NOAA Technical Memorandum NWS WR-109

FORECASTING NORTH WINDS IN THE UPPER SACRAMENTO VALLEY AND ADJOINING FORESTS

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Redding, California
September 1976

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I. INTRODUCTION

The highest fire dangers in northern California are associated with north and northeasterly winds. Like the Santa Ana winds in southern California, these are foehn-type winds. The surface map at the onset of these winds is usually like that in Figure 1. High pressure builds into the Pacific Northwest and as the air moves from Oregon into the north Sacramento Valley it is warmed. Since the air mass is relatively dry to start with, it is not uncommon to have humidities of less than 10 percent while temperatures sometimes exceed 110 degrees in the valley. Wind speeds with these outbreaks vary due to topography, pressure gradient, and upper-level flow. Figure 2 shows the 70 kPa (700 mb) chart for the same time as the surface chart in Figure 1. In this occurrence strong winds aloft join with strong surface pressure gradients to give wind speeds in excess of 18 m/s (40 mph) in the northern Sacramento Valley.

Fire season in northern California is usually from June through mid-October. These north wind periods occur in all months with the lowest frequency of occurrence in July and early August. From a fire-danger standpoint the September and October occurrences are the most critical because by this time the herbaceous vegetation condition in the grasses and fine fuels is down to zero and the other fuels have had all summer to dry and cure.

The U. S. Forest Service and the California Division of Forestry have established certain weather criteria for which a "red-flag" warning is issued. Examination of red-flag warnings issued by the Redding fire-weather office over the last several years shows that almost all red-flag warnings were for north wind outbreaks.

II. DEVELOPMENT OF OBJECTIVE AID

Since our highest fire danger in northern California is during these north wind periods, it would be highly desirable to have a method of forecasting these winds at least 24 hours in advance. During the last 25 years several north wind studies have been done. These are described by Harman (1965). These studies had a point of verification in the lower Sacramento Valley south of the Redding fire-weather district. Therefore, north wind cases affecting only the north valley were not picked up. Also, indicated time of onset of these north winds isn't applicable for northern valley locations because north winds start in the north end of the valley earlier than in the central and southern portions.

The first step in developing an objective aid was to find the areas where pressure gradients would have the greatest influence on north winds.

Numerous stations were checked and it was found that for a north-to-south gradient, the most representative were the Medford-to-Red Bluff and Red Bluff-to-Sacramento gradients (see Figure 1).

It was also noted that as the high-pressure cell shifted into the Great Basin, the north winds would diminish. A good check on this was the Medford to Reno pressure gradient. Originally, just these gradients were used, and only a slight correlation was found. There were several times when north winds were forecast and none materialized. Examination of these days showed that high pressure was definitely building along the West Coast but was not pushing into the Pacific Northwest and, therefore, winds in northern California would remain light. After checking several pressure changes, it was found that the pressure change at Spokane, Washington, was the best indication of surface ridging into the Pacific Northwest.

Using these different variables, data were analyzed for 1972, 1973, and 1974. Observations are taken hourly at the Red Bluff Weather Service Office so this was used as the verification point. Figure 3 shows the results. Data plotted are the wind that occurred the next day. The chart was divided into three sections. Section A has an 86 percent north wind (320°-040°) occurrence, section C has a 95 percent occurrence of winds other than north and section B was a marginal area with only 63 percent occurrence of north winds.

The study was put into use during the 1975 fire season. For the period June through September or 122 days, there were 26 north wind days. Of these 26 days, 24 (92 percent) were forecast correctly (15 in section A and 9 in section B). In all, 40 forecasts fell in section A or B. On the 16 days that weren't true north wind days, the wind was usually north in the morning, but would switch to south in the afternoon.

Evaluation of the performance of this aid at the end of the fire season showed it to be useful in giving a yes or no forecast for north winds the next day. One problem was to sort out the north winds that switch to the south in the afternoon from the true north wind cases. It would also be useful to have a method of estimating expected wind speeds. In order to solve these problems, it was necessary to include upper-air data in a graphical regression method. If the forecast was in section C of Figure 3, it was considered to be a non-north wind day and nothing further was done. If the forecast was in section A or B, the charts in Figures 4 and 5 were used. These charts use the 70-kPa (700-mb) temperature difference between Oakland and Medford (see Figure 2) and the 24-hour change in this as the ordinate. The abscissa is the 20Z Red Bluff-to-Sacramento surface-pressure gradient plus the 24-hour change in the Medford-to-Red Bluff gradient.

