P 1.2 THE APPLICATION OF TOTAL LIGHTNING DATA IN THE WARNING DECISION MAKING PROCESS

[1]Priscilla V. Bridenstine*, [1]Christopher B. Darden, [1]Jason Burks, [2]Steven J. Goodman

[1]National Weather Service Forecast Office
[2]NASA Marshall Space Flight Center
320 Sparkman Drive
Huntsville, AL 35805

1. INTRODUCTION

The National Weather Service Forecast Office in Huntsville, Alabama is co-located with the University of Alabama in Huntsville (UAH) and scientists from NASA. The collaboration between NASA atmospheric scientists and NWS meteorologists have provided forecasters several unique datasets to utilize during forecast and warning operations. The North Alabama Lightning Mapping Array (LMA) is one such dataset that was developed in November 2001 and has proven beneficial for the short-term forecasting of severe and hazardous weather.

The North Alabama LMA, developed by NASA scientists and centered in Huntsville, Alabama, has allowed NWS offices across the region the opportunity to view in-cloud, cloud-to-cloud and cloud-to-air lightning in near real-time. This is in addition to cloud-to-ground lightning data readily available to forecasters through the NWS Advanced Weather Interactive Processing System (AWIPS). Total lightning displays available through AWIPS have been used numerous times since becoming operational in May 2003. Access to total lightning data has enhanced situational awareness in the local forecast offices and has added additional confidence to the warning decision making process.

2. BACKGROUND

The North Alabama regional LMA consists of ten VHF receivers. These receivers are deployed across northern Alabama, with a base station located on the campus of UAH at the National Space Science and Technology Center (NSSTC). This system locates the source of VHF radio signals by measuring the arrival of signals at different receiving stations. Each station records the time of the peak lightning radiation signal and magnitude in successive 100 μs intervals. These signals are recorded within a local unused television channel, in this case 76-82 MHz.

Storm characteristics and positions within each volume scan are updated by a storm cell identification and tracking algorithm. The cloud-to-ground and total (LMA) lightning with each cell is associated by a nearest neighbor spatial-temporal clustering algorithm. This permits trending of radar-derived storm characteristics and lightning rate.

A one to five-minute interval flash density is produced at either 1 or 2 km resolution within a 400 km x 400 km horizontal x 17 km vertical level domain, resulting in a 3D gridded data set. The NWS Local Data Acquisition and Dissemination (LDAD) system ingests the near real-time flash density grids into AWIPS. This allows the forecasters to interrogate the data on AWIPS on all 17 horizontal levels, as well as the cumulative flash density.

3. RESULTS

a. 6 May 2003

Several storm complexes moved across the Tennessee Valley during the early morning hours of 6 May 2003. The most intense MCS affected north Alabama between 1000 and 1500 UTC. An HP supercell developed as the storms tracked across Limestone County. Only weak rotation was detected from the KHTX WSR-88D and the storm appeared disorganized throughout its lifetime. This supercell produced several tornadoes across Limestone and Madison counties with the strongest being an F1 in the city of Meridianville.

The flash density data provided by the North Alabama Lightning Mapping Array shows a definitive increase in electrical activity prior to tornado touchdown. This “lightning jump” occurred approximately 15 to 20 minutes prior to the strongest tornado touching down (figure 1) and provided additional confidence in the strength of the storm.

*Corresponding Author: Priscilla Bridenstine, National Weather Service, 320A Sparkman Drive, Huntsville, AL 35805;
E-mail: Priscilla.Bridenstine@noaa.gov

b. 31 May 2004

An intense bow echo moved across the Huntsville CWA during the early morning hours of 31 May 2004. This line produced widespread wind damage, as well as sporadic tornado touchdowns. Several F1 tornadoes producing 36 m/s (70 kts) winds touched down across Lauderdale, Limestone and Madison counties. Weak tornadoes developed immediately north of the apex of the bow as it moved east across northern Alabama.

Lightning data in advance of each tornado touchdown indicated a definitive jump in the lightning flash rates. The increase in total lightning occurred, on average, 3 to 5 minutes prior to tornado touchdown (figure 2).

c. 20 August 2004

On 20 August 2004, a line of thunderstorms developed ahead of a strong cold front approaching from the Central Plains. The most intense storms affected extreme northeast Alabama and southern middle Tennessee. Weak F0 tornadoes affected Skyline, Alabama and Booneville, Tennessee during the mid-afternoon.

The LMA data displayed a significant increase in flash rates approximately 8-10 minutes before tornado touchdown time in Booneville, Tennessee (figure 3). This notable jump in lightning intensity provided added benefit to severe thunderstorm analysis and may prove extremely valuable in the warning decision making process.

4. SUMMARY

The ability to view total lightning information in the AWIPS decision support system has allowed the NWS forecaster even greater situational awareness and warning decision making capability (figure 4). The lightning trends from the preceding case studies have increased forecaster confidence in the warning decision making process. Several correct warning decisions have been made due to data provided by the North Alabama Lightning Mapping Array, including decisions to not warn in several cases. Many tornado touchdowns across the Huntsville CWA have been preceded by "lightning jumps." The trends in the total flash rate may provide additional lead time for severe weather warnings when used in conjunction with other tools.

