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SEVERE THUNDERSTORM CLIMATOLOGICAL DATA FOR THE NEW JACKSONVILLE, FLORIDA, COUNTY WARNING AREA

Richard W. Anthony
National Severe Storms Forecast Center
Kansas City, MO

Scientific Services Division
Southern Region
Fort Worth, TX

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Ronald H. Brown, Secretary

National Oceanic and Atmospheric Administration
Diana H. Josephson
Acting Under Secretary

National Weather Service
Elbert W. Friday
Assistant Administrator

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ABSTRACT

A detailed severe weather climatology for the land area within 125nm of Jacksonville, Florida, was produced to assess risk and identify suitable forecast problems relating to severe weather. For the period 1955-1993, 685 tornadoes were reported within 125nm of Jacksonville, while more than 1430 wind events and 450 hail events were reported. The monthly tornado distribution maximum occurs in May, the maximum for severe thunderstorm wind reports occurs in June, and the maximum for hail reports occurs in April. These data show a consistent minima in reports northwest of Jacksonville which correlates with the Okefenokee Swamp and the lower population density.

1. INTRODUCTION

The Jacksonville, Florida, Weather Service Office (WSO), like many other WSOs, will evolve from a WSO to a NEXRAD WSO (NWSO), and finally to a Weather Forecast Office (WFO). Severe thunderstorm activity is one of the most significant meteorological events that can affect a forecast area. Climatological information on tornado characteristics and severe thunderstorm wind and hail events is vital to assessing the threat for any given area of the country. Schmocker et. al. (1990) identify several reasons for developing this kind of climatological database, but perhaps the most important is that it provides basic meteorological knowledge forecasters will need for their forecasts and warnings.

Fig. 1 shows the future WFO Jacksonville County Warning Area (CWA) consisting of 15 counties in northeast Florida and 14 counties in southeast Georgia, including forecast zones by county and zone number. The major rivers and swamps located in the Jacksonville CWA are also depicted. Fig. 2, which also shows the CWA, is shaded according to population density. Duval County where Jacksonville is located has the greatest population density, while counties such as Clinch and Charlton in southeast Georgia have relatively low population. The primary topographical feature influencing the severe thunderstorm climatology seems to be the Okefenokee Swamp with its relatively low population density. The following sections provide more specific information on the Jacksonville CWA severe thunderstorm climatology.

2. SEVERE THUNDERSTORM CLIMATOLOGY

The tornado/severe thunderstorm climatology has been compiled by the National Severe Storms Forecast Center (NSSFC) for the period 1955 through 1993. Data presented were extracted from the NSSFC database via a PC-based software package called SVRPLOT (Hart, 1993). By definition, only convectively induced phenomena producing tornadoes, convective wind damage, or gusts $>26ms^{-1}$ (50kts), and hail diameter >1.9cm (¾ in) are included in these data. The severe weather events presented include all documented events over land within 125nm radius of Jacksonville, Florida. The area covered actually extends beyond the Jacksonville County Warning Area (CWA) (Fig. 1).

The historic climatological trend of all severe reports for the period 1955-1993 is presented in Fig. 3a. These data show a significant yearly increase after the early 1970s. Of the many factors likely responsible for this trend, the two more dominant are probably the increase in population and improved reporting procedures. Fig. 3b provides a yearly total for each severe type. These data show that much of the significant increase in reports noted since the early 1970s was generally due to tornadoes and wind reports in the mid 1970s but primarily due to wind and hail reports in the 1990s.

2.1 TORNADO CLIMATOLOGY

Fig. 4 is a plot of the 685 tornado reports for the period 1955-1993. The circle in the figure delineates the area within 125nm of Jacksonville. It is interesting that several counties in southeast Georgia have had very few tornadoes reported for the 1955-1993 time period. From an inspection of Fig. 1, one sees that the counties of Echols, Clinch, Charlton, and Ware are primarily swamp and thus are sparsely populated. While there may be a valid meteorological reason for a lack of tornadoes in this area, a more likely explanation is that it suffers from a lack of observations. Fig. 4 suggests that the tornado events over northeast Florida are much more uniformly distributed, with a slight concentration of reports in Duval and Suwannee counties where the population density is greater.

The monthly tornado distribution (Fig. 5a) indicates that tornado activity is at a maximum in May, but April and June are not far behind. The late fall months of October and November have the fewest tornadoes. These data appear to reflect the occurrence of strong late spring and early summer weather systems that produce severe weather outbreaks. Unlike the June maximum noted by Schmocker et al. (1990) for Melbourne, Florida, the May maximum for Jacksonville suggests the influence of late spring weather systems with stronger dynamics.

The hourly distribution (Fig. 5b) approaches a normal curve with the mean time of occurrence 1400 EST. Although tornadoes have been reported at every hour of the day, there is a more gradual rise in reports in the morning and a steeper decrease in reports during the evening. However, about two thirds of all tornadoes occur during the afternoon hours (1200-1800 EST), suggesting strong influence of diurnal heating.

Details on the characteristics of the tornadoes are provided by graphs of F-scale, path length, path width, and mean touchdown time shown in Figs. 6a-d, respectively. The graphs show that the majority of tornadoes are relatively weak, narrow, and short-lived. However, unlike the Melbourne CWA, more Fl than F0 tornadoes are reported. This probably reflects the fact that a majority of the tornadoes form in the stronger instability of the afternoon within the slightly stronger dynamic environment of late spring and early summer. The average tornado, computed from all tornado reports with sufficient data, has an F-scale of .88, a path length of 2.O6 miles, and a path width of 100 yards. Fig. 6a shows that there has never been a reported F4 or F5 tornado within 125nm of Jacksonville, but 11 F3s, and 132 F2s have been documented. Fig. 6d shows the average time of tornado touchdown by month for all tornadoes in the Jacksonville CWA. Most notable is the observation that the mean touchdown time for all months is 1448 EST, but it is prior to noon for February and March and in the afternoon for all other months.

The hourly distribution of tornadoes by month (Figs. 7a-d) is presented to more clearly detail the monthly and seasonal characteristics of tornado occurrences. The distribution for January, February, and March (Fig. 7a) is clearly different from the others, with most of the tornadoes occurring prior to noon. January tornadoes peak just after noon, while February tornadoes peak at 0900 EST with a secondary peak at 14OO EST. March tornadoes peak at 0900-1000 EST with a secondary peak at 0600 EST.

In April, May, and June (Fig. 7b) the majority of tornadoes occurs in the mid afternoon, peaking at 1600 EST in April, 1500 EST in May, and 1500 EST in June. However, considerable mid to late morning activity is also noted.

In the summer months (Fig. 7c), tornadoes occur almost exclusively in the afternoon and early evening hours. The highest hourly frequency of tornadoes for the year occurs at 15OO EST in June and 1500 and 1600 EST in July. Not surprisingly, the timing of warm season tornadoes appears closely correlated with afternoon heating.

The fewest tornadoes recorded are in the months of October, November, and December (Fig. 7d). However, a relative maxima for all three months is evident in the early afternoon.

The monthly frequencies of strong tornadoes (which produced 90% of the fatalities and nearly 70% of the injuries) (F2-F3), deaths, and injuries are shown in Figs. 8a and b. Strong tornadoes have occurred in every month of the year with a maximum frequency in April (31). Frequencies are surprisingly uniform from January to June. Tornado fatalities have occurred in five months (March, April, May, November, and December) while injuries have occurred in every month except September. The most injuries (116) seem to occur in April. The frequency scale was expanded in Fig. 8b so that the lower frequency information can be seen. From these data it is evident that the risk of injuries from strong tornadoes is greatest during the winter and spring months of December through April.

The hourly distribution of strong tornadoes, deaths, and injuries is shown in Figs. 9a,b. The injury maxima at 2300 EST in Fig. 9a is associated with the March 12-13, 1993, tornado outbreak where one tornado caused 60 injuries and one death. As in Fig. 8b, the number of injuries at 1000 EST was truncated in Fig. 9b to enhance the details in the lower frequency data. Note that the strong tornadoes are more uniformly distributed (than weaker tornadoes) throughout the day (except late evening). Also, there is a bimodal maximum in strong tornado reports with the highest frequency at 1500 EST, while a secondary one is evident at 0600 EST. This secondary maximum has been documented by several climatological studies of southeastern United States severe weather (Anthony 1988; Hagemeyer and Schmocker 1992; Knupp and Garinger 1993).

2.2 SEVERE THUNDERSTORM WINDS (>50 KNOTS OR CONVECTIVE WIND DAMAGE)

A plot of all severe thunderstorm wind gusts recorded within the 125nm radius of the Jacksonville WSO is depicted in Fig. 10. Similar to Fig. 4 for tornadoes, there is a minimum of severe wind gusts reported west northwest of Jacksonville. This minimum in reports can be attributed to both the Okefenokee Swamp and as a result of lower population density.

The monthly and hourly frequency distributions of severe thunderstorm wind gusts are depicted in Figs. 11a,b, respectively. During the period 1955 to 1993, 1433 events occurred. One sees that the early summer months of June/July have the highest frequency of wind gusts. The distribution shows a steady increase of events from April to June with a rather marked decrease in events from August through October. The distribution is similar to Fig. 5a for tornadoes, but the peak is delayed by one month.

Significant wind gusts (>60kts) are also depicted in Fig. 11a. Note that although the frequency of occurrence is much lower, in part, because most winds events are damage reports, not measured gusts, the distribution is more uniform, with minor peaks in June and July. The diurnal distribution (Fig. 11b) of wind events shows a normal distribution with the peak frequency during maximum solar insolation.

2.3 SEVERE THUNDERSTORM HAIL (>.75 OF INCH)

Fig. 12 depicts the 458 events of severe thunderstorm hail reports recorded within 125nm of the Jacksonville WSO during the period 1955-1993. The average number of hail events for the period is about 12 a year; however, recent trends (1990s) noted in Fig. 3b suggest an average of nearly 45 events may be more representative. As in Figs. 4 and 10, there is a distinct minimum of reported severe hail events northwest of Jacksonville.