III. APPLICATION IN THE FIELD

The California Division of Forestry and the six National Forests within the Redding fire-weather district were asked for dates and locations of all class E fires and greater (300 acres or larger) for 1972, 1973, 1974, and 1975. These fires are plotted on the map shown in Figure 7. Next the wind study was checked to see if the forecast for the day of the fire was in section A or B (north winds) and for those days the circles are shaded in. If the forecast was in section C, the circle is left blank. Two fires occurred on non-north wind days, but had been preceded by 2-3 days of strong drying north winds. These are the half-shaded circles.

Figure 7 also shows the areas (stippling) where the north wind has a foehn effect. The key point here is that even though north winds occur about 22% of the time, 82% of the large fires in this shaded area occur with north winds. This demonstrates the importance of accurately forecasting these winds.

IV. CONCLUSION

North and northeast winds are very critical in certain areas of the Redding fire-weather district. A method of forecasting these winds 24 hours in advance has been presented. This study may also be useful to other offices that forecast for the north part of the state since north winds also affect agriculture and recreation in this area.

V. REFERENCE

Harman, W. E., 1965: Forecasting northerly winds in northern and central California. Technical Note 26-WR-2, Environmental Science Services Administration, U. S. Department of Commerce, Washington, D. C., 8 pp.

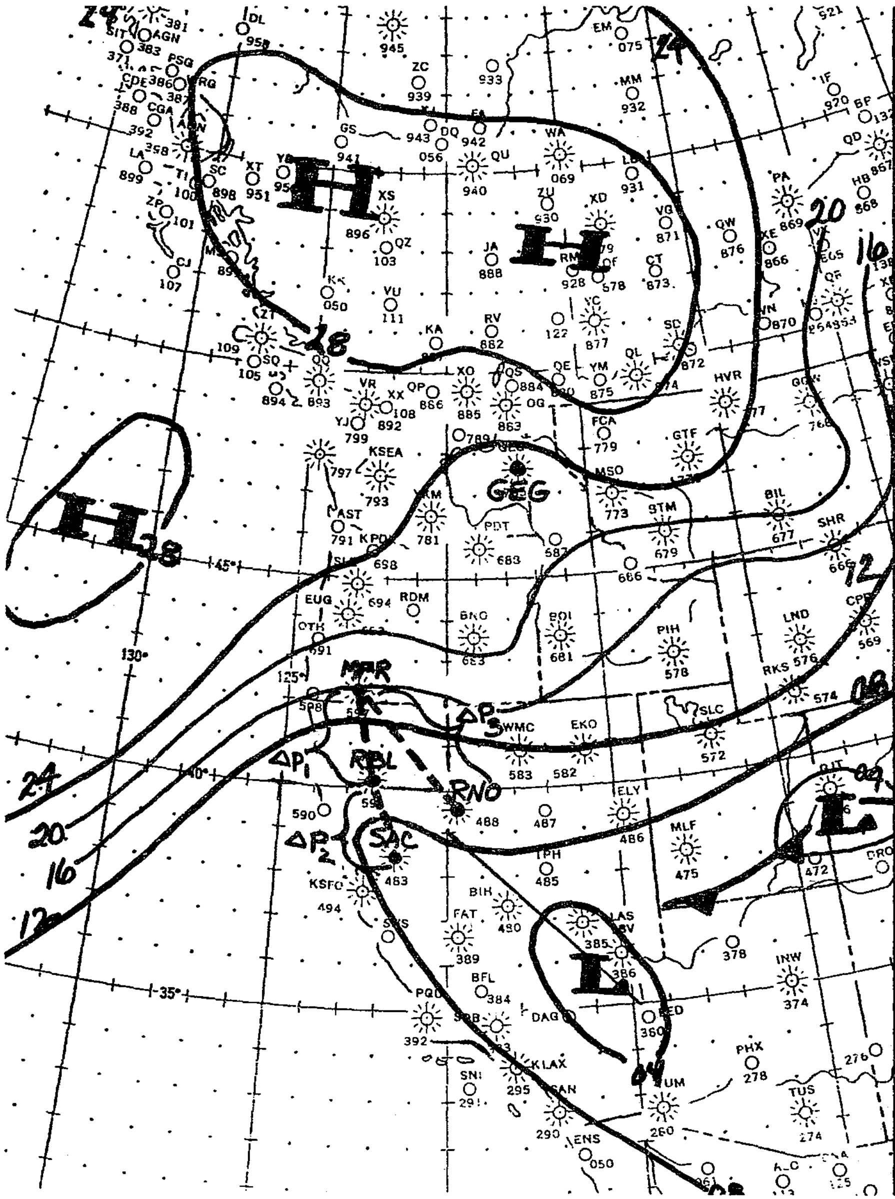

Figure 1. Example of surface pattern associated with onset of northerly foehn-type winds, 1200Z September 11, 1974.

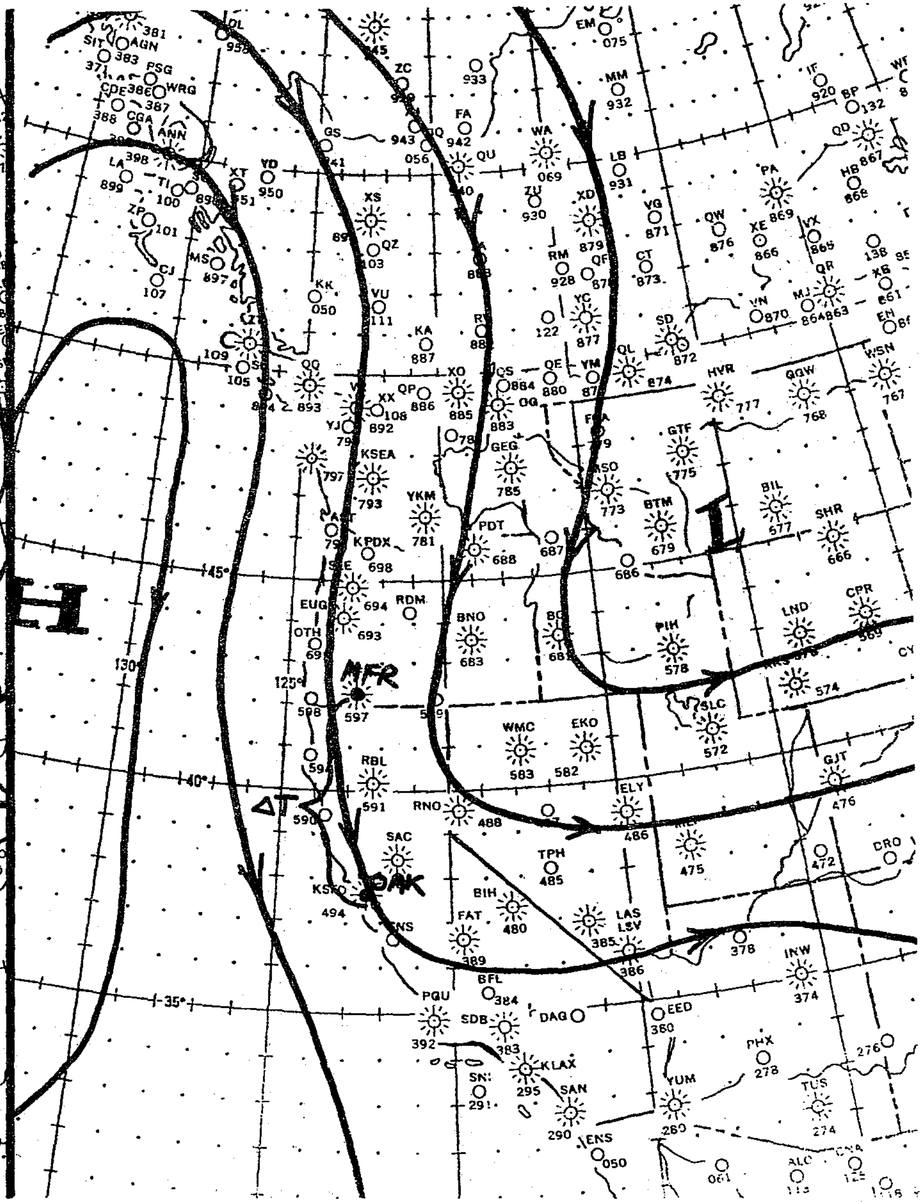

Figure 2. 70 kPa map for 1200Z September 11, 1974.

