A 10-yr Monthly Lightning Climatology of Florida: 1986–95

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ABSTRACT

Average cloud-to-ground lightning flash density values for Florida have been calculated for the 10-yr period 1986–95. An annual mean map and monthly mean maps were constructed from a database exceeding 25 million flashes. These maps represent a 10-yr climatology of the geographic distribution of detected cloud-to-ground lightning flashes and provide an insight into the thunderstorm distribution in Florida. The locations of relative areas of lightning maxima and minima are strongly affected by the various combinations of synoptic and mesoscale contributions and are discussed. During the cool season, November–February, the greatest flash densities occur over the panhandle from storms mostly associated with midlatitude synoptic-scale systems. During the spring transitional period of March–May, flash densities increase over the entire state as synoptic contributions transition to mesoscale. Flash density totals in the warm season, June–August, exceed 10 flashes km^{-2} in the central part of Florida. Flash density maxima in the summer are locally enhanced by mesoscale convergence and convection, especially along the west and east coasts of the central peninsula. Neither the panhandle nor the south peninsula show these impressive maxima. During the autumn transition period, September and October, flash densities decrease sharply across the state except for an area maximum that does remain over the eastern part of the peninsula.

1. Introduction

Networks that detect cloud-to-ground (CG) lightning flashes have covered parts of the United States for the past two decades, beginning with the Bureau of Land Management System in the west in the late 1970s (Krider et al. 1980). Subsequent networks were installed throughout the United States (Orville et al. 1983; Mach et al. 1986), culminating in the formation of the National Lightning Detection Network in 1989 (Orville 1991). The state of Florida was instrumented with magnetic direction finders (DFs) in 1985. Since that time, the Florida network has been blended with time-of-arrival (TOA) sensors and continues to detect and record cloud-to-ground lightning flashes. Studies have been reported by Reap (1994) using Florida lightning data from 1 March–30 September for the years 1987–90. However, we now possess a 10-yr record composed of over 25 million flashes in Florida. The purpose of this study is to present the average annual distribution and the average monthly distribution of cloud-to-ground flashes in Florida from 1986 through 1995. To the best of our knowledge, this is the first complete 10-yr summary of cloud-to-ground lightning flash density based on the continuous operation of a lightning network. Although our presented climatology only includes flash densities over the Florida landmass, it is the intention of the authors to subsequently include a coastal marine climatology to complete the total climatology. This will likely give better definition to contributions from synoptic effects over land while perhaps revealing the electrical character of certain mesoscale maritime environments.

Florida has been labeled the ‘‘lightning capital’’ of the United States. The title is well deserved as mesoscale meteorological influences often provide an environment conducive to thunderstorm production as was first recognized by Byers and Braham (1949).

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Surrounded by water on three sides, Florida has a coastline approximately 2000 km in length with obvious maritime influences. Florida also has roughly 140 000 km^2 of land and 11 500 km^2 of land-locked water (Fernald 1981). Differential heating, related to land–water thermal contrasts, provides for an abundance of mesoscale boundaries often serving as lifting and/or focusing mechanisms for deep convection. Irregular geographic features include coastline protrusions at Apalachicola and Cape Canaveral, the large bays at Biscayne and Tampa, Charlotte Harbor, the St. Johns River, Lake Okeechobee, the Everglades, and the island chain of the Florida Keys. The Atlantic Ocean borders the east coast with the embedded Gulf Stream current near shore at Palm Beach and about 145 km offshore at Jacksonville. To the west, the more shallow waters of the Gulf of Mexico border the panhandle and west peninsula coasts. Each of these features has an impact on the local distribution of lightning density. Topographical relief is minimal along the entire coastal zone and the southern one-third of the peninsula. The highest elevations, only 60–90 m, are along the northern reaches of the panhandle and along the central Florida ridge that runs north–south down the center of the northern two-thirds of the peninsula. Orography is not considered a significant lifting mechanism for the production of thunderstorms.

Generally, Florida has a near-tropical climate. This becomes more evident with decreasing latitude. During the cool and transitional seasons, the state experiences the passage of midlatitude synoptic-scale cold fronts that are often electrically active. This is especially true for the panhandle region. South Florida, on many occasions, serves as the dying ground for these fronts as they become stationary and eventually become diffuse. However, at times these fronts remain active and return north as warm fronts. Conversely, during the warm and transitional seasons, differential heating generates discernible mesoscale fronts as sea (lake or bay) breezes. These boundaries often become electrically active. It is during both transitional periods when the combined contributions of synoptic-scale effects and mesoscale effects have the greatest impact on the magnitude of flash densities and their associated distributions. Additionally, from June through November, Florida is a prime landfall target for tropical cyclones. However, it should be understood that lightning activity is usually minimal with tropical cyclones due to their thermodynamic structure and associated low buoyancy (Zipser and LeMone 1980; Jorgensen 1984). For lightning to develop, strong and sufficiently deep updrafts are necessary to promote charge separation in the mixed-phase region between supercooled water and ice particles (Jayaratne et al. 1983; Dye et al. 1986; Samsury and Orville 1994). This is difficult to achieve except along the outer fringes of such systems, although the eyewall of Hurricane Andrew did produce cloud-to-ground flashes during landfall over southeast Florida (Lascody 1993).

While it is true that other Florida lightning and convective climatologies have been constructed, most were limited to warm season convection over the peninsula. Blanchard and López (1985) examined the spatial pattern of convection over south Florida. They argued that there are primarily three basic convective patterns observed over south Florida during the summer months. López and Holle (1987) later stated that thunderstorm activity over Florida was controlled by a complex interaction between repetitive sea-breeze circulations and the different flow and airmass characteristics that are determined by synoptic- and large regional-scale situations in relationship to the underlying topography. López and Holle (1987) then investigated the distribution of summer season lightning as a function of low-level wind flow over central Florida during the summer. They defined certain low-level wind flow regimes that tended to increase flash densities for certain parts of the peninsula. Holle et al. (1992) analyzed lightning flash distributions associated with synoptic map types over Florida. Their purpose was to improve short-range forecasting of lightning/thunderstorms within the Kennedy Space Center. Reap (1994) also studied the effects of synoptic-scale forcing under a variety of low-level flow regimes focusing on the subsequent temporal and spatial distribution of warm season lightning activity to develop experimental probability equations for predicting thunderstorm distributions associated with major flow regimes. In addition, various ‘‘thunderstorm day’’ climatologies have been drafted in the past. These were often based on the occurrence of ‘‘thunder heard’’ at a given location (manual surface observational procedure) while indifferent to the type of lightning or its distance from the observing station (MacGorman et al. 1984). Our study will offer a more concise picture of how local geography affects cloud-to-ground lightning distributions, climatologically during each month of the year, and for the entire state. Similar but less comprehensive studies were performed over Georgia in preparation for the 1996 Summer Olympic Games in Atlanta, Georgia (Livingston et al. 1996; Watson and Holle 1996).

2. Data

The lightning detection network in Florida has evolved since the first installations in 1985. The original Florida DF installations were an expansion of the New England network reported by Orville et al. (1987), which used DFs identical to the equipment described by Krider et al. (1976, 1980) and evaluated by Mach et al. (1986). A map of the DF locations in Florida for the period 1985–93 can be found in recent publications (Orville 1991, Fig. 2; Reap 1994, Fig. 1). By 1994, the lightning sensors included both the TOA and magnetic

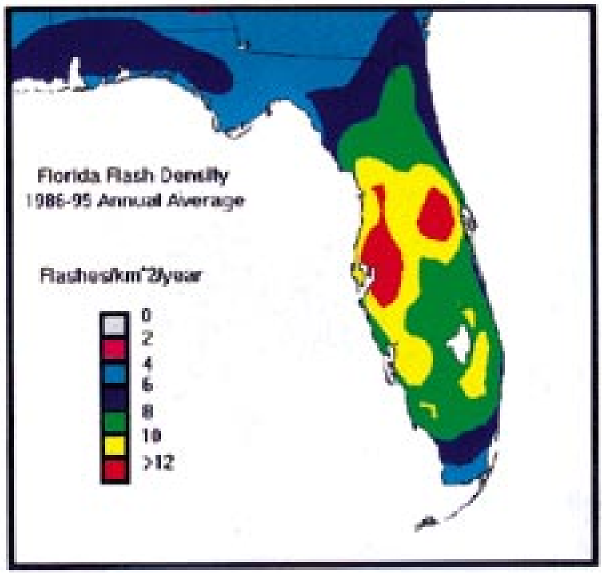

FIG. 1. Mean annual cloud to ground lightning flash density for the period 1986–95. Measured flash counts have been multiplied by a factor of 1.4 to correct for the estimated 70% detection efficiency of the lightning detection network.

direction finding techniques. In addition, some of the sensor locations changed (Cummins et al. 1996, Fig. 4) in the latter part of 1994.

The detection efficiency of the lightning network in Florida has varied during the 10 yr, 1986–95. Experimental work (Orville et al. 1987) suggests values of 70% are appropriate, but more recent measurements in Florida suggest values of 53%–72% (Maier 1991). Detailed evaluations of the new sensors installed in 1994 in the National Lightning Detection Network reveal average detection efficiencies of 76% for seven storms in the New York area in 1994 (Cummins et al. 1996). For the purpose of our analysis, we assume a detection efficiency of 70% and multiply all the flash counts by a factor of 1.4. Readers interested in the measured value can reduce the contours in this paper by 30% to obtain the measured value of the flash density.

The grid size used in this analysis is 60 east–west by 50 north–south points, resulting in a grid interval of 21 km in the east–west and 14 km in the north–south directions. Thus, flash density variations occurring at less than these distances cannot be resolved. From the lightning database for the continental United States cloud-to-ground flashes occurring in the Florida area were isolated, producing a set of 25 million flashes. These were further broken down into monthly datasets and summed to produce 10-yr averages for each month. The contoured results are presented in the next section.

3. Results and discussion

Figures 1 and 2 summarize the results of contouring 10 yr of CG flashes for the state of Florida, once for the average year, and then for the average month.

a. Ten-year average

Figure 1 is the result of contouring the 25 million flashes for the Florida area, dividing by 10, and multiplying by 1.4 to correct for the estimated 70% lightning network detection efficiency. The result is the average flashes per kilometer squared per year for the period 1986–95.

Overall, the annual flash density (Fig. 1) shows a surprising range across the state. Flash densities range in excess of 12 flashes km^{-2} over the central sections of the peninsula to 4 flashes km^{-2} over the southern part of the peninsula and the eastern panhandle (‘‘big bend’’ area).

Three separate maximum flash densities are noted over the peninsula. The two maxima over the east-central and west-central regions of the peninsula are related to the positioning of the subtropical ridge axis and subsequent low-level wind flow regimes over the peninsula during the warm season. In general, these maxima represent the prevalence of either southeasterly or southwesterly low-level wind flow during the warm season and are the most dominate signals. Climatologically the low-level ridge axis is located frequently over the north-central part of the state, which often promotes a collision of the sea-breeze boundaries over the west coast, resulting in the greatest enhancement of lightning activity over the west-central peninsula. Conversely, when the ridge axis is forced south, the low-level flow over the central peninsula becomes southwest. This allows for the collision of the sea breezes to occur along the east-central side of the peninsula.

The third flash density maximum is located east of Lake Okeechobee and is largely due to the collision of the lake-breeze boundary with the east coast sea breeze. This maximum typically occurs in the warm and transitional seasons under weak low-level flow.

In addition to the flash density maxima, two areas of flash minima are noted. The first, over the southern part of the state is due to a combination of geography and climatology. The extreme southern part of the peninsula is relatively narrow, which reduces the time that the sea breeze remains over warm land. Furthermore, this area