The monthly and hourly frequency distributions for severe hail reported within 125nm of Jacksonville are depicted in Figs. 13a,b. The late spring to early summer months are the primary hail season. Note that the maxima in the distribution is April and May, while the maxima for severe wind gusts (Fig. 11a) is in June and July. These data suggest that the dynamics supporting these storm systems as they move into the region tend to lower freezing level heights such that the thunderstorms associated with the systems are more likely to produce hail events at the surface. As the seasons progress and thunderstorms become more frequent, the mean wet bulb temperature increases, and thunderstorms are less likely to produce hail. Fig. 13b, the diurnal frequency distribution, is similar to Fig. 11b in that both show dominant maxima during the peak solar heating period.

3. SUMMARY

This climatological analysis of data for the period 1955-1993 demonstrates that the threat of severe weather within 125nm of Jacksonville is significant. The Jacksonville CWA averages about 18 tornadoes per year. Also, about two-thirds of all tornadoes reported are F1 or greater. Of the 685 tornadoes reported, 143 (21%) were in the strong category. Seventy-five percent of the strong tornadoes occur from January to June with nearly 25% (31) occurring in April. Five hundred nine injuries were reported during the period studied, and 338 (66%) were a result of strong tornadoes. Twenty deaths were recorded as a result of the tornadoes; 18 (90%) were attributed to strong tornadoes, and 15 of the 20 (75%) occurred before noon.

Historically, about 38 severe thunderstorm wind events occur per year. However, trends since the mid 1980s (Fig. 3b) suggest a number nearly double this may be more representative. During the 39-year period, the 1433 wind events caused 50 injuries and three fatalities. The increasing number of reports from January through June (Fig. 11a) suggests that the combination of strong synoptic-scale dynamics and early summer insolation/instability contribute to the majority of reports.

Severe thunderstorm hail events have averaged about 12 per year until recently. The most dominant season for severe hail reports is late spring and early summer. These data suggest that weather systems that move into the region are sufficiently strong to lower freezing levels to heights that favor the production of severe hail events.

One specific area for further investigation would be to define the synoptic environment associated with the weak, short-lived tornadoes that tend to occur during the afternoon in the summer months from June to September, and contrast it with the environment supporting the stronger tornadoes that tend to occur during the morning hours from December to March.

Since these data indicate that a transition seems to occur in the late spring and early summer months between hail and wind-producing storms, additional study is needed to identify specific atmospheric changes that support this finding.

The morning peak in tornadoes evident in the February and March hourly tornado distribution (Fig. 7a) has been hypothesized by Knupp and Garinger (1993) to be primarily a gulf coast phenomenon. Since the Jacksonville CWA includes several inland gulf coast counties, additional climatological detail by counties might identify how much of the Jacksonville CWA is affected by this phenomenon. Perhaps hourly distribution county data for hail and wind events would also identify other meteorological phenomena affecting the severe thunderstorm climatology in the Jacksonville CWA.

5. ACKNOWLEDGMENTS

The author thanks Mike Manker for his assistance in creating Fig. 1 and 2 and John Hart for his assistance in manipulating SVRPLOT to obtain desired results. Also, my sincere appreciation to Karl Jungbulth, Steve Weiss, and Carolyn Kloth for their suggestions and careful review of this manuscript.

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Knupp, K.R. and L.P. Garinger, 1993: The gulf coast region morning tornado phenomenon. *Preprints, 17th Conf. on Severe Local Storms*, St. Louis, Amer. Meteor. Soc., 20-24.

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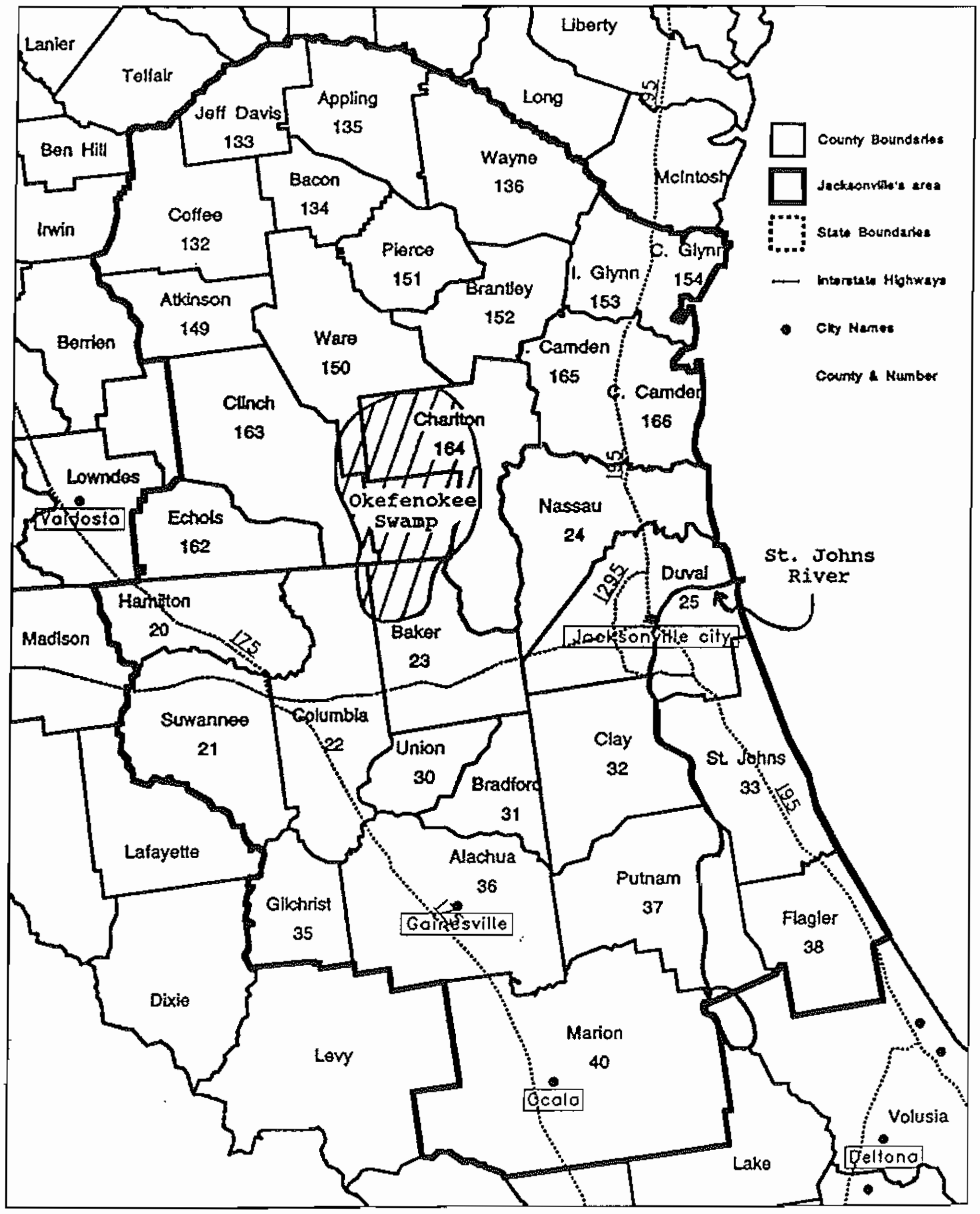


Fig. 1. WFO Jacksonville, Florida, CWA including forecast zones by county, zone number,and topographical features. Figure produced by Mike Manker.

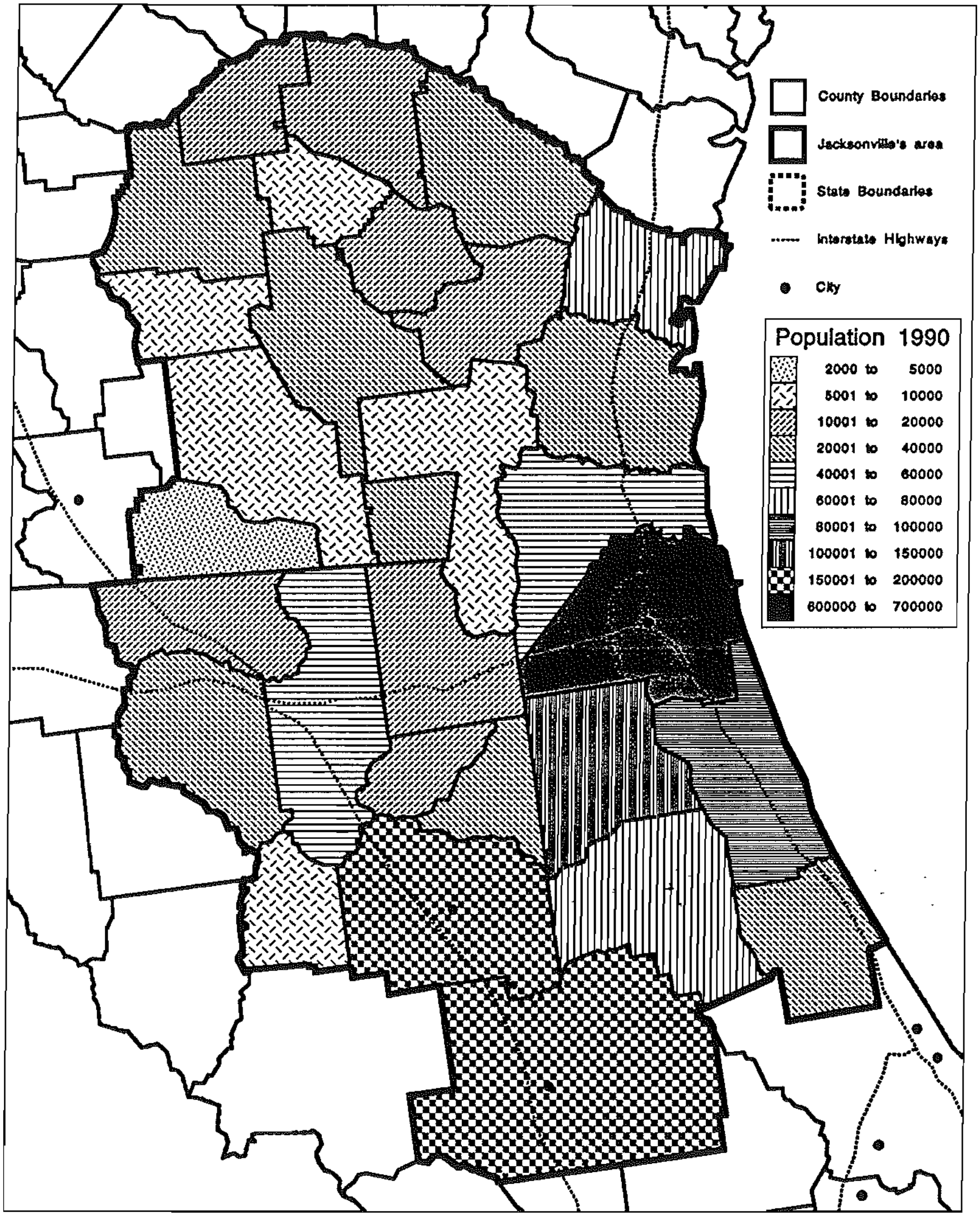


Fig. 2. WFO Jacksonville, Florida, CWA gray shaded for population density. Figure produced by Mike Manker.