PLOTTED VALUE IS WIND THAT OCCURRED THE NEXT DAY WITH NORTH BEING 320° to 040°.

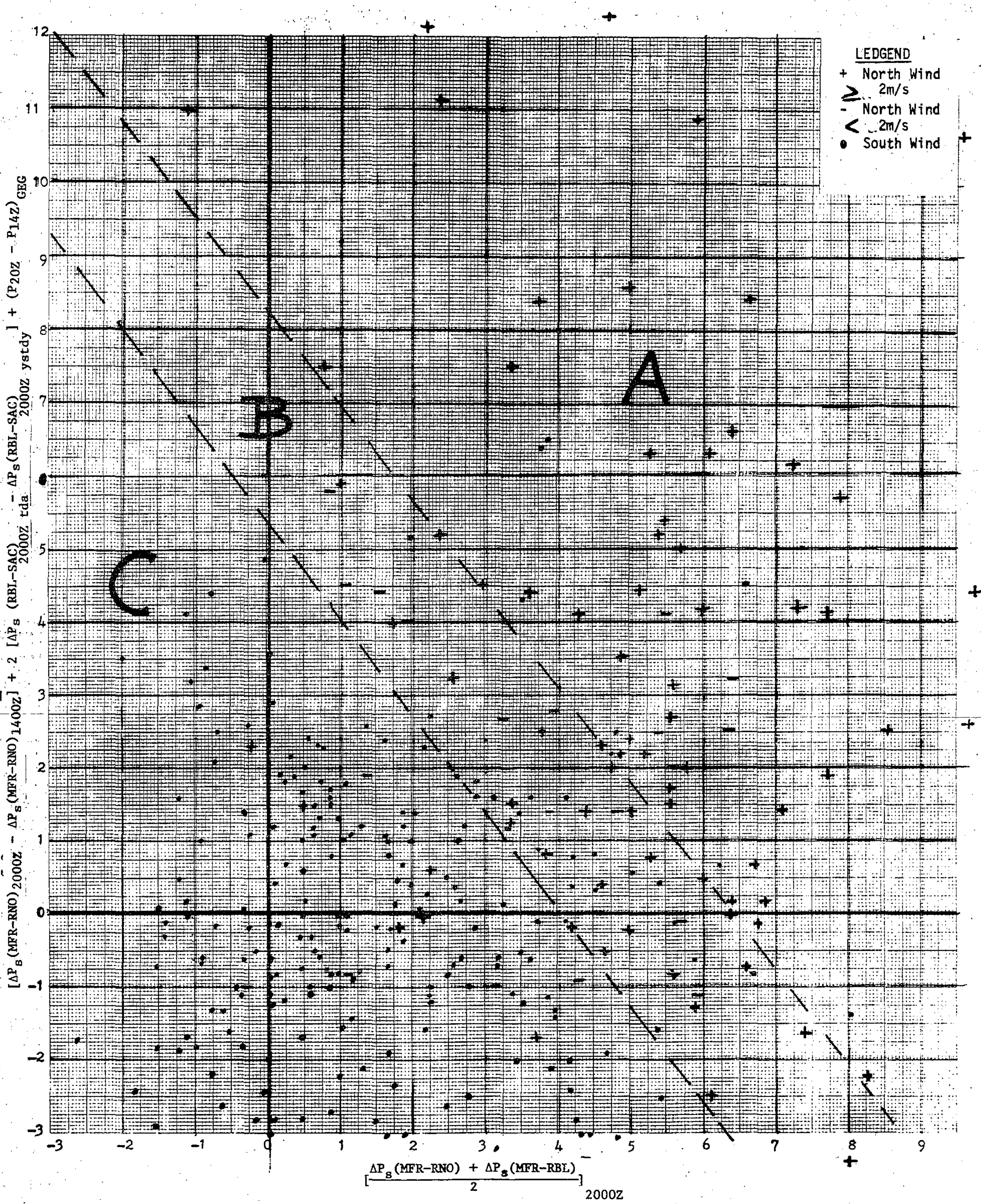

Figure 3. Scatter diagram relating north wind days in the northern Sacramento valley to selected pressure gradients and pressure changes.

