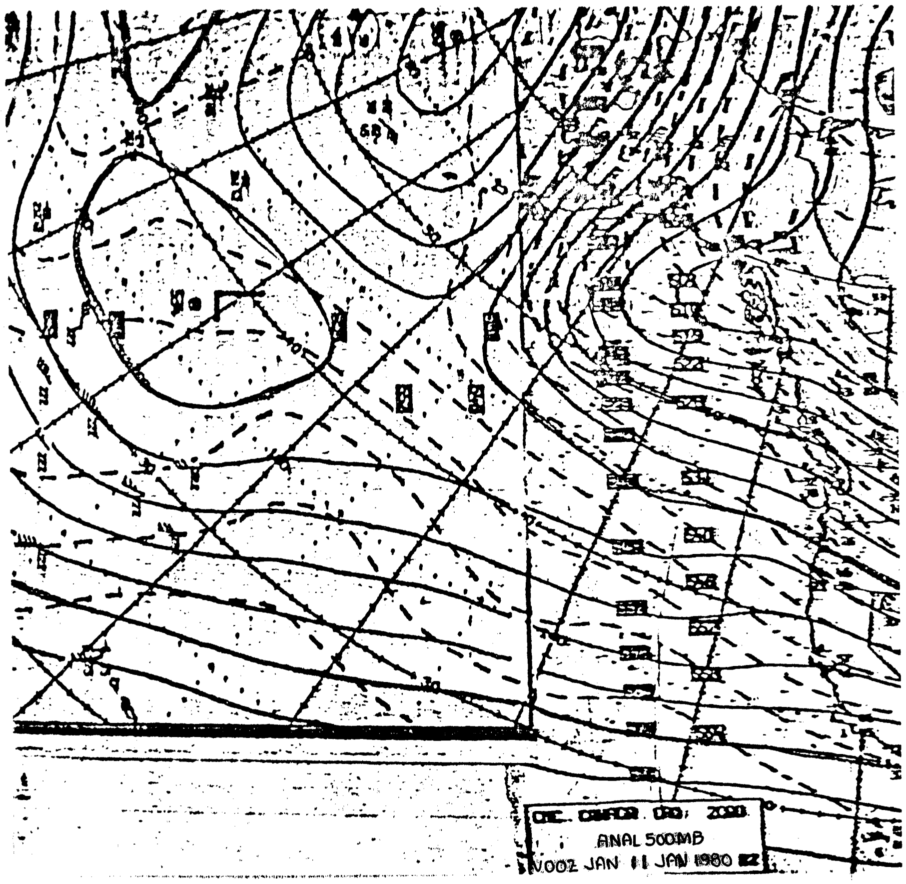

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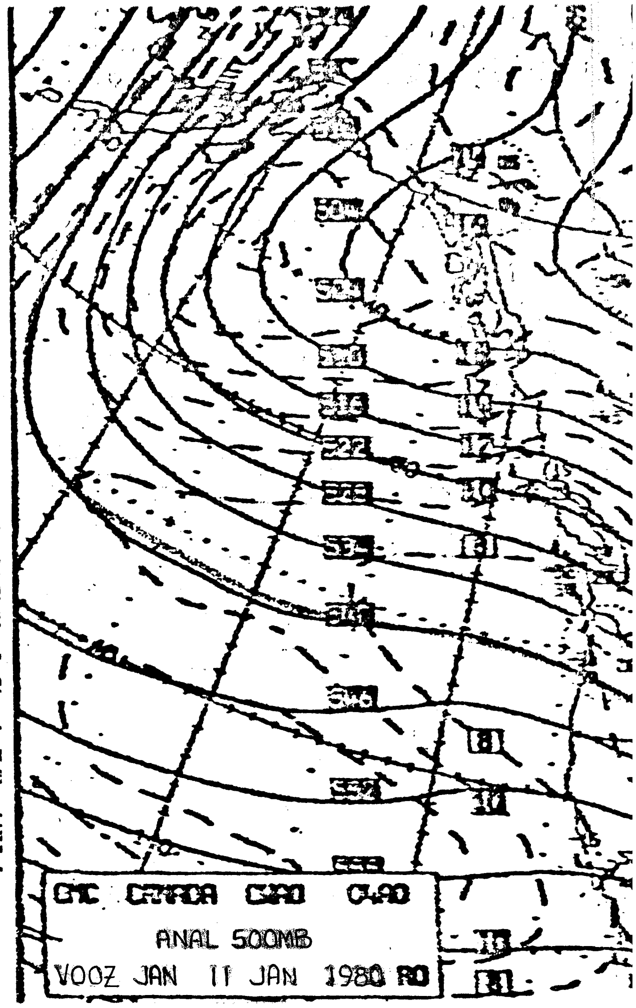

