THREE TYPES OF COLD FRONTS IN THE NORTHEAST

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ABSTRACT

Three distinctly different types of cold fronts that affect the Northeast have been identified. Each has its own characteristic accompanying weather. Upper level flow patterns favoring each type of frontal passage have also been determined and can be used for forecasting purposes.

1. INTRODUCTION

Much of the significant weather in the Northeast is associated with cold frontal passages. In an average year, nearly 90 such occurrences produce varying amounts of precipitation and cloudiness as well as changes in wind direction, temperature, and humidity. After observing the weather in the Northeast for a number of years, it became apparent that there were different types of cold fronts. They approached the Northeast from various directions, and each had its own characteristic weather associated with it. In addition, certain upper level flow patterns were conducive to a particular type of cold front and could probably be used for prediction. This study combines the results of, and intensive investigation from, 1976-1978 with some general ideas gathered over the years. Some of the terminology is new and meant to be simple and descriptive.

2. DATA

Frontal passages, upper level flow patterns, and precipitation occurrence were determined from the NOAA Daily Weather Maps. For a frontal passage to be included, the cold front had to pass at least as far east and south as New Jersey. The results of the analysis are shown in Table 1. A full description of frontal types follows.

3. FRONT DOOR COLD FRONT

The most common type of cold front in the Northeast is one that basically moves from west to east. As shown in Table 1, about 75 per cent of all frontal passages are of this type. Ahead of the cold front, winds are southerly bringing in warm and usually moist air. Precipitation commonly occurs prior to frontal passage. In the warmer months, it is often in the form of showers and thunderstorms. In the colder months when warm fronts or cyclones are often involved, steadier precipitation in the form of rain or snow is likely. Following frontal passage, winds shift to the west usually with rapid clearing and much cooler conditions.

The high pressure area behind the cold front is usually of Canadian origin and represents a cP air mass. The common track of the high is southward out of western Canada, down into the Plains states, and then eastward to the East Coast. Occasionally, a mP high will move eastward all the way across the country from the Pacific to the Atlantic. This type of air mass would not be as cold as the Canadian type.

At upper levels, such fronts are usually associated with pronounced short wave troughs that are moving

across the country. Their great amplitude allows for the advection of warmth and moisture ahead of the front. In the warmer months, the troughs are not as pronounced but convective instability usually produces rainfall.

Figures 1-4 show examples of a typical "front door" cold front.

4. SIDE DOOR COLD FRONT

Occasionally, cold fronts approach the Northeast from the northwest rather than the due west. As shown in Table 1, about 20 per cent of all frontal passages are of this "side door" type. Typically, winds preceding the cold front are from the west and are relatively dry and not overly warm. The frontal passage is usually accompanied by little if any precipitation except in the summer when convective showers are possible. Behind the front, winds shift to the northwest bringing in unseasonably cool, dry air. The coldest weather in the Northeast usually is associated with "side door" cold fronts.

The high behind the front usually originates in Central Canada and is again a cP air mass. However in this case, the high usually moves southeast out of Canada, across the Great Lakes, and into the Northeast. This more direct route from the cold air source region is the reason for the abnormally low temperatures.

At upper levels, "side door" cold fronts are usually associated with fairly intense, small-amplitude short wave troughs. The limited latitudinal extent does not allow for the advection of warmth and moisture ahead of the front, hence the scarcity of precipitation. The centers of the troughs are also usually well north in Canada.

The long wave pattern favoring "side door" frontal passages finds the long wave trough position near or just off the East Coast. A long wave ridge is found to the west over the western and central portion of North America. Short wave troughs which have moved over this ridge begin to intensify as they move southeast towards the long wave trough position.

A closer examination of the data showed two different situations involving "side door" cold fronts. One was in the winter, when a developing short wave trough produced the long wave near the East Coast. Another short wave moving into the trough position from the northwest produces the "side door" front. In this case, a secondary type cold front is produced normally following by a day or two the primary front.

In the transition seasons, especially spring, the long waves can develop with the westerlies being further north. In this case, a more persistent pattern may be established and numerous "side door" frontal passages may occur over a period of weeks. Such situations favor dry conditions and are often associated with dangerous fire weather.

Figures 5-10 show a typical example of a "side door" cold front.

Although most "side door" frontal passages are dry, there is one exception. When the long wave trough position is very close to the East Coast, the short wave dropping into it can occasionally initiate cyclogenesis along the coast. Such a storm can produce significant precipitation and is difficult to forecast. An example of this is shown in Figures 11-14. It was noted that the 6-7 February 1978 snowstorm in the Northeast was such a development.