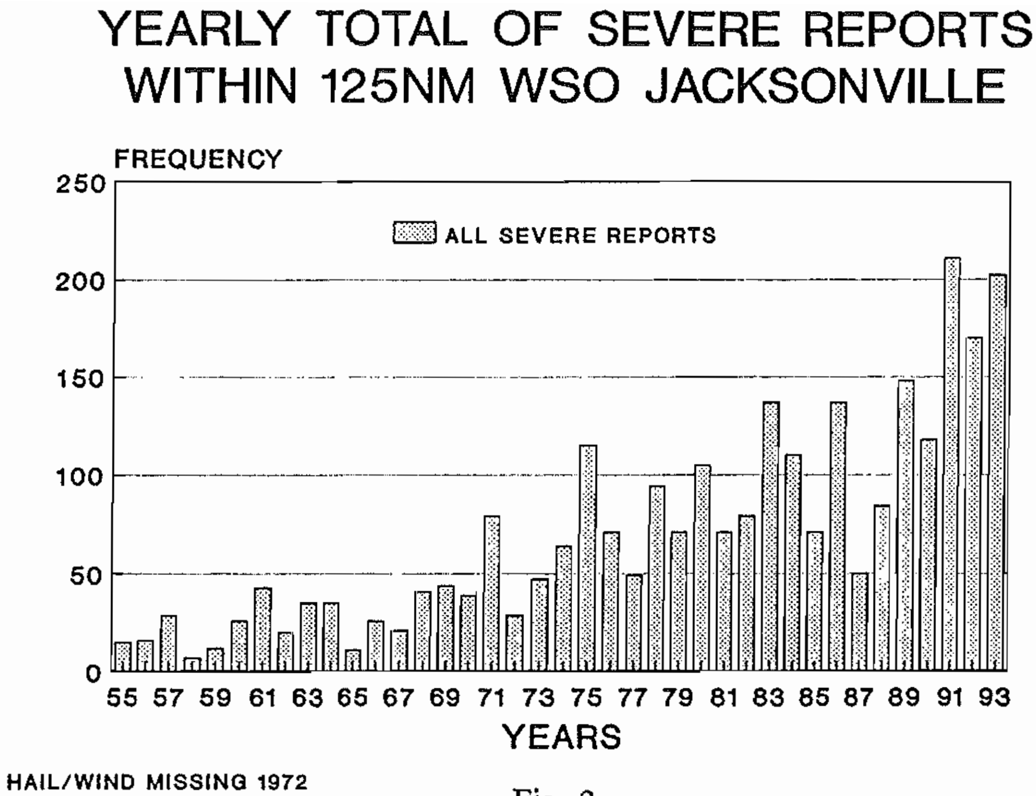


Fig. 3a

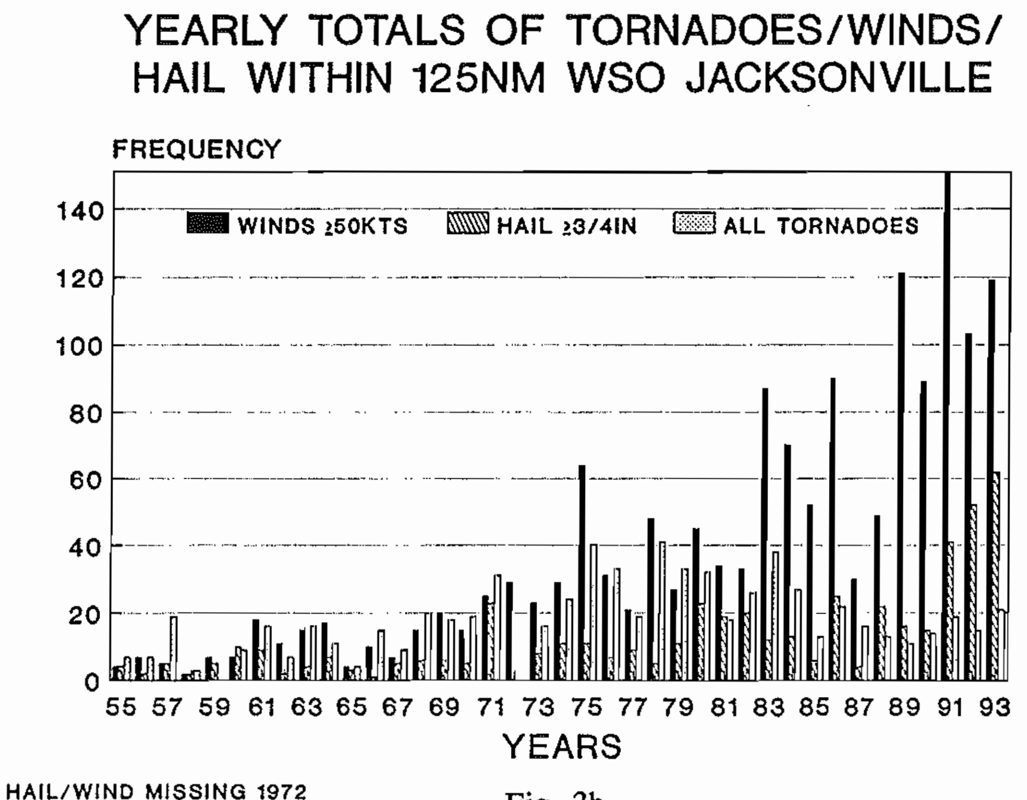


Fig. 3b

Fig. 3. Yearly total of all severe reports and each severe type within 125nm of WSO Jacksonville, Florida, for the period 1955-1993. (1972 wind/hail reports missing)

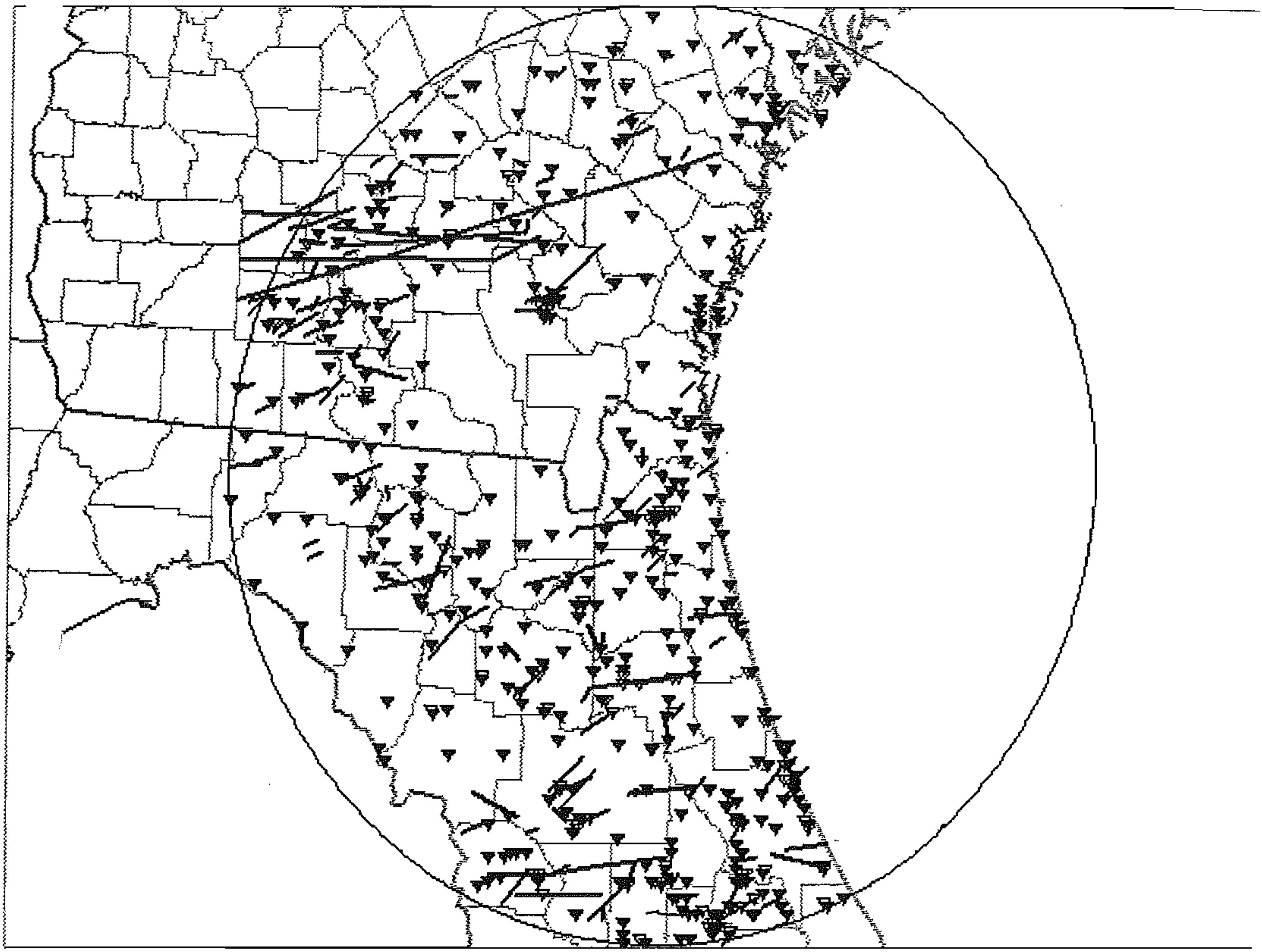


Fig. 4. Plot of reported tornadoes within 125nm Jacksonville, Florida. A total of 685 tornadoes for the period 1955-1993 are plotted. Inverted triangles represent tornado touchdowns and line segments identify tornado tracks.

