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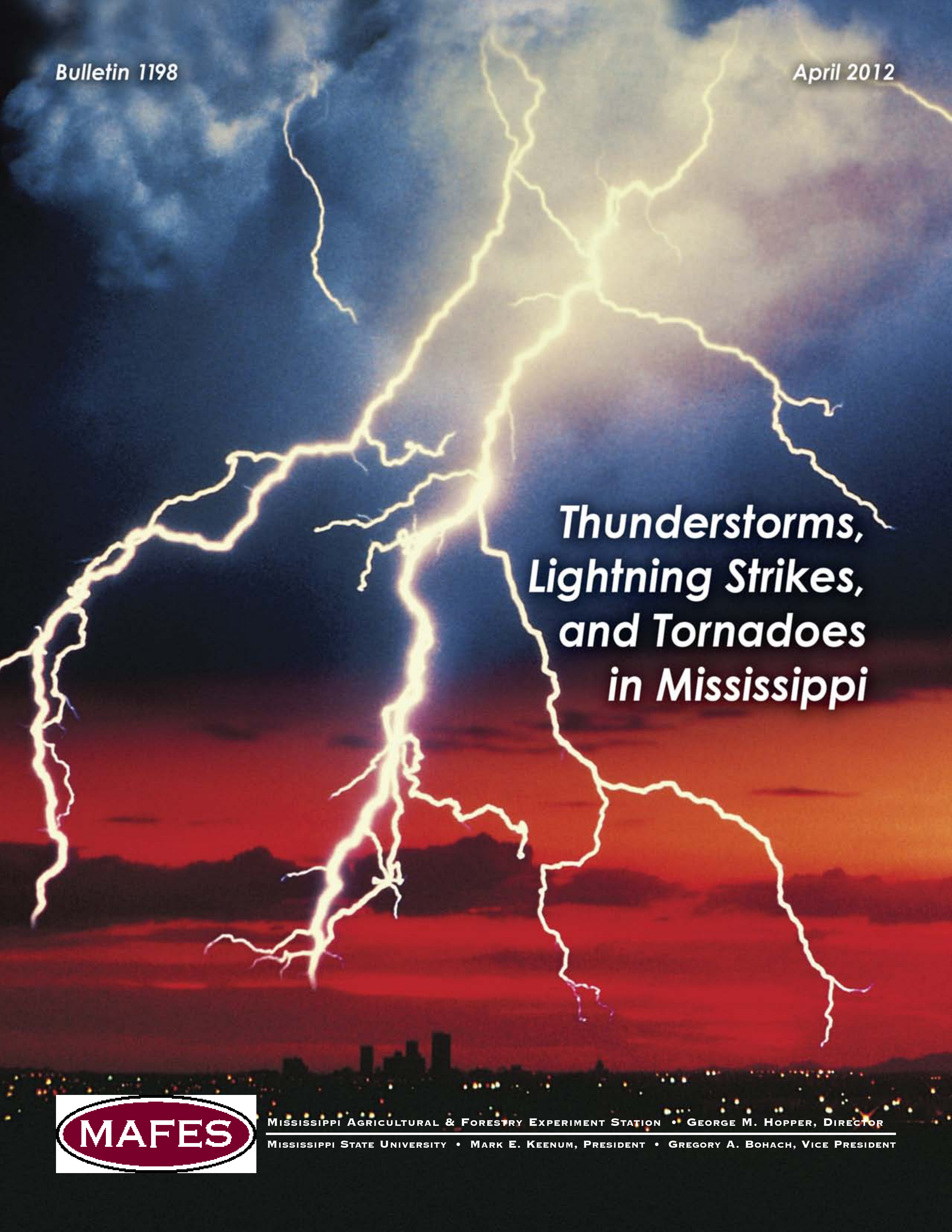

Thunderstorms, Lightning Strikes, and Tornadoes in Mississippi

MAFES

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Thunderstorms, Lightning Strikes, and Tornadoes in Mississippi

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Introduction

To Mississippians, dangerous and severe weather is a well-known part of the climate. Mississippi experiences thunderstorms on an average of 81 days per year, ranging from 56 days in Montgomery County to 121 days in Pearl River County. These thunderstorms produce an average of almost 10,000 cloud-to-ground lightning strikes per year in each county, ranging from 5,459 in Choctaw County to 19,446 in Jackson County. For the 7-year period 2001–2007, an astounding 5,643,965 cloud-to-ground lightning strikes were recorded in Mississippi. Additionally, an average of 27 tornadoes is reported in Mississippi annually. For the period 1950–2006, 1,541 tornadoes were reported in the state, ranging from four in Ittawamba County to 52 in Hinds County.

The storm of April 23–24, 2010, provides perspective on fatalities and economic destruction brought to the state by severe weather. The series of storms that formed produced seven tornadoes. The most significant of these began in Madison Parish, Louisiana, and tracked northeastward into Oktibbeha County, Mississippi. At its greatest intensity, the tornado was rated EF-4 (a description of the Enhanced-Fujita scale is included as Appendix A), with estimated winds of 170 miles per hour (mph) in Yazoo and Holmes counties. The tornado track was an astonishing 149 continuous miles on the ground and reached a width of 1.75 miles. The tornado was actually on the ground for nearly 3 hours, killing 10 and injuring 146 Mississippians, and damaging or destroying hundreds of structures. While a path of 149 miles is an extreme occurrence, it should be noted that Mississippi leads the nation in tornado path length.

Mississippi's geographic location accounts for the large amount of dangerous weather events occurring in the state. Warm, moist air masses originating in the Gulf of Mexico to the south often interact with midlatitude cyclones and associated fronts coming into the state from the north and west. Mississippi is located in a region known as "Dixie Alley," which rivals the classic "Tornado Alley" in the number of tornadoes normalized by square miles. In fact, Mississippi ranks eighth in the number of area-normalized tornadoes. Additionally, Mississippi ranks second in total tornado-related deaths behind Texas. However, when these data are normalized for total state population, Mississippi leads the nation in tornado-related deaths per million people. Of the top 10 killer tornadoes in U.S. history, three occurred in Mississippi: Natchez, May 1840, with 317 deaths; Purvis, April 1908, with 143 deaths; and Tupelo, April 1936, with 216 deaths.

Even lifelong residents of the state may not realize the magnitude and spatial distribution of dangerous weather events in Mississippi. Advances in data availability now make it possible to quantify and visualize these aspects of the climate, enhancing awareness and safety throughout the state. The objective of this bulletin is to provide specific information on thunderstorms, lightning strikes, and tornadoes for each county in the state.

Data Sources and Methods of Analysis

The lightning dataset was obtained from the National Lightning Detection Network (NLDN) through an outreach grant from University Corporation for Atmospheric Research (UCAR) Cooperative Program for Operational Meteorology and Training (COMET). This dataset contains latitude and longitude coordinates for all cloud-to-ground lightning strikes for the United States for the 8-year period 2000–2007. Only strikes that occurred in the state of Mississippi were used for this analysis. Geographic information system (GIS) technology was employed to spatially and temporally display and organize the 5,643,965 lightning strikes that occurred in Mississippi over the 8-year period. These data were categorized by county, day, month, and year.

A single thunderstorm generally produces multiple lightning strikes. The high variability in the frequency of thunderstorms and the number of strikes produced could bias the accurate quantification of the true number of thunderstorms occurring in each county. Therefore, the concept of a thunderstorm day was utilized to identify the number of days on which thunderstorms occurred. A thunderstorm day is defined as a day in which at least one cloud-to-ground lightning strike was recorded. This analysis provided the average number of thunderstorm days statewide and within each county annually and monthly. This information has never before been available.

The tornado dataset was obtained from the Storm Prediction Center (SPC) of the National Weather Service (NWS). This dataset contains all reported tornadoes, nationwide, for the period 1950–2006. GIS was used to spatially and temporally display and organize the 1,541 tornadoes reported in Mississippi during the 57-year time period. The data were categorized by county, month, and year. Death, injury, and economic loss data were derived from the National Climatic Data Center's Storm Event Database (NOAA, 2010).