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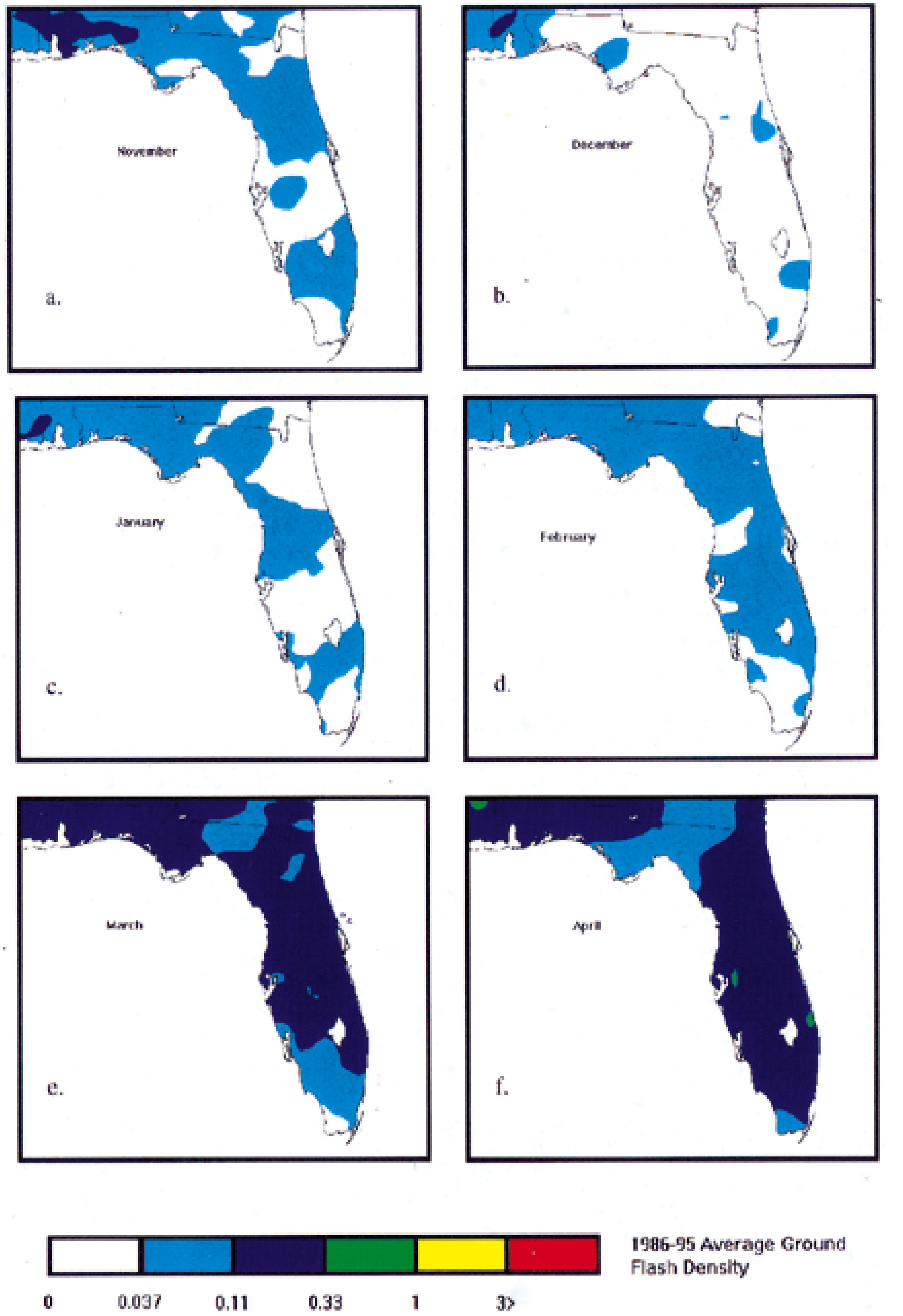
FIG. 2. Mean monthly cloud-to-ground lightning flash density for the period 1986–95. The flash density scale is based on the logarithm of the corrected flash count to the base 3.