5. BACK DOOR COLD FRONT

The classic "back door" cold front is one that moves from north to south, down the New England Coast. As shown in Table 1, "back door" cold fronts account for only 5 per cent of all frontal passages. Usually ahead of the front, winds are from the southwest. Humidities may vary, but temperatures are characteristically high. Heat wave conditions are common. Little or no precipitation usually accompanies the frontal passage. Following frontal passage, winds shift to the north or northeast. Temperatures fall dramatically, often bringing welcome relief. In some situations, low clouds and fog may also accompany an onshore flow.

In this case, the surface high tracks

eastward across Canada. Only when it reaches the East coast does it drop southward across the Canadian maritimes. This pushes the cold front southward. The air mass is usually a combination of continental polar and maritime polar. Often the front moves northward as a warm front within a day or two.

The upper level maps show a typical situation. A long wave trough is well off the East Coast. A long wave ridge is just to the west and is associated with the warm surface high. Short wave troughs move up over the ridge and then down into the trough, intensifying as they go. As they move off the East Coast, the building surface high forces the front down the coast.

A characteristic "back door" front is shown in Figures 15-20.

6. GARAGE DOOR COLD FRONT

There was one other type of frontal passage which could be identified in this study. This is a version of the common "front door" cold front, but in this case the front actually approaches the region from the southwest. In this rare case, a major low is found to the west of the area, and the cold front is being swept cyclonically around the storm's center. This type of front is preceded by very warm, moist air and heavy rainfalls. The continental polar high behind the front is well to the west and has driven far south. At upper levels, a major trough or even closed low is found to the west. An example of a "garage door" cold front is shown in Figures 21-24.

7. SEASONAL DISTRIBUTION

An analysis of frontal passages by season showed surprisingly little variation. Total frontal passages showed only a slight maximum in the colder months. It was believed that domination of the Northeast by the Bermuda High in summer would cause a winter maximum in frontal passages. However during these very cold winters, the area was often under a dominant Canadian high.

Looking at types of frontal passages, the "front door" cold front occurred slightly more often in the colder months. The "side door" type was equally distributed throughout the year, probably due to the two different types. The "back door" cold front showed a definite maximum in late spring and early summer was over 50 per cent of occurrences in May, June, and July. The "garage door" front is typically a winter phenomenon.

8. CONCLUSIONS

Some or perhaps even all of the preceding information is common knowledge to experienced forecasters in this region. However, to my knowledge, much of this has never been published before. Hopefully, this will be a useful reference to less experienced forecasters and will initiate similar studies in other parts of the country.

REFERENCES

NOAA. 1976-1978. "Daily Weather Maps"

TABLE 1 Frontal passages 1976-78

TYPE (see text for full explanation)

YEAR	FRONT	SIDE	BACK	GARAGE	TOTAL
1976	62	18	3	0	83
1977	66	19	7	1	93
1978	71	11	4	1	87
Total	199	48	14	2	263

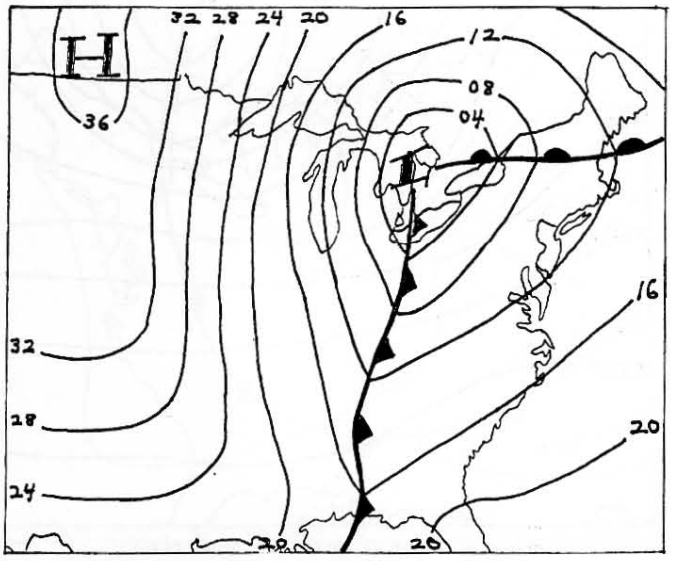


Figure 1. 1200Z 20 December 1976 Surface Chart

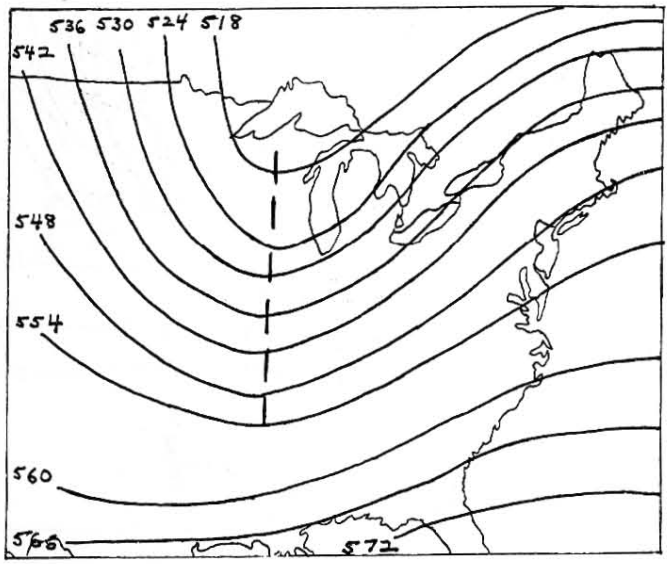


Figure 2. 1200Z 20 December 1976 500mb Chart

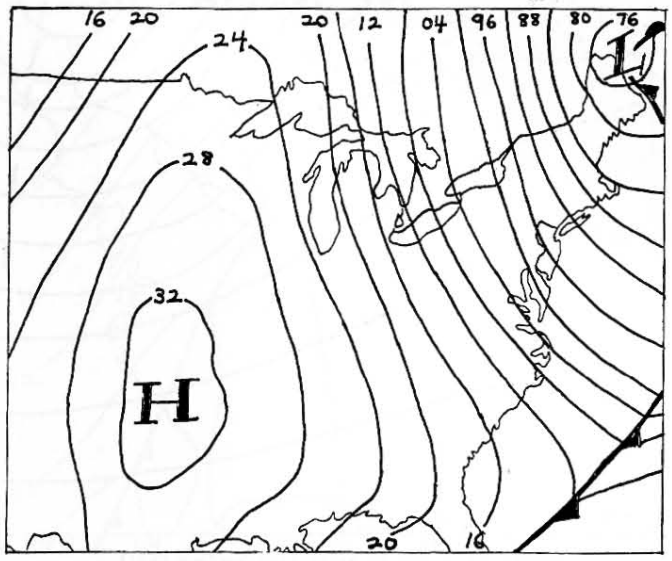
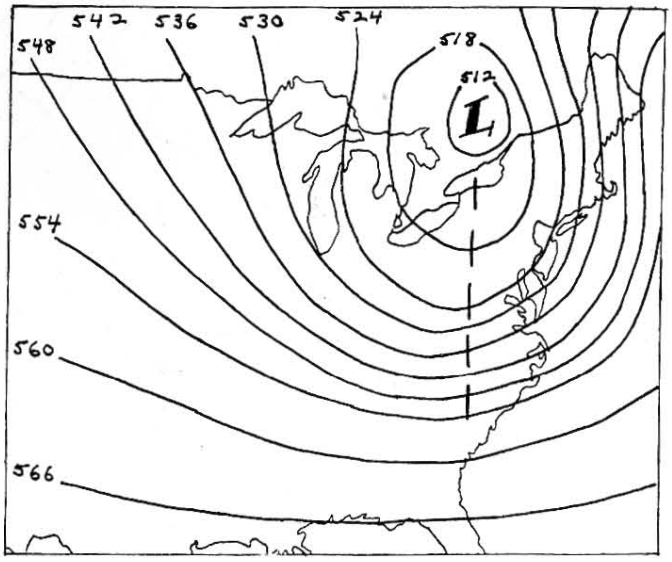


Figure 3. 1200Z 21 December 1976 Surface Chart



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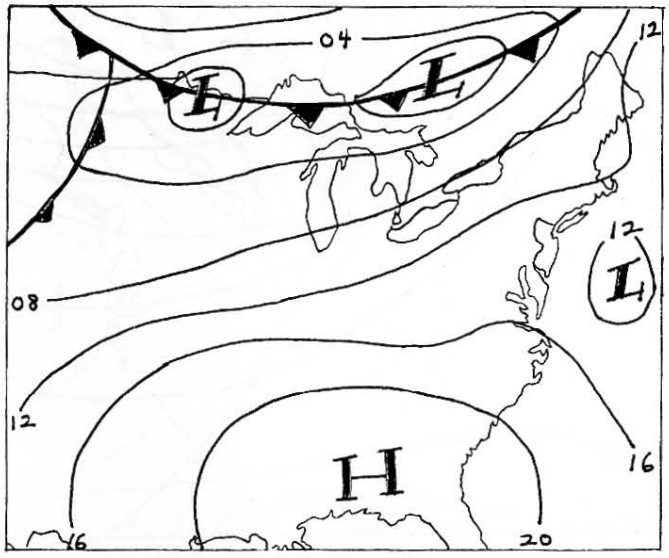
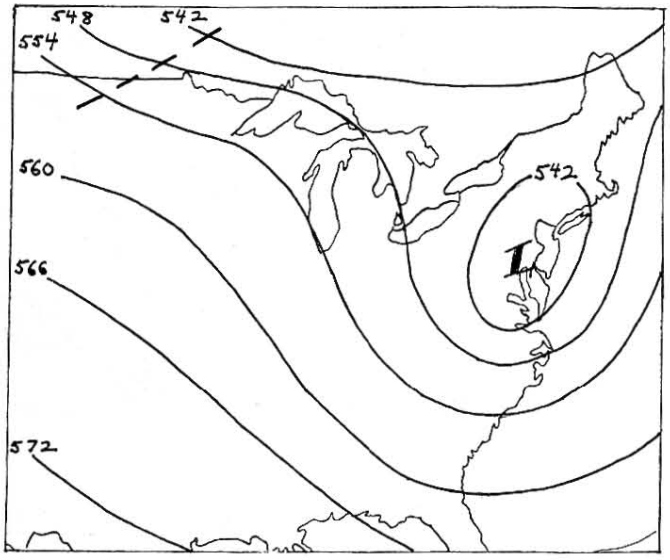


