NWSO ALBUQUERQUE
SEVERE WEATHER CLIMATOLOGY FOR NEW MEXICO
1959-1998

INTRODUCTION

The staff at National Weather Service field offices have no greater duty priorities than to issue timely severe weather warnings for the protection of life and property. A thorough understanding of the state's severe weather climatology can better prepare forecasters for anticipating the timing, strength, extent and nature of severe weather. In addition, climatological information provides important information to emergency managers and government or private agencies on the characteristics of severe weather across New Mexico. Therefore, the purpose of this study is to quantitatively describe the severe weather climatology for New Mexico using reports from 1959 to 1998.

DATA

The primary source of data for this study was obtained from *Storm Data* for the years 1959 through 1998 (NOAA 1959-1998). *StormData* is prepared and distributed by the National Oceanic and Atmospheric Administration (NOAA), using summaries compiled by the National Weather Service (NWS). Only weather events reported to the NWS are included in the publication. The extremely low population density of New Mexico has likely resulted in many severe weather events not being reported, especially those which occur away from the highly skewed population centers of the larger cities in New Mexico. **Therefore, it is important to note that the events from which statistics in this study are generated are actually a subset of all significant events which have occurred in New Mexico.**

WEATHER HAZARDS

New Mexico is the fifth largest state in the United States, with nearly 122,000 sq mi. and elevations vary from under 3,000 ft to over 13,000 ft. This vertical extent of nearly two miles over a large spatial area brings to New Mexico a vast array of climate regimes with exceptionally diverse weather.

By definition, weather events classified as severe storms include thunderstorms with a tornado on the ground, hail at least 0.75 inches, or winds of 58 mph or higher. Severe weather includes tornadoes, severe hail and strong winds. Statistics from severe weather events will be presented in this study. In addition, other significant weather events will be examined, including flash floods, lightning, microbursts (wet or dry) and dust devils. While not "severe weather" by strict definition, these latter four events are frequent and often dangerous aspects of New Mexico's weather. Winter storms are not included in this report, except for their role in weather-related injuries and fatalities.

Figure 1 depicts the number of weather-related injuries and deaths in New Mexico reported from 1959 to 1998. The greatest weather hazard in New Mexico is lightning, which is responsible for the greatest number of fatalities and injuries. In fact, New Mexico leads the country in lightning deaths per capita (see Table 1 in Appendix I). Floods and flash floods are the next most dangerous hazards when considering fatalities, however, tornados, winter weather and wind are responsible for more injuries than flood and flash floods. While tornados are responsible for a number of injuries across the state, only two fatalities due to tornados have been reported. The greatest number of fatalities occur from May to September, primarily caused by lightning and flash floods. Most injuries occur during the months of May through August, with tornados in addition to lightning and flash floods as the major contributors to the totals, and in December, with winter storms accounting for all but one reported injury.

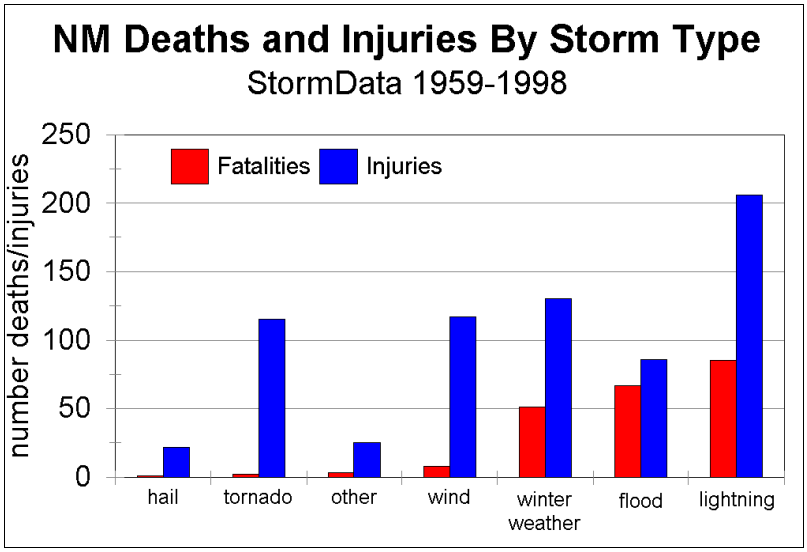

Figure 1. Injuries and fatalities in New Mexico partitioned by weather event for the period 1959-1998.