5. REFERENCES

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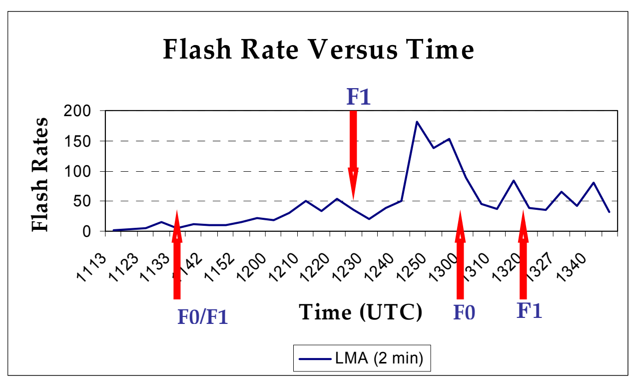

Figure 1: Flash Rate versus Time for HP supercell that tracked across north Alabama, 6 May 2003.

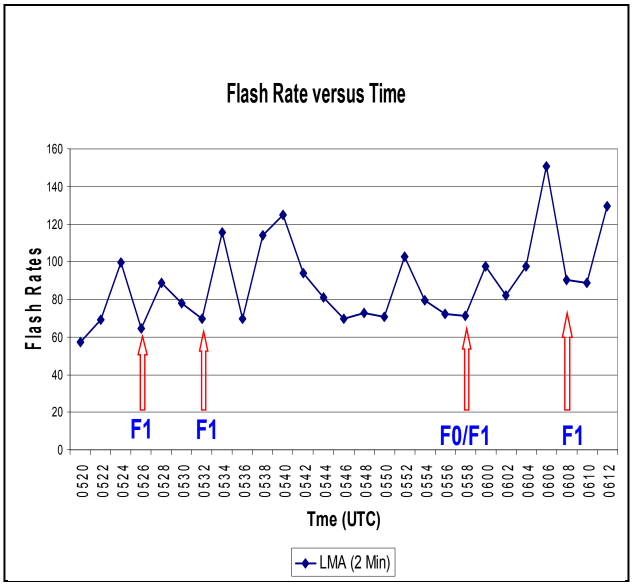

Figure 2: Flash Rate versus Time for tornado producing squall line over north Alabama, 31 May 2004.

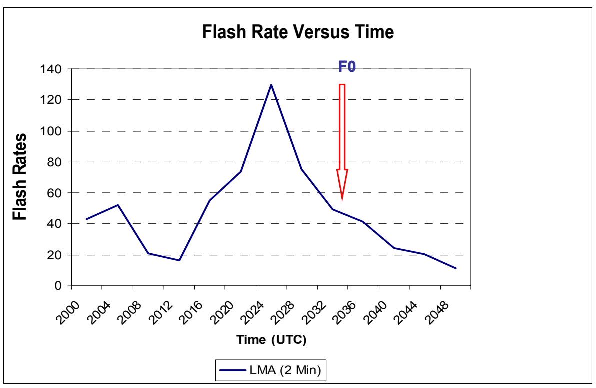

Figure 3: Flash Rate versus Time for tornadic thunderstorm over Moore County, Tennessee, 20 August 2004.

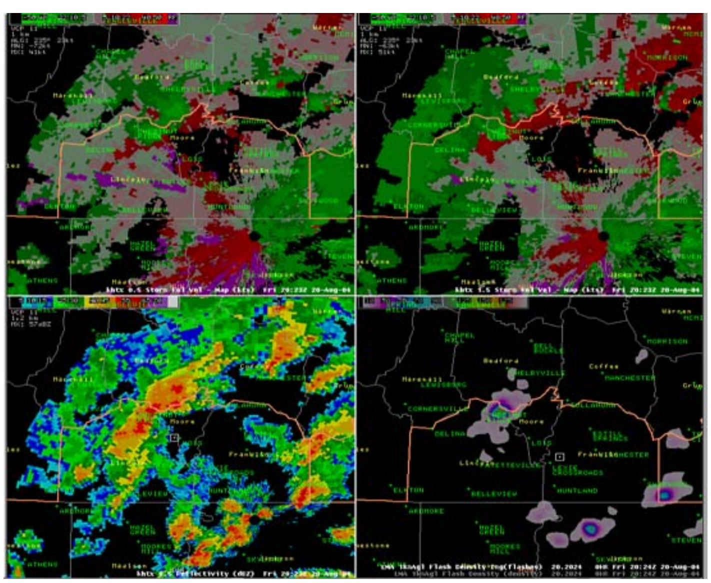

Figure 4: Tornadic storm over Lincoln County, TN at 2023 UTC on 20 August 2004. Rotation, evident at 1.5° from KHTX WSR-88D, is very ill-defined at 0.5°. A notable increase in flash density was noted with this storm, