12.5 Utilizing the IFPS/GFE to Incorporate Mesoscale Climatologies into the Forecast Routine at the Tallahassee NWS WFO

Andrew I. Watson, T.J. Turnage, Kenneth J. Gould
NOAA/National Weather Service
Tallahassee, Florida

Jessica R. Stroupe, Todd P. Lericos, Henry E. Fuelberg
Department of Meteorology
Florida State University
Tallahassee, Florida

and

Charles H. Paxton
NOAA/National Weather Service
Ruskin, Florida

Jason E. Burks
NOAA/National Weather Service
Huntsville, Alabama

1. INTRODUCTION

The Interactive Forecast Preparation System (IFPS) allows National Weather Service (NWS) forecasters to prepare graphical depictions of present and predicted weather. No longer will the forecaster type in text for routinely scheduled forecast products. Instead the forecaster works in a forecast database environment containing various grids of weather elements. He/she populates these grids with model data or information from other sources, such as locally developed studies or climatologies. The forecaster then edits the grids to reflect local experience and knowledge to provide “value-added” input to the forecast. A set of “tools” allows the forecaster to interpolate, fill in other associated weather elements, check for consistency among the weather elements, publish the grids to a national database, generate graphical products for the web, and produce routinely scheduled text products for public, marine, and fire weather services. The Graphical Forecast Editor (GFE) is the central part of the IFPS.

The close association of WFO Tallahassee with the Department of Meteorology Department of Florida State University (FSU) has made it possible to develop special climatologies that can be easily incorporated into the GFE system. These include lightning, radar, and precipitation distributions, which have been developed or are currently being developed. Much of the summertime precipitation in Florida is attributed to sea breeze induced convection. The patterns of Florida convection are controlled by the low-level, large-scale flow. We currently are incorporating the summertime lightning distributions, for various low-level flow regimes, into IFPS/GFE as a first guess for daily thunderstorm patterns.

This paper describes the utility of using the lightning climatologies, their incorporation into the GFESuite, and how they can be used as a “first guess” for normal daily summertime thunderstorm activity.

2. PREVIOUS WORK

Watson and Holle (1996), Camp et al. (1998), and Lericos et al. (2002) developed lightning climatologies for the Southeast U.S. and Florida using data from the National Lightning Detection Network (NLDN). The NLDN is owned and operated by Vaisala Global Atmospherics Inc. The cloud-to-ground lightning data used in this study were for the period May through September 1989 through 2001, with the exception of 2000, which will be incorporated in the future.

---

* Corresponding author address: Andrew I. Watson, NWS, Love Building, FSU, Tallahassee, FL 32306-4509; e-mail: irv.watson@noaa.gov.