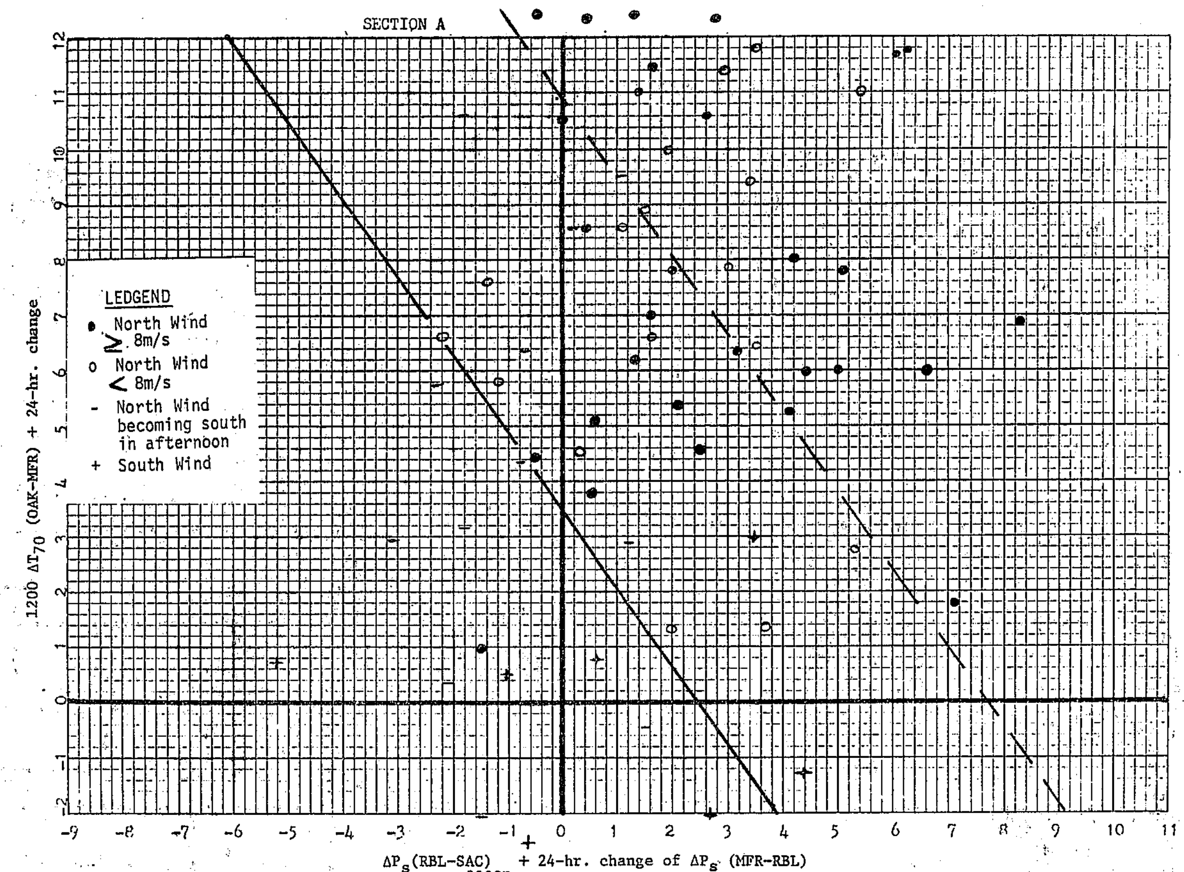

Figure 4. Scatter diagram separating north wind days from non-north wind days in section A.

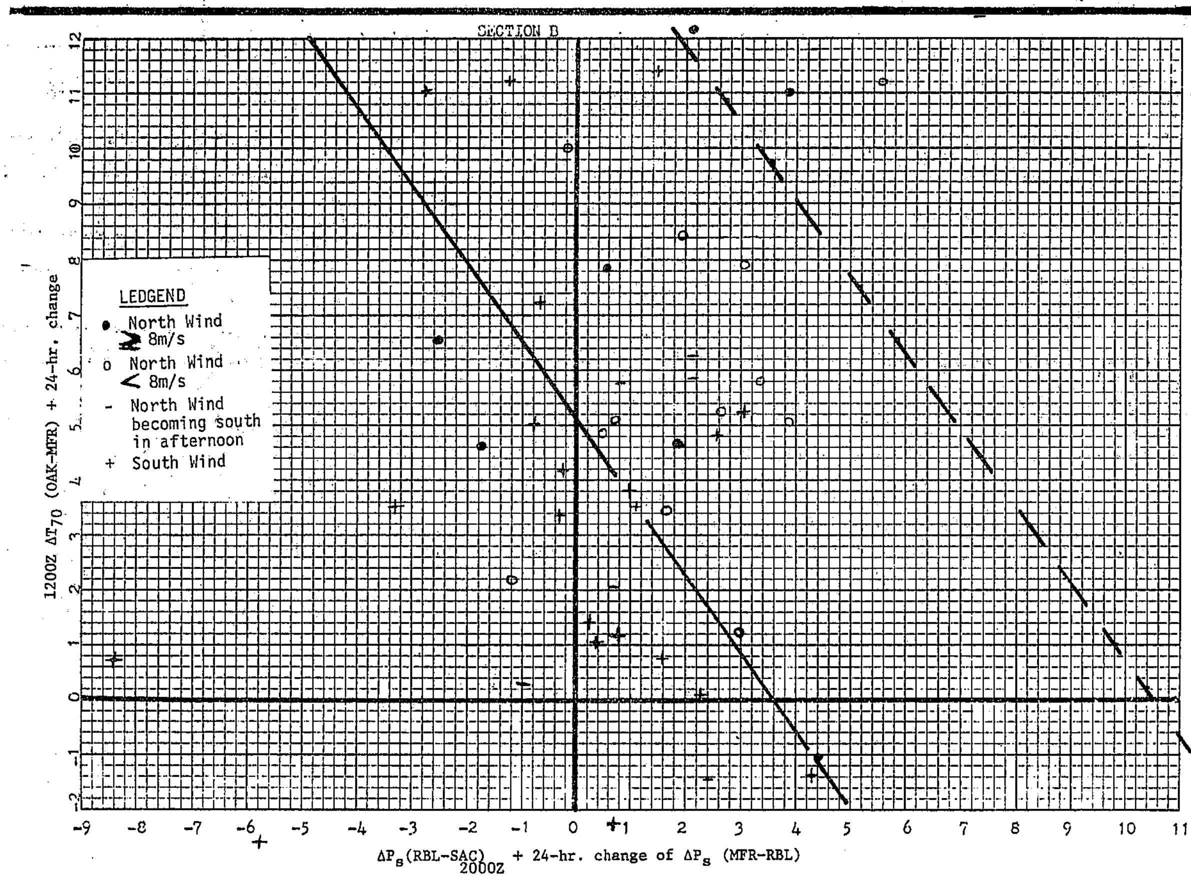

Figure 5. Same as Figure 4, except for section B.

TABLE I

FORECAST \ OBSERVED	NORTH 320°-040°	Non-North
North 320°-040°	24	16
Non-North	2	80

Contingency table for 1975 data using Figure 3.

TABLE II

FORECAST	NORTH 320°-040°	Non-North
North 320°-040°	20	4
Non-North	6	92

Contingency table for 1975 data using Figures 3, 4, and 5.

Figure 6. Contingency table for 1975 data using Figure 3 (Table I) and Figures 3, 4, and 5 (Table II).

CLASS E FIRES OR GREATER IN THE REDDING FIRE-WEATHER DISTRICT FOR THE YEARS 1972 THROUGH 1975.