Thunderstorms

A thunderstorm is defined as any storm that produces lightning and therefore thunder. In Mississippi, thunderstorms are produced by frontal activity: warm, moist summer air masses; sea breezes in the coastal region; and land-falling tropical systems that move across the state. A thunderstorm can and often does produce damaging winds, hail, heavy rainfall, and of course lightning. Common air-mass thunderstorms (thunderstorms that develop due to daytime heating) lasting 60–90 minutes account for the bulk of thunderstorm activity in Mississippi. Thunderstorms that produce hail 1 inch or larger, winds 58 mph or greater, and/or a tornado are considered severe thunderstorms, and these also occur in Mississippi. The types of storms that often meet the severe criteria include the supercell storm, clusters of storms known as mesoscale convective complexes (MCC), and lines of storms known as mesoscale convective systems (MCS), commonly referred to as squall lines. The percentage of thunderstorms that reach severe status in Mississippi is unknown, but 10% of thunderstorms nationwide are classified as severe and about 2–3% are classified as supercells. While severe storms garner the greatest attention, the majority of thunderstorm-related deaths are the result of flash flooding and lightning.

Appendix B shows the average monthly and annual number of thunderstorm days for each county. Two-thirds of the days when thunderstorms occur are during May through September. The thunderstorms that occur during this period are predominantly air-mass thunderstorms. Figure 1 depicts the spatial pattern of annual average thunderstorm days in the state.

Counties were grouped together to form a southern, central, and northern region (Figure 2). The southern region is composed of 24 counties south of a line between Jefferson and Wayne counties. The northern region is composed of 17 counties north of a line between Coahoma and Itawamba counties. The central region is composed of the 41 counties between the southern and northern regions. The characteristic numbers of thunderstorm days for each month and year for each region were calculated by averaging each individual county's monthly value. Figure 3 shows the spatial differences in the average annual number of thunderstorm days among the three regions, revealing a decreasing south-to-north gradient. Figure 4 represents the distribution of thunderstorm days by month through the year. The chart shows the high number of thunderstorm days during the summer season in all regions, as well as the predominance of thunderstorm days in the southern region in all but 2 months of the year. For example, three-fourths of total thunderstorm days occur during the 6-month period from April through September, on average, for all regions.

The gradient in numbers of thunderstorm days from the coast to the northern part of the state, as evident in Figure 3, is a response to increasing distance from the Gulf of Mexico. Maritime tropical air masses that originate in the Gulf are the source of moisture and warm air, necessary ingredients for thunderstorm formation. Seasonal differences in the processes that lift the warm, moist air to initiate thunderstorm development are clearly distinct in Figure 4. In the northern region, thunderstorm days outnumber those in the southern region and peak in April and May, most likely due to frontal activity. By contrast, the southern region's thunderstorm days peak in the middle of summer, most likely due to the inherent instability of the air-mass and sea-breeze processes, not frontal activity.

Information on the number of thunderstorm days across the state is needed for many reasons. Historically, the National Weather Service has kept records of the number of days with thunderstorms at weather service offices at airports. Those observations are not available in a climatology of thunderstorms summarized to characterize the occurrence of the storms spatially and temporally.

Furthermore, those observations are only representative of point locations and are limited in spatial coverage, available in Mississippi only at Hattiesburg, Jackson, Vicksburg, Greenville, Greenwood, Meridian, and Tupelo. By contrast, this new analysis is based on a dataset with no spatial limitations and therefore provides information for each county in the state.

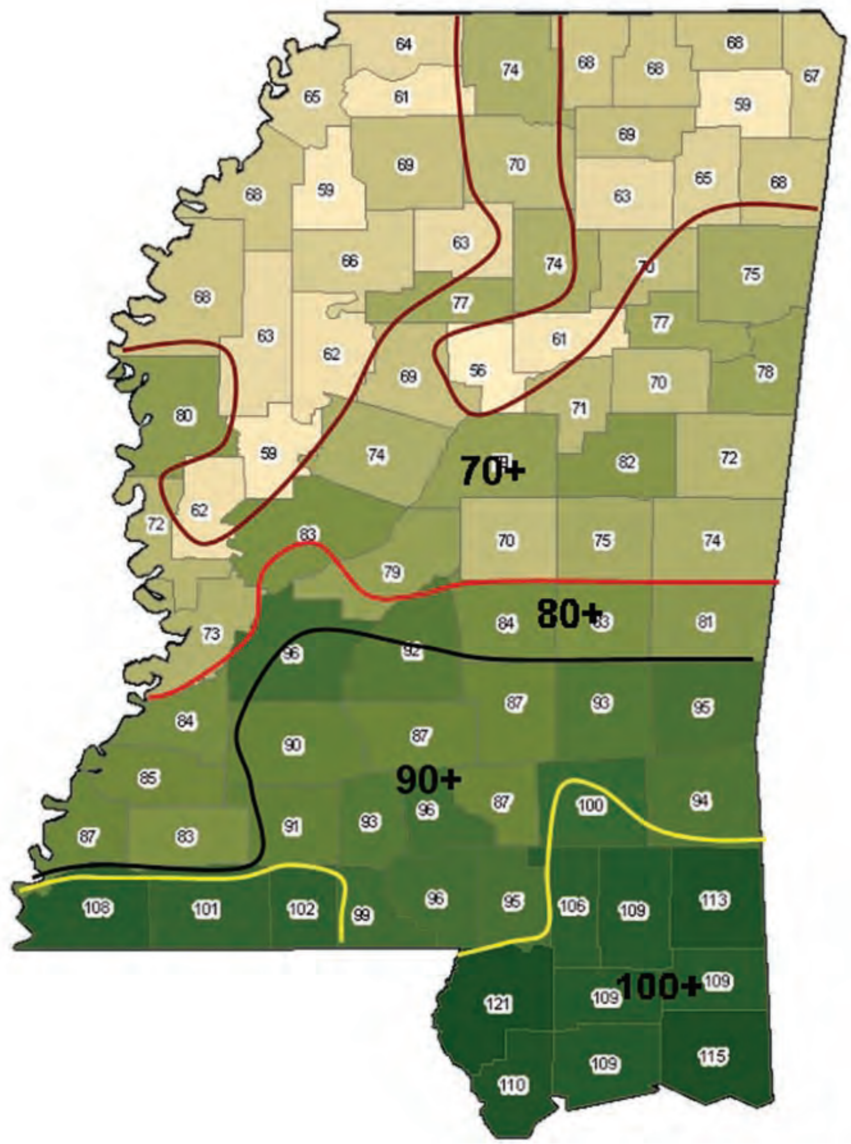

Figure 1. Average number of thunderstorm days in Mississippi annually.

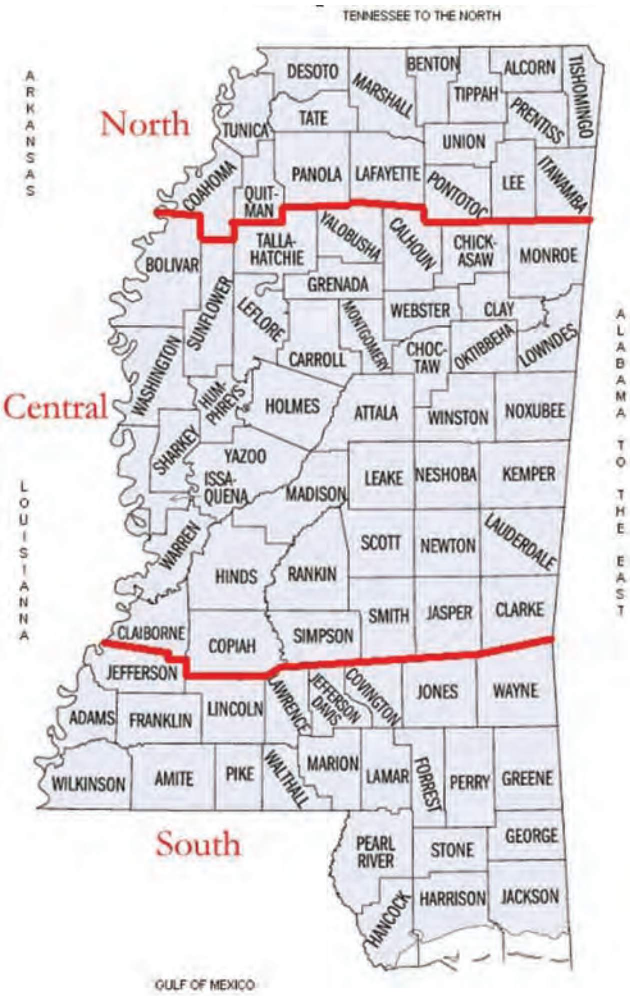

Figure 2. Counties in the north, central, and south divisions.

