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SEVERE THUNDERSTORM CLIMATOLOGY IN SOUTH-CENTRAL AND SOUTHEASTERN MONTANA

David A. Spector - NWSO Billings, MT

Introduction

This study involves the climatology of severe thunderstorms over south-central and southeastern Montana between 1955 and 1997. Occurrences of damaging wind gusts in excess of 58 mph, hail of 0.75 inches or greater in diameter, and tornadoes are included in the study. The occurrences of each of these parameters are compared by month and by hour to determine the part of the year and the hours when severe thunderstorms are most likely to occur in south-central and southeastern Montana.

Purpose

The purpose of this project is to document which months and hours of the day are most prone to severe thunderstorms and the frequency of particular phenomena associated with severe thunderstorms in south-central and southeastern Montana. The counties included in the study were Park, Sweet Grass, Wheatland, Golden Valley, Musselshell, Stillwater, Carbon, Yellowstone, Big Horn, Treasure, Rosebud, Custer, Powder River, Carter, Fallon, Prairie, Dawson and Wibaux.

Background

Severe thunderstorm frequency is greater in the Billings county warning area (CWA) than in most of the Western Region of the National Weather Service (Storm Prediction Center's Severe Local Storm Warning Verification Statistics). The Billings CWA includes most of south-central and southeastern Montana. The number of severe thunderstorms in the Billings CWA varies from year to year, but records have been kept on station regarding the number of severe thunderstorm wind gusts which produced damage, large hail reports and tornado occurrence. A thunderstorm is currently classified as severe if it produces wind gusts of 58 mph or greater, contains hail of 0.75 inches (in diameter) or greater or produces a tornado. Because of the large number of severe wind gusts that were reported, only gusts that produced property damage were recorded. All severe thunderstorm hail reports and tornadoes were recorded. The study includes data from the period from 1955 to 1997.

Data

The data used for this study was obtained from records kept on file at NWSO Billings, the monthly Storm Data publication from the National Climatic Data Center, and data provided by the Storm Prediction Center's climatological database. These data were consolidated and graphical tables were made using Quattro Pro. Several graphs were produced comparing damaging wind reports, large hail reports, and tornado reports from 1955 to 1997 in south-central and southeastern Montana. The statistics from 1972 were not included in this study since they were not included in the Storm Prediction Center's database.

Results

Over the period 1955 to 1997, three years (1983, 1994, and 1995) had significantly more damaging wind reports and number of days with damaging wind reports (Fig. 1). There also appears to be a significant rise in reports of severe hail after 1990 (Fig. 2). However, this is most likely the result of better verification efforts and increased spotter participation, and not an increase in the frequency of severe thunderstorms. Even though there was an increase in the number of hail reports in the 1990s, this was not the case for damaging winds or for tornadoes. No trends appeared with regard to the number of tornadoes over the 43-year period (Fig. 3), although there were significantly more tornadoes in 1991 (11) than in any other year. Most of these tornadoes occurred on two days within a three-day period in June of 1991 (Hales and Crowther, 1992).

The severe weather season in the Billings CWA is generally from May through August (Fig. 4). There is a dramatic increase in severe hail from May to June and a significant decrease from July to August (Fig. 4). In August, there is usually less moisture in the lower levels of the atmosphere while freezing levels are higher indicating warmer air aloft, and henceforth, a more stable atmosphere in the afternoon than what is typical for June and July. Damaging winds are concentrated between June and August. This is most likely because afternoon surface temperatures are usually at their warmest during those three months. Tornadoes tend to occur between May and July with a significant decrease in August. Hail and tornadoes peak in June and early July when supercell type thunderstorms are most common in south-central and southeastern Montana, while damaging winds peak in July possibly because of drier sub cloud environments, and storms in weak shear environments. In May, the main threat of severe weather is from hail, but by August the threat is equally split between wind and hail.

The main threat for damaging winds occurs from 2:00 p.m. through midnight MDT (Fig. 5). The severe hail threat exists from 2:00 p.m. to 2:00 a.m. MDT while the tornado threat runs from 4:00 p.m. to 9:00 p.m. MDT. There is a lack of severe weather reports from 2:00 a.m. to 2:00 p.m. MDT, which is most likely because of boundary layer decoupling which hinders potential winds from surfacing. The stabilization of the near-surface atmosphere that takes place after sunset overnight (the formation of a surface inversion). The low report totals may also be caused by the lack of spotter calls during the early morning hours.

As previously discussed, hail reports rise dramatically in June (Fig. 4). Large hail (1.75 inches diameter or greater) reports display a similar trend of peaking in June and decreasing thereafter. Golf-ball sized or larger hail has not been reported in April or September (Fig. 6). Of all hail reports, about 20-30% are 1.75 inches or greater in diameter (Fig. 7). The time frame for large hail is similar to that of all severe hail (Figs. 5 and 7) with a peak occurrence between 2:00 p.m. and 2:00 a.m. MDT.

Tornado occurrence drops off dramatically in August (Fig. 8). This is most likely because of the lack of dynamics and sufficient shear by late summer. However, an interesting peak in F2 occurrence is evident in July. One possible explanation is that most of these occurrences happen early in July when dynamics is still a major contributor. Tornadoes occur from 11:00 a.m. to 2:00 a.m. MDT, although F2's or greater have only occurred from 3:00 p.m. to 10:00 p.m. MDT (Fig. 9). F2 tornadoes are most common between 6:00 p.m. and 10:00 p.m. MDT which is often when the evening atmosphere is most unstable.