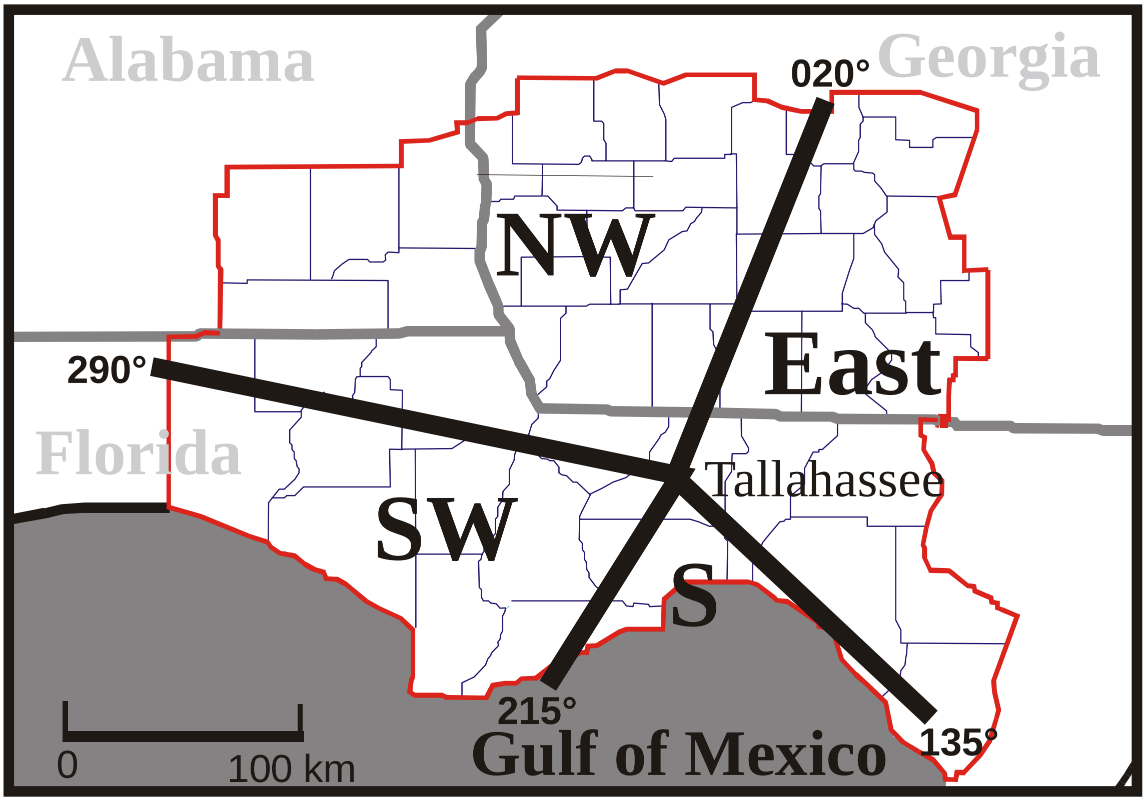

Figure 1. NWS Tallahassee County Warning Area (outlined in red) and divisions for the four principal flow directions (E, S, SW, NW). Each direction is divided into moderate and strong flow. A calm flow regime is also included for a total nine flow regimes.

The patterns and locations of Florida convection are directly related to the low-level synoptic winds (Byers and Rodebush 1948 ; Gentry and Moore 1954). Gould and Fuelberg (1996) and Camp et al. (1998) created categories of synoptic flow for the WFO Tallahassee region. Days were categorized by the 1000-700 mb vector mean wind. We have slightly modified their wind regimes. Figure 1 summarizes the Tallahassee wind regimes selected for this paper. Table 1 summarizes divisions of vector mean wind speed.

Table 1. Divisions of low-level (1000-700-mb) vector mean wind speed.

Calm	< 5 kts
Moderate	5-10 kts
Strong	> 10 kts

3. THUNDERSTORM DAY

The concept of thunderstorm day was first identified in the literature by Alexander (1935). A thunderstorm day is defined by a 24-hr period during which thunder is heard at the observation site. Watson and Holle (1996) modified the idea of thunderstorm day by relating it to lightning data. Their definition was the occurrence of one lightning flash within a grid square (5 x 5 km grid in this case) per day. An example of 12 years of warm season thunderstorm days for the SW (strong) flow regime is displayed in Fig. 2. Spotty amounts greater than 96 days are located across inland portions of the Florida panhandle. Notice that much greater values are found across central Florida and up the Florida east coast.

Building upon the thunderstorm day concept, we consider the frequency of occurrence, or probability of lightning within a grid square, by dividing the thunderstorm day total by the number of days within the wind regime. For example, the southwest (strong) regime contains 395 days for the 12 years of warm season data. If, for example, 150 of those 395 days record one lightning flash in a particular gridbox, the probability of lightning for this regime is 39%. This determination of frequency could be done on a daily basis, as well as hourly, or in the case of probability of precipitation (POP) forecasts, 12 hours.

The majority of precipitation in Florida during the summer is a result of thunderstorm activity. It then follows that the frequency, or probability, of lightning can be a surrogate for the probability of precipitation. The climatological lightning grids can be used to populate the GFE grids, given the synoptic situation is not disturbed in any way, and only normal summertime convective development is expected.

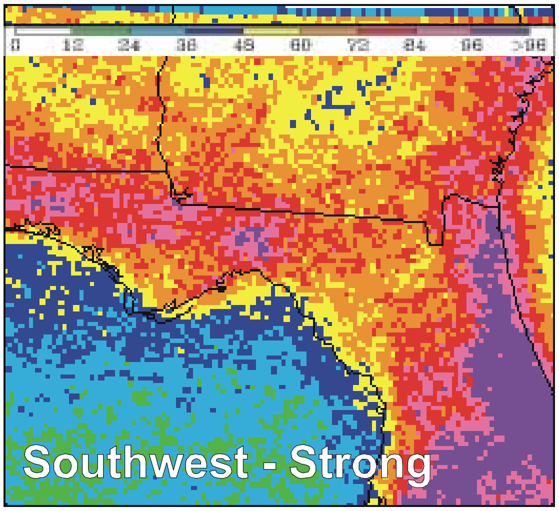

Figure 2. Warm season thunderstorm days for the southwest (strong) flow regime.