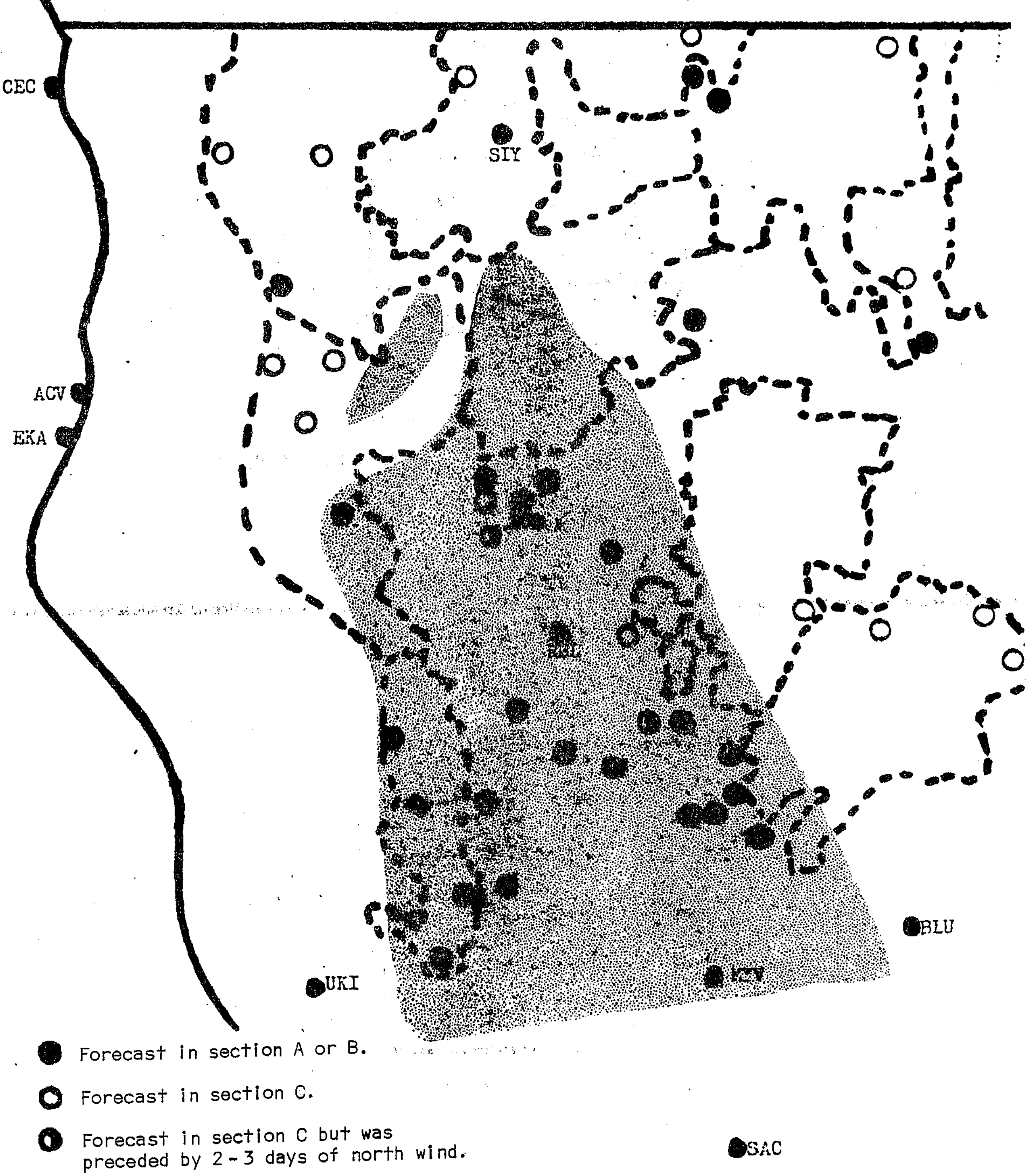

Figure 7. All class E or larger fires (300 acres or larger in the Redding fire-weather district for 1972, 1973, 1974, and 1975. Stippling indicates area where foehn-type winds occur.

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