Conclusions

Severe thunderstorm reports have become a more common occurrence in south-central and southeastern Montana during the 1990s. However, this is most likely due to better detection and verification efforts. Severe thunderstorm activity is most common in south-central and southeastern Montana between 3:00 p.m. and 10:00 p.m. MDT between May and August. Damaging winds are most common between 2:00 p.m. and midnight MDT from June through August. Severe hail is most common between 2:00 p.m. and 2:00 a.m. MDT in June and July, while tornadoes are most common between 4:00 p.m. and 9:00 p.m. MDT in May through July.

Acknowledgments

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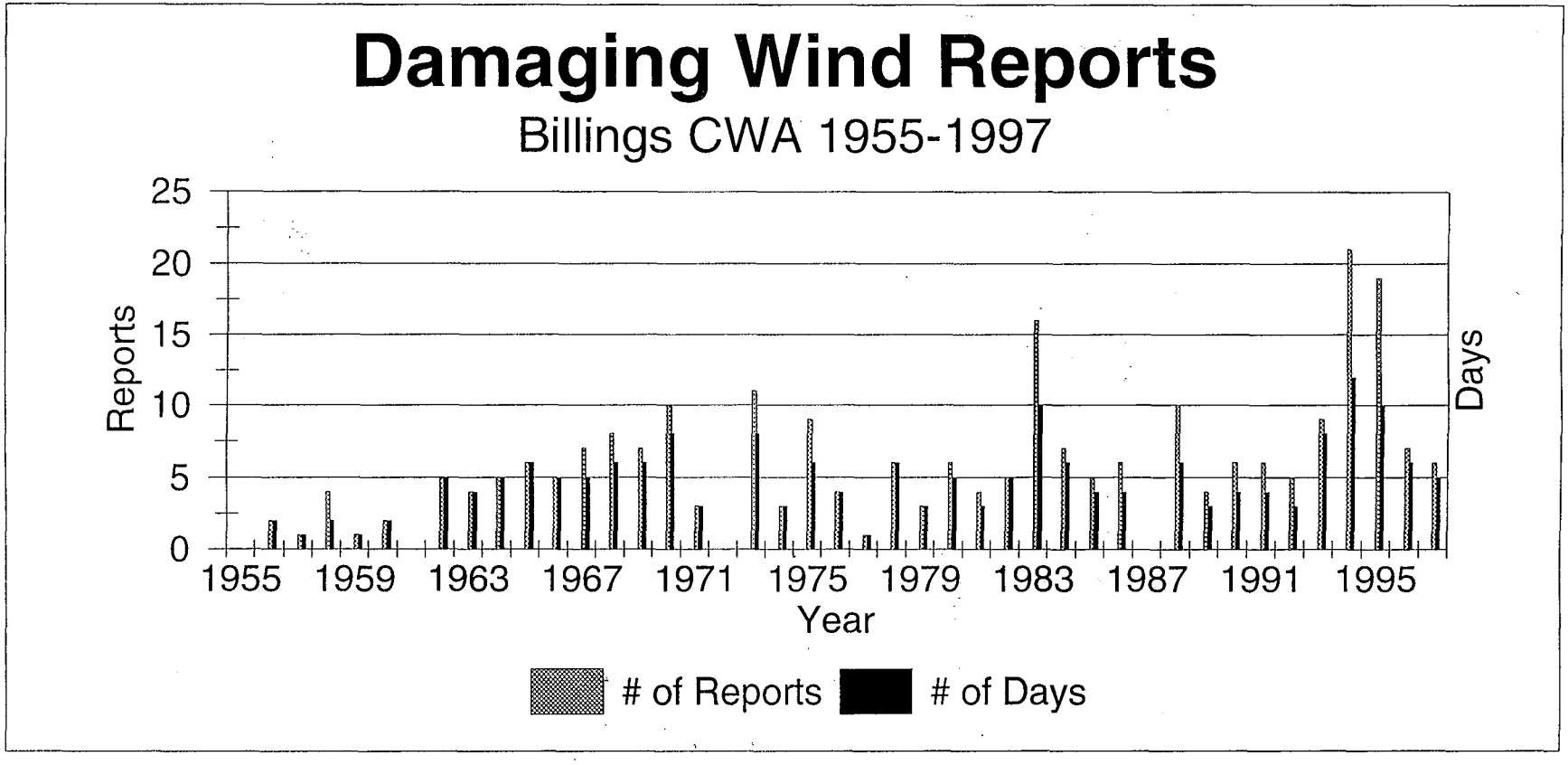

Figure 1: Damaging wind reports and number of days with damaging winds in the Billings CWA annually from 1955 to 1997.