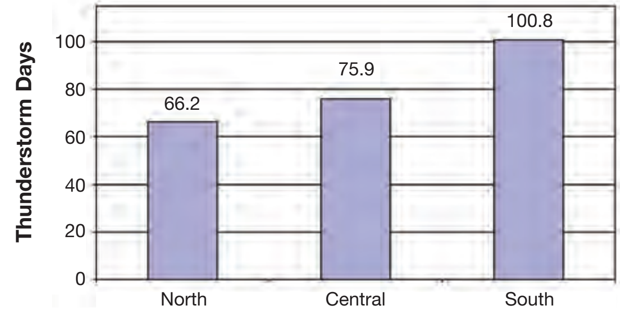

Figure 3. Average annual thunderstorm days for the north, central, and south regions of Mississippi from 2001 to 2007.

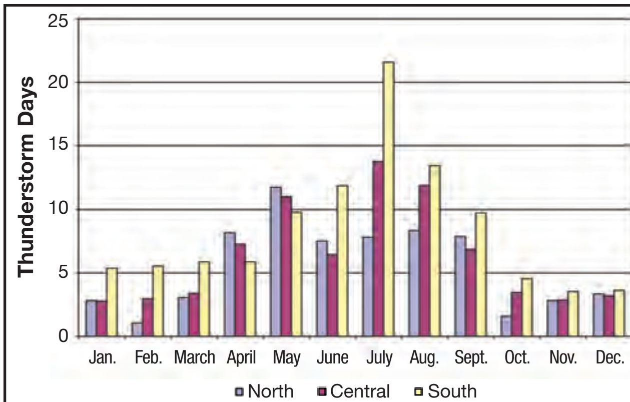

Figure 4. Monthly distribution of thunderstorm days for the north, central, and south regions of Mississippi from 2001 to 2007.

LIGHTNING

Lightning is defined as the electrical discharge of a thunderstorm. Lightning can travel from the base of a cloud at nearly 130,000 mph and reach temperatures three to four times the surface of the sun. Lightning is the most deadly feature of a thunderstorm, and the extent to which it occurs in Mississippi has never been established. This analysis shows how much more widespread and frequent lightning strikes are in the state than generally recognized. For example, an analysis of these new data show that in an average year, 50 lightning strikes occur within a radius of 1 mile of the flagpole at the center of the Mississippi State University campus. Within 3 miles, that number exceeds 1,200. In comparison to any other weather phenomenon, these numbers are extraordinarily large and point out the threat to life and property posed by lightning across the state.

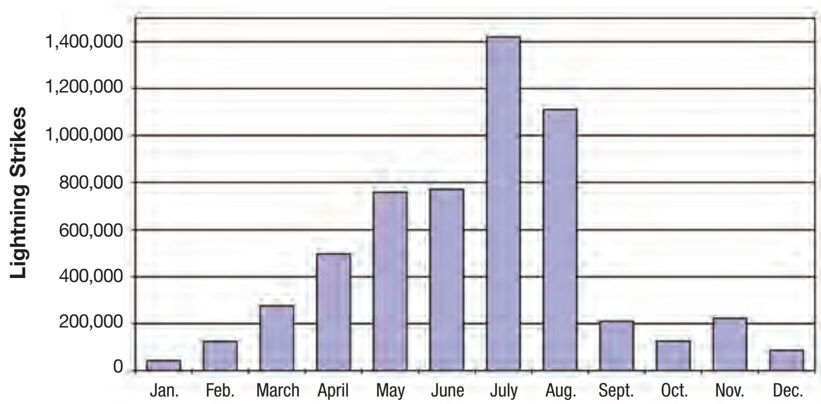

Figure 5. Monthly lightning strikes statewide (2001–2007).

Table 1 lists the number of cloud-to-ground lightning strikes that occurred from 2001 to 2007 in each Mississippi county, monthly and annually. The total in the state during this period was a shocking 5,643,965, with an annual average of 806,281 strikes. However, from 1994 to 2010, a total of only 203 lightning events

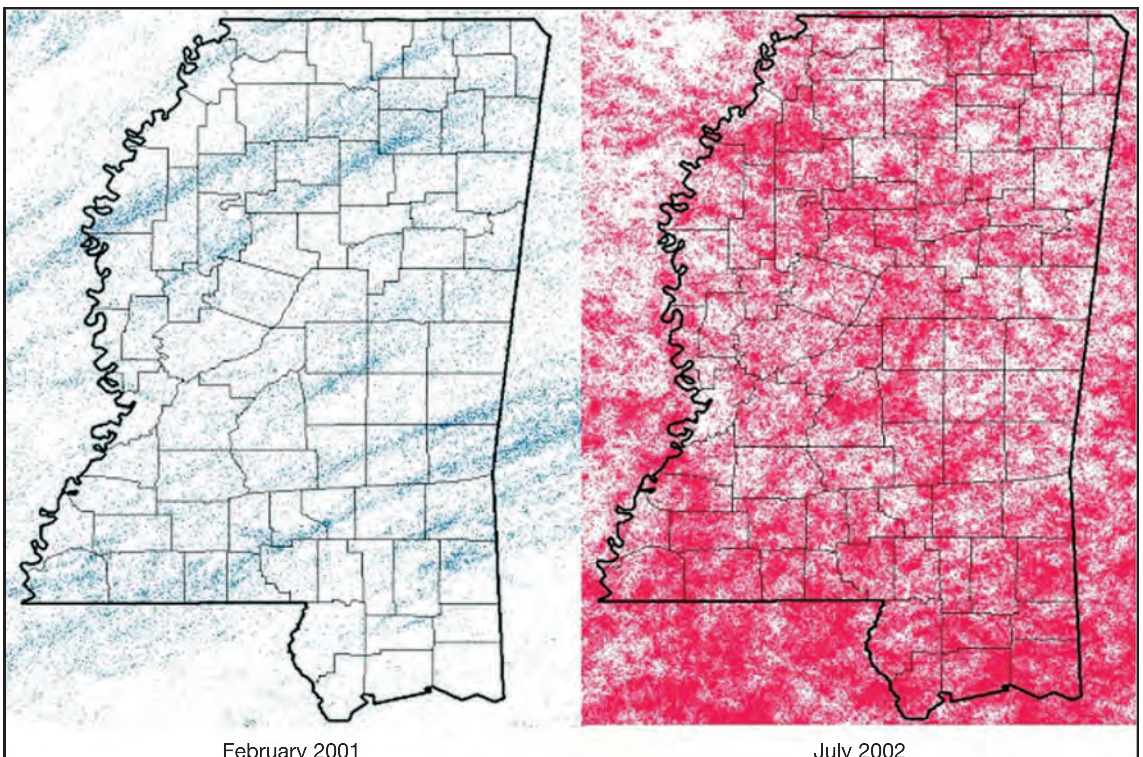

Figure 6. Seasonal differences in the spatial distribution of lightning strikes in Mississippi (colors are intended to indicate only differences in seasons and not density of lightning strikes).

were reported in Mississippi (NOAA Storm Data), resulting in 15 deaths, 35 injuries, $10.4 million in property damage, and $9,000 in crop damage. The majority of these reported events involved structures that were struck by lightning and burned. Therefore, it is evident that lightning events are underreported in the state and underestimated as a weather threat to Mississippians.

Unlike the data in Appendix B, which lists the number of thunderstorm days, the data in Table 1 are the actual number of strikes recorded by the National Lightning Detection Network. One thunderstorm is capable of producing multiple strikes, so the number of lightning strikes is much larger than the number of thunderstorms. The seasonality of lightning is evident in Figure 5, which shows that nearly half the year's total occurs in July and August, and almost three-fourths of the year's total occurs between May and August. By contrast, December and January combined have less than 1% of the year's total. Figure 6 shows this distinct seasonality and explains the difference in the origin of the lightning. The spatial distribution of February lightning strikes is related to the movement of individual thunderstorms with the passage of cold fronts, producing linear patterns of strikes. The distribution of lightning strikes in July, by contrast, is representative of the ever-present afternoon thunderstorms in the warm, muggy summer air masses.

Unlike the tornado data presented in this bulletin, the lightning and thunderstorm day data do not rely upon human observation of the event. Instead, the locations of the lightning strikes are measured by the automated National Lightning Detection Network. As a result, there are no inherent population biases (i.e., more reports near towns and cities and fewer in rural areas) with these data or analyses.

Table 1. Cloud-to-ground lightning strikes during the interval 2001–2007 in each county in Mississippi, monthly and annually.

County	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual avg.	Total
Adams	269	2342	3089	3133	7765	9729	12500	12070	2423	1337	4113	1630	**8629**	**60400**
Alcorn	588	719	1570	2953	4650	3710	12645	9165	2327	2309	1426	339	**6057**	**42401**
Amite	446	3772	7387	7439	12496	19112	31295	19852	4098	1732	1804	2269	**15957**	**111702**
Attala	682	2067	2539	9904	8051	8952	20530	14348	1983	1653	5303	1330	**11049**	**77342**
Benton	198	502	1499	4997	5959	4485	11378	7442	2430	2294	1827	846	**6265**	**43857**
Bolivar	1418	2240	4408	7927	23891	12989	18408	14444	2528	2530	4432	1911	**13875**	**97126**
Calhoun	380	1441	4467	5189	14401	13944	13922	12804	2044	1999	2467	1098	**10594**	**74156**
Carroll	404	1040	2561	4540	7911	8888	15767	11374	1512	1499	2443	1095	**8433**	**59034**
Chickasaw	452	674	3158	4125	10884	7622	11251	13653	1539	1146	2114	937	**8222**	**57555**
Choctaw	501	1251	1599	3207	5441	3600	10252	6697	1240	499	3346	578	**5459**	**38211**
Claiborne	392	1241	3019	3110	12919	7925	15291	10129	2275	682	3961	1366	**8901**	**62310**
Clarke	623	2190	5282	7353	8737	10992	20013	22249	2963	1521	1733	1609	**12181**	**85265**
Clay	432	759	2534	3072	7565	6684	11299	8775	1185	1016	3154	419	**6699**	**46894**
Coahoma	625	886	4321	5145	17174	9975	14522	9517	1397	2057	2874	872	**9909**	**69365**
Copiah	507	4338	4381	4595	13438	17401	27829	20358	5459	1429	3836	1631	**15029**	**105202**
Covington	173	1108	4223	4472	4404	6556	13994	9955	2128	327	1824	553	**7102**	**49717**
De Soto	376	638	2987	4465	9146	5175	10634	8074	1544	1625	3539	533	**6962**	**48736**
Forrest	419	677	3320	5576	4785	10021	18057	14257	2762	961	1626	1062	**9075**	**63523**
Franklin	524	3480	4593	3311	10031	14670	21399	14903	3938	1145	2463	1403	**11694**	**81860**
George	353	707	2761	5103	5644	12756	20678	18501	3541	1724	1625	1045	**10634**	**74438**
Greene	764	1214	4201	6961	8164	15068	27579	18692	5240	1691	4333	1558	**13638**	**95465**
Grenada	259	1271	3074	3754	10734	7398	11043	9605	1193	1355	2489	709	**7555**	**52884**
Hancock	368	1245	3220	5558	7112	12454	22390	15154	4412	2031	1721	1193	**10980**	**76858**
Harrison	457	1712	2905	8249	8491	19452	28874	23401	6728	2726	2343	1226	**15223**	**106564**
Hinds	509	1702	4522	8129	15177	12923	22861	15949	3050	1308	5661	1778	**13367**	**93569**
Holmes	523	1676	2311	8659	8680	12526	14679	11613	1317	1952	3218	1232	**9769**	**68386**
Humphreys	286	994	1489	4022	4864	7184	8953	5729	1748	994	1290	912	**5495**	**38465**
Issaquena	294	1010	1385	4855	5986	5208	8763	6230	1770	770	1341	1043	**5522**	**38655**
Itawamba	770	660	2393	5709	11320	6184	13620	9676	2652	2048	2634	807	**8353**	**58473**
Jackson	263	1490	4560	10431	8101	24647	37109	35687	7525	2629	2254	1427	**19446**	**136123**
Jasper	594	1989	4531	6200	8536	8067	23448	18358	3580	968	2685	820	**11397**	**79776**
Jefferson	508	2366	3539	3700	12417	10979	17772	13496	3915	1063	4363	1578	**10814**	**75696**

Table 1 (continued). Cloud-to-ground lightning strikes during the interval 2001–2007 in each county in Mississippi, monthly and annually.														
County	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual avg.	Total
Jeff. Davis	180	1753	3828	3607	3948	7195	15645	9617	2408	300	1518	557	**7222**	**50556**
Jones	634	1468	7310	8280	10515	13449	23068	16082	2013	761	3551	1491	**12660**	**88622**
Kemper	466	1887	3136	9139	15031	7591	18995	18232	2242	3446	1628	1026	**11831**	**82819**
Lafayette	765	1629	3966	9837	15675	9314	20689	14850	2951	3205	3065	930	**12411**	**86876**
Lamar	391	709	3369	4617	4795	9441	15371	12357	4177	838	2142	973	**8454**	**59180**
Lauderdale	506	2094	4520	8372	14761	10049	21592	16372	2394	2557	1932	911	**12294**	**86060**
Lawrence	420	2164	3504	3460	5676	8296	13323	11153	1621	508	1399	645	**7453**	**52169**
Leake	411	1657	1650	9820	5143	6692	16765	13868	1756	853	2340	777	**8819**	**61732**
Lee	414	783	3108	5663	9687	5055	13007	10914	2354	2045	1546	677	**7893**	**55253**
Leflore	524	1454	2870	6093	11489	9129	12986	8806	2286	1572	3423	971	**8800**	**61603**
Lincoln	643	3319	5122	4278	7434	14882	19543	17394	3119	829	1693	1357	**11373**	**79613**
Lowndes	452	1360	2181	4867	5568	6538	15313	11846	1953	1206	4800	410	**8071**	**56494**
Madison	408	1704	2372	7556	8946	10146	17865	14610	2587	919	4611	1126	**10407**	**72850**
Marion	243	1364	5898	5688	4702	8713	14648	13965	2380	991	2075	921	**8798**	**61588**
Marshall	606	632	2914	9124	12199	7087	18415	12246	3632	3152	3751	1306	**10723**	**75064**
Monroe	962	1301	4068	8452	14306	10041	20683	12312	4453	1693	4703	495	**11924**	**83469**
Montgomery	311	675	1877	2317	4489	5445	11339	8995	823	1006	1795	856	**5704**	**39928**
Neshoba	477	1894	2372	11134	7349	5682	14317	16723	1493	1765	1698	935	**9406**	**65839**
Newton	636	2047	3319	7458	9539	6501	18705	14161	2195	1293	1229	987	**9724**	**68070**
Noxubee	438	1986	2640	7146	6102	7206	19696	16386	1907	1485	2725	1123	**9834**	**68840**
Oktibbeha	607	1201	2203	3713	4120	5391	14007	10777	948	604	4250	343	**6881**	**48164**
Panola	1005	1345	3396	9282	16720	11674	18565	12343	2730	3129	4168	1149	**12215**	**85506**
Pearl River	1591	1383	5020	11595	9921	17827	29967	28231	4531	2680	5021	2038	**17115**	**119805**
Perry	527	1158	4019	7278	6857	14150	22044	20281	3682	1671	2841	1464	**12282**	**85972**
Pike	382	1558	3787	4270	5913	7770	13671	10430	2239	711	1851	1122	**7672**	**53704**
Pontotoc	469	1350	3844	6530	12110	6272	15556	13059	2578	2264	2007	578	**9517**	**66617**
Prentiss	499	517	1757	4381	6238	3990	12841	8270	1188	1430	1165	519	**6114**	**42795**
Quitman	431	583	3067	4579	10741	5837	10806	7270	859	1751	2671	578	**7025**	**49173**
Rankin	727	3089	3424	7810	12846	14298	28387	22451	3481	1182	3519	1788	**14715**	**103002**
Scott	877	1980	3450	7976	9206	7727	20076	19528	2366	548	2316	1213	**11038**	**77263**
Sharkey	370	978	1565	3955	7011	3991	9845	6162	1404	570	1424	1031	**5472**	**38306**
Simpson	708	2972	3647	3630	6135	10376	19671	16193	2276	697	2452	1018	**9968**	**69775**
Smith	603	2497	3840	5507	8507	8135	23163	17198	2778	1019	2412	933	**10942**	**76592**
Stone	488	705	2870	6676	3786	12187	19407	18231	3233	1569	2227	883	**10323**	**72262**
Sunflower	610	1400	3388	8251	12945	10828	16429	11527	2813	2264	3854	1170	**10783**	**75479**
Tallahatchie	739	1713	3544	7853	19879	12697	16366	15555	2751	2212	2899	818	**12432**	**87026**
Tate	389	266	1882	5218	9393	4561	7833	8323	1411	1274	2414	707	**6239**	**43671**
Tippah	409	765	1405	4546	6706	4963	16962	8477	1459	2272	1719	970	**7236**	**50653**
Tishomingo	535	730	2036	3232	5478	3769	13428	8876	2251	1473	1017	326	**6164**	**43151**
Tunica	161	610	2346	4309	9141	4654	8987	7498	1670	1804	2252	558	**6284**	**43990**
Union	509	747	2210	6541	9010	4938	11755	11751	1932	2954	1513	697	**7794**	**54557**
Walthall	246	1361	4654	5261	3709	7770	12958	10357	1635	855	1743	850	**7343**	**51399**
Warren	435	1409	2520	6648	12207	8818	15742	9103	2428	1058	3072	1482	**9275**	**64922**
Washington	464	1498	3584	7875	7897	8148	14365	7830	2492	1281	3233	900	**8510**	**59567**
Wayne	658	1766	6659	9184	10227	14810	25595	24272	3578	772	2944	1323	**14541**	**101788**
Webster	458	539	2601	2284	6085	8705	11963	7946	845	1063	1788	606	**6412**	**44883**
Wilkinson	448	4115	6310	5889	11175	17501	26153	16642	3202	2858	3572	2495	**14337**	**100360**
Winston	472	1909	2082	6105	6691	5087	18789	16228	1357	1151	3909	1049	**9261**	**64829**
Yalobusha	412	1172	3982	5197	12829	9418	14095	10295	2173	1496	2644	563	**9182**	**64276**
Yazoo	826	1803	3150	9227	12054	8488	19875	12104	2599	1657	4221	1841	**11121**	**77845**
Statewide	**42299**	**124400**	**276094**	**497553**	**757765**	**770508**	**1420021**	**1110254**	**210079**	**125713**	**222984**	**86295**	**806281**	**5643965**

Tornadoes

A tornado is defined as a violently rotating column of air that is in contact with the ground and the base of a cumulonimbus cloud. Although tornadoes can exhibit many shapes, they are most commonly recognized by a funnel shape. On the small scale, tornadoes are the most destructive of all atmospheric phenomena. Extremely strong pressure gradients associated with the rotating structure of these storms produce wind speeds that can exceed 100 to 200 mph and cause nearly total destruction of the area hit by the storm. Tornadoes are regarded as one of nature's most destructive atmospheric forces.

Mississippi is located in the middle of "Dixie Alley," a region that gets a number of tornadoes that is proportional with the better-known "Tornado Alley" in the Great Plains. Given the nature of the forested landscape in Mississippi as compared with the relatively flat and open landscape of the Great Plains, the hazard from tornadoes to life and property in the state is considerable. Normalized by area, Mississippi has more total annual tornadoes than Illinois, Texas, and Nebraska (Grazulis, 1993). Only Oklahoma, Kansas, and Iowa have more than Mississippi. When considering just strong and violent tornadoes (EF-4 and EF-5 ratings), Mississippi is second only to Oklahoma. Furthermore, mobile homes account for nearly 20% of total housing units in Mississippi, second in the nation only to South Carolina (Brooks, 2001). These mobile homes are subject to greater damage at lower wind speeds when compared with traditionally built structures as indicated by the Enhanced Fujita Scale (Texas Tech University, 2006).

Figure 7. All tornado occurrences in Mississippi, 1950–2006.

Unlike the thunderstorm and lightning data, reporting of tornadoes relies upon human observation, and therefore the tornado database exhibits a population bias. This bias exists for a number of reasons: the population density of a region; the terrain (i.e., observation distance); the existence or absence of organized storm-spotting organizations; and the road network of the region (Kelly, et al., 1985). Consequently, the spatial and temporal distributions of tornadoes are presented with the understanding that rural areas may be underrepresented. This analysis provides for the first time information on monthly tornado occurrence in Mississippi by county based on the period 1950–2006.

Figure 7 shows the pattern of tornado touchdowns and paths in the state during this 57-year period. A tornado path has clear beginning and ending locations with continuous or nearly continuous damage between the two, whereas a tornado touchdown is a single-point location of isolated damage. Tornado events mapped in Figure 7 include both touchdowns in a single county and paths that crossed multiple counties. As generally expected, the figure shows the characteristic southwest-to-northeast direction of movement evident in the paths. The pattern also shows that tornadic activity appears to be greater in the southern and central portions of the state.

Figure 8 shows the distribution of tornadoes by month in the state. Unlike the summer maximum of thunderstorm and lightning activity in the state, tornadoes exhibit both an early-spring and a late-fall peak. These two periods represent the times when frontal passages are most frequent in the state. Figure 9 displays the distribution of tornadoes by regions in the state, showing the predominance of tornadoes in the south and central regions and once more emphasizing the extent to which the Gulf of Mexico influences severe weather in Mississippi.

A detailed monthly listing of tornado occurrences for each county is included in Appendix C. Only two counties, Hinds and Lauderdale, have experienced tornadoes in every month of the year. On the other extreme, Itawamba County has experienced tornadoes only in March, April, and May. Figure 10 shows the spatial distribution of all tornado events by county. This figure highlights the areas of apparent greatest tornado frequency as the Delta, the central, and the coastal regions.

April is the month when the greatest number of tornadoes occurs in the state. Figure 11 shows the spatial distribution of tornadic activity for that month in Mississippi, once more indicating the pattern of greatest occurrence in the Delta, central, and southern regions of the state. Figure 12 shows the spatial distribution of tornadic activity in November, the secondary peak of activity for the year in Mississippi. As the figure shows, the greatest concentration of tornadoes occurs south of Highway 82 in November. The month with the minimum amount of tornadic activity in Mississippi is July. Figure 13 shows that the spatial distribution in July is the same as the more active months, but fewer events occur statewide.

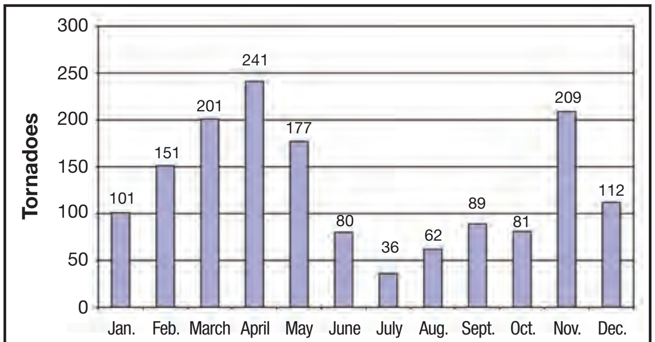

Figure 8. Total tornado occurrences by month in Mississippi, 1950–2006.

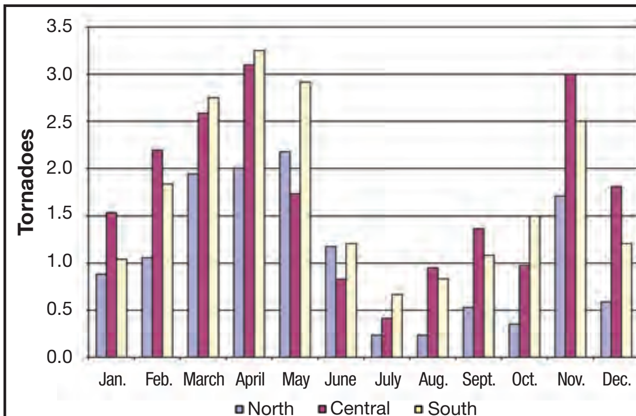

Figure 9. Annual average of tornado occurrences in three regions of the state.

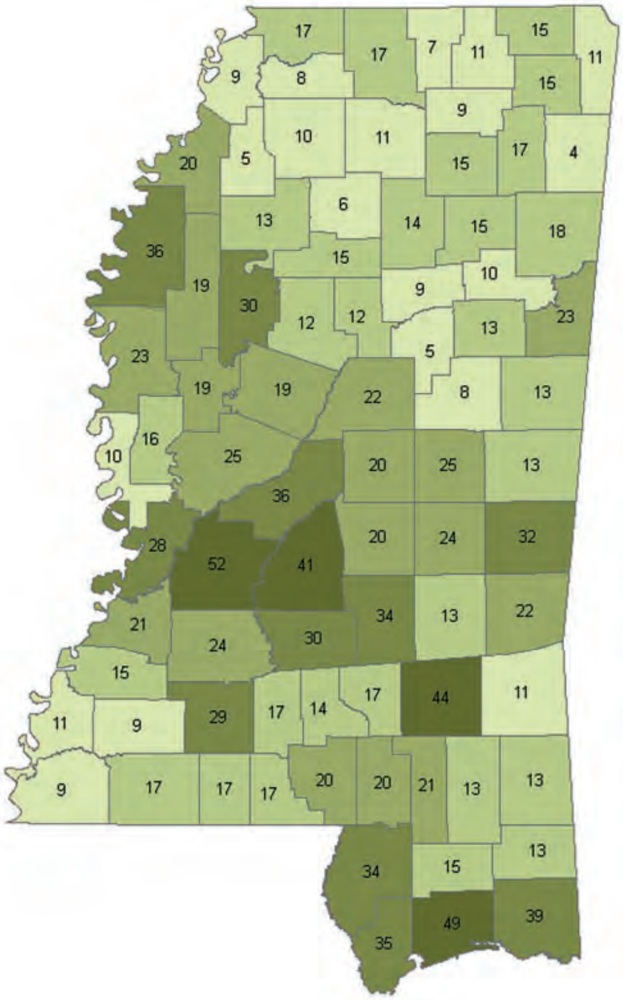

Figure 10. All tornadoes 1950–2006 (raw tornado counts inside each county).