November
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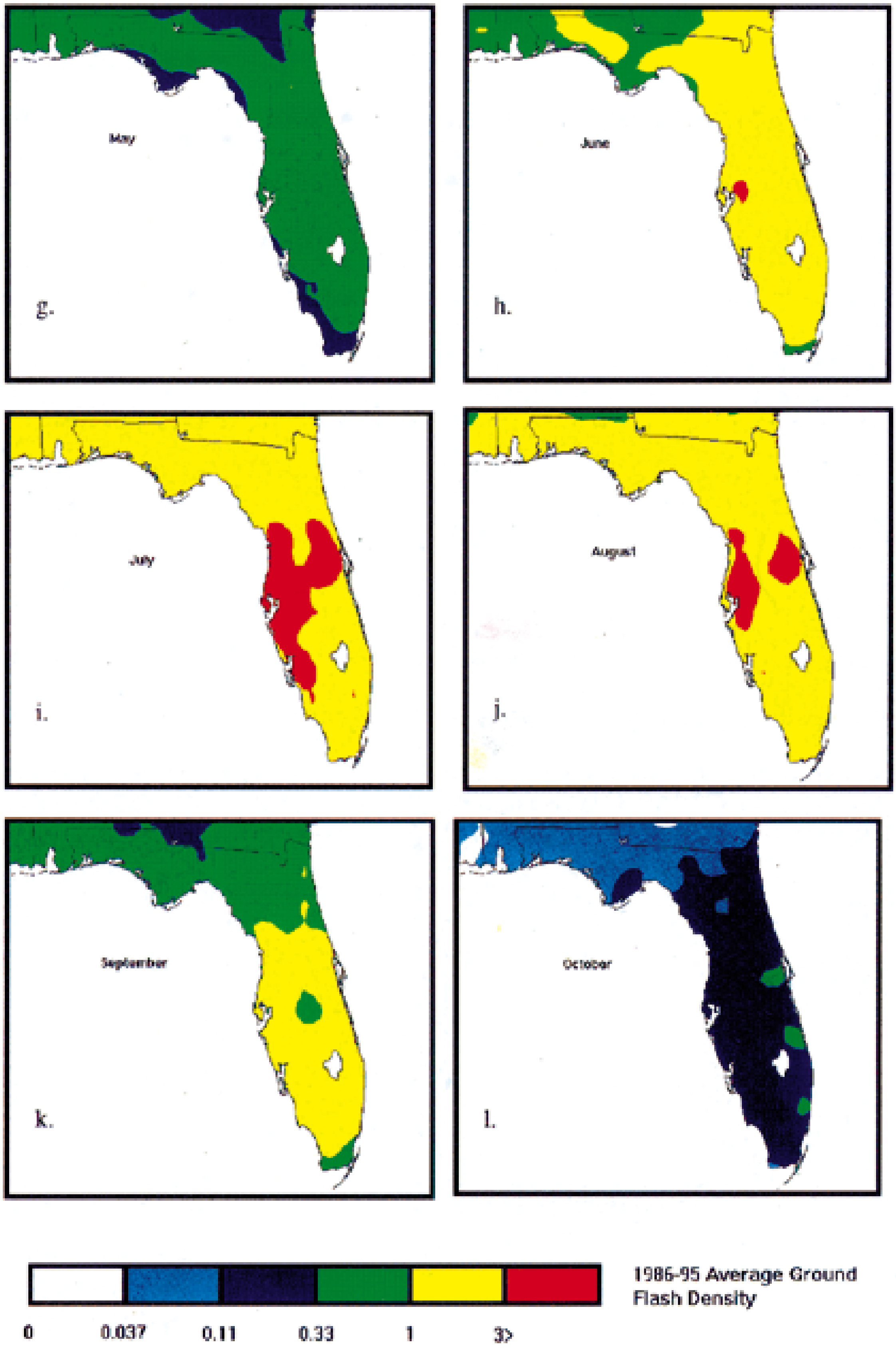
1986-95 Average Ground Flash Density


May
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1986-95 Average Ground Flash Density

is dominated by wet grasslands that limit the effects of strong differential heating. Also, during the late summer months, the upper-level subtropical ridge is often located over the southern part of the state, which further tends to retard excessive convection.

The second minimum, over the big bend north of Apalachee Bay, is somewhat perplexing. On the larger scale during the cool and transitional months, many Florida forecasters have witnessed the reduction in rainfall roughly centered around longitude 85°W over the panhandle. One plausible explanation for the minimum is that convection associated with gulf coast frontal waves decreases as the secondary cyclones develop off the mid-Atlantic states; another is that the average cyclone tracks are farther north with convergence along the front or prefrontal squall weakening as it approaches the panhandle. During the warm season, coastal contouring on either side of Apalachee Bay results in two short-length sea-breeze sections that propagate away from one another as they move inland. Most importantly, unlike the peninsula, where the collision between the sea-breeze boundaries enhances flash densities, only one major sea breeze exists in the panhandle.

b. Monthly flash densities

The monthly flash density maps (Fig. 2) are divided into four periods that we call the cool season, the spring transitional, the warm season, and the autumn transitional. Note that in the monthly maps the flash density, in flashes km^{-2}, is expressed on a logarithmic scale to the base 3. This provides for a wider range of numbers to show the variation of lightning counts throughout the year. We begin the analysis with the cool season that extends from November through February.

1) COOL SEASON (NOVEMBER–FEBRUARY)

During the cool season (November–February) lightning flash densities over the entire state are at a minimum (Figs. 2a–2d). Flash densities are mostly below 0.11 flashes km^{-2}, except for the slightly higher values up to 0.33 flashes km^{-2} over the western panhandle. Lower flash densities during this time of the year are a consequence of a greater frequency and duration of increased atmospheric static stability over the region and decreased solar insolation. In December, lightning is at its annual monthly minimum. Lightning occurring this time of the year is associated with the passage of midlatitude frontal systems.