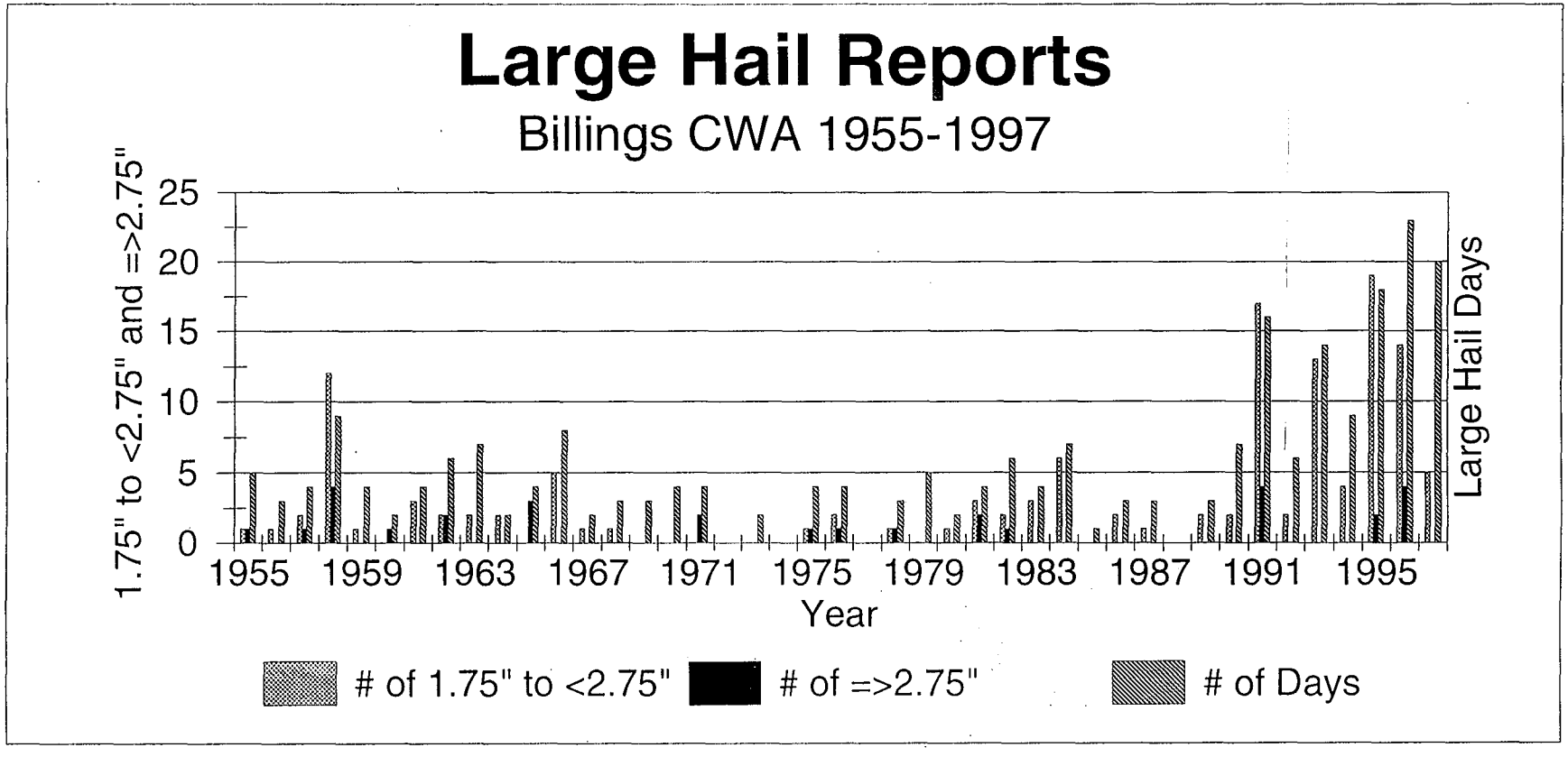

Figure 2: Large hail reports with the number of reports of hail at least 1.75 inches in diameter but less than 2.75 inches in diameter, hail of 2.75 inches or greater in diameter, and the number of days of large hail in the Billings CWA annually from 1955 to 1997.

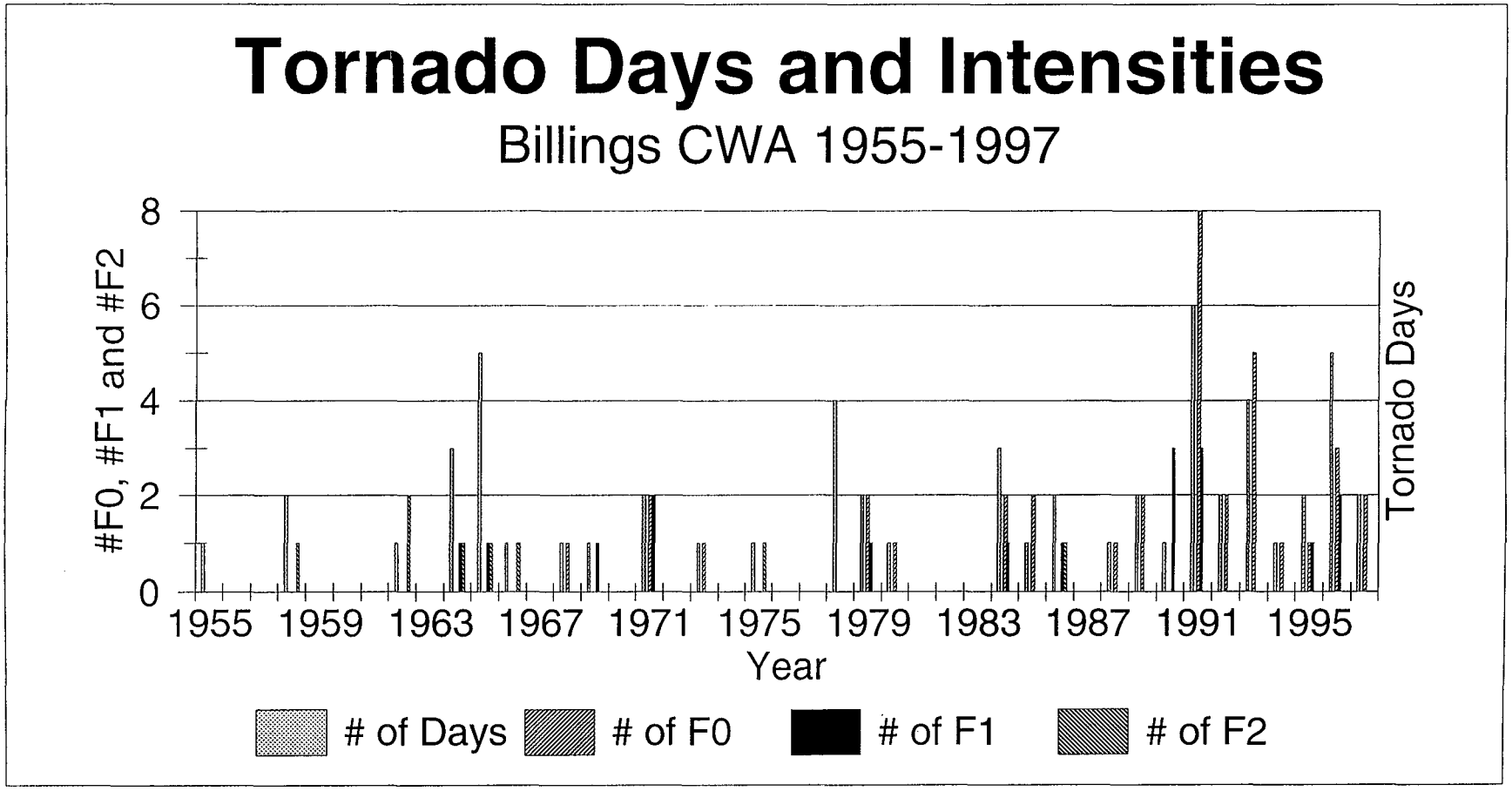

Figure 3: The number of F0, F1 and F2 tornadoes and the number of days in which tornadoes were reported in the Billings CWA annually from 1955 to 1997.

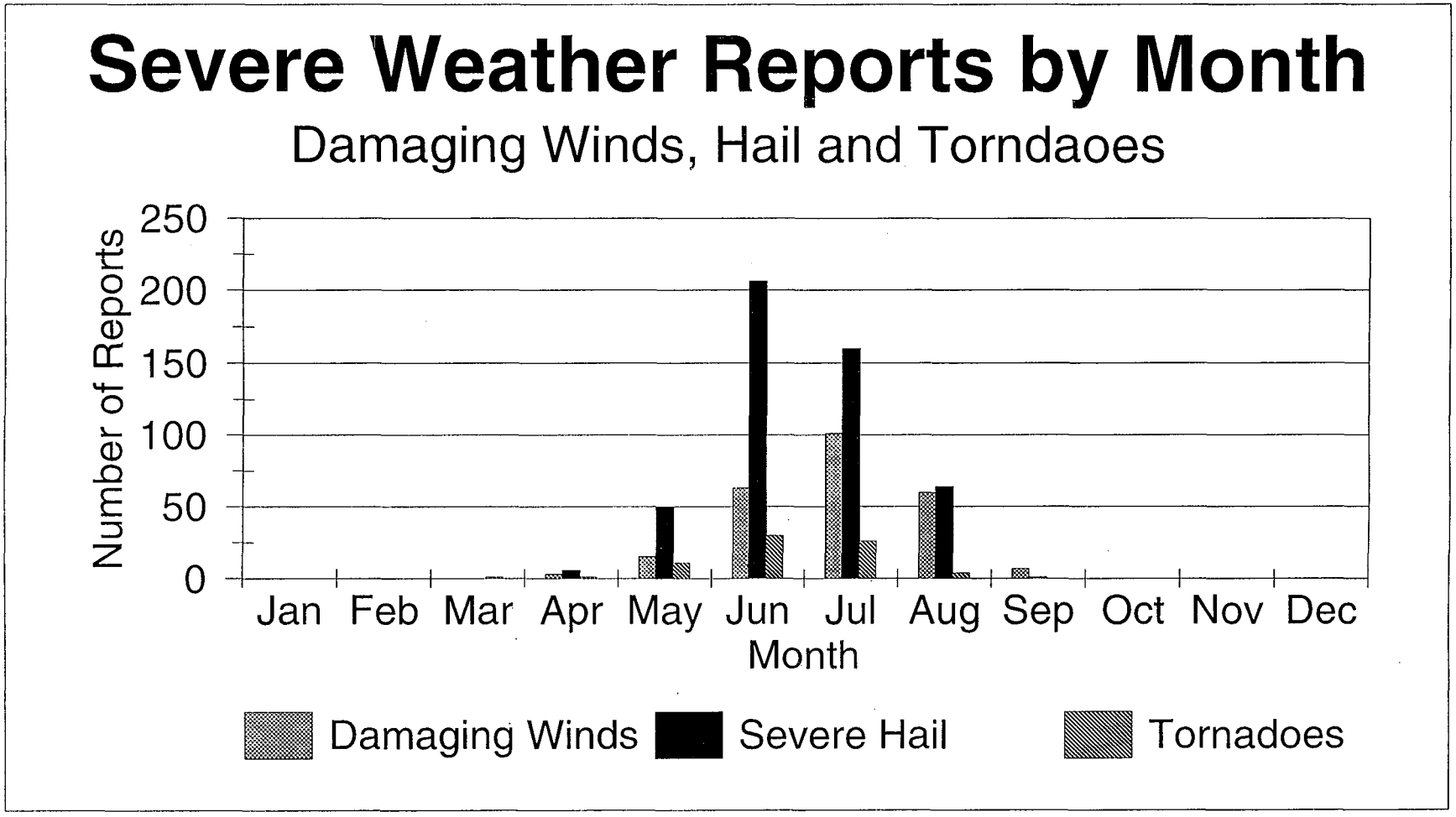

Figure 4: Severe weather reports by month including damaging winds, severe hail, and tornadoes.

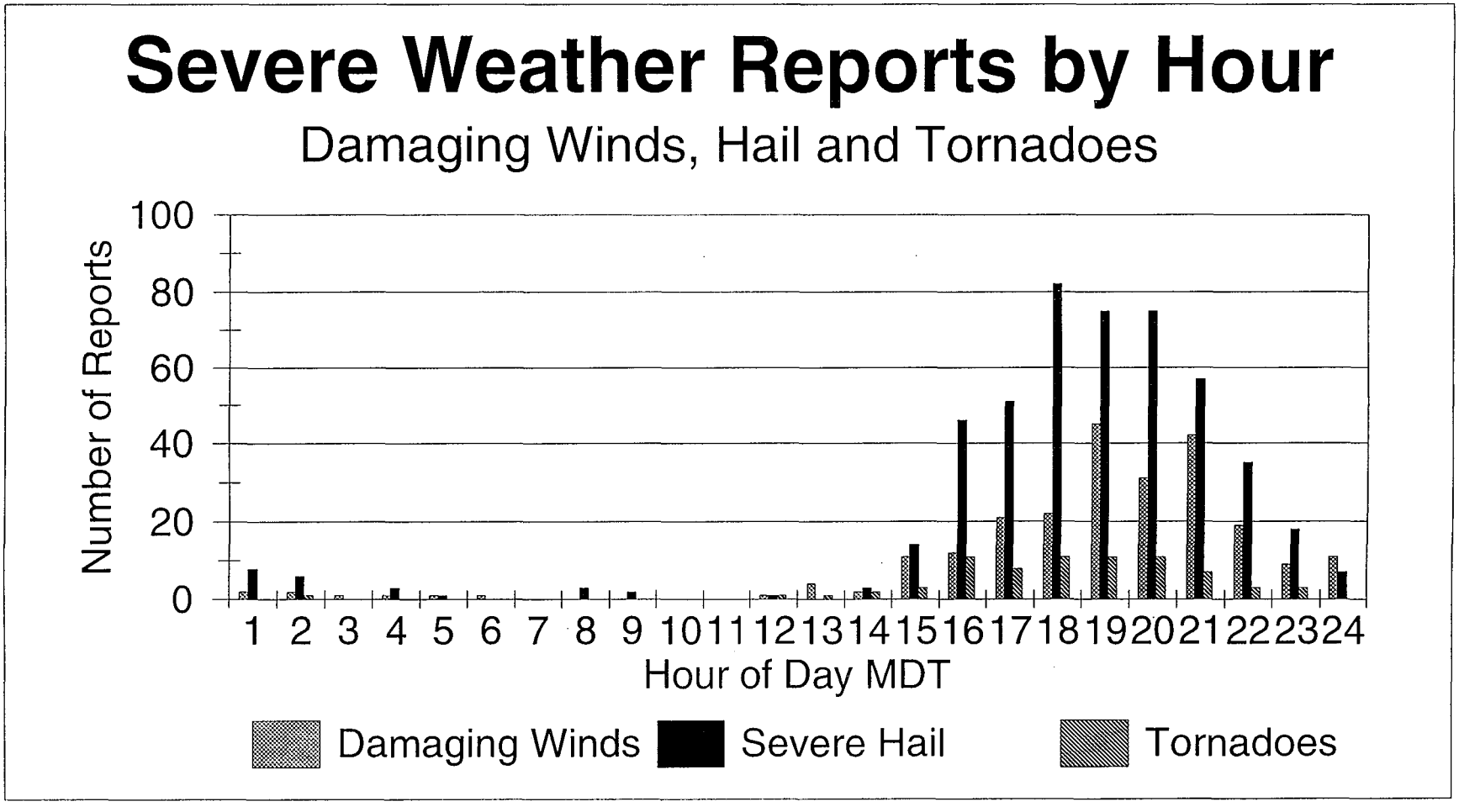

Figure 5: Hail reports by month including all severe hail, hail at least 1.75 inches in diameter but less than 2.75 inches in diameter and hail of 2.75 inches or greater in diameter.