Figure 5. 1200Z 27 April 1977 Surface Chart



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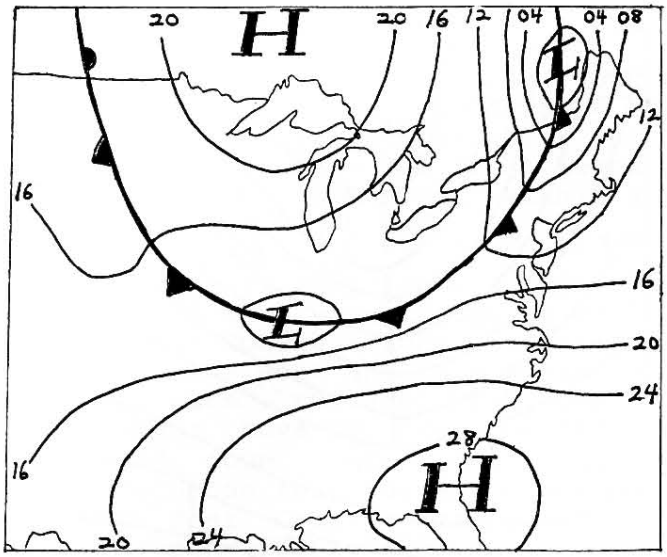
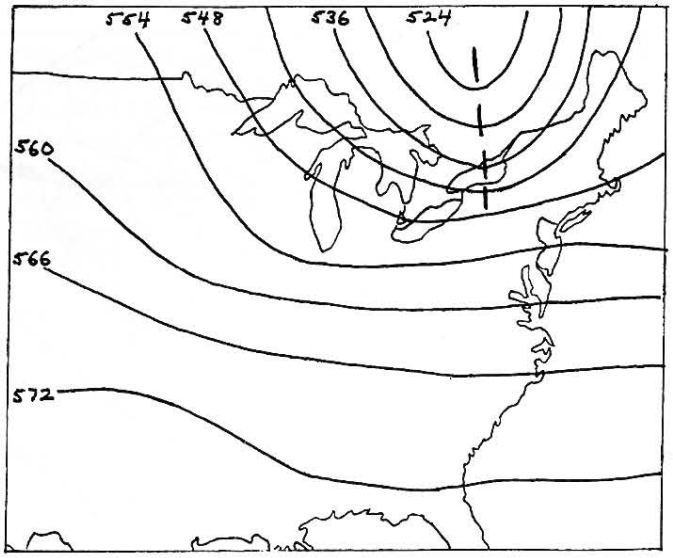


Figure 7. 1200Z 28 April 1977 Surface Chart



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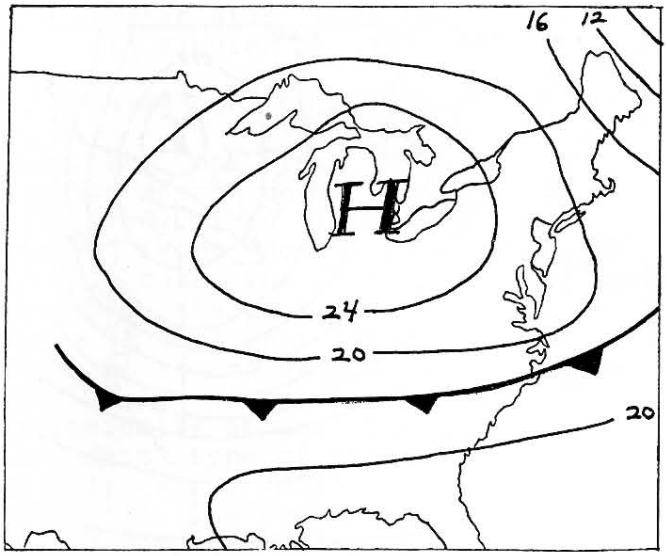