3.1 Daily Wind Regime Results

Daily lightning frequencies for the nine wind regimes (Fig. 1) are shown in Fig. 3. Cool colors denote lower lightning frequencies, while warm colors signify higher frequencies, with red beginning at 30 %. The greatest amount of lightning is over land. Note that the highest frequencies are down in the Florida peninsula, where the highest values are in the south (moderate) flow regime. Overall, the south, southwest, and calm wind regimes have the greatest lightning frequencies.

Moving north and concentrating on the Florida Big Bend and panhandle, lightning frequencies are significantly lower than those in the peninsula. Nearly all wind regimes show some focusing of lightning north of Apalachicola and Cape San Blas (the triangular coastline protruding into the Gulf of Mexico). The maxima in each regime are slightly different and deviated downwind. Interestingly, the concave coastline of the Big Bend south of Tallahassee often exhibits a relative minimum in this region. In summary, each regime shows major features that recur on a daily basis. Daily convective activity is modulated by the availability of moisture. Low-level moisture varies little during the warm season, but the amount of moisture aloft plays a very important role in daily convective development, and will be examined in future studies.

3.2 Hourly Lightning Frequencies

Hourly lightning frequencies for the calm wind regime are presented in Fig. 4 at 2-hour increments beginning with 1600 UTC (noon EDT). At noon EDT, only a few isolated spots have a 1% chance for lightning, mainly in the western Florida panhandle and along the Florida east coast. Offshore, the chance for lightning gets as high as 3%, primarily greater than 60 nm offshore. By 2000 UTC (1600 EDT), the sea breeze nears its maximum intensity. The coastal regions of the Florida panhandle become more active, with 5% chances apparent north of Apalachicola, north of Fort Walton Beach, and north of Tampa. At 2200 UTC (1800 EDT), the chances increase to 7% in a large area north of Apalachicola. Down the peninsula, a double sea breeze forms with lightning chances reaching 7%.

The chances for lightning in the Florida panhandle and Big Bend decrease considerably by 0000 UTC (2000 EDT). In fact, the chances for lightning lessen across the entire area. Notice that the lightning chance offshore is practically zero.

Finally at 0200 UTC (2200 EDT), activity weakens even more, with what could be called a weak merger of the east coast sea breeze with the Gulf coast sea breeze approximately 50 nm west of Jacksonville.