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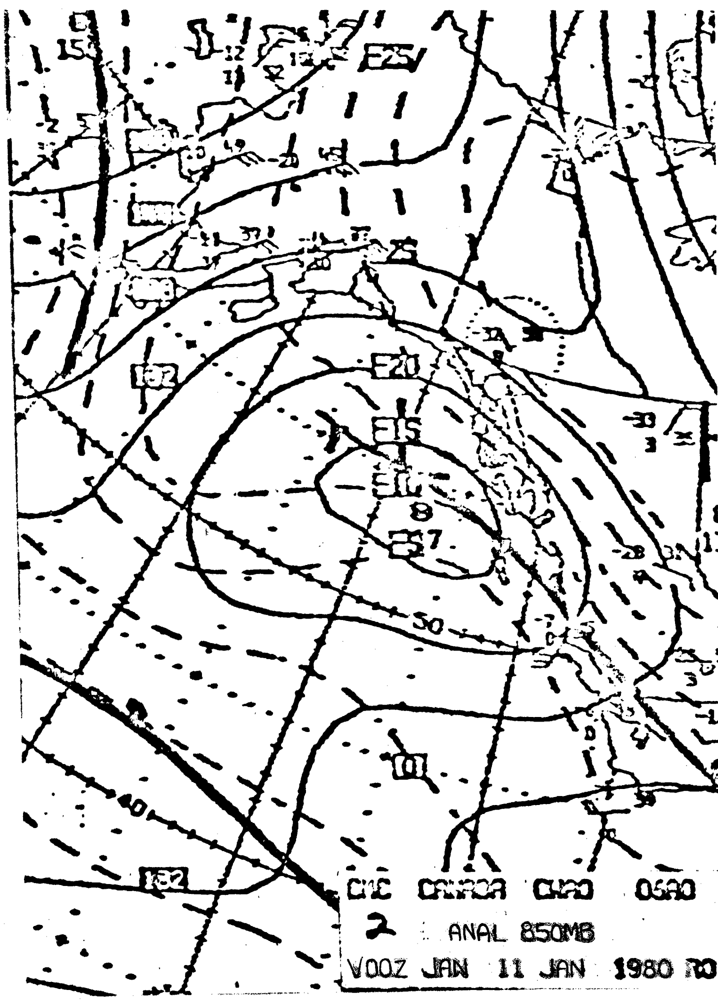

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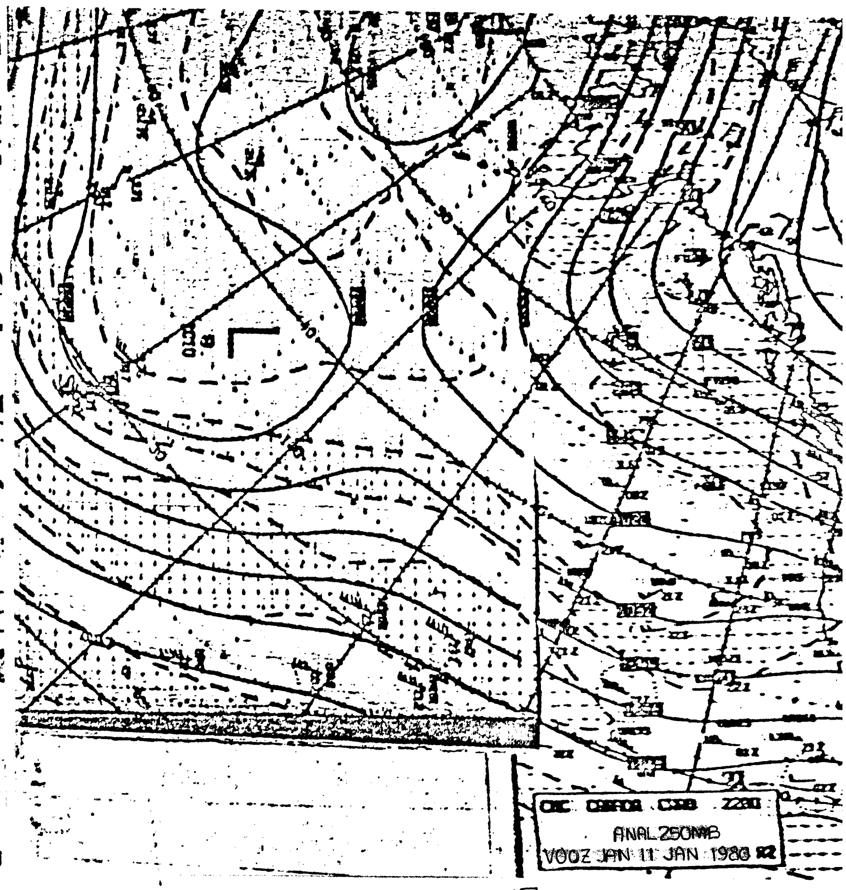

FIGURE 17.