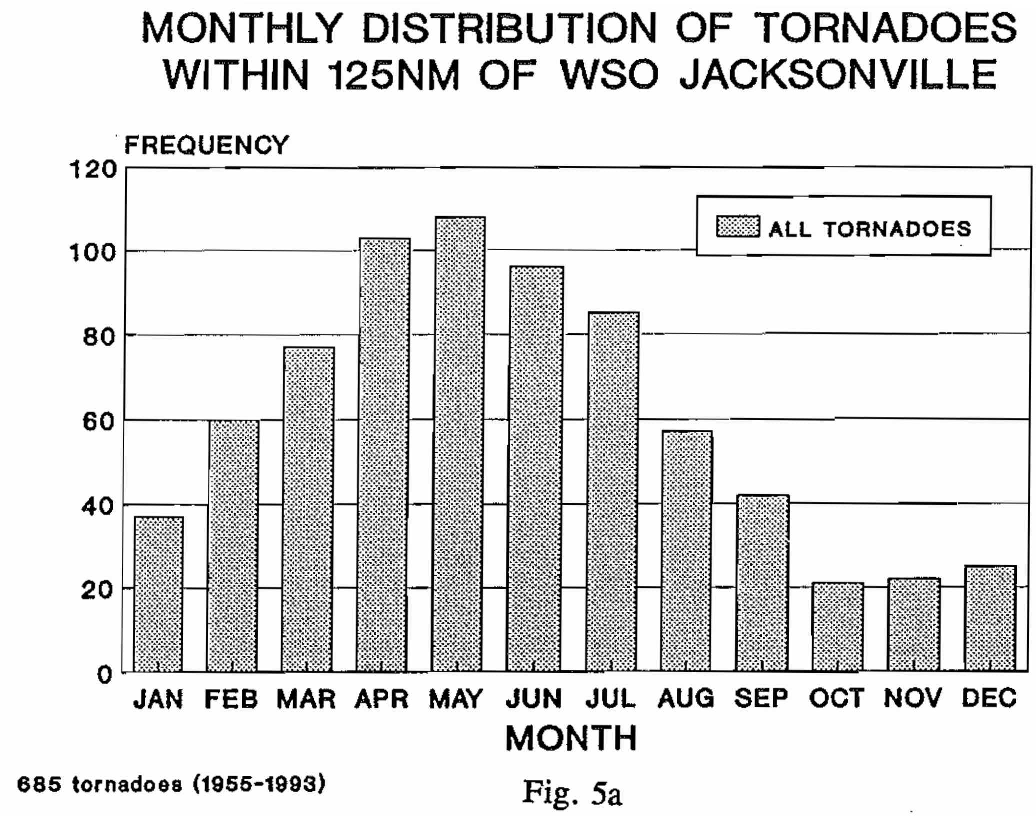


Fig. 5a

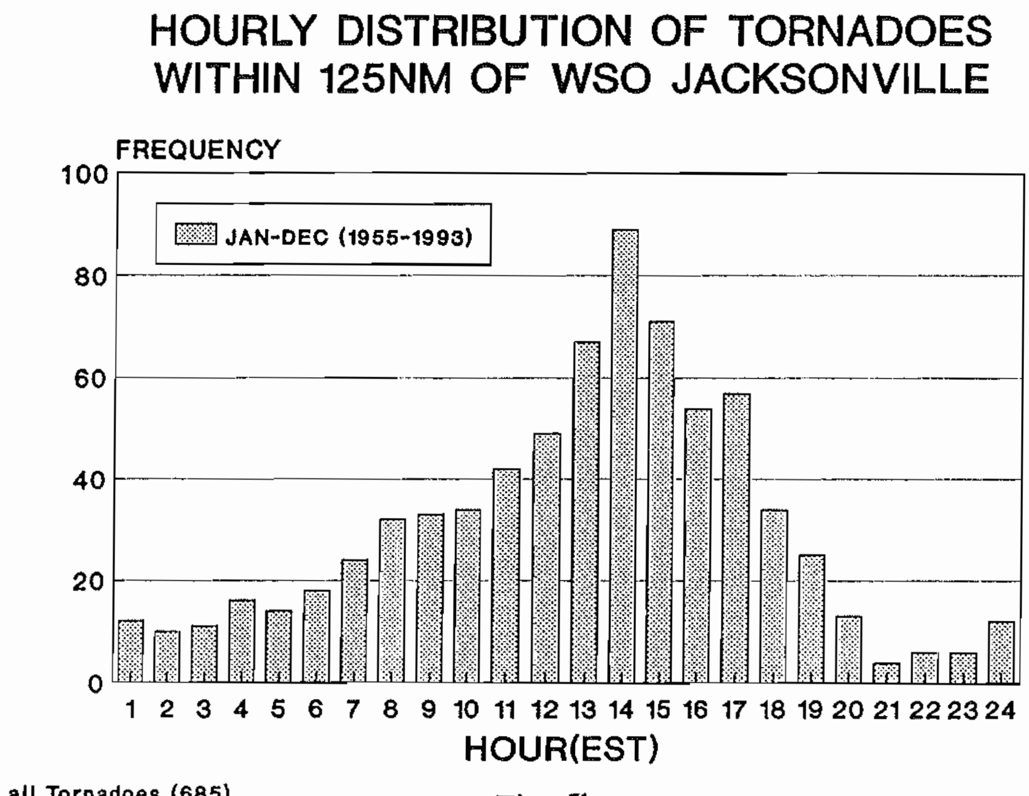
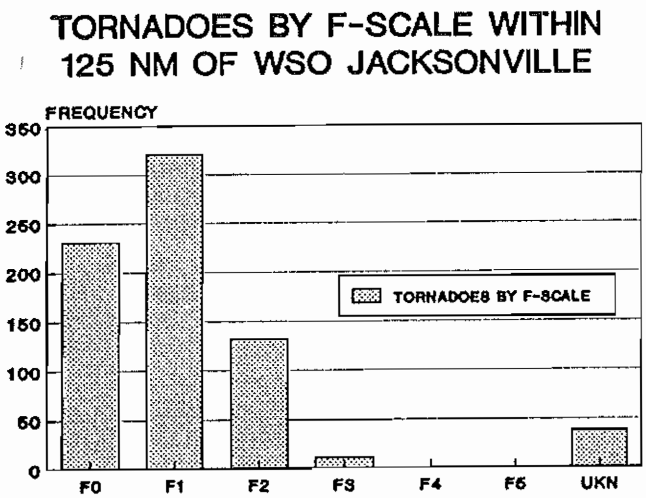


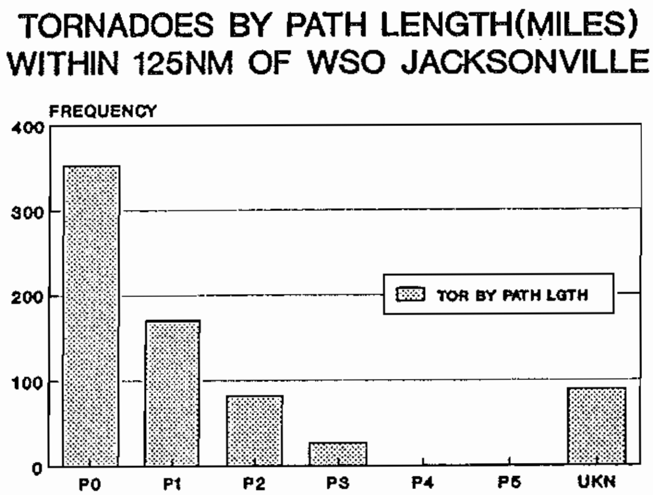
Fig. 5b

Fig. 5. Monthly and hourly distribution of tornadoes within 125nm of Jacksonville, Florida, for the period 1955-1993.



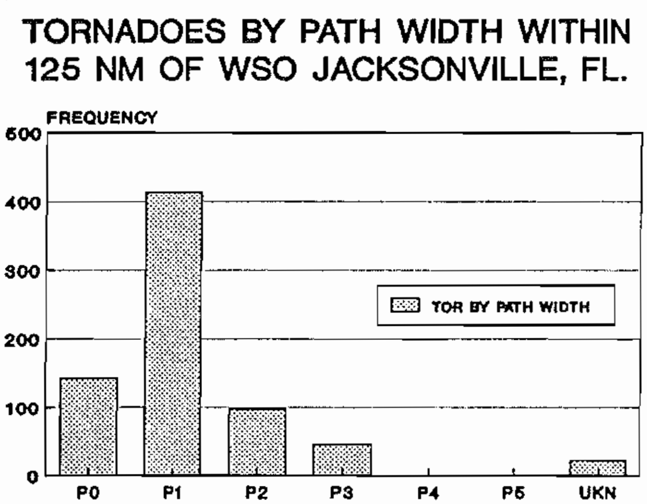
F0 <72mph: F1 73-112: F2 113-157
F3 158-206: F4 207-260: F5 261+ mph

Fig. 6a



P0 < 1. miles: P1 1.0-3.1:P2 3.2-9.9
P3 10-31:P4 32-99:P5 100+ miles

Fig. 6b



P0 <18 yards:P1 18-55: P2 56-175
P3 176-526: P4 527-1759: P5 1760+ yards

Fig. 6c

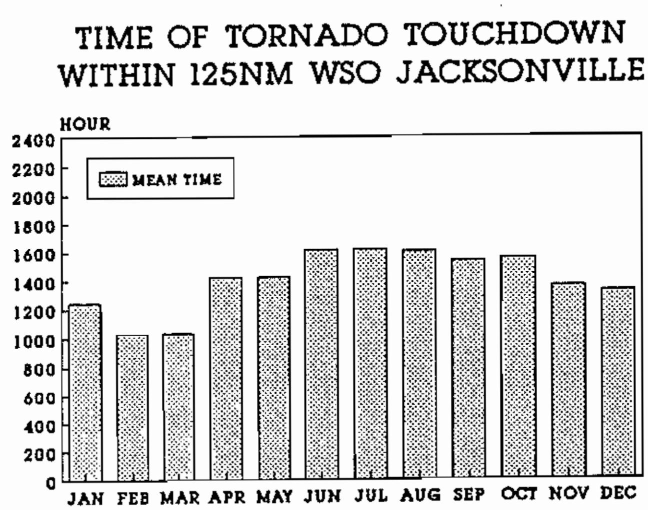


Fig. 6d

Fig. 6. Tornadoes by F-scale (6a), path length (6b), path width (6c), and time of tornado touchdown (EST) (6d).