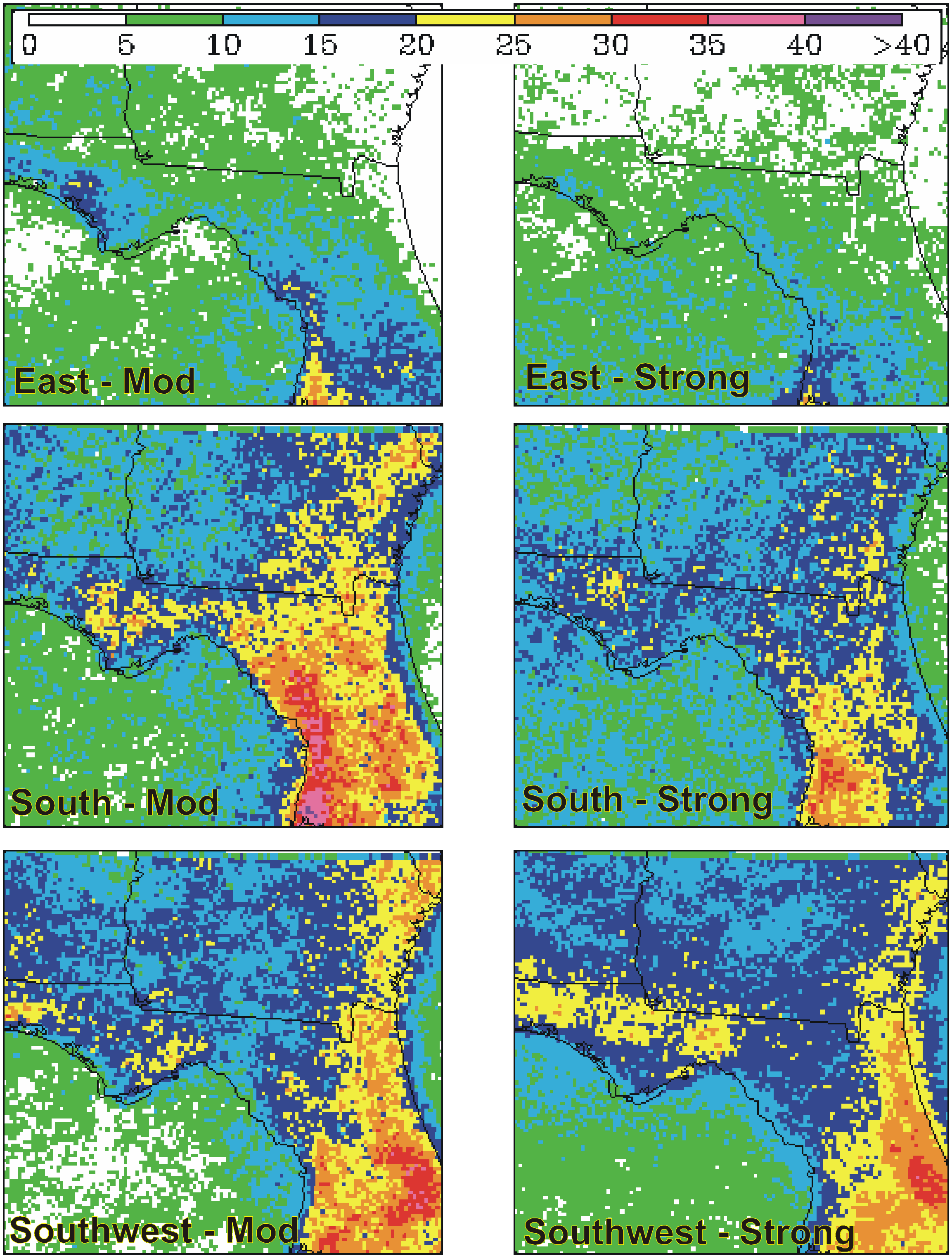

Figure 3. Daily lightning frequencies (percent) for the nine low-level flow regimes (east-moderate, east-strong, south-moderate, south-strong, southwest-moderate, southwest-strong, northwest-moderate, northwest-strong, and calm).