SEVERE WEATHER CLIMATOLOGY

Thunderstorms and Related Weather

Thunderstorms are responsible for a large percentage of the severe weather across New Mexico. The thunderstorm season in New Mexico is well defined, although it varies considerably between western and eastern sections of the state. The thunderstorm season begins over the high plains of eastern New Mexico in mid to late April, peaks in May and June, declines slightly in July and August, then drops sharply in September and October. In contrast, across western New Mexico there are few thunderstorms during the months of April, May and June, but a sharp increase in early July that continues through August, then thunderstorms decrease rapidly in September. Over the central mountain chain, thunderstorms are an almost daily occurrence during July and August, especially over the northwest and north central mountains of New Mexico.

Thunderstorms also have different characteristics within the state. Across the Eastern Plains thunderstorms often develop in a significantly sheared environment, either along a dryline or with a low-level moist inflow from the southeast, beneath a west or northwest flow in the mid and high troposphere. These thunderstorms tend to be more organized, long-lived and occasionally severe, producing large hail, high winds and tornadoes. Thunderstorms in the west tend to be less severe on average. However, they do occasionally produce life-threatening flash floods and are noted for their prolific small hail accumulations. Most of the storms in western New Mexico are associated with the “Southwest Monsoon,” especially over the southwest counties. Large hail and tornadoes over the west are rare, with the main threat flash floods.

Tornadoes

Tornadoes are a common occurrence in New Mexico, primarily across the Eastern Plains. For the state, the average of reported tornadoes is approximately 10 per year. Figure 2 shows the distribution of reported tornadoes by county since 1950, based on a 10,000 sq mi. area. A distribution based on an area, rather than strictly by county, was used in order to show a more "smoothed" representation of the number of tornadoes. These statistics reveal that eastern New Mexico can be considered as the western extension of "tornado alley". Most tornadoes occur with one of two favored synoptic regimes: (1) An active dryline moving/mixing eastward, or (2) Moist, low-level flow with an easterly component beneath mid-to-high level westerlies. The Eastern Plains of New Mexico have a high frequency of early summer vertical wind profiles that enhance relative inflow into storms and subsequent evolution into supercells.

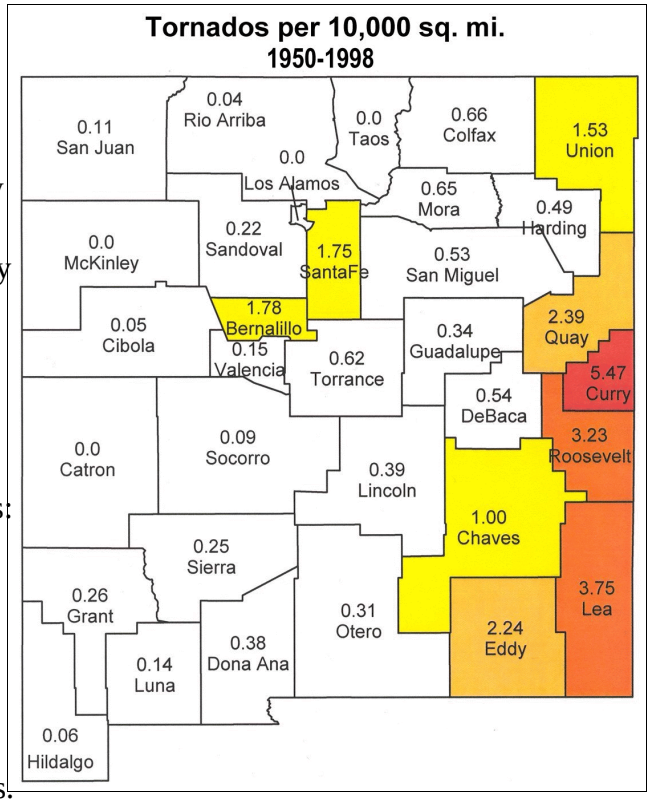

Figure 2. The number of reported tornadoes in each county per 10,000 square miles.