Excluding December, the Florida panhandle region shows a relative flash density maximum for the state. This increased density for the panhandle is due to higher θ_e air advecting northward in advance of eastward moving synoptic cyclones traversing the continental United States. As the cyclones move east, associated cold fronts cross the panhandle, lifting the warm, moist unstable air from the Gulf of Mexico. However, based on the operational experience of many Florida meteorologists, the main core of synoptic-scale energy and upper-level support can often be observed to pass to the north, affecting mainly the panhandle.

The higher flash densities observed over the southeast part of the peninsula during the cool season are a consequence of stalled frontal systems and are generally oriented southwest to northeast. During the cool season, cold fronts stall over south Florida or the Florida Straits as the anticyclones to the north move off the mid-Atlantic coast. These stationary fronts will usually erode but may become active once again if the pressure gradient to the north of the front increases under frontogenetic conditions. Synoptic-scale lift can be enhanced if the subtropical jet interacts with the stalled frontal system. This type of frontal system often becomes electrically active due to increasing low-level convergence. They usually remain quasi-stationary and can produce significant convective rainfall events over southeast Florida (Gonzales and Moore 1990). We suggest that this type of weather system is the prime contributor to the general flash density maximum over southeast Florida during the cool season.

2) SPRING TRANSITIONAL (MARCH–MAY)

The spring transitional season (March–May) shows an increase of lightning activity over the entire state of Florida. At this time of the year, Florida experiences its most dynamically driven severe weather. For example, the occurrence of central Florida's record hail storms and the ''storm of the century'' (Orville 1993) both occurred during March and were electrically impressive. Both solar insolation and low-level moisture increase, while temperatures aloft remain relatively cool and the polar jet is often located over the continental United States (Schmocker et al. 1990). As the season progresses, the contribution to flash density distributions shifts from synoptic scale to mesoscale as the polar jet lifts northward and the sea- and lake-/bay-breeze convergence zones begin to intensify.

During March (Fig. 2e.), lightning flash densities over Florida are generally uniform and governed synoptically. The minimum, however, over south Florida can be explained by two factors. The first part involves the less frequent passage of frontal systems as compared to the rest of the state. The second, and most important reason, is the geography of the region. Local effects on convection within the region are influenced by the ''sea of grass''—the Florida Everglades—as well as the relative narrowness of the extreme southern peninsula. This region of grass and water locally reduces the extent of differential heating, which in turn leads to a minimum in mesoscale forcing and subsequent thunderstorm development (Gannon 1978; McCumber and Pielke 1981). This density minimum is noticeable during every month of the year, especially during the cool and transitional periods.

We note that though the lightning data depict a steady increase from March to May, precipitation climatologies over the state are at a minimum. Interestingly, April is climatologically the driest month for Florida (NOAA 1989).

A brief discussion of the central Florida sea-breeze character will be helpful in understanding the transitional and warm season flash density maps and the remaining monthly figures. Numerous observational and numerical studies (Pielke 1974; Blanchard and López 1985; and others, see Reap 1994 for a review) have documented that the movement of the sea breeze over Florida is controlled by the low-level synoptic flow. As these sea-breeze boundaries develop, showers and thunderstorms typically form along them and propagate inland. The low-level environmental wind will either assist or impede their inland progress. For example, embedded in easterly low-level wind flow, the east coast sea breeze (ECSB) would initiate just inland during the late morning and uniformly produce an increase in lightning discharges as the ECSB moves westward. In contrast, inland penetration of the west coast sea breeze (WCSB) would be impeded. Lightning flashes associated with the WCSB will remain concentrated along the west coast. By late afternoon, CG flashes occur frequently as the two boundaries collide over the west-central part of the peninsula.

The reverse pattern to the above discussion would be valid for westerly low-level flow. For northerly or southerly flow, both sea breezes will form but with little chance of collision. An extremely weak low-level flow promotes the ECSB–WCSB collision at some midway point. As a result, the impact on flash densities and the location of relative maxima/minima provide insight to the influences of the low-level wind flow pattern. In general, given sufficient thermodynamic instability for thunderstorms to form along sea-breeze boundaries, the strength and direction of the low-level wind will determine the movement of these boundaries and where they will collide. Importantly, it is the collision of the ECSB–WCSB boundaries that greatly enhances the density of CG flashes for the central peninsula. The panhandle sea breeze does not experience a collision process.