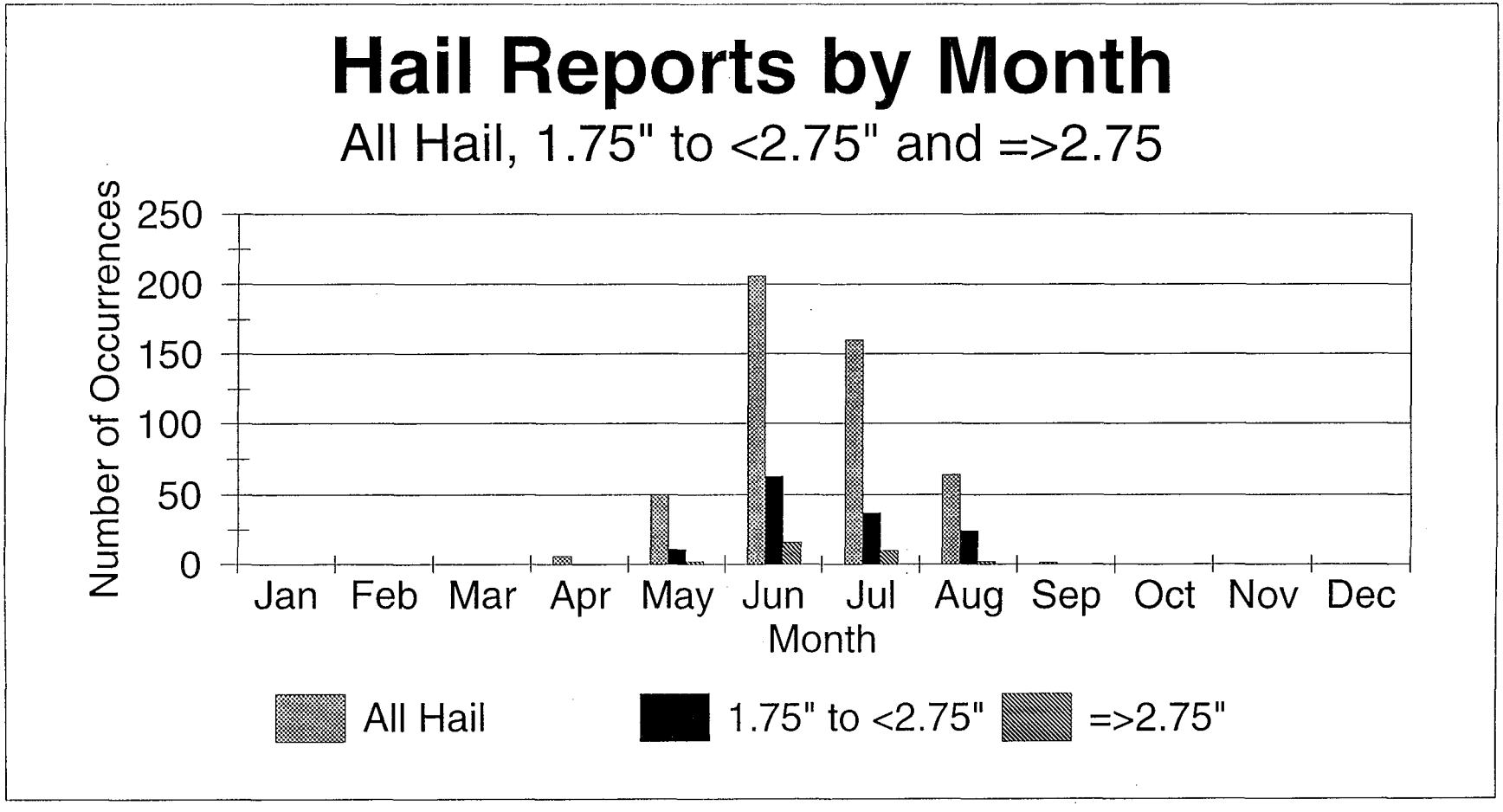

Figure 6: Tornado reports by month including all tornadoes and F2 or greater tornadoes.