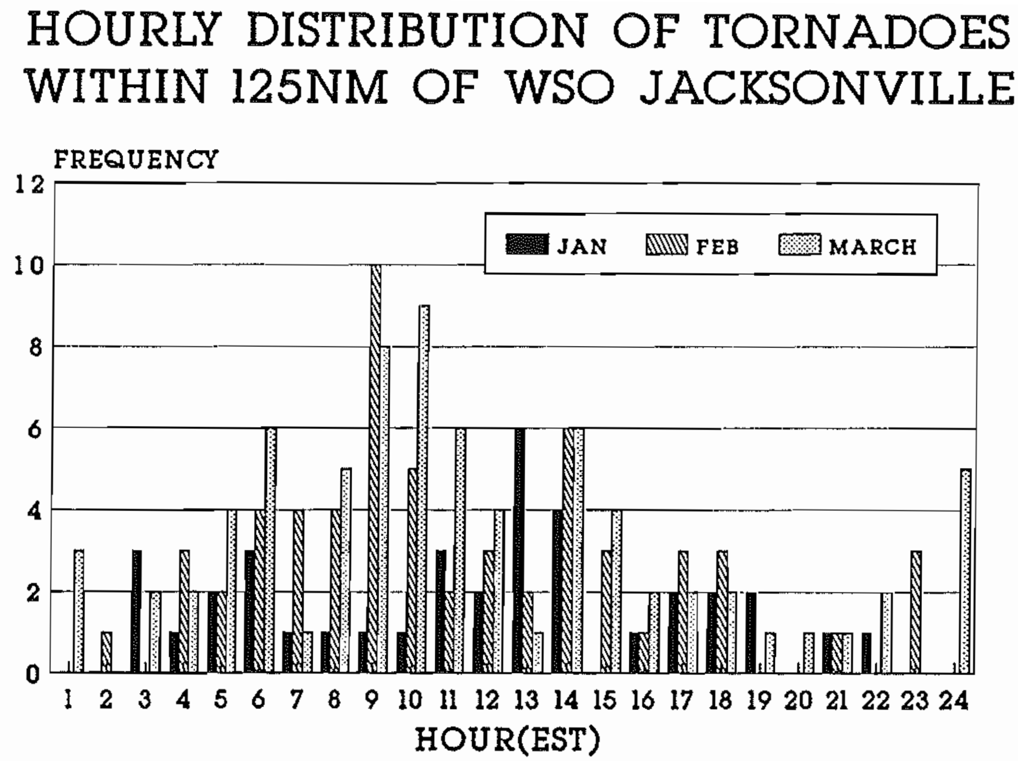


Fig. 7a

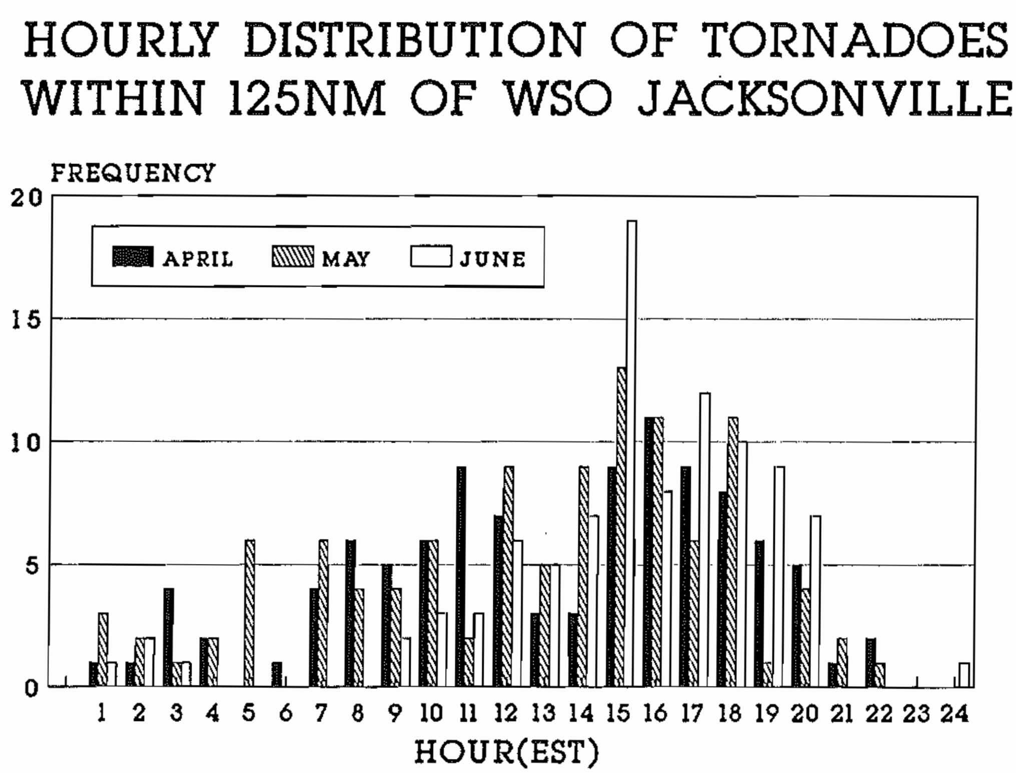


Fig. 7b

Fig. 7. Hourly distribution of tornadoes by month within 125nm of WSO Jacksonville, Florida, for the period 1955-1993.