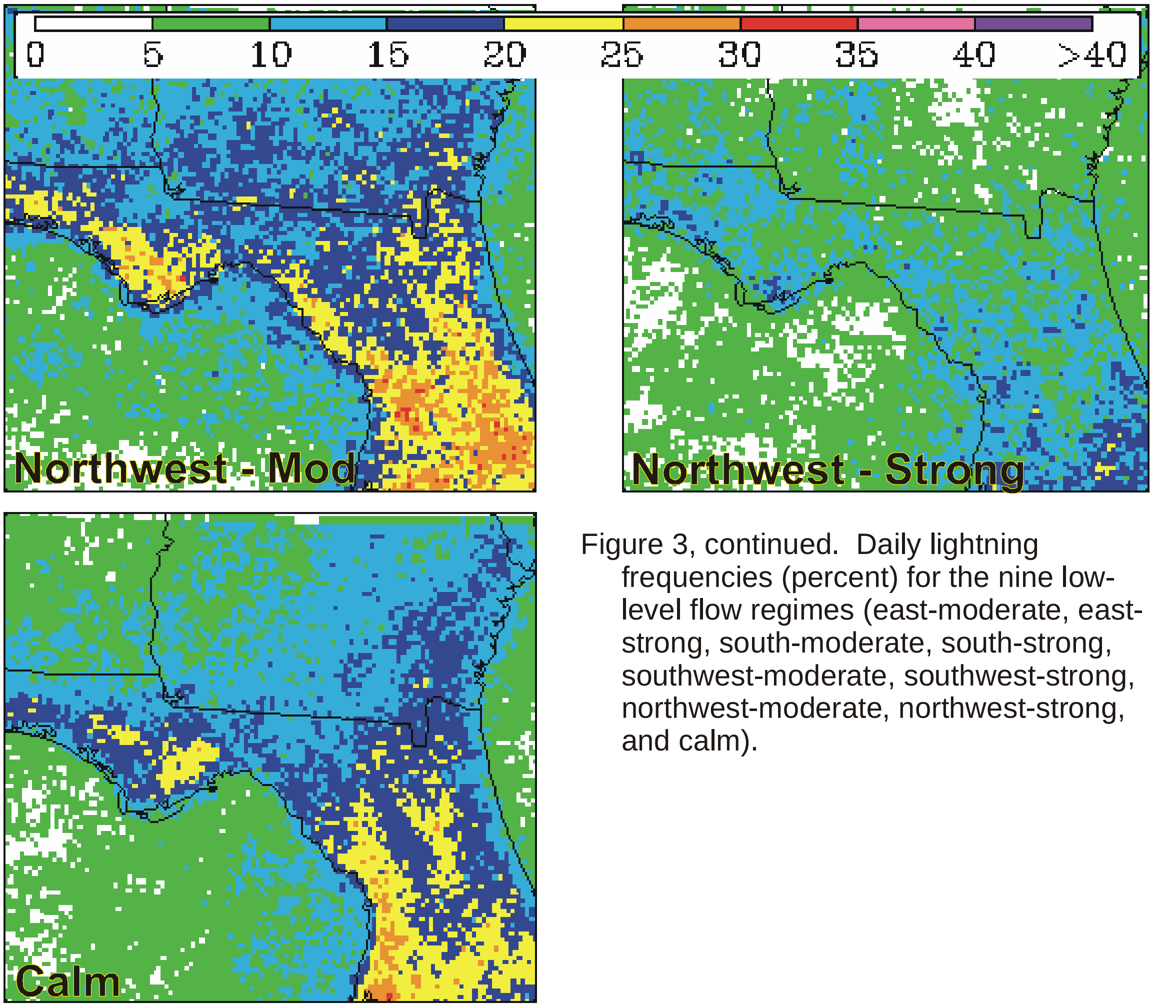

Figure 3, continued. Daily lightning frequencies (percent) for the nine low-level flow regimes (east-moderate, east-strong, south-moderate, south-strong, southwest-moderate, southwest-strong, northwest-moderate, northwest-strong, and calm).

4. GFE AND LIGHTNING CLIMATOLOGIES

The AWIPS Forecast Preparation System (AFPS) was developed at the NOAA Forecast Systems Laboratory (FSL) in Boulder, Colorado, and at the National Weather Service (NWS) Meteorological Development Laboratory (MDL) in Silver Spring, Maryland. Mathewson (1996) and LeFebvre (1996) first described the IFPS and GFE system.

With the cooperation of FSL, NWS WFO Tampa has undertaken ground-breaking work to make climatologies, such as the lightning climatologies described above, available within GFE. To our knowledge, this is the first such accomplishment, i.e., to import gridded data other than current and forecast model data.

Why do we want to do this? As stated earlier, a majority of warm season days in Florida have no synoptic influences other than the large-scale flow that is dominated normally by the position of the subtropical (Bermuda) ridge axis. The atmosphere is nearly always conditionally unstable. Surface moisture varies little all summer, with mixing ratios of 16-18 gm kg^{-1}. Patterns of sea breeze convection are influenced by the low-level flow regime. The various wind regimes in Fig. 1 also control mid level moisture to some degree. However, mid level moisture remains highly variable from regime to regime, and controls the extent of areal coverage of convection. Thus, a long term climatology such as lightning or radar can be used as a first guess to predict weather elements such as POP, weather, and QPF.

Lightning was selected to be the first climatology to be added to the GFE since a 10-year lightning climatology recently was completed by Lericos et al. (2002). The lightning data divided by wind regimes is composed of hourly gridded data. These data are then converted into netcdf format and named appropriately for GFE recognition. GFESuite is configured by modifying localConfig.py.

An example of flash densities (flashes km^{-2}) for the southwest flow regime for the WFO Tampa county warning area is shown in Fig. 5. Through a procedure developed by WFO Tampa, QPF (Fig. 6) is calculated from the flash densities in Fig. 5.

5. SUMMARY AND CONCLUSIONS

IFPS is a paradigm shift in the way the NWS makes forecasts. Converting from writing text to modifying gridded forecasts opens the door to unlimited possibilities of new products and uses. In this paper, we have shown that forecasts can be made from climatologies imported into GFE. These climatologies can populate any forecast day for which they are suitable. If a forecaster determines that day 5 will have moderate southwesterly flow, then he/she can populate day 5 with the southwest (moderate) grids. Through procedures and Smart Tools, flash density or lightning frequency can be converted into POPs, weather, and QPF.

We are adding additional lightning data each year to continue building the climatologies. Currently, the 10-year Lericos et al. (2002) Florida peninsula lightning climatology is being updated to 14 years.

In the near future, it is planned that Florida gage/radar-derived precipitation climatologies recently developed at the FSU Meteorology Department also will be incorporated into the GFESuite.

6. REFERENCES

Alexander, W.H., 1935: The distribution of thunderstorms in the United States, 1904-33. *MWR*, **63**, 157-158.

Byers, H.R., and H.R. Rodebush, 1948: Causes of thunderstorms of the Florida peninsula. *J. Meteor*., **5**, 275-280.