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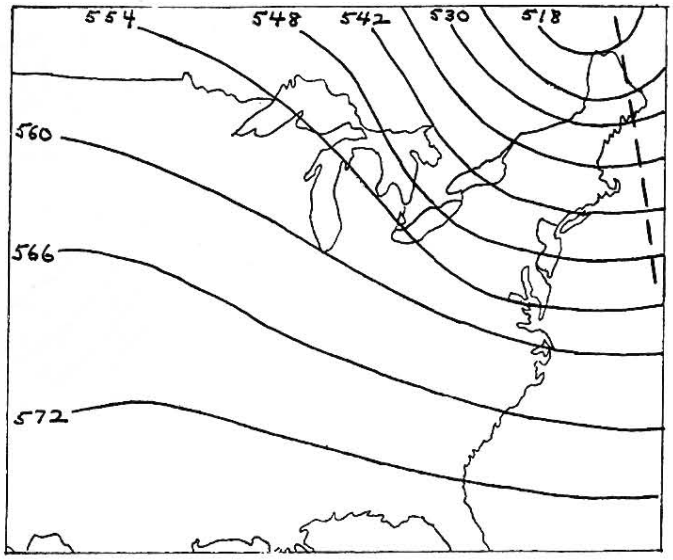

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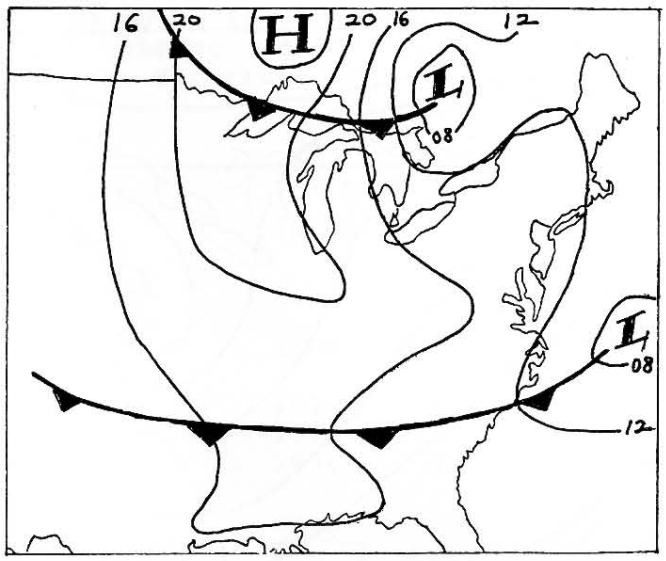
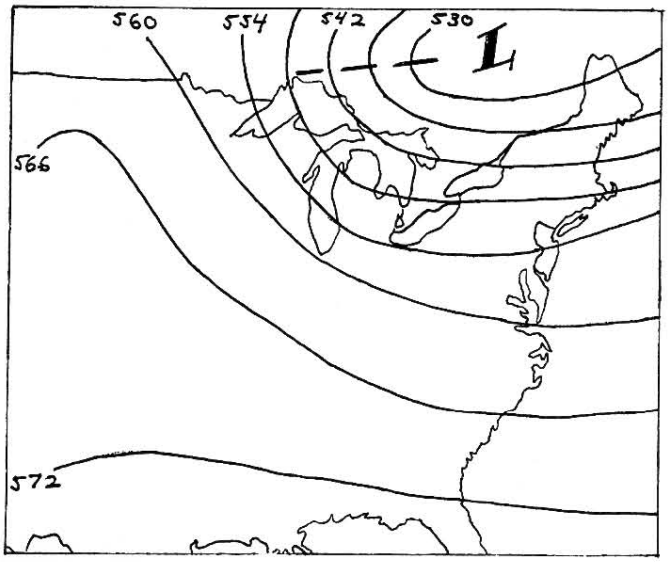