HOURLY DISTRIBUTION OF TORNADOES WITHIN 125NM OF WSO JACKSONVILLE

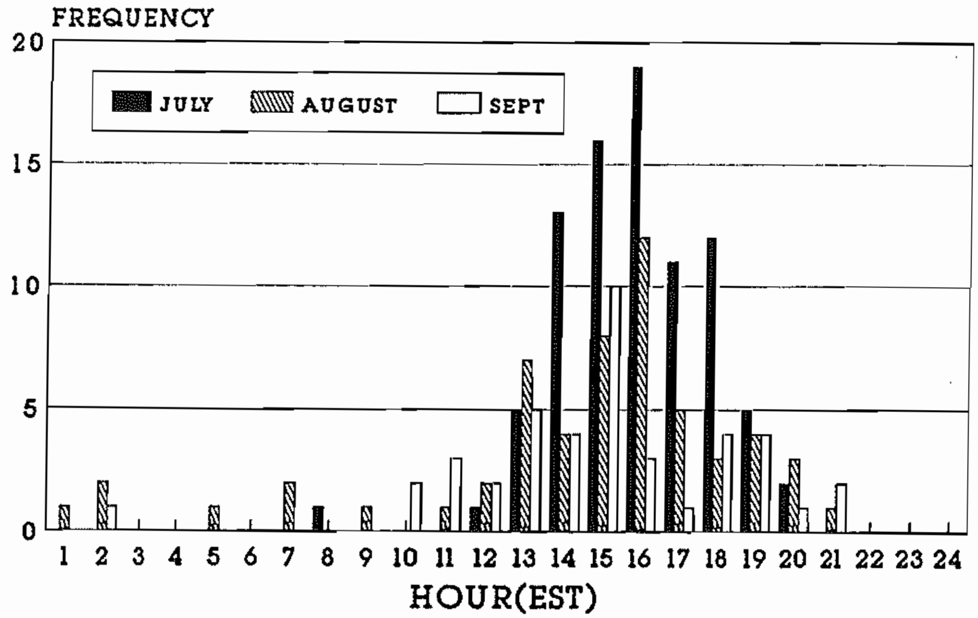


Fig. 7c

HOURLY DISTRIBUTION OF TORNADOES WITHIN 125NM OF WSO JACKSONVILLE

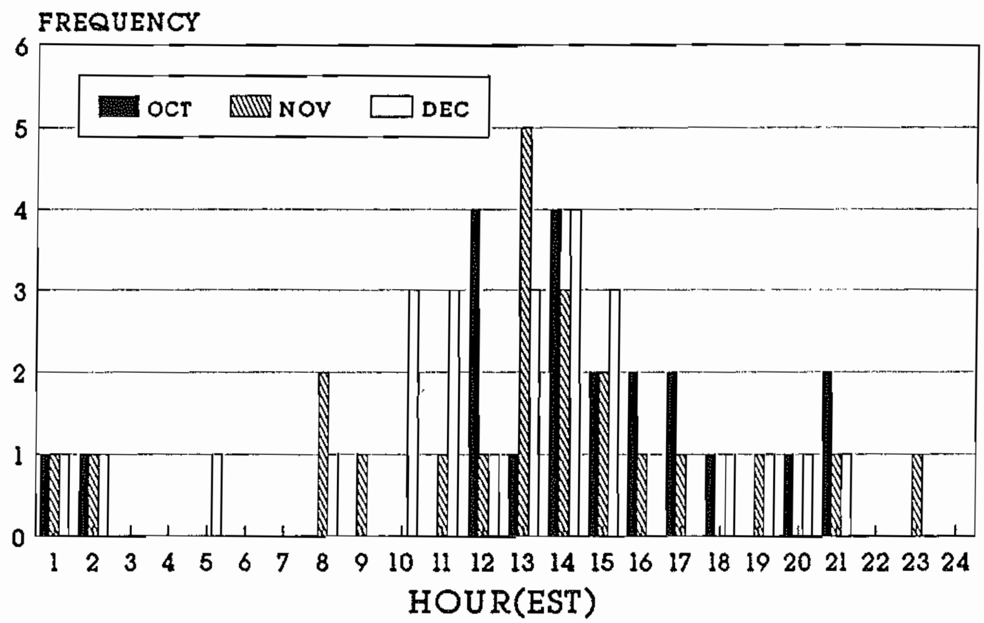


Fig. 7d

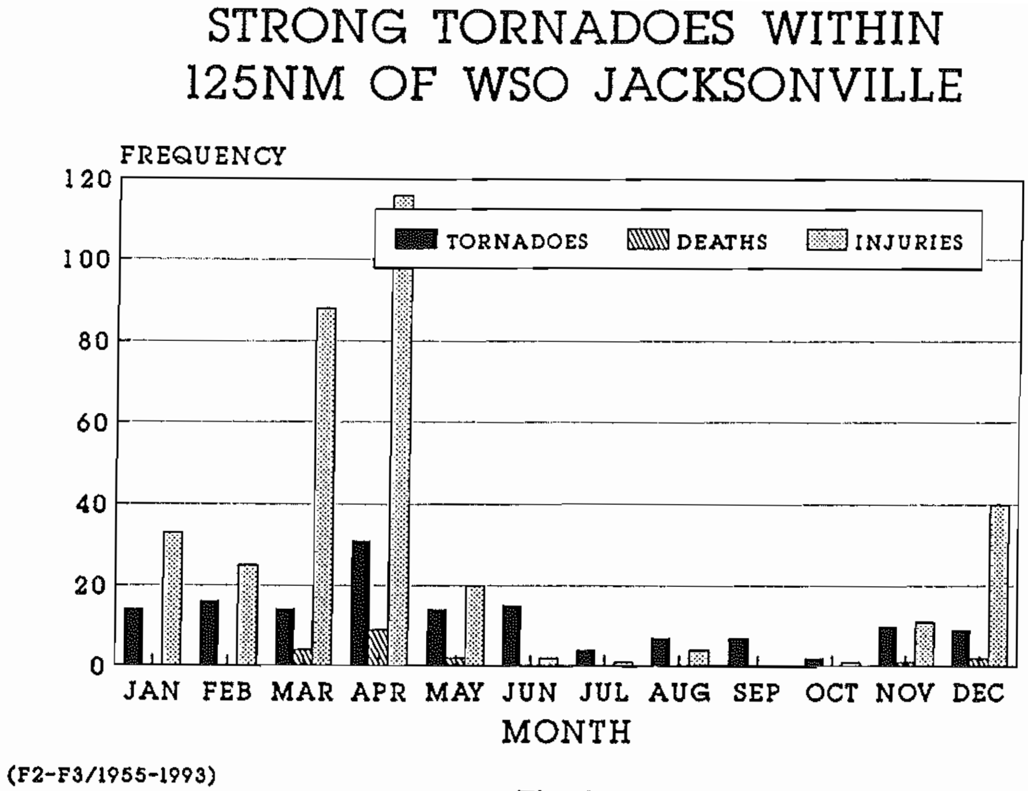


Fig. 8a

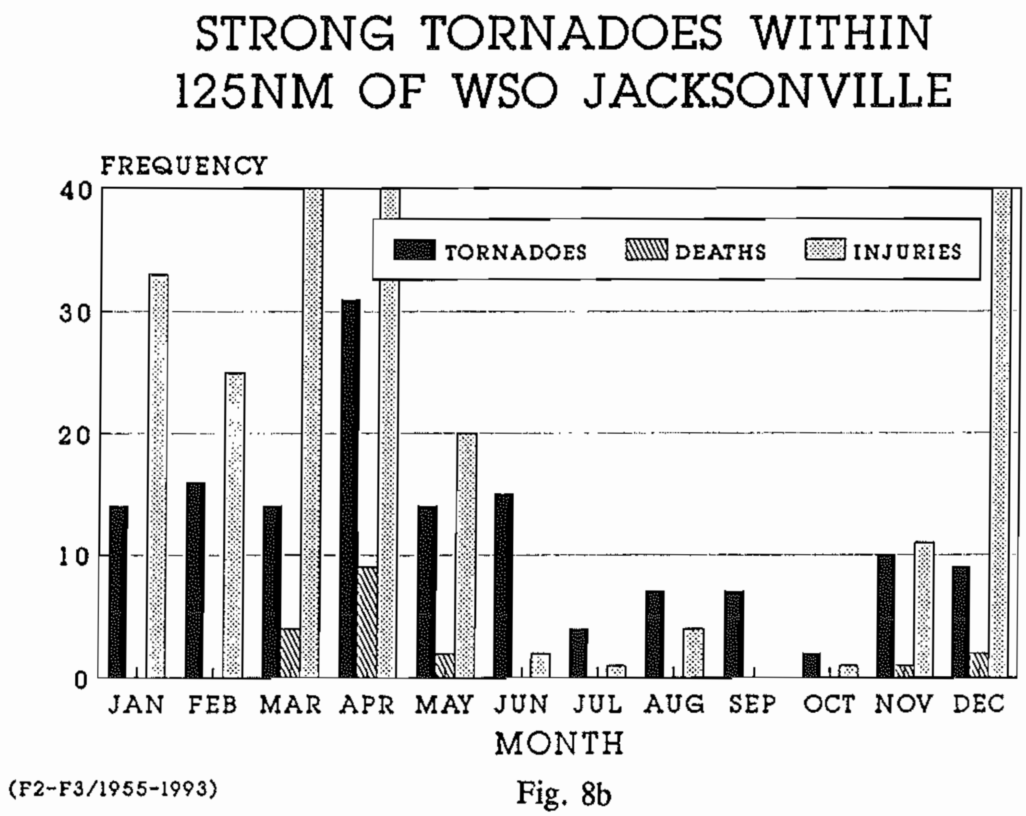


Fig. 8b

Fig. 8. Monthly distribution of strong tornadoes within 125nm of WSO Jacksonville,Florida, for the period 1955-1993.