Camp, J.P., A.I. Watson, and H.E. Fuelberg, 1998: The diurnal distribution of lightning over north Florida and its relation to the prevailing low-level flow. *Wea. Forecasting,* **13**, 729-739.

Connell, B.H., K.J. Gould, and J.F. W. Purdom, 2001: High-resolution GOES-8 visible and infrared cloud frequency composites over northern Florida during the summers 1996–99. *Wea. Forecasting*, **16**, 713–724

Gentry, R.C., and P.L. Moore, 1954: Relation of local and general wind interaction near the sea coast to time and location of air mass showers. *J. Meteor*., **11**, 507-511.

Gould, K.J., and H.E. Fuelberg, 1996: The use of GOES-8 imagery and RAMSDIS to develop a sea breeze climatology over the Florida panhandle. *Preprints, Eighth Conf. On Satellite Meteorology and Oceanography*, Atlanta, GA, Amer. Meteor. Soc., 100-104.

LeFebvre,T.J, .C. Bacco, and M. Romberg, 1996: Gridded forecast products and services under development at FSL. *Preprints, 17th Conference on Weather Analysis and Forecasting*, Norfolk, VA, Amer. Meteor. Soc.

Lericos, T.P., H.E. Fuelberg, A.I. Watson, and R.L. Holle, 2002: Warm season lightning distributions over the Florida peninsula as related to synoptic patterns. *Wea. Forecasting*, **17**, 83-98.

Mathewson, M.A., 1996: Using The AWIPS Forecast Preparation System (AFPS). Preprints, Twelfth International Conference on Interactive Information and Processing Systems for Meteorology, Oceanography, and Hydrology (IIPS), Atlanta, GA, Amer. Meteor. Soc.

Watson, A.I., and R.L. Holle, 1996: An eight-year lightning climatology of the southeast United States prepared for the 1996 Summer Olympics. *Bull. Amer. Meteor.* Soc., **77**, 883-890.