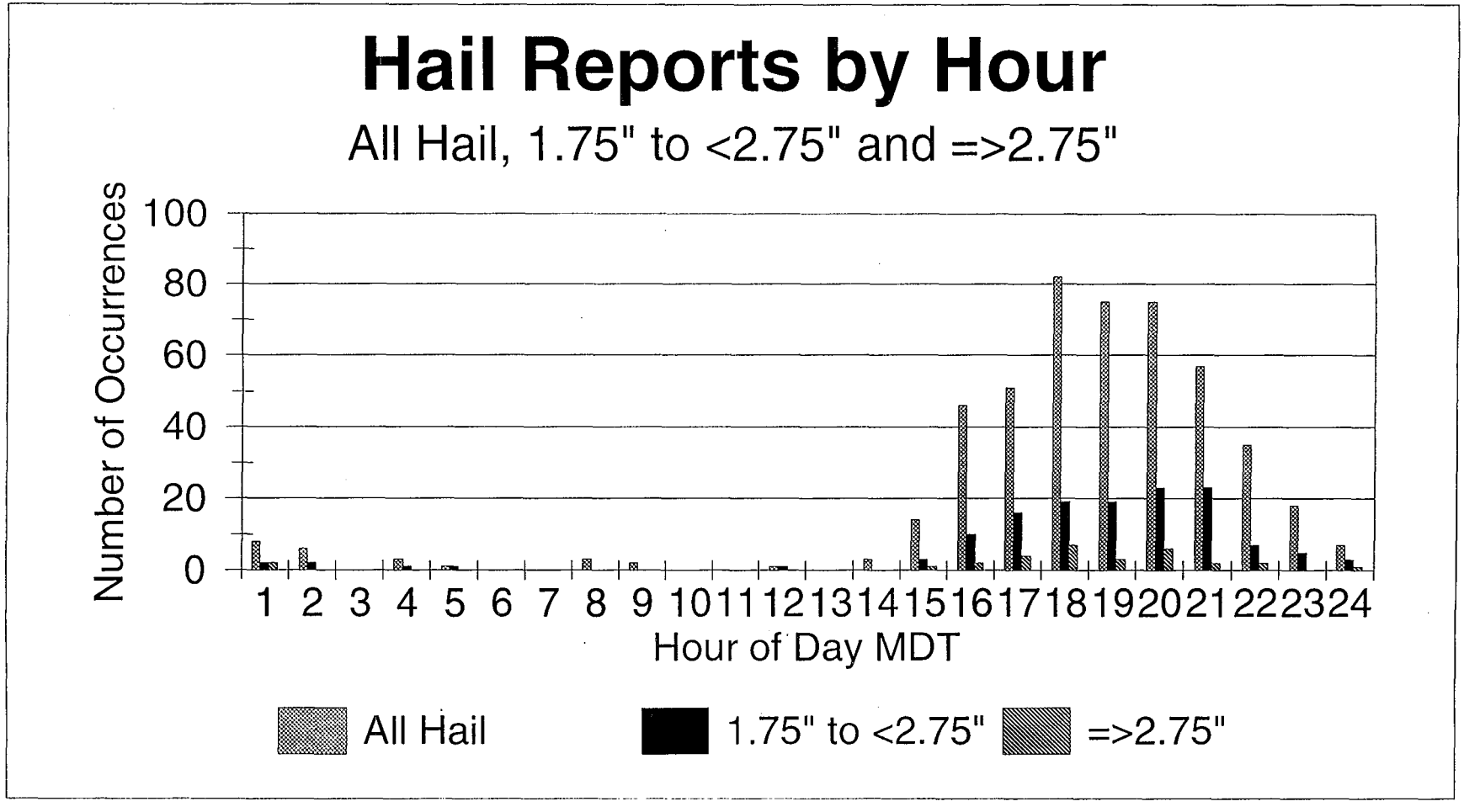

Figure 7: Severe weather reports by hour including damaging winds, severe hail, and tornadoes.

