P1.4 A comparison of lightning flash rate to rainfall over Florida

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Introduction

A wet season hourly lightning flash density climatology by flow regime, Stroupe et. al. (2002), provides a detailed account of lightning patterns over Florida. Watson et. al. (2002), describes a methodology for utilizing the lightning flash density climatology in the National Weather Service Graphical Forecast Editor (GFE). When wind flow patterns are similar to those used to develop the climatology, these data provide a detailed outlook of convective activity for a day and may be inserted into the graphical forecast. If the pattern does not match, then forecasters revert to drawing a less detailed weather pattern. When the pattern fits, how can other fields such as rainfall be derived from the lightning climatology data?

Graphical Forecast Editor

The Graphical Forecast Editor (GFE) is the core of the NWS Interactive Forecast Preparation Systems (IFPS), software. It was recognized by the NOAA Forecast Systems Laboratory (FSL) developers that by creating a framework through GFE that is open-ended, local development will flourish. The analysis programs created with GFE scripts or "Smart Tools" provide new avenues of product development that aid forecasters in the forecast process. The GFE is evolving into a graphical analysis tool allowing forecasters to manipulate data and incorporate forecast techniques specific to the local forecast area (LeFebvre, 2001).

Methodology

To demonstrate the utility of lightning flash density as method of estimating rainfall amount, lightning flash rate and rainfall were compared in 1 and 24 hour time intervals during the summer of 2004. The National Weather Service (NWS) Tampa Bay Area, Ruskin Florida WSR-88D radar estimated rainfall amount and lightning flash rates were overlaid and compared. In most cases higher flash densities were associated with areas of heavier rainfall. Some cases had higher rainfall and lightning areas offset by 5 to 10 km or more from anvil lightning. Scenarios with nearby tropical systems were less representative to the lightning data and to rainfall.

Figures 1 through 3 show a scenario with light low level winds and convection driven by a dominant east sea breeze and a weaker west coast sea breeze. Precipitable water and CAPE at the beginning of the 24 hour period were 51 mm and 924 J/kg and CAPE and moisture increased slightly toward the end of the period (not shown). In this case higher lightning flash rates were coincident with areas of greater rainfall particularly over the land.

Figures 4 through 6 show the influence of a weak mid latitude trough with light low level winds that become a more dominant westerly flow with convection linked to mid level instability. Precipitable water and CAPE at the beginning of the 24 hour period were 47 mm and 3000 J/kg and varied little for the next 24 hours. Some variability existed, but again the higher frequency lightning areas matched higher rainfall over most areas.

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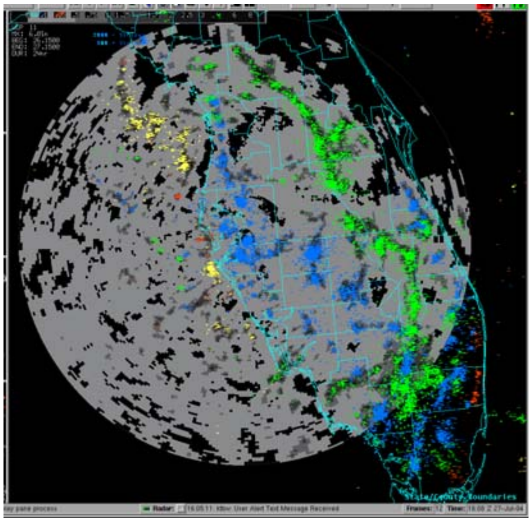

Fig. 1. Rainfall 1200 UTC 26 July 2004 to 1200 UTC 27 July 2004 and associated 24 hour lightning.

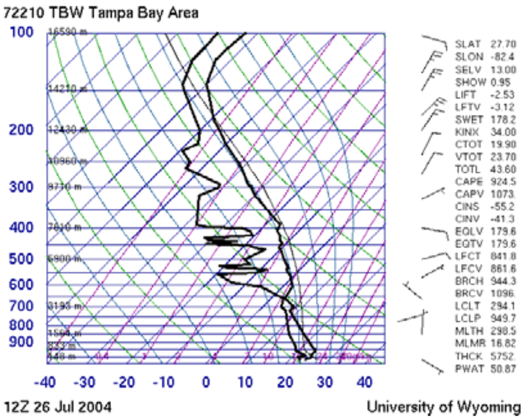

Fig. 2. 1200 UTC 26 July 2004 Tampa Bay Area Ruskin sounding.