Figure 11. 1200Z 8 May 1977 Surface Chart



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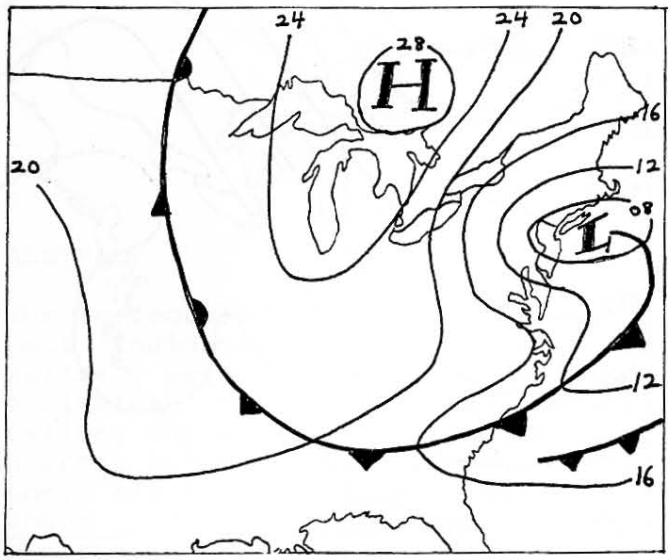
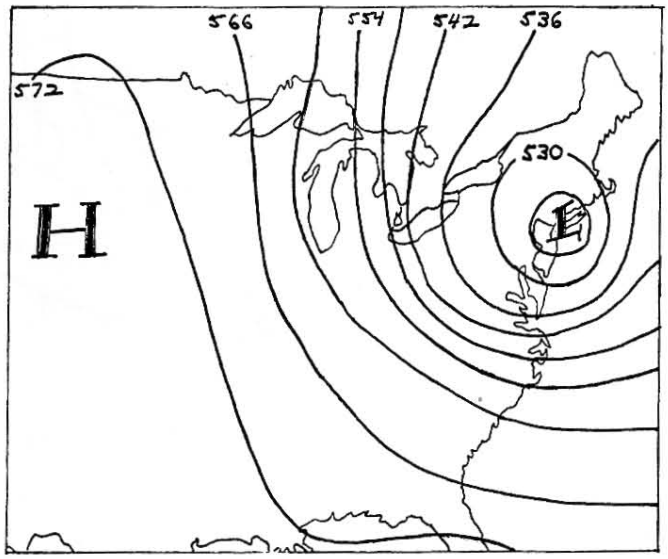


Figure 13. 1200Z 9 May 1977 Surface Chart



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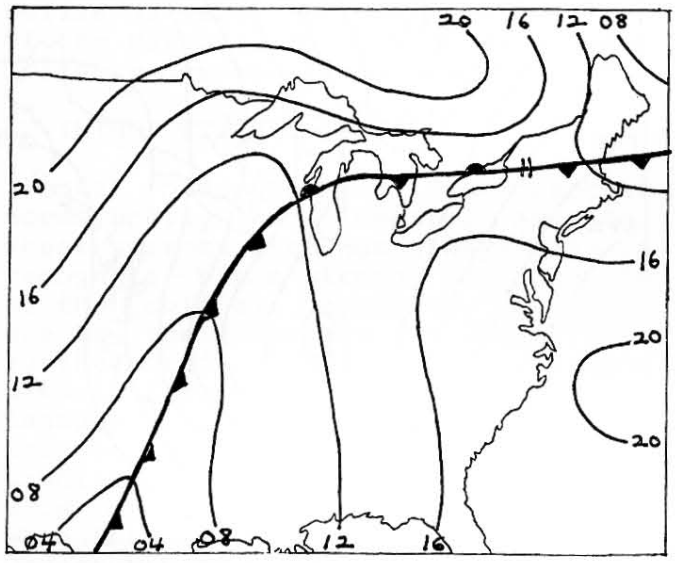
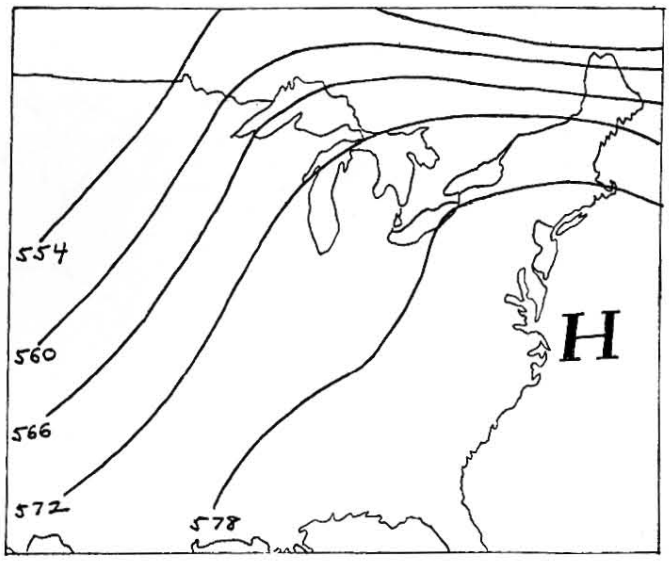


Figure 15. 1200Z 10 May 1977 Surface Chart



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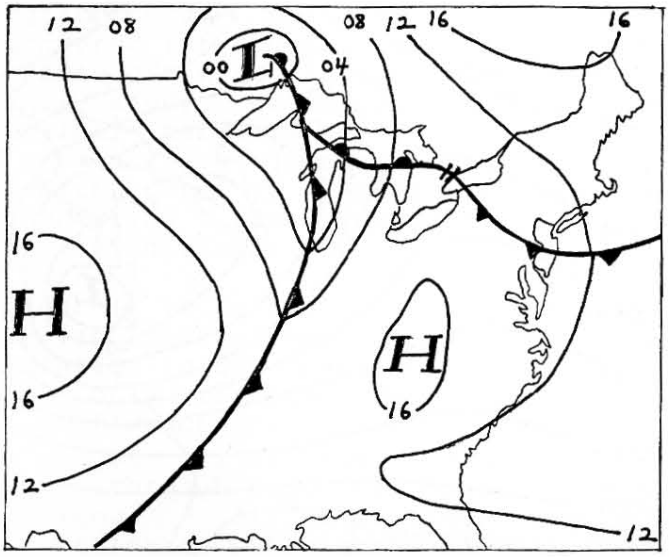