Despite the rather high frequency of tornadoes in New Mexico, only 2 fatalities have been reported since 1959, while 115 injuries were documented. The low number of fatalities can be partially explained by the strength of tornadoes found across the state. Since the mid 1980's, a tornadoes strength has been measured using the Fujita Scale, or F scale (Fujita 1981). This scale ranks tornadoes by damage intensity, with F0 being the weakest and F5 being the strongest. It is important to note the damage intensity was developed to relate wind speed ranges to various degrees of structural damage. With an obvious lack of structures in New Mexico, the application of the Fujita scale is difficult to apply. In Fig. 3, the reported New Mexico tornadoes are listed by F scales. While the strength of many tornadoes is not known, less than 5% of the tornadoes with a known intensity are in the strong category (F2 or F3). For the period 1880-1989, Grazulis (1993) notes only four F3 tornadoes in New Mexico. Based on this information and *Storm Data*, a high percentage of reported tornadoes in this state are weak, either F0 or F1.

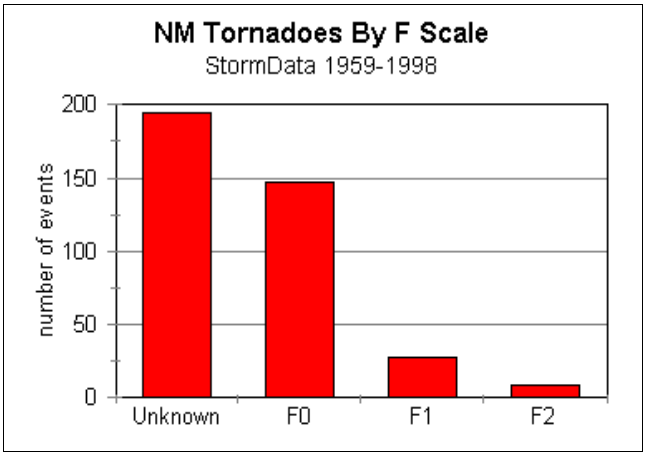

Figure 3. Tornado frequency by F scale.

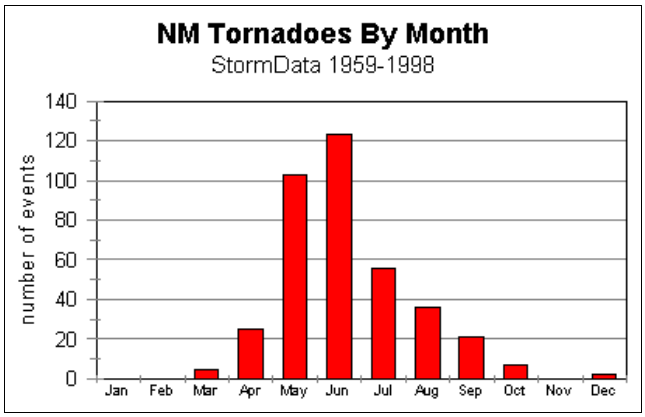

Figure 4. Tornado frequency by month.

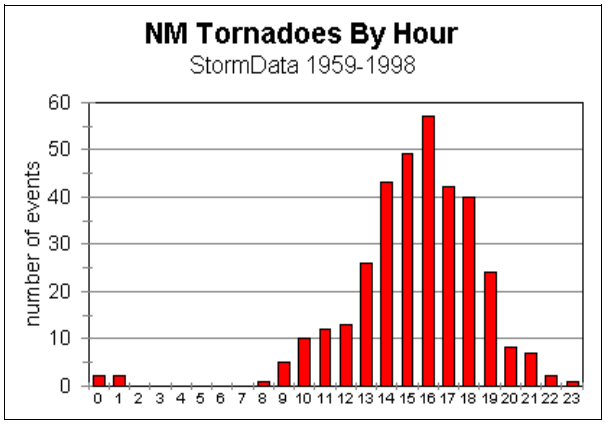

Figure 5. Tornado frequency by hour.

Figure 4 depicts the monthly frequency of all reported tornadoes. Over 95% of tornadic storms occur in April through September, with about 60% occurring in May and June. Tornadoes were reported in all months except January, February and November, while F2 tornadoes were only recorded in May, June and July. Figure 5 shows the frequency of tornadoes by hour, with a majority of tornadic storms occurring between 2:00 PM and 7:00 PM MST. The number of tornadoes that occur after dark (8:00 PM MST) is very small, with no reports of tornadoes between 2:00 AM and 7:00 AM MST. This is likely another factor helping to keep the number of tornado fatalities and injuries low across New Mexico.

Hail

Hail ranks as the most frequent type of severe weather in New Mexico, and is responsible for a considerable percentage of property and crop damage. However, only 1 fatality and 20 injuries have been reported due to hail.