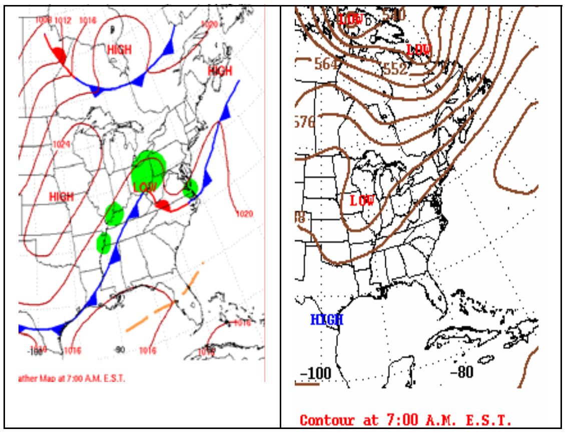

Fig. 3 Surface and 500hPa 1200 UTC 26 July 2004

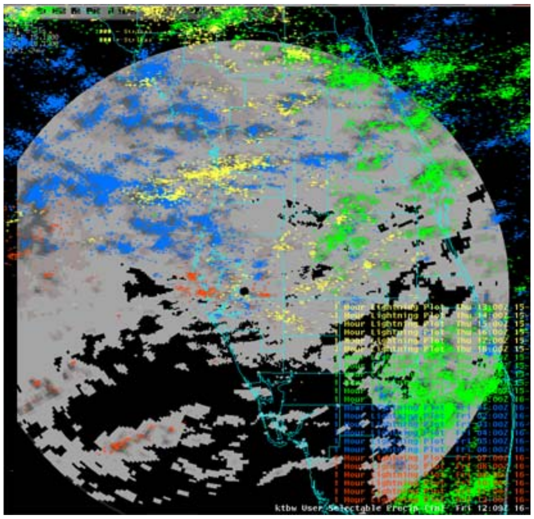

Fig. 4. Rainfall 1200 UTC 15 July 2004 to 1200 UTC 16 July 2004 and associated 24 hour lightning.

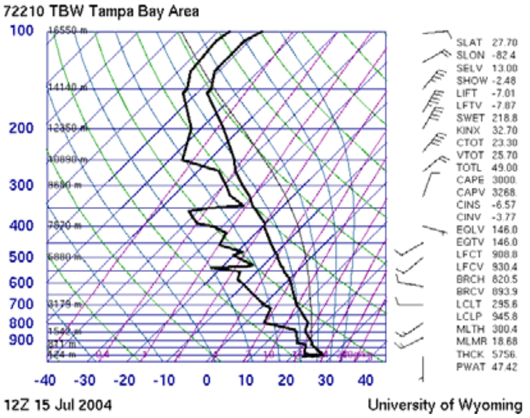

Fig. 5. 1200 UTC 15 July 2004 Tampa Bay Area Ruskin sounding.