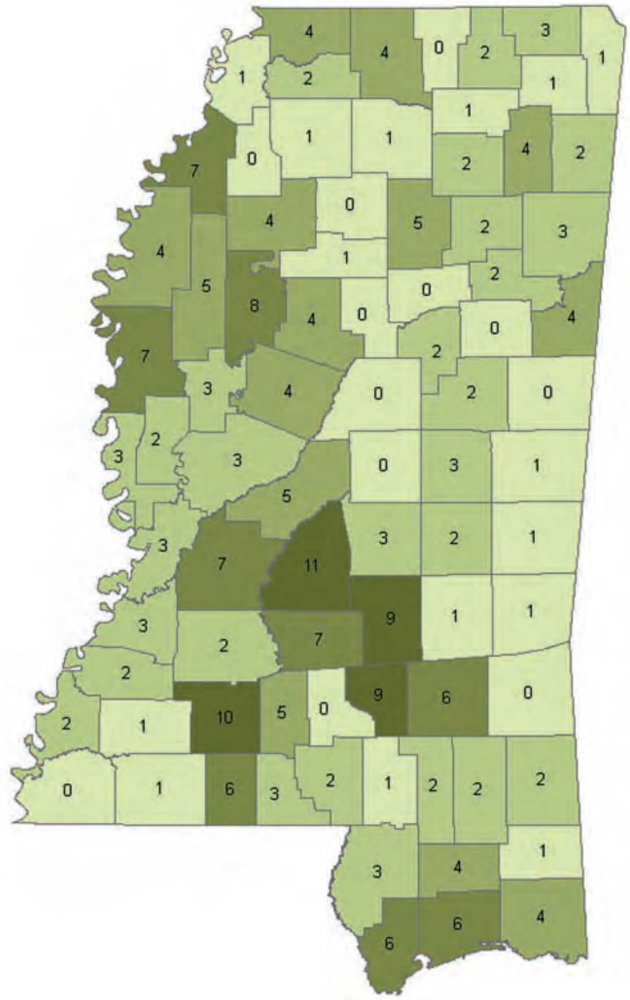

Figure 11. April tornadoes 1950–2006 (raw tornado counts inside each county).

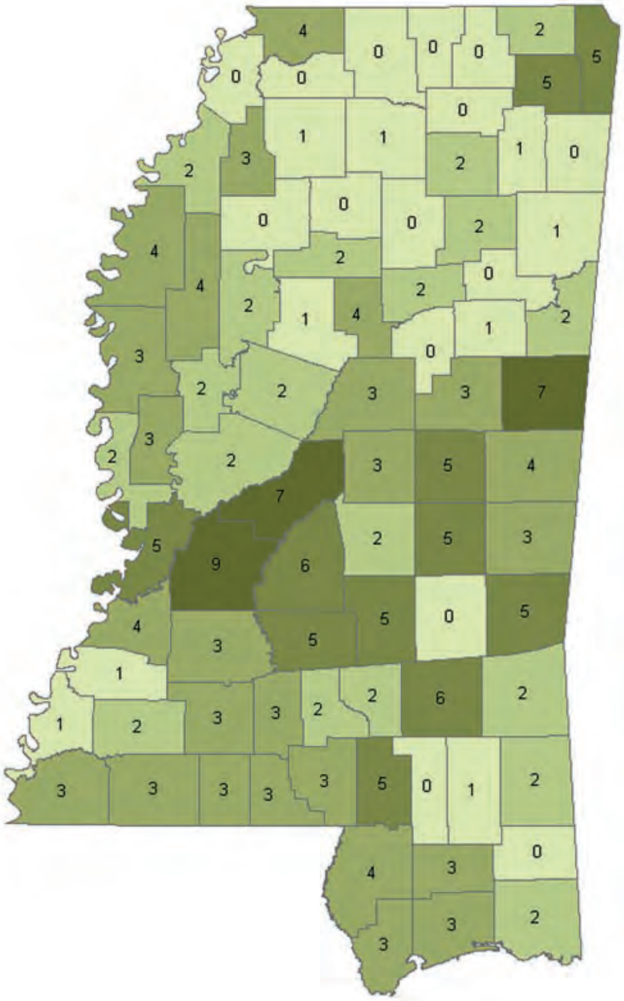

Figure 12. November tornadoes 1950–2006 (raw tornado counts inside each county).

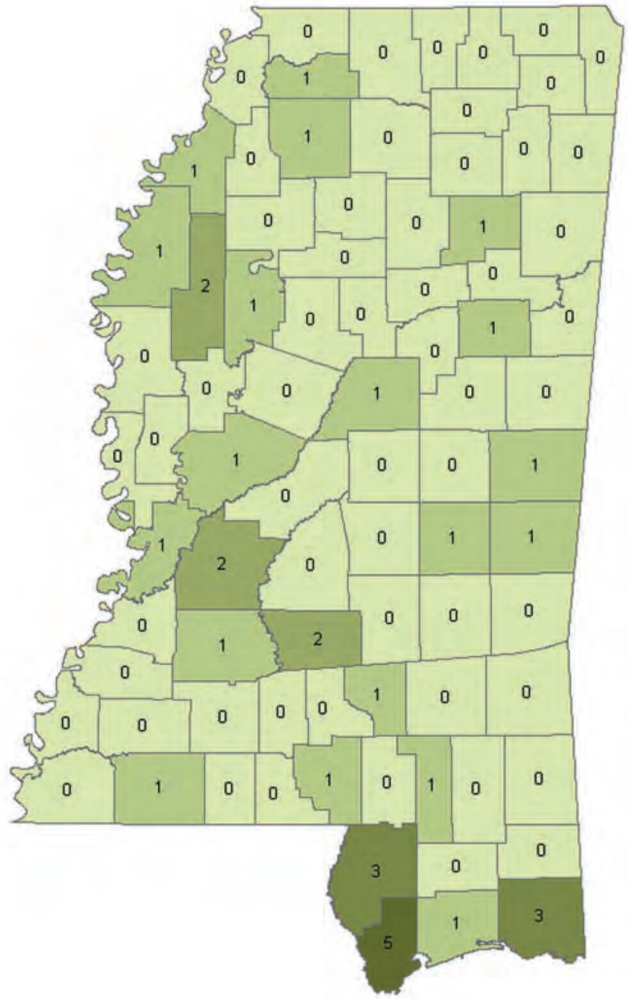

Figure 13. July tornadoes 1950–2006 (raw tornado counts inside each county).

Conclusions

The effect of severe weather in Mississippi has a profound impact on life and property each year. During the period 2000–2007, the average annual number of lightning strikes in the state (more than 800,000) killed one citizen and injured two. Lightning strikes also caused more than $650,000 in economic damage each year. During the period 1950–2006, the annual average number of tornadoes (27) killed six citizens and injured another 90 each year. Tornadoes also caused more than $15.2 million in economic damage yearly. For perspective, lightning damage averaged about $0.82 of economic loss per strike, whereas each tornado produced an average of about $560,000 of economic loss.

However, when we focus on tornado activity from 2000 to 2007, there was an average of 57 tornadoes, two deaths, 45 injuries, and $35 million in economic losses each year. The increased average number of tornadoes during this period may be a result of better detection and reporting rather than an actual increase in tornado occurrence. The reduction in death and injuries may be attributed to advances in tornado detection and communication technology leading to better warnings, as well as to increased media coverage and public awareness. The increase in economic loss during the more recent 8-year period may be the direct result of increased population, urban growth, and related infrastructure in the state.

Since Mississippians are exposed to so much severe weather, it is recommended that safety precautions and awareness continue to be promoted and observed across the state. In the case of thunderstorms and lightning, the 30/30 rule is endorsed by the National Weather Service. That is, when you see lightning, count the seconds until you hear the thunder. If the number of seconds is less than 30, go indoors and stay there for 30 minutes after the last thunder. If tornadoes are possible in an area, the National Weather Service will issue a tornado watch for that area. This means that conditions for tornado formation are favorable and present. Monitor the situation by tuning to local communications media or a NOAA weather radio. If a tornado is indicated by radar or spotted by an observer, a tornado warning will be issued. At this time, immediate action is necessary. Move to the interior of the lowest floor of your residence and stay there until the storm has passed. Plan your response to tornado warnings in advance. Understanding the threat of severe weather in Mississippi and your vulnerability to those threats can help prevent injury, death, and economic loss.