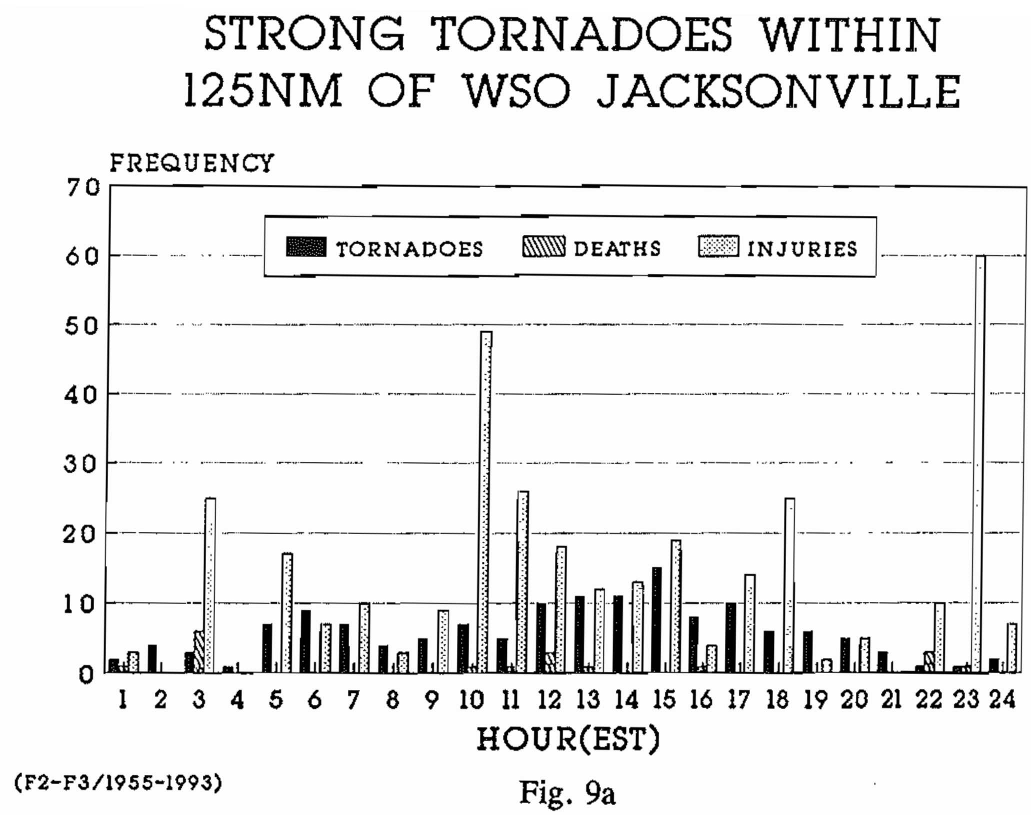


Fig. 9a

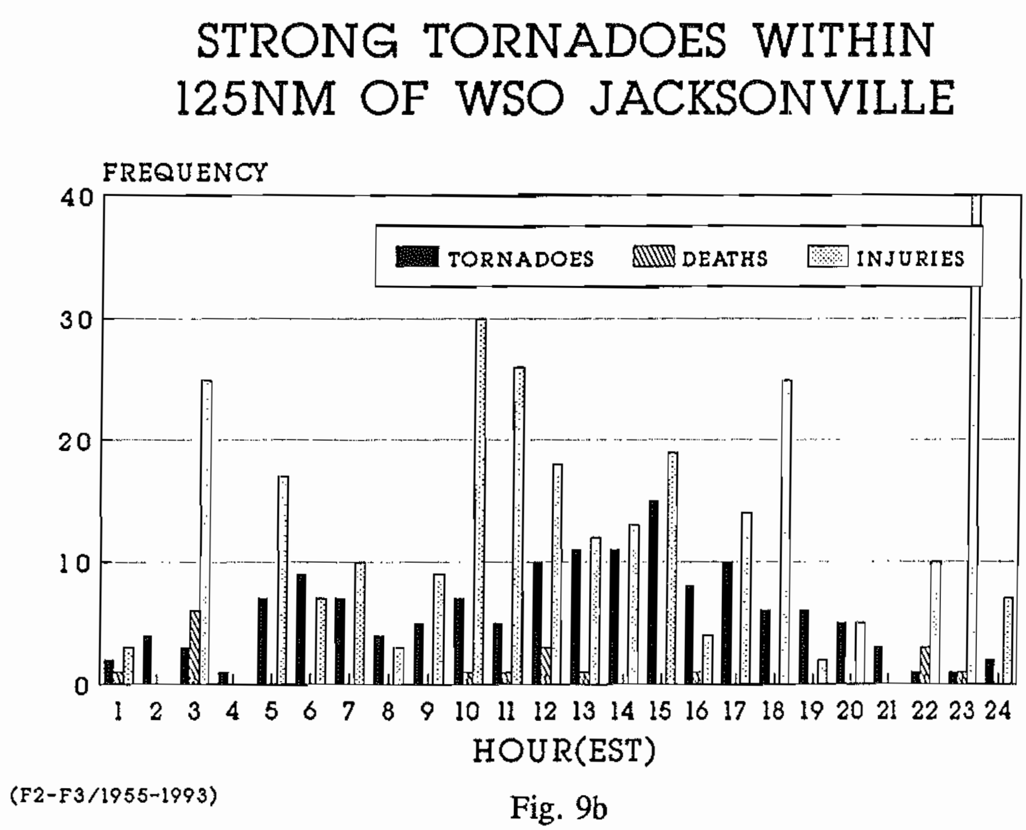


Fig. 9b

Fig. 9. Hourly distribution of strong tornadoes within 125nm of Jacksonville, Florida, for the period 1955-1993.

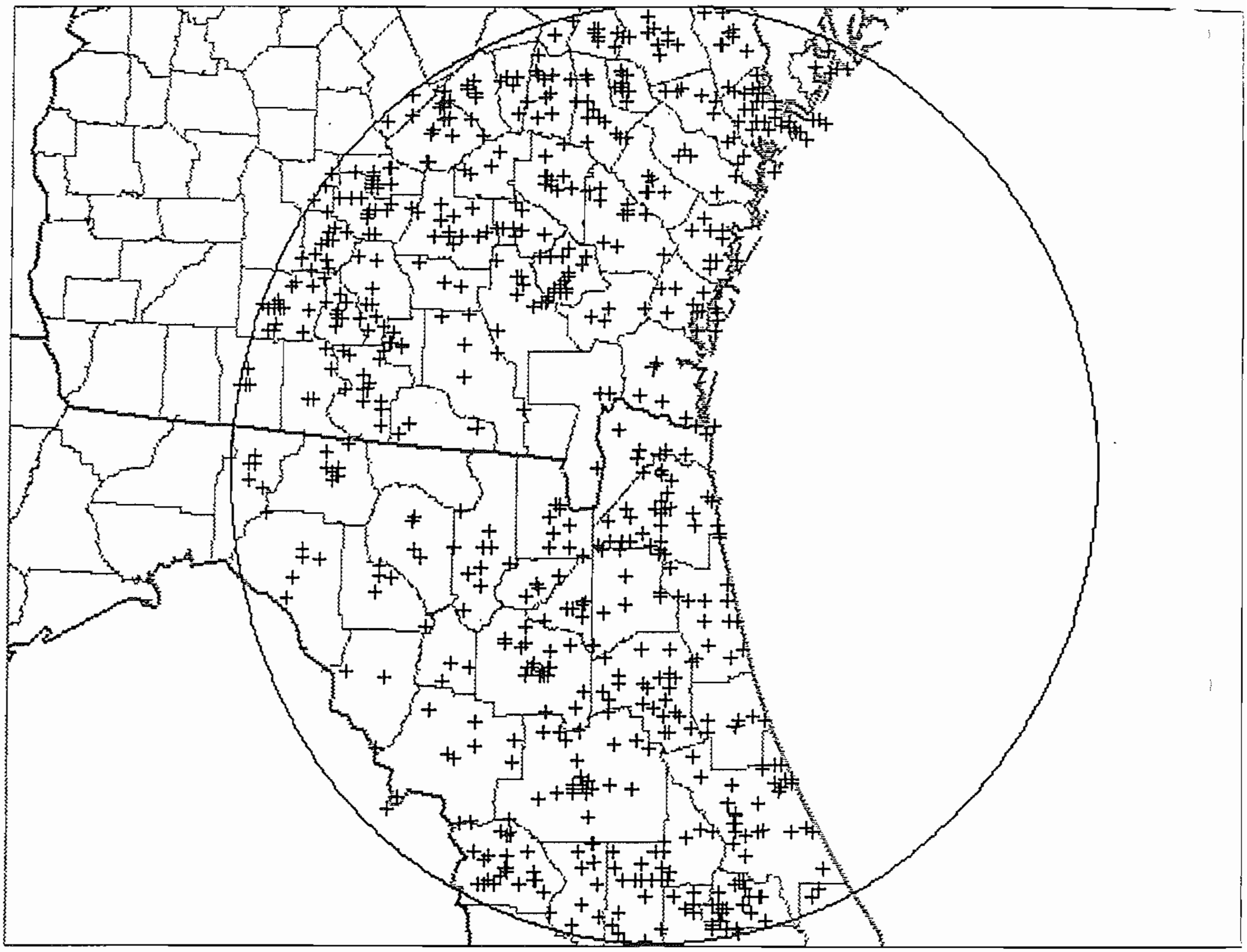


Fig. 10. Plot of reported severe thunderstorm wind gusts >50 kt or convective wind damage within 125nm of Jacksonville, Florida. A total of 1433 wind events for the period 1955-1993 are plotted.

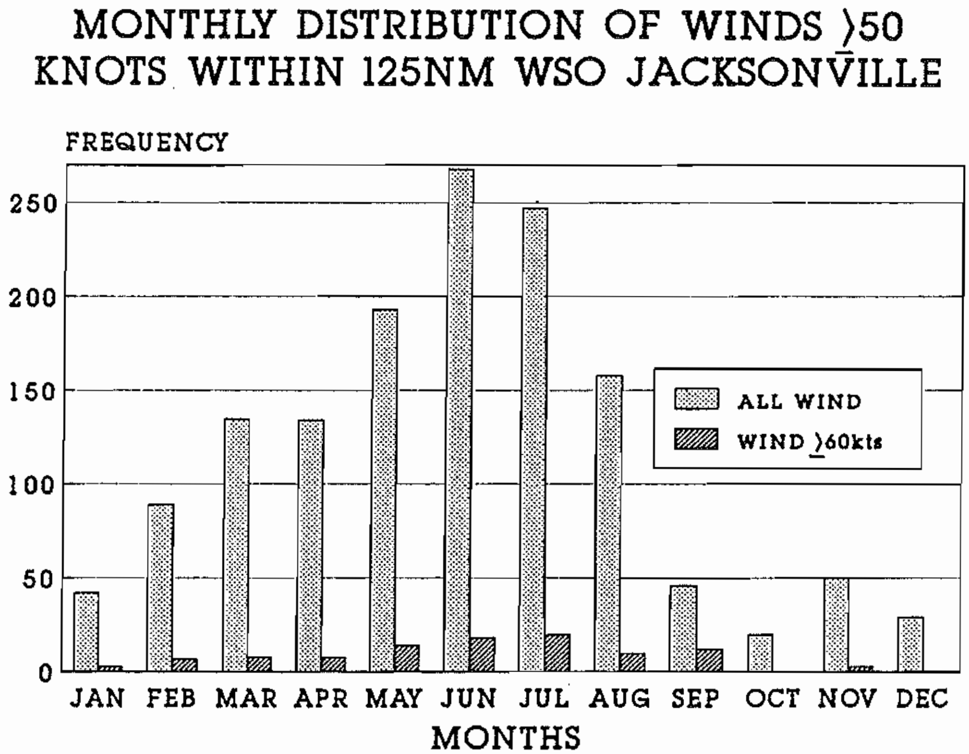


Fig. 11a

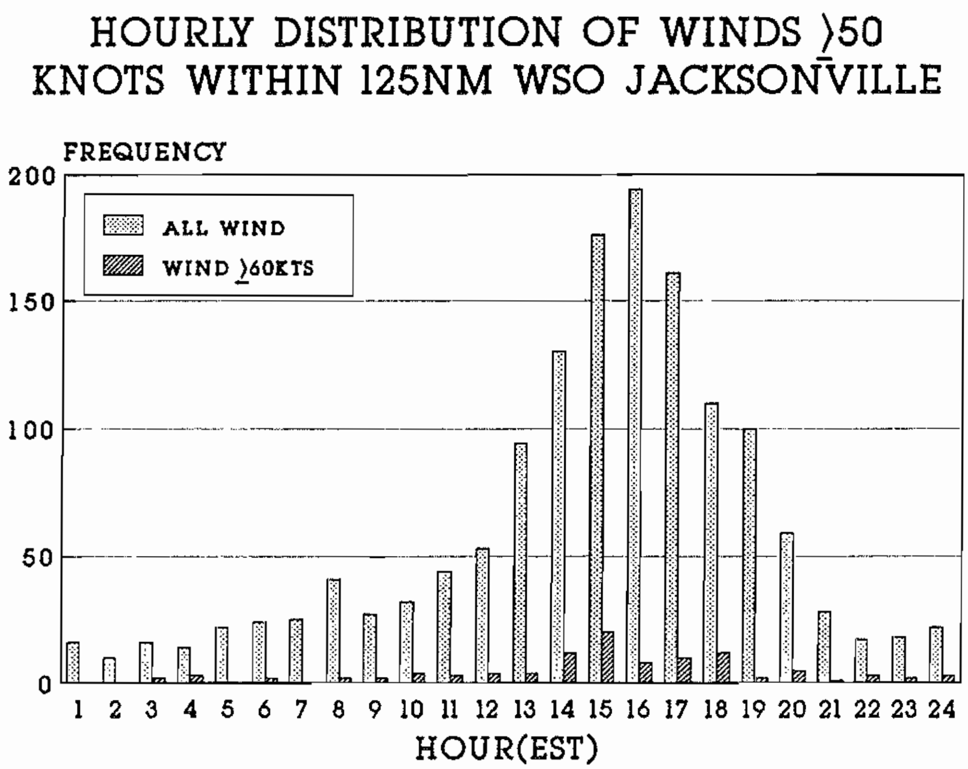


Fig. 11b

Fig. 11. Monthly and hourly distribution of wind events within 125nm of Jacksonville, Florida, for the period 1955-1993.