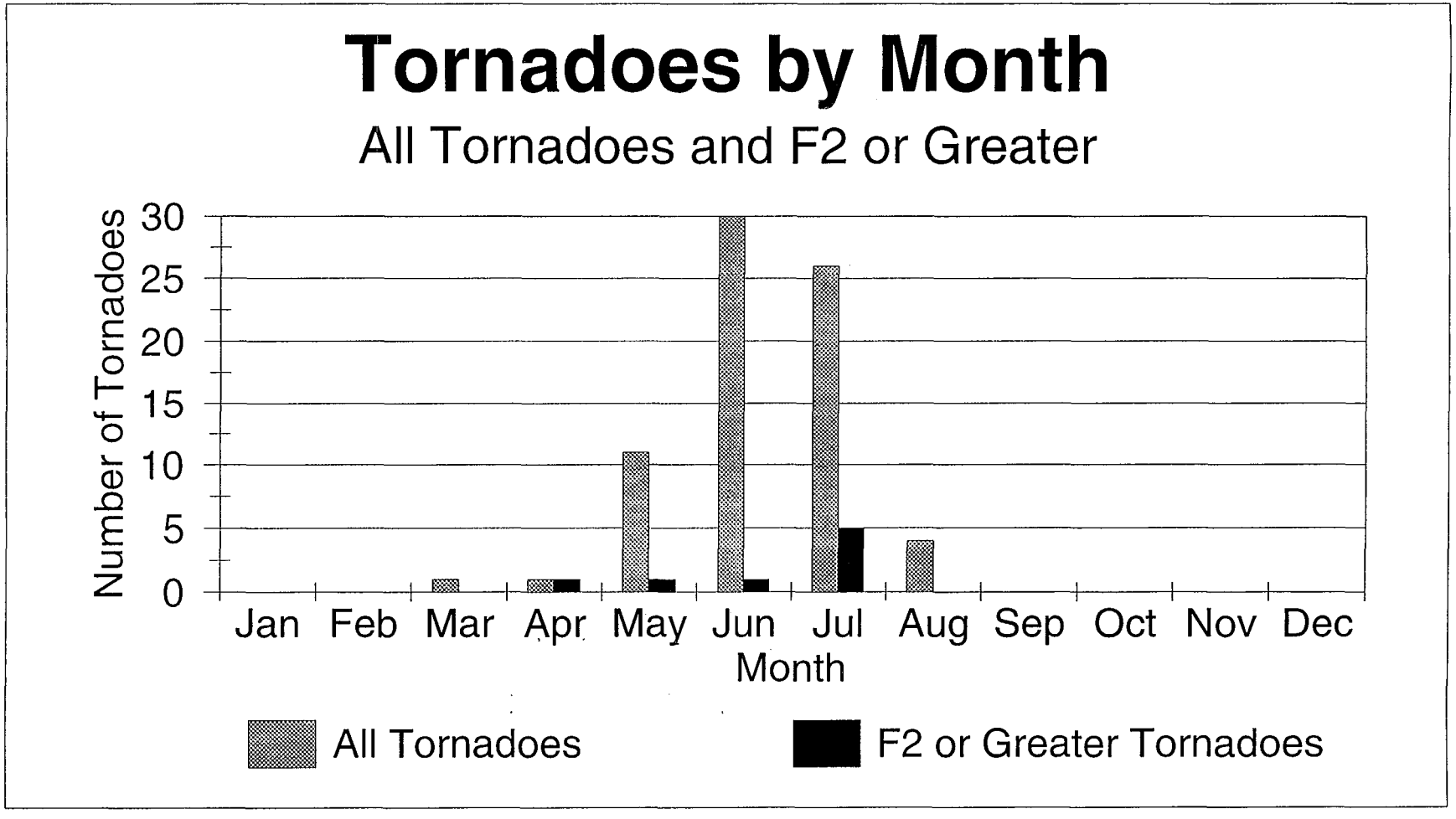

Figure 8: Hail reports by hour including all severe hail, hail at least 1.75 inches in diameter but less than 2.75 inches in diameter and hail of 2.75 inches or greater in diameter.

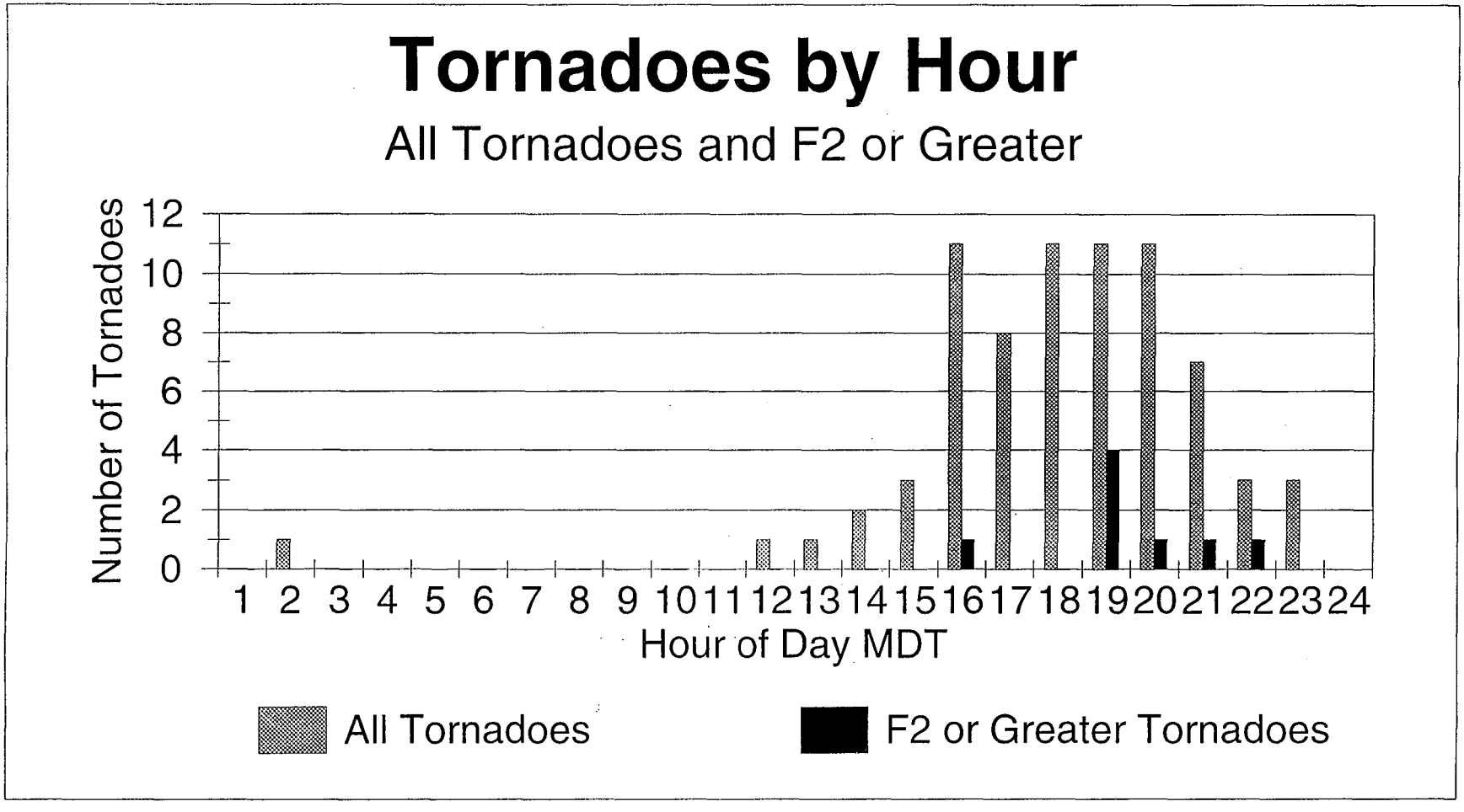

Figure 9: Tornado reports by hour including all tornadoes and F2 or greater tornadoes.