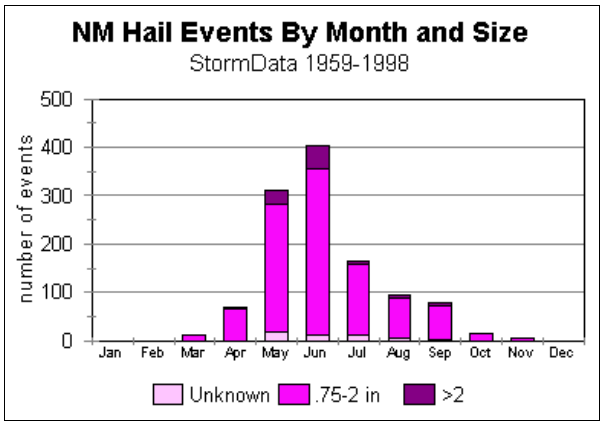

Figure 6. Monthly frequency with distribution by size of hail.

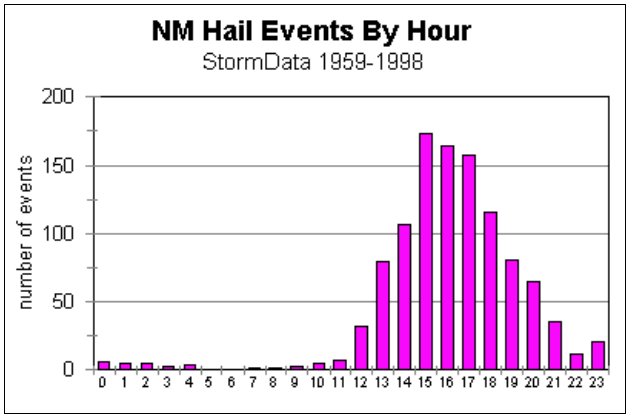

Figure 7. Hail frequency by hour.

Figure 6 shows the number of hail reports by month and by size. Damaging or severe hail (0.75 to 2.00 inches) is most common in May and June, as is very large hail (over 2.00 inches), although a significant number of hail reports also occur in July through September. The size of some hail reports are not known, but were included in *Storm Data* because they caused significant crop and/or property damage or had a significant accumulated depth. The reports are included in this study due to their likelihood of

being severe hail. Figure 7 reveals damaging hail is most likely to fall in the afternoon and early evening, as is the case with tornadoes. Nearly 70% of the reported large hail events fell between 2:00 PM and 6:00 PM MST

Wind

Most residents of New Mexico are aware of the strong wind that frequent the state. It is difficult to determine from *Storm Data* reports whether a high wind event was the result of a severe thunderstorm, a microburst, or a larger scale weather system. Therefore, these statistics include any wind event that has caused injury or fatalities. There have been 4 fatalities and over 100 injuries due to high winds. Figure 8 illustrates the monthly frequency of all wind events. A pronounced summer maximum is evident and is associated with thunderstorms. The Spring and Fall months contain wind damage from dry microbursts, when lower level moisture is often lacking. March through May also have a large number of events that are related to Springtime winds, when relatively strong jet stream winds are able to mix down to the surface. There is a significant number of wind events in the winter months of December through February as well, associated with large scale weather systems.

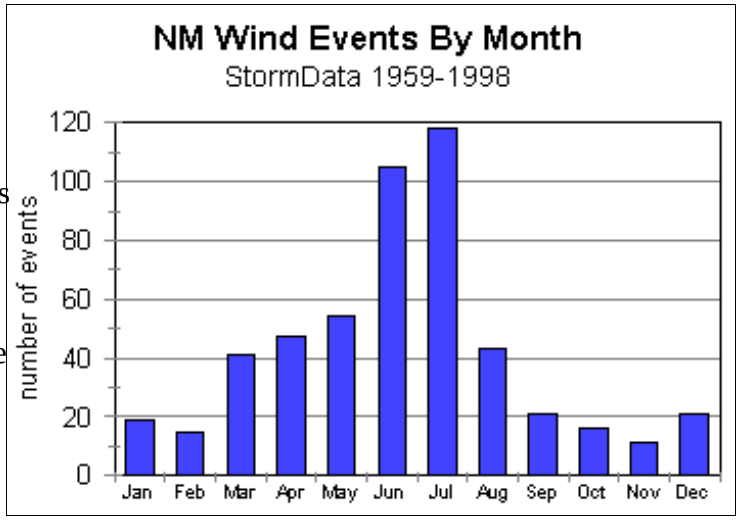

Figure 8. Monthly distribution of all wind events.