Figure 17. 1200Z 11 May 1977 Surface Chart

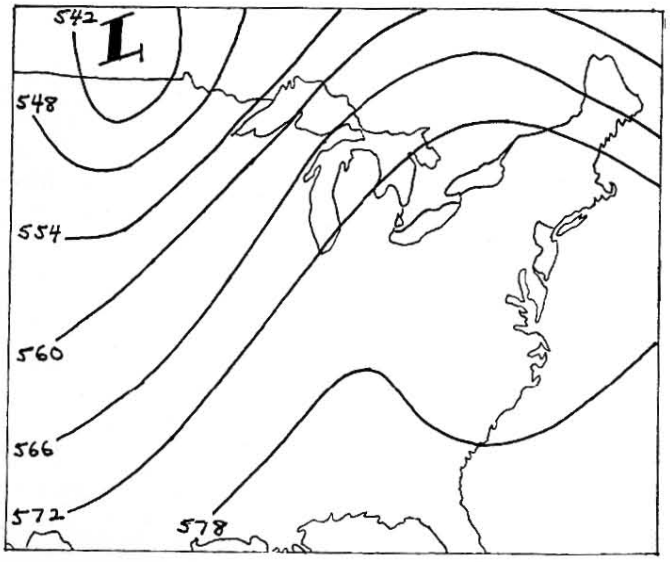


Figure 18. 1200Z 11 May 1977 500mb Chart

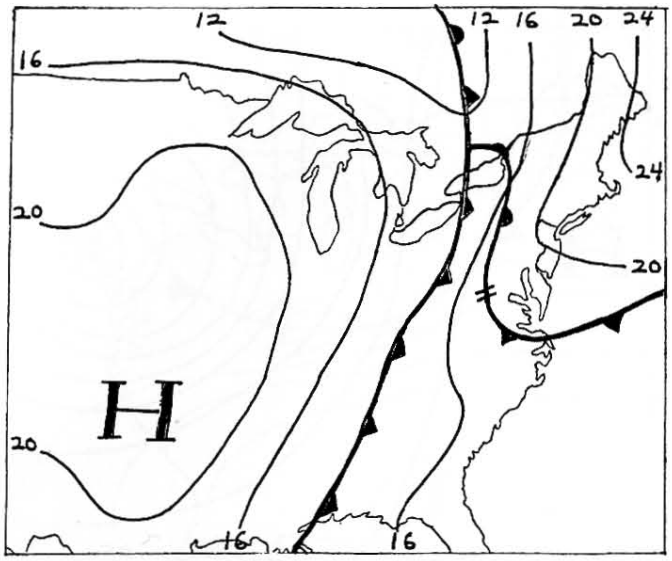
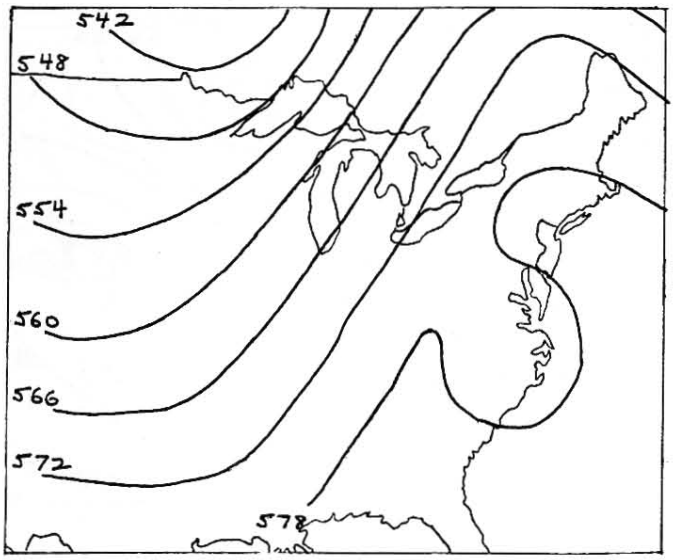