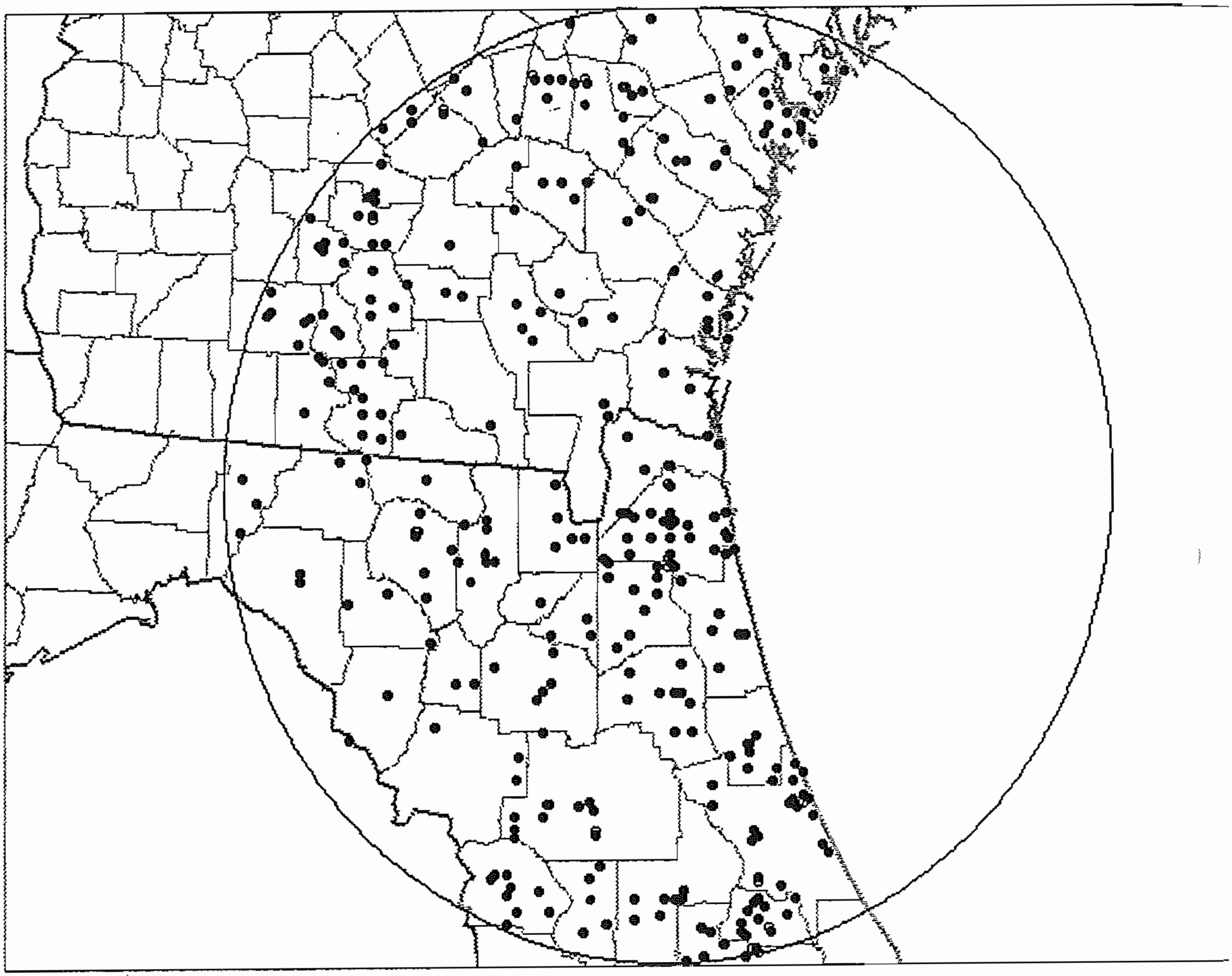


Fig. 12. Plot of reported severe thunderstorm hail > ¾ in within 125nm of Jacksonville, Florida. A total of 458 hail events for the period 1955-1993 are plotted.

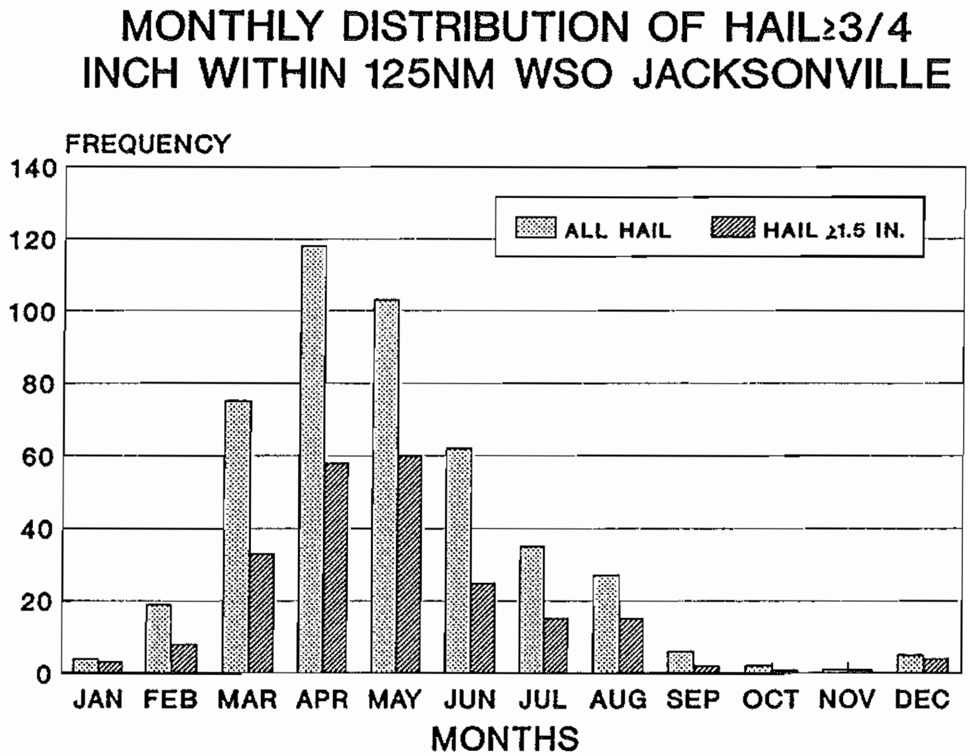


Fig. 13a

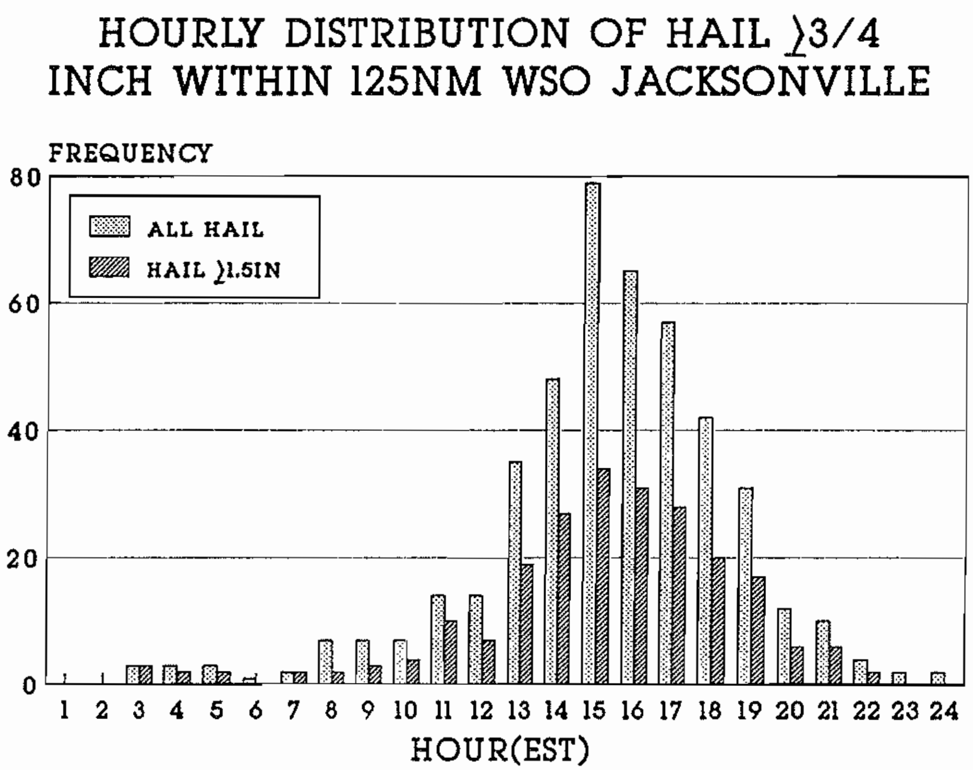


Fig. 13b

Fig. 13. Monthly and Hourly distribution of hail events within 125nm of Jacksonville, Florida, for the period 1955-1993.