SIGNIFICANT WEATHER EVENTS

As mentioned previously, this study will also briefly discuss other significant weather events in New Mexico, including flash floods, lightning, dry or wet microbursts, and dust devils. Recall that weather events which result in fatalities, injuries, or significant crop or property damage are included in *StormData*.

Flash Floods

Flash floods are responsible for more fatalities than any other weather event across the Nation. In New Mexico, flash floods rank second to lightning in the number of reported fatalities. New Mexico ranks tenth in the nation in flash flood deaths per capita (see Table 2 in Appendix I). In the western U.S., a monthly distribution of flash flood reveals a summer maximum due to thunderstorms, and a secondary winter maximum due to wet storms. The monthly distribution of flash floods in New Mexico is shown in Fig. 9, and illustrates a strong association with the summertime "Southwest Monsoon," with nearly two-thirds of the flash floods occurring in July and August. Unlike much of the western U.S., there is no secondary maximum in the winter months. Figure 10 shows the distribution of flash floods by hour. Most of the flash floods occur between 3:00 PM and 7:00 PM, similar to the peak hours of severe hail and tornadoes.

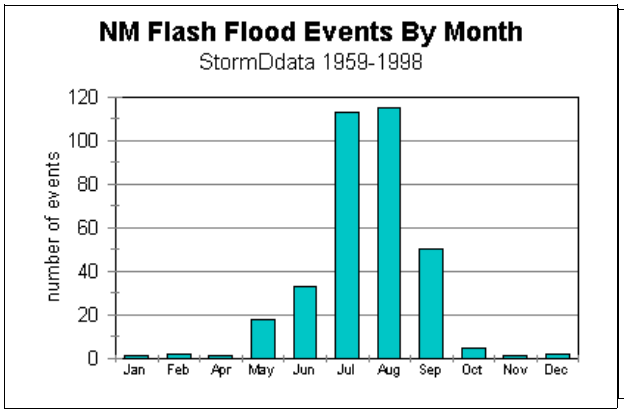

Figure 9. Flash flood frequency by month.

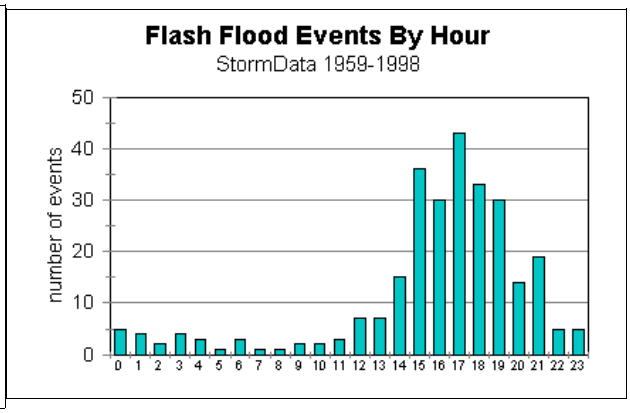

Figure 10. Flash flood frequency by hour.