Figure 19. 1200Z 12 May 1977 Surface Chart



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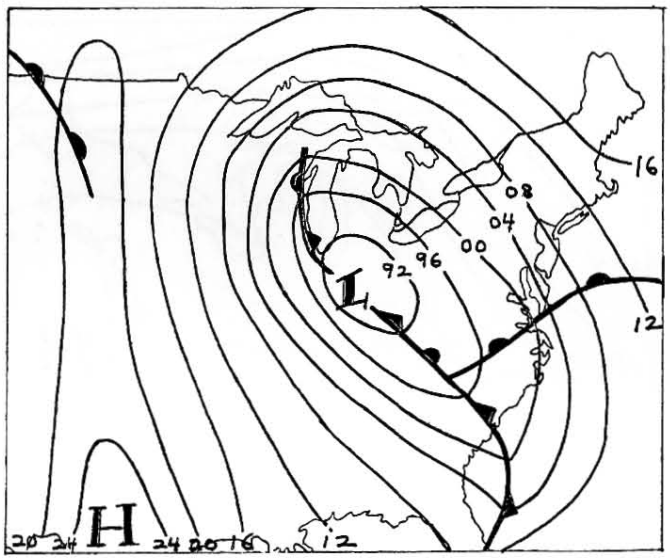
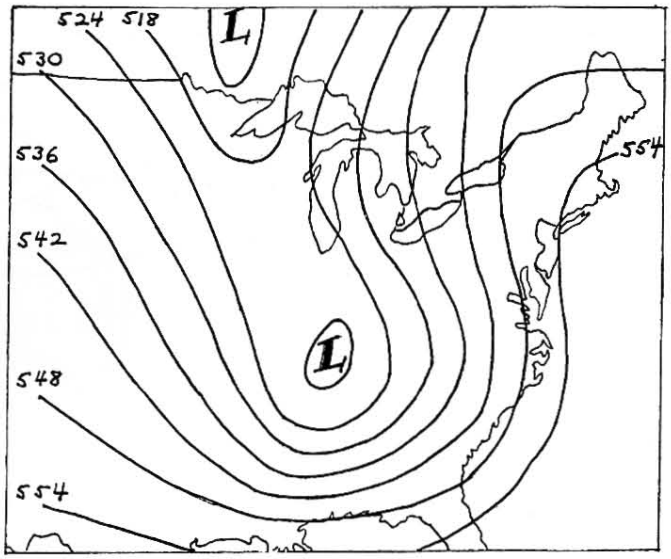


Figure 21. 1200Z 24 January 1979 Surface Chart



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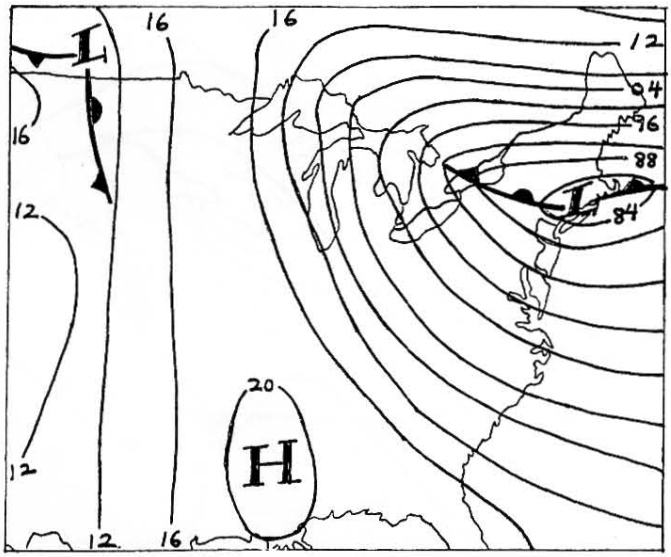

Figure 23. 1200Z 25 January 1979 Surface Chart

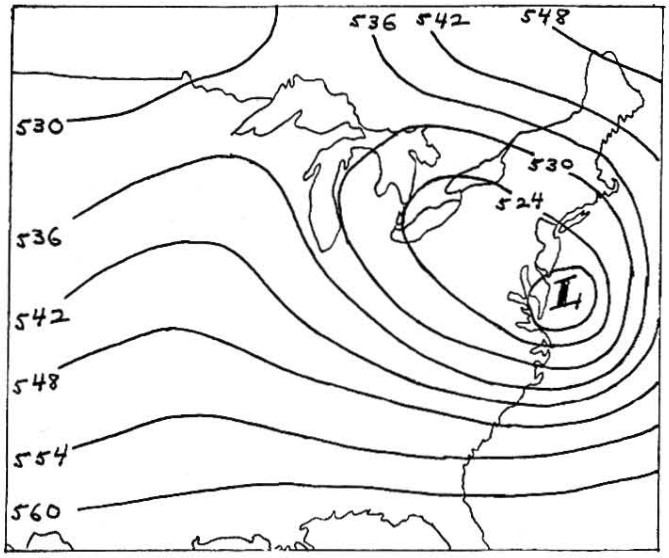

Figure 24. 1200Z 25 January 1979 500mb Chart