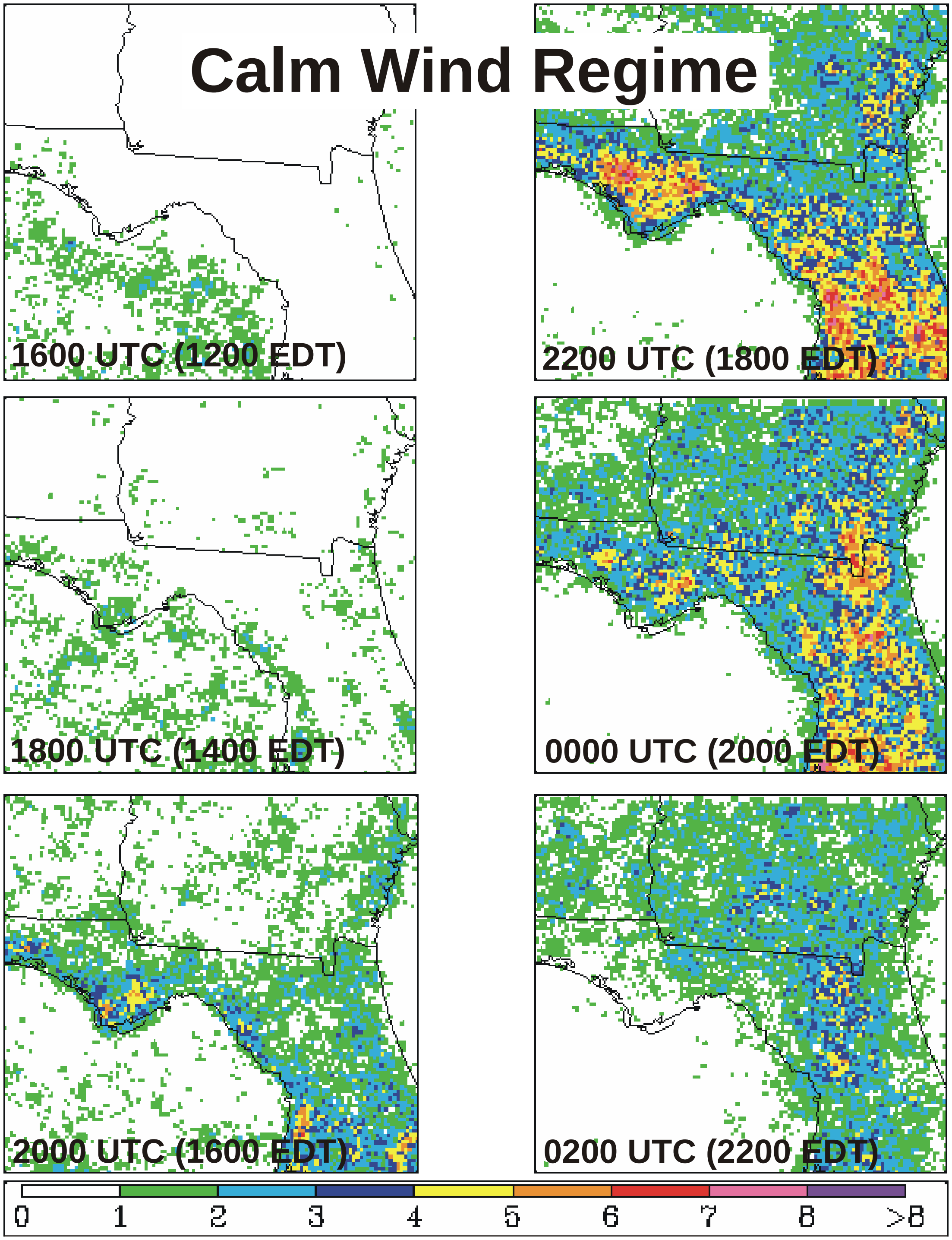

Figure 4. Hourly lightning frequencies (percent) for the calm wind regime at 2-hr increments beginning at 1600 UTC (1200 EDT).