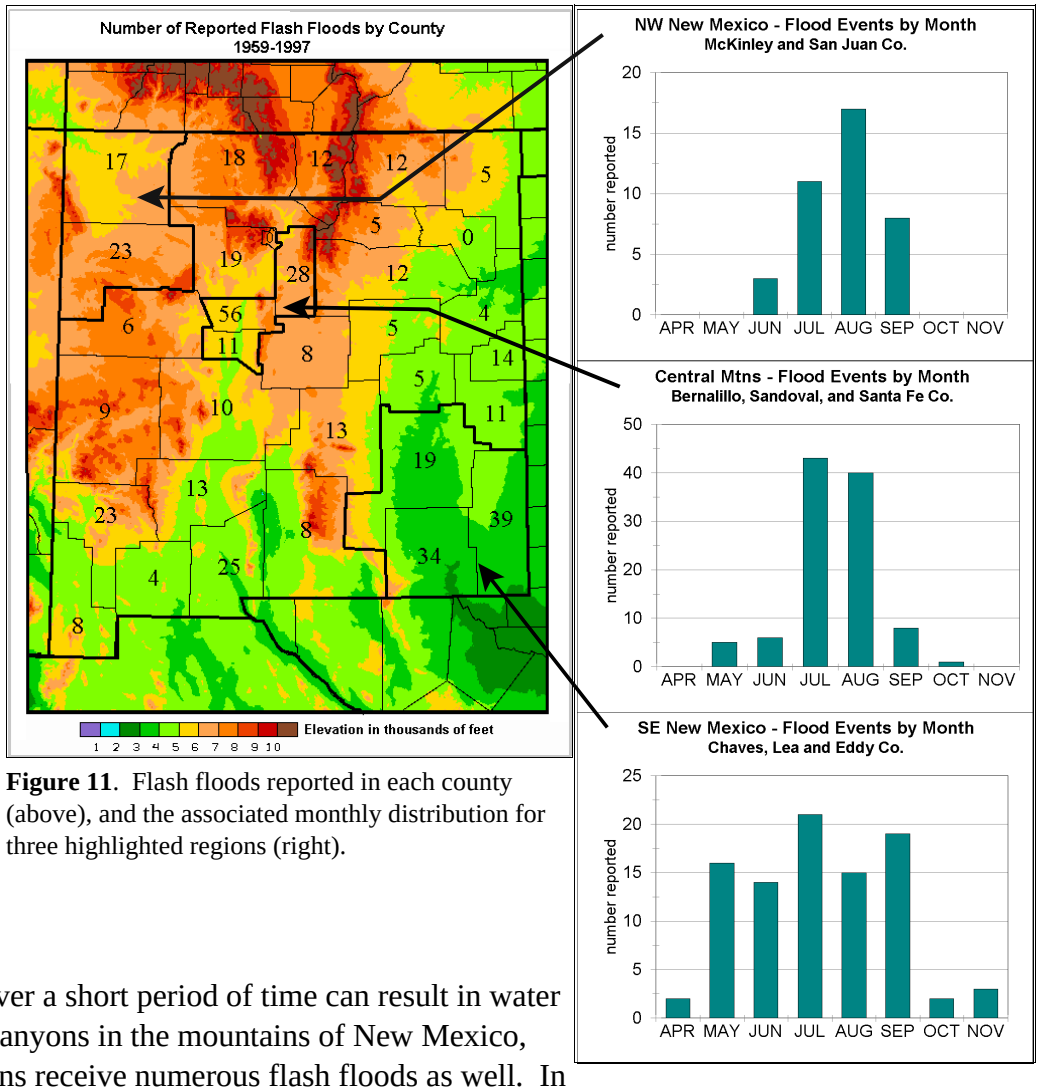

Figure 11. Flash floods reported in each county (above), and the associated monthly distribution for three highlighted regions (right).

Intense rainfall over a short period of time can result in water roaring through canyons in the mountains of New Mexico, however, the plains receive numerous flash floods as well. In Fig. 11, the number of reported flash floods for each county and the monthly distribution for three highlighted areas of the state is shown. Flash floods in the southern plains (bottom graph) are fairly evenly distributed from May through September. Intrusion of moisture west of the central mountains causes flash flood frequency to jump dramatically in the Middle Rio Grande Valley and central mountains region during July and August (middle graph). Finally, flash flood activity becomes more predominant in extreme northwest New Mexico in late July into early September, peaking in August (top graph).

Lightning

Thunderstorms and lightning are a common occurrence in New Mexico, especially during the summer months. Because the state has one of the highest thunderstorm frequencies in the nation, New Mexico

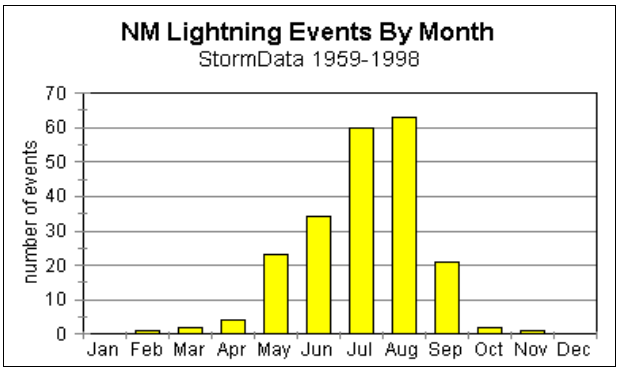

Figure 12. Lightning frequency by month.