The flash density maximum east of Lake Okeechobee is first seen during April and is a product of the collision of the lake breeze and the sea breeze. This maximum can be seen on several of the monthly charts and is also quite distinct on the annual chart. This collision process continues through the warm season and into the autumn transitional period but its manifestation is difficult to see on some maps due to scale resolution. This collision occurs when either the southern part of the state is under weak zonal flow, or when the strength of the synoptic flow is negligible. When the easterly wind is weak, the ECSB will develop and move slowly inland. As it approaches the east side of Lake Okeechobee, it encounters a weak lake breeze. As these boundaries collide, convection is enhanced. If the wind flow is from a weak westerly component, the lake breeze and the ECSB will form. In this situation, the lake breeze will move east and encounter the ECSB to enhance convection near the east coast. When the synoptic flow is negligible, both breezes will form and collide midway between the lake and the east coast. It is important to note that the occurrence of CG lightning increases only during weak flow patterns for this area. If the wind flow is relatively strong, lightning activity will be reduced as either the east side of the lake breeze will be minimized under strong easterly flow or the ECSB will be minimized under strong westerly flow.

Over the panhandle, flash densities remain the same or decrease slightly, from March to April (Figs. 2e and 2f.). Although the availability of low-level moisture increases over the panhandle along with increased solar insolation during this time of the year, densities do not significantly increase compared to the peninsula. The transition to stronger mesoscale signals, which first begins in the southern part of the state, has not yet reached north Florida.

During the month of May (Fig. 2g), flash densities increase statewide, with lightning coverage rather uniform across the state. Minimum flash densities are located along the coast of the panhandle and over extreme south Florida. Contributions to the minimum over south Florida are the weaker low-level forcing over the Everglades, the narrowness of the south peninsula, and a climatological subsidence south of the subtropical ridge axis. The minimum flash density along the panhandle coast is due to the shallow nature of the sea-breeze when it initially develops. As the panhandle sea breeze moves inland, it becomes deeper reaching the level of free convection away from the coast as the lightning increases. The same can be said of the peninsula sea breezes except that late afternoon collisions near the coast mask this feature.

3) WARM SEASON (JUNE–AUGUST)

The warm season in Florida brings a large increase in the number of CG lightning flashes. During this time of the year (Figs. 2h–j), CG lightning flash densities increase dramatically statewide, particularly over the peninsula. Flash densities are at their annual monthly maxima. It is noteworthy that most of the state experiences densities greater than 1 flash km^{-2}, with values exceeding 3 flashes km^{-2} over parts of the central peninsula. The atmosphere over the state characteristically becomes more tropical. It is during the warm season that Florida earns its nickname as the ‘‘lightning capital.’’

June (Fig. 2h) is similar to May in that flash density minima occur near the panhandle coast and in the extreme south of Florida. However, the greatest flash density is now clearly over central Florida. An obvious difference for June is the remarkable flash density increase of three to nine times over the May values. This increase is due to deeper, more intense updrafts associated with thunderstorms that usually occur on a near-daily basis. Maximum flash density distributions over the central peninsula are governed by the location of the subtropical ridge axis, which affects the prevailing low-level pattern. The west coast shows a slightly greater increase in flash density that is caused by the dominance of the prevailing low-level easterlies and interaction with the Tampa Bay breeze and WCSB. We believe that this small area, just east of Tampa Bay, may experience a greater flash density (Reap 1994) than anywhere else in the United States. This signal is evident as early as April (Fig. 2f).

July (Fig. 2i) is the most active period for lightning over the state and shows the greatest areal extent of high flash density. There is a bimodal peak in flash density over the central peninsula. The west coast maximum is much larger than the east coast maximum, which is likely a function of the climatological positioning of the subtropical ridge axis across central Florida, resulting in differential motion to its north and south. This was also expressed by Reap (1994) as an artifact of southeasterly low-level flow, which is the most prevalent synoptic ''map type'' for the peninsula in July. A small flash density maximum appears south of Lake Okeechobee. The relative minima noted previously along the panhandle coast and over south Florida have disappeared. This may be an artifact of the logarithmic scale as the increments in flash density values are now much larger between divisions.