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Appendix A. Enhanced-Fujita Scale.

Category	Wind speed (mph)	Potential damage
EF-0	65–85	**Light damage**. Peels surfaces off roofs; some damage to chimneys; branches broken off trees; shallow-rooted trees pushed over; mobile homes pushed off foundations or overturned; sign boards damaged.
EF-1	86–110	**Moderate damage**. Roofs torn off frame houses; windows and glass doors broken; moving autos blown off roads; mobile homes demolished; boxcars overturned.
EF-2	111–135	**Considerable damage**. Roofs torn off well-constructed houses; foundations of frame homes shifted; large trees snapped or uprooted; light-object missiles generated; cars lifted off ground.
EF-3	136–165	**Severe damage**. Some walls torn off well-constructed houses; trains overturned; most trees in forests uprooted; heavy cars lifted off the ground and thrown; structures with weak foundations blown away some distance.
EF-4	166–200	**Devastating damage**. Well-constructed houses and whole frame houses completely leveled; structures with weak foundations blown away some distance; trees debarked; cars thrown and small missiles generated.
EF-5	> 200	**Incredible damage**. Strong frame houses leveled off foundations and swept away; brick houses completely wiped off foundations; automobile-sized missiles fly through the air in excess of 100 meters.

Appendix B. County and state monthly and annual thunderstorm days.

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Adams	6	4	5	6	11	11	21	4	6	6	3	4	**87**
Alcorn	6	1	3	8	13	6	7	9	8	1	3	3	**68**
Amite	1	6	8	7	10	12	24	11	9	6	2	5	**101**
Attala	3	4	5	5	12	4	17	13	8	3	3	2	**79**
Benton	6	1	5	8	10	4	9	9	8	2	3	3	**68**
Bolivar	2	2	2	11	11	10	6	8	6	2	4	4	**68**
Calhoun	3	2	1	7	13	8	12	11	7	3	3	4	**74**
Carroll	6	1	2	8	11	5	13	8	6	4	2	3	**69**
Chickasaw	3	2	1	8	11	6	13	12	7	2	2	3	**70**
Choctaw	1	2	3	5	9	7	17	15	6	1	3	2	**71**
Claiborne	6	3	5	7	9	8	18	11	9	3	2	3	**84**
Clarke	1	5	6	5	12	10	15	20	7	4	5	5	**95**
Clay	6	3	1	9	12	6	15	11	7	2	3	2	**77**
Coahoma	2	1	4	9	13	8	3	9	10	2	4	3	**68**
Copiah	6	5	5	7	12	8	19	9	8	4	3	4	**90**
Covington	6	5	5	5	12	9	18	11	7	3	3	3	**87**
De Soto	1	1	5	8	12	9	4	9	8	1	3	3	**64**
Forrest	6	5	6	6	10	14	21	13	12	3	6	4	**106**
Franklin	1	5	6	6	7	7	18	12	9	5	3	4	**83**
George	6	6	5	5	9	14	24	14	12	7	3	4	**109**
Greene	6	7	5	6	10	13	27	16	13	2	4	4	**113**
Grenada	1	2	2	7	11	6	11	9	8	14	2	4	**77**
Hancock	6	7	9	6	5	14	25	15	10	6	4	3	**110**
Harrison	6	6	5	6	8	16	24	17	10	7	2	2	**109**
Hinds	6	3	5	8	13	9	18	14	9	5	3	3	**96**
Holmes	1	5	3	9	10	6	12	11	7	3	3	4	**74**
Humphreys	6	1	3	7	8	4	7	8	7	2	3	3	**59**
Issaquena	6	2	4	7	9	7	13	7	5	4	4	4	**72**
Itawamba	1	2	1	9	10	8	12	13	5	2	3	2	**68**
Jackson	6	7	5	6	9	16	23	20	11	6	3	3	**115**
Jasper	2	5	6	6	10	8	19	18	7	4	3	5	**93**
Jefferson	6	3	7	8	10	9	16	11	5	2	4	4	**85**
Jeff. Davis	6	5	5	6	10	11	20	14	8	4	4	3	**96**
Jones	6	5	5	5	12	12	20	16	8	3	4	4	**100**

Appendix B (continued). County and state monthly and annual thunderstorm days.													
	Jan.	**Feb.**	**March**	**April**	**May**	**June**	**July**	**Aug.**	**Sept.**	**Oct.**	**Nov.**	**Dec.**	**Annual**
Kemper	1	4	3	5	12	5	15	16	6	2	1	4	**74**
Lafayette	1	1	2	8	13	9	11	7	9	3	2	4	**70**
Lamar	6	6	6	5	9	10	19	12	10	5	4	3	**95**
Lauderdale	1	4	5	6	12	7	16	14	7	3	3	3	**81**
Lawrence	6	5	5	6	10	10	22	12	8	4	2	3	**93**
Leake	1	3	3	7	11	6	13	11	6	4	3	2	**70**
Lee	2	1	1	10	11	6	10	10	7	1	2	4	**65**
Leflore	1	2	3	10	10	4	10	7	7	2	3	3	**62**
Lincoln	6	5	5	7	10	7	20	12	9	3	3	4	**91**
Lowndes	1	2	2	7	12	6	13	10	6	14	2	3	**78**
Madison	1	2	5	7	11	7	16	14	6	3	4	3	**79**
Marion	6	6	6	6	11	10	18	13	10	4	3	3	**96**
Marshall	2	1	5	8	13	6	11	8	10	2	4	4	**74**
Monroe	3	1	1	9	12	8	14	12	6	2	3	4	**75**
Montgomery	1	1	1	6	6	5	13	9	7	1	3	3	**56**
Neshoba	6	5	3	6	13	4	14	12	5	3	2	2	**75**
Newton	1	5	4	7	12	8	13	15	7	4	4	3	**83**
Noxubee	1	3	5	5	12	7	15	13	4	1	3	3	**72**
Oktibbeha	1	2	2	4	10	6	17	14	6	3	3	2	**70**
Panola	2	1	4	8	13	9	7	7	10	1	3	4	**69**
Pearl River	6	6	6	5	9	14	27	19	14	8	4	3	**121**
Perry	6	6	6	5	11	13	23	14	12	2	6	5	**109**
Pike	6	6	8	6	10	11	23	12	11	4	2	3	**102**
Pontotoc	2	1	1	7	12	8	8	9	8	1	2	4	**63**
Prentiss	2	1	3	8	6	10	10	6	6	1	3	3	**59**
Quitman	1	1	3	9	11	8	4	6	6	3	3	4	**59**
Rankin	6	4	5	9	10	6	17	17	7	5	3	3	**92**
Scott	1	5	5	8	12	5	16	14	8	5	3	2	**84**
Sharkey	6	2	4	5	8	5	9	7	7	2	3	4	**62**
Simpson	6	5	5	6	11	9	16	13	6	4	2	4	**87**
Smith	1	5	5	7	11	7	17	16	8	4	2	4	**87**
Stone	6	6	5	5	10	17	22	14	10	6	4	4	**109**
Sunflower	1	1	2	11	11	6	7	8	6	2	4	4	**63**
Tallahatchie	1	2	3	11	12	5	6	9	8	3	3	3	**66**
Tate	1	1	4	8	12	9	5	5	9	1	3	3	**61**
Tippah	6	1	3	7	13	5	10	8	8	2	2	3	**68**
Tishomingo	1	1	3	8	12	9	9	10	6	1	3	4	**67**
Tunica	6	1	3	9	12	8	3	7	9	2	3	2	**65**
Union	6	1	2	7	13	6	10	10	7	1	2	4	**69**
Walthall	6	7	7	7	8	10	20	12	11	4	3	4	**99**
Warren	1	3	6	7	9	7	12	11	7	4	3	3	**73**
Washington	6	3	4	11	12	9	9	11	6	2	3	4	**80**
Wayne	6	5	5	4	12	11	17	13	9	3	5	4	**94**
Webster	1	2	1	5	12	4	12	10	8	2	2	2	**61**
Wilkinson	1	4	6	7	12	13	26	15	10	6	4	4	**108**
Winston	1	3	5	8	12	6	20	14	6	2	3	2	**82**
Yalobusha	2	1	1	8	12	6	10	7	7	3	3	3	**63**
Yazoo	6	4	3	7	10	5	18	12	8	3	3	4	**83**
Statewide	**4**	**3**	**4**	**7**	**11**	**8**	**15**	**12**	**8**	**3**	**3**	**3**	**81**

Appendix C. County totals of tornado events by month, 1950–2006.

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Adams	1	0	3	2	2	2	0	0	0	0	1	0	**11**
Alcorn	1	2	1	3	5	1	0	0	0	0	2	0	**15**
Amite	0	0	4	1	4	0	1	0	0	1	3	3	**17**
Attala	2	1	5	0	2	3	1	1	2	1	3	1	**22**
Benton	0	1	2	0	3	0	0	0	1	0	0	0	**7**
Bolivar	5	2	5	4	4	2	1	0	7	1	4	1	**36**
Calhoun	2	2	3	5	0	1	0	0	0	0	0	1	**14**
Carroll	2	2	0	4	1	0	0	0	1	0	1	1	**12**
Chickasaw	0	1	1	2	2	2	1	0	1	0	2	3	**15**
Choctaw	1	1	0	2	0	0	0	0	1	0	0	0	**5**
Claiborne	2	2	4	3	0	0	0	1	3	1	4	1	**21**
Clarke	2	0	2	1	6	0	0	4	1	1	5	0	**22**
Clay	1	0	3	2	1	1	0	1	0	1	0	0	**10**
Coahoma	0	0	1	7	4	3	1	0	0	1	2	1	**20**
Copiah	1	3	3	2	0	0	1	3	0	3	3	5	**24**
Covington	0	0	2	9	1	0	1	0	1	0	2	1	**17**
De Soto	2	0	3	4	1	2	0	1	0	0	4	0	**17**
Forrest	1	2	5	2	6	1	1	1	0	0	0	2	**21**
Franklin	1	0	0	1	0	1	0	0	2	2	2	0	**9**
George	1	3	2	1	2	1	0	0	1	2	0	0	**13**
Greene	0	3	3	2	1	0	0	0	0	0	2	2	**13**
Grenada	0	5	1	1	1	1	0	0	0	0	2	4	**15**
Hancock	0	2	1	6	9	2	5	2	2	2	3	1	**35**
Harrison	0	3	6	6	10	3	1	5	9	3	3	0	**49**
Hinds	5	7	6	7	3	1	2	2	6	1	9	3	**52**
Holmes	2	2	2	4	2	0	0	1	0	2	2	2	**19**
Humphreys	2	1	1	3	1	0	0	1	5	0	2	3	**19**
Issaquena	1	1	2	3	0	0	0	0	0	0	2	1	**10**
Itawamba	0	0	1	2	1	0	0	0	0	0	0	0	**4**
Jackson	3	5	2	4	9	4	3	3	2	0	2	2	**39**
Jasper	2	3	3	1	1	0	0	0	1	1	0	1	**13**
Jefferson	1	1	3	2	2	0	0	0	4	1	1	0	**15**
Jeff. Davis	2	1	1	0	3	0	0	0	0	2	2	3	**14**
Jones	2	3	9	6	2	4	0	0	0	5	6	7	**44**
Kemper	0	0	1	1	1	0	1	2	0	0	4	3	**13**
Lafayette	0	2	4	1	1	1	0	1	0	0	1	0	**11**
Lamar	2	2	4	1	0	0	0	2	1	3	5	0	**20**
Lauderdale	2	3	6	1	3	1	1	6	2	1	3	3	**32**
Lawrence	2	3	0	5	0	0	0	3	1	0	3	0	**17**
Leake	2	3	4	0	2	0	0	2	1	2	3	1	**20**
Lee	1	0	3	4	4	0	0	0	1	2	1	1	**17**
Leflore	4	2	1	8	4	1	1	0	3	0	2	4	**30**
Lincoln	2	2	3	10	1	0	0	1	0	5	3	2	**29**
Lowndes	1	3	5	4	1	1	0	0	1	3	2	2	**23**
Madison	1	5	8	5	6	0	0	0	1	0	7	3	**36**
Marion	1	3	3	2	1	2	1	1	0	2	3	1	**20**
Marshall	2	1	3	4	3	1	0	0	2	1	0	0	**17**
Monroe	3	3	3	3	2	1	0	0	1	0	1	1	**18**
Montgomery	2	1	1	0	1	0	0	0	0	3	4	0	**12**
Neshoba	1	3	4	3	1	1	0	4	0	2	5	1	**25**
Newton	1	4	2	2	1	2	1	3	1	0	5	2	**24**
Noxubee	0	0	3	0	1	1	0	0	1	0	7	0	**13**
Oktibbeha	2	1	1	0	1	0	1	0	2	0	1	4	**13**
Panola	1	1	2	1	1	1	1	0	0	0	1	1	**10**
Pearl River	2	4	4	3	8	0	3	2	1	3	4	0	**34**
Perry	0	3	2	2	1	2	0	0	0	0	1	2	**13**
Pike	2	1	2	6	0	2	0	0	0	0	3	1	**17**
Pontotoc	2	2	2	2	4	0	0	0	0	0	2	1	**15**
Prentiss	2	0	1	1	1	1	0	0	0	1	5	3	**15**
Quitman	0	0	0	0	1	1	0	0	0	0	3	0	**5**

Appendix C (continued). County totals of tornado events by month, 1950–2006.													
	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Rankin	2	10	2	11	3	0	0	0	2	2	6	3	**41**
Scott	0	3	0	3	4	3	0	1	0	2	2	2	**20**
Sharkey	1	0	4	2	0	1	0	1	2	1	3	1	**16**
Simpson	1	2	5	7	2	0	2	1	1	2	5	2	**30**
Smith	3	2	3	9	1	2	0	1	2	4	5	2	**34**
Stone	0	1	0	4	1	2	0	0	1	2	3	1	**15**
Sunflower	1	1	1	5	2	0	2	0	3	0	4	0	**19**
Tallahatchie	0	0	3	4	1	2	0	0	0	0	0	3	**13**
Tate	1	0	0	2	2	0	1	1	0	0	0	1	**8**
Tippah	0	1	0	2	3	3	0	0	2	0	0	0	**11**
Tishomingo	1	0	1	1	1	2	0	0	0	0	5	0	**11**
Tunica	0	5	0	1	1	1	0	0	0	0	0	1	**9**
Union	0	2	5	1	0	0	0	0	1	0	0	0	**9**
Walthall	1	1	4	3	3	1	0	0	1	0	3	0	**17**
Warren	3	2	0	3	2	2	1	1	2	2	5	5	**28**
Washington	2	4	0	7	0	3	0	0	2	1	3	1	**23**
Wayne	0	1	3	0	3	1	0	0	0	1	2	0	**11**
Webster	0	1	3	0	1	1	0	0	1	0	2	0	**9**
Wilkinson	1	0	0	0	1	1	0	0	0	2	3	1	**9**
Winston	0	1	0	2	1	0	0	0	0	0	3	1	**8**
Yalobusha	1	1	1	0	2	0	0	0	0	0	0	1	**6**
Yazoo	0	2	4	3	4	1	1	3	0	3	2	2	**25**
Total	**101**	**151**	**201**	**241**	**177**	**80**	**36**	**62**	**89**	**81**	**209**	**112**	**1541**

Glossary

Cumulonimbus — Exceptionally dense and vertically developed cloud, often associated with thunderstorms capable of producing heavy rain, hail, lightning, and tornadoes.

Enhanced-Fujita (EF) scale — Damage scale used to assess the intensity of a tornado (see Appendix A).

Lightning — Electrical discharge of a thunderstorm which can be intercloud (cloud to cloud), intracloud (within a cumulonimbus cloud), or cloud to ground.

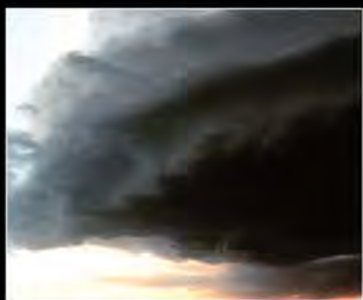
Mesoscale convective complex (MCC) — Large complex of merged thunderstorms that is defined by the extent of the cloud cover using satellite imagery.

Mesoscale convective systems (MCS) — A line of thunderstorms frequently referred to as a squall line.

Thunderstorm — Any storm that produces lightning and therefore thunder.

Thunderstorm day — A day in which at least one thunderstorm occurs in a defined region.

Tornado — A violently rotating column of air that is in contact with the ground and the base of a cumulonimbus cloud.



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