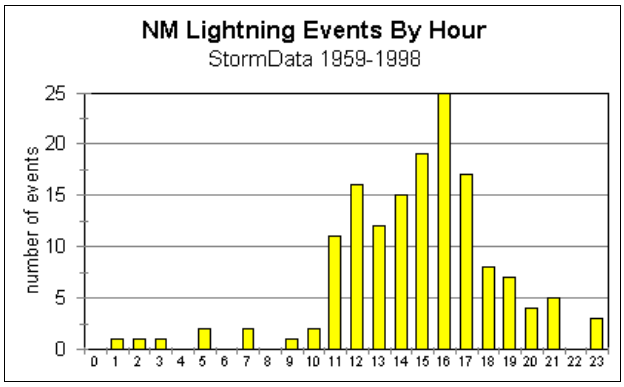

Figure 13. Lightning frequency by hour.

has the highest lightning fatalities per capita in the U.S. Figure 12 depicts the monthly distribution of "significant" lightning events. The majority of lightning events occur in May through September, with a peak in July and August. This is slightly different from that of tornadoes and hail. The maximum lightning events correspond to the "Southwest Monsoon" of July and August. The hourly distribution is shown in Fig. 13 and is similar to that of tornadoes and hail, except there is a pronounced early peak around 12:00 PM MST. This early maximum is the result of the initial formation of thunderstorms over the mountains, particularly the northern mountains, and is supported by Fosdick and Watson (1985). The latter peak is the result of more widespread thunderstorm development during the afternoon and early evening hours.

Other Wind Events

Like much of the Nation, New Mexico has its fair share of wet microbursts that produce damaging convective winds. They are most common during the heart of the summer, in July and August. The *dry* microburst is more unique and found mainly in the Southwest U.S. and on the High Plains, just east of the Rocky Mountains. Conditions favorable for dry microbursts include a subtropical jet providing sufficient moisture to the mid and upper levels of the troposphere, with a deep, dry adiabatic layer in the low levels. These conditions are found most often across New Mexico in the transition periods into and out of summer. There is only a very small sample of known microburst damage presented in *Storm Data* and no real microburst climatology. However, it is accepted by the staff at the WFO in Albuquerque that damaging winds from dry microbursts are a common occurrence in New Mexico and pose a danger to people and property.

Another fairly common wind event in this state is the dust devil. While most dust devils are harmless, there are a few reports in *Storm Data* of damage to structures totaling several thousand dollars, and possibly even a couple of deaths. The WFO Albuquerque staff has noted the strongest and highest frequency of dust devils generally occur on days with the greatest microburst potential.

SUMMARY

The results of this study can be summarized as follows:

- New Mexico's population density averages only 12.5 persons per sq mi, well-below the national average (70.3 persons per sq mi), which contributes to the difficulty in accurate reports of severe and significant weather.

- The highest thunderstorm frequency in the U.S. during the summer (June through August) occurs over the northern Mountains, near the New Mexico/Colorado border.

- Tornadoes and severe hail peak in May and June, while high wind events peak in June and July.

- Most of the tornadoes and severe hail occur between 2:00 PM MST and 7:00 PM MST.

- Most tornadoes in New Mexico are weak, either F0 or F1.

- Flash floods peak during the "Southwest Monsoon" season of July and August. New Mexico ranks ninth nationally in flash flood fatalities per capita.

- Lightning is responsible for more fatalities and injuries than any other weather event in the state. New Mexico has the highest lightning fatalities per capita in the U.S.

- Little information is available concerning microbursts and dust devils, but they are a frequent and potentially dangerous event during the Spring through early Fall months.

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Appendix I

Fatality Statistics Extracted from *StormData**

Table 1. Lightning Deaths Per Million People (1959-1999).

Rank	State	Deaths per Million People
1.	**New Mexico**	72.5
2.	Wyoming	60.0
3.	Arkansas	55.5
4.	Florida	45.4
5.	Colorado	44.1
6.	Georgia	42.0
7.	Mississippi	39.2
8.	Texas	35.2
9.	Oklahoma	34.3
10.	Louisiana	32.9

Table 2. Flash Flood Deaths Per Million People (1959-1999).

Rank	State	Deaths per Million People
1.	South Dakota	149.3
2.	West Virginia	139.7
3.	Texas	127.3
4.	Colorado	70.9
5.	Montana	66.2
6.	Georgia	54.6
7.	Vermont (tie)	50.0
7.	Virginia (tie)	50.0
9.	**New Mexico**	49.2
10.	Arizona	48.9

*****National Oceanic and Atmospheric Administration, 1959-1998: *Storm Data*. National Climatic Data Center, Asheville, NC, **1-40**, Nos. 1-12.