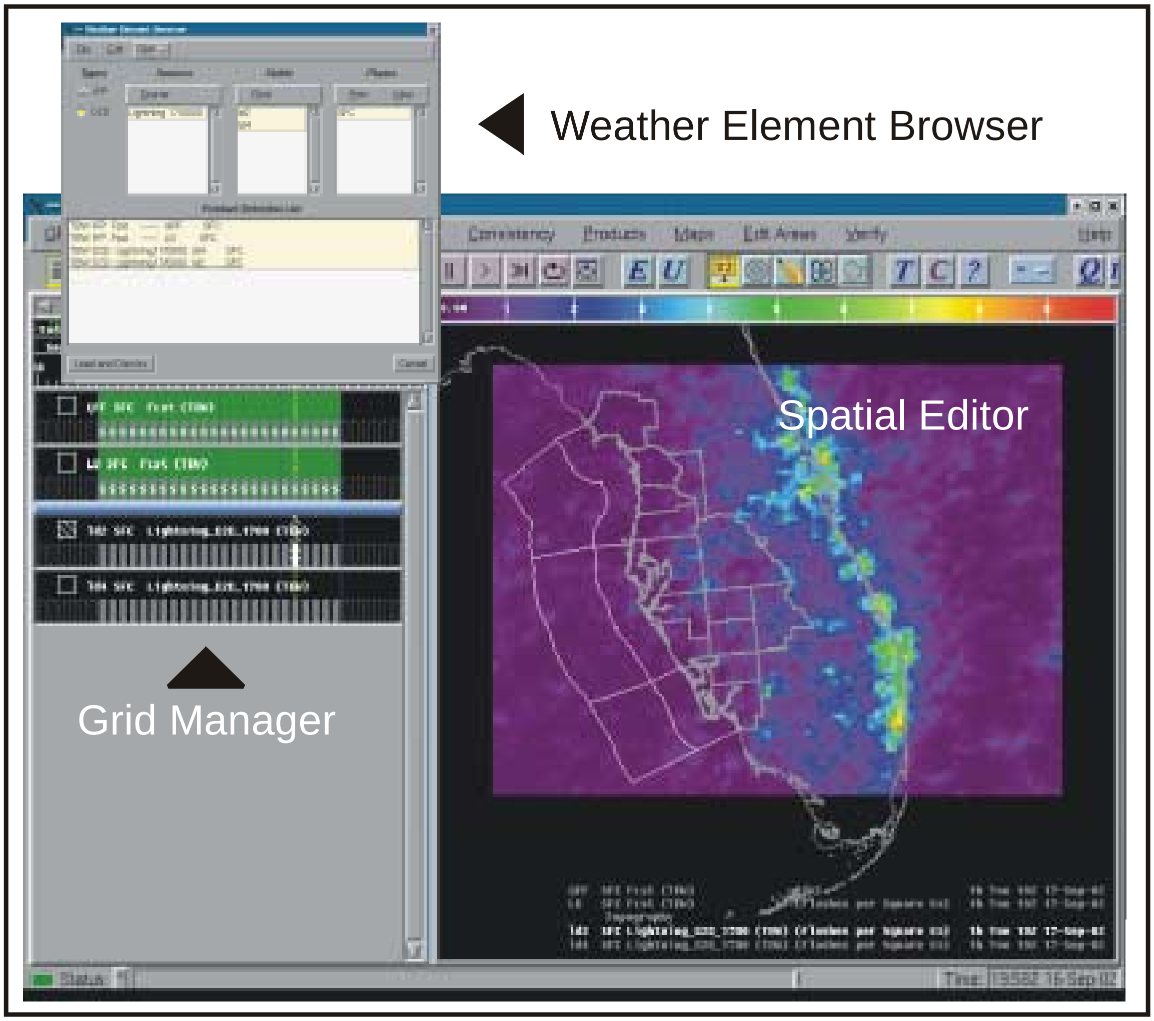

Figure 5. GFE GUI with lightning flash density in the Spatial Editor box. Lightning regimes have been loaded into the Grid Manager via the Weather Element Browser.

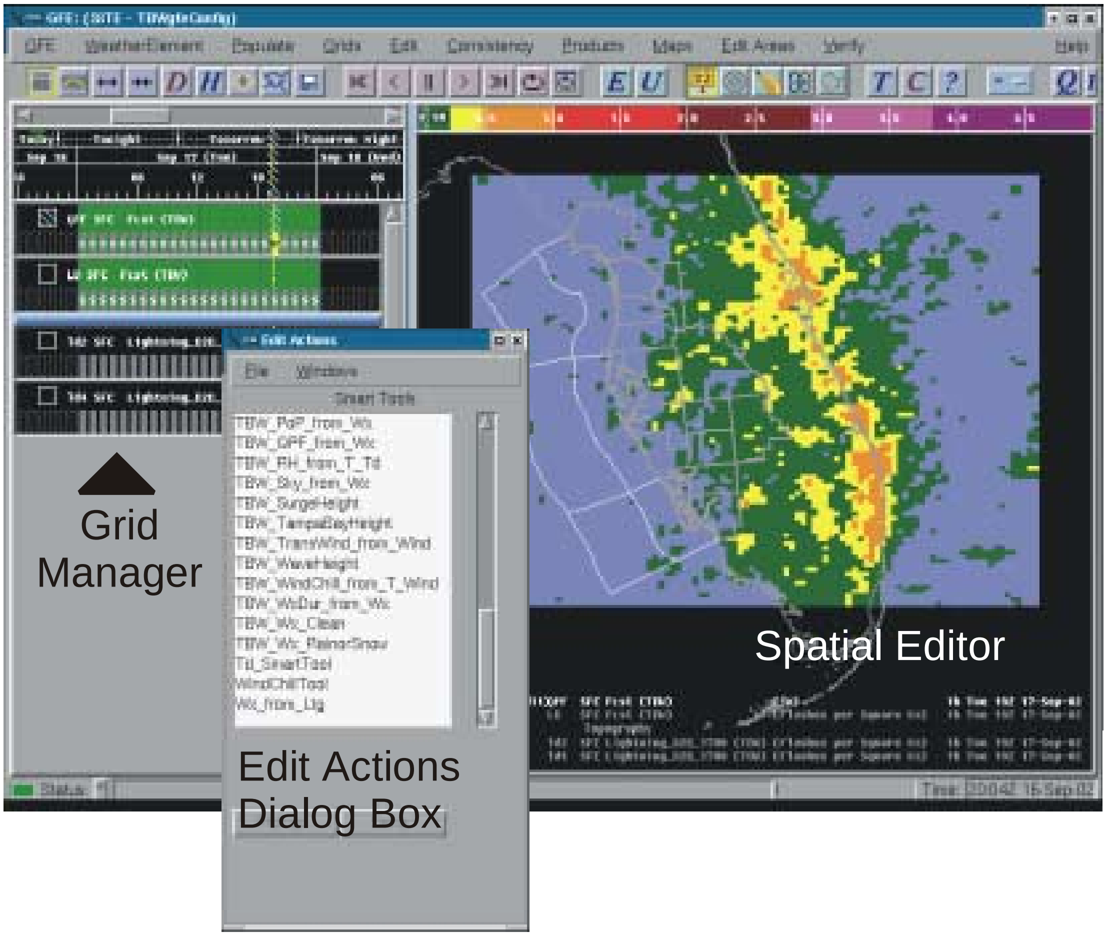

Figure 6. By means of a procedure in the Edit Actions Dialog Box, lightning data are converted into a QPF forecast.