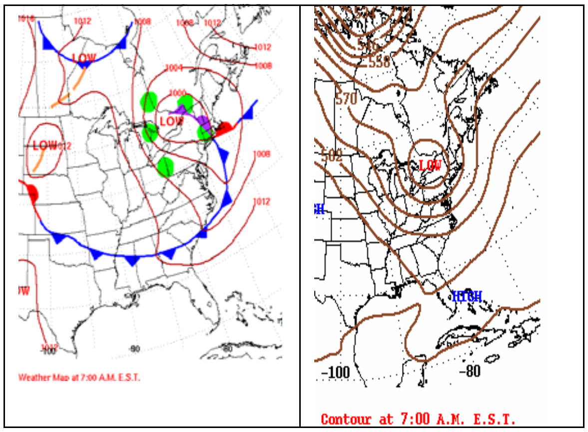

Fig. 6 Surface and 500hPa 1200 UTC 15 July 2004

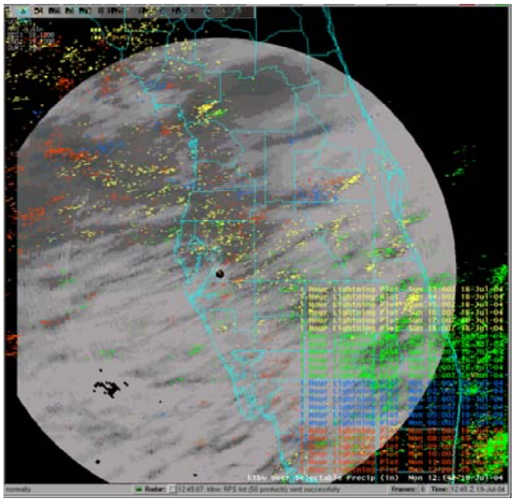

Fig. 7. Rainfall 1200 UTC 18 July 2004 to 1200 UTC 19 July 2004 and associated 24 hour lightning.

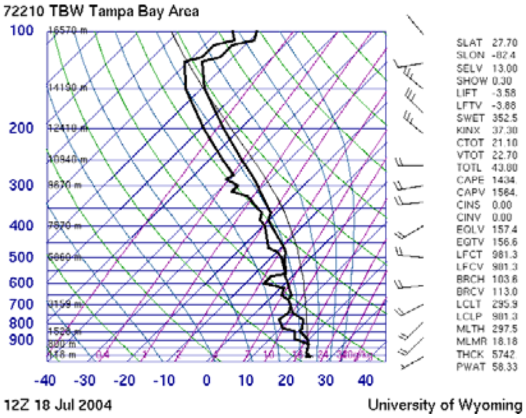

Fig. 8. 1200 UTC 18 July 2004 Tampa Bay Area Ruskin sounding.

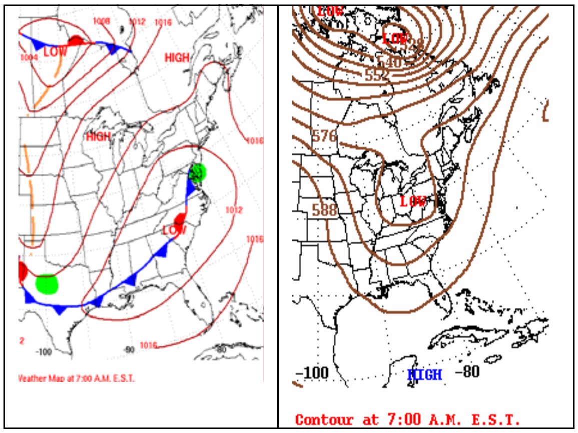

Fig. 9 Surface and 500hPa 1200 UTC 18 July 2004

Figures 7 through 9 show a stronger mid latitude trough westerly flow scenario with convection embedded in areas of stratiform precipitation. Precipitable water and CAPE at the beginning of the 24 hour period were 58 mm and 1434 J/kg. This illustrates a case where observed higher lightning flash densities do not coincide with greater rainfall amounts. In similar cases, climatological lighting data would not be representative for rainfall amounts.

Conclusion

Lightning climatology data in the GFE environment provide a detailed hourly gridded forecast. In most cases higher flash densities were associated with areas of heavier rainfall, but some variability existed. Some cases had higher rainfall and lightning areas offset by 10 km or more. Weather scenarios with nearby tropical systems were less representative to the lightning data and to rainfall. To account for the daily variability in timing and intensity of convection in the GFE grids under different flow regimes and thermodynamic profiles, some smoothing of the resulting smart tool derived rainfall grid is recommended.

More study is needed to compare the following lightning and convection patterns that may produce unrepresentative results: 1) Scenarios with displaced anvil lighting, 2)tropical situations, 3)convection embedded in stratiform precipitation.

References

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.

Watson, A.I., T.J. Turnage, K.J. Gould, J.R. Stroupe, T.P. Lericos, H.E. Fuelberg, C.H. Paxton, and J.E. Burks, 2003: Utilizing the IFPS/GFE to incorporate mesoscale climatologies into the forecast routine at the Tallahassee NWS WFO. Nineteenth Conf on IIPS, American Meteorological Society, Long Beach, Paper 12.5