August (Fig. 2j) is strikingly similar to July. The primary difference, however, is the distinct separation in high flash densities (>3 flashes km^{-2}) toward the west- and east-central regions of the peninsular coasts. This slight lowering of values over inland central Florida favors the notion of a less frequent collision of the ECSB–WCSB boundaries along the spine of the peninsula. This trend continues into September. The weakest climatological wind flow for Florida is generally during August (NOAA 1992). Interestingly, the distribution of high flash density values for August is nearly identical to the annual distribution.

4) AUTUMN TRANSITIONAL (SEPTEMBER AND OCTOBER)

We define the months of September and October as the autumn transitional period, since the lightning activity decreases sharply statewide (Figs. 2k and 2l).

September (Fig. 2k) begins a decline in flash density statewide. More so, the high flash densities over the central peninsula relax to values less than three flashes km^{-2}. Land and water thermal differences are not as acute as water sources are now well warmed. However, the air mass over Florida remains somewhat ''tropical'' in nature, but with a stronger subsidence inversion south of the ridge axis, which has been documented to decrease widespread thunderstorm activity (Burpee 1979; Blanchard and López 1985). The ECSB–WCSB collision process that is required to produce the high flash densities does not occur as frequently.

The maximum flash densities are still large, with decreasing values in the north and central regions and the southern tip of the state. During September, wind flow patterns change from east-southeast to east-northeast, except over south Florida where east-southeast flow dominates. The change is caused by the eastward migration of the Bermuda high over the Atlantic. In addition, large anticyclones enter the southeastern United States from the northwest, which causes the climatological low-level flow over Florida to shift to the east-northeast. Although parcel trajectories bring air off the warm Atlantic, airmass origins are continental and still bring sufficiently cooler, more stable air over the state. Consequently, thunderstorm development for the month declines.

In October (Fig. 2l) flash density values decrease to less than 0.33 flashes km^{-2} over most of the state. In the panhandle, the densities decrease to less than 0.11 flashes km^{-2}. Thunderstorms occurring over the state begin to experience larger synoptic contributions although they can still occasionally form along the sea-breeze boundaries. The three separate maxima over the east coast, we believe, potentially reveal the preferred locations of stalled frontal systems. At times, these fronts serve to focus convection that may form in the warm moist sector to the south, especially if the low-level flow possesses a southerly component.

4. Summary and conclusions

Cloud-to-ground flash density distributions over a 10-yr period have been analyzed for the state of Florida. Flash density totals in the warm season (June, July, and August) exceed 10 flashes km^{-2} in the central part of the state. As the result of Florida's geography, its juxtaposition with water, and seasonal changes in atmospheric forcing, significant spatial and temporal variations in the numbers of CG lightning flashes exist. During the cool season (November–February), the greatest flash densities occur over the panhandle from thunderstorms associated with synoptic-scale systems. During the spring transitional season (March–May), flash densities increase over the entire state. However, a maximum remains over the western panhandle. The April and May flash density distributions show a transition from larger-scale frontal forcing to diurnal mesoscale forcing on localized thermal boundaries. Specific heat differences between land and water cause sea (lake/bay) breezes to develop, which release potential and static instability resulting in thunderstorms.

Entrenched in a near-tropical environment and surrounded by water on three sides, Florida is prone to the production of various sea- (lake-/bay-) breeze boundaries, primarily during the transitional and warm season months. Geographical features like Tampa Bay and Cape Canaveral further enhance local convergence and convection and subsequently thunderstorms. Flash densities are greatest (with maxima over the peninsula) during the warm season resulting from diabatic processes and subsequent formations of sea-breeze convergence zones along the west and east coasts. The environmental low-level wind flow has a significant impact on the flash density distributions during this time of year. The panhandle does not experience these extreme maxima. From May to June, the flash densities increase by a factor of 3–10 statewide. By September, flash densities begin to decrease statewide as solar insolation decreases. During the autumn transitional season (September and October), flash densities decrease sharply statewide with the maximum over the east peninsula. Overall, on the annual map, the central Florida peninsula experiences the greatest flash density, while the ‘‘big bend’’ area and the extreme southern tip of the peninsula experience the least. By month, lightning flash densities are at a maximum statewide in July and at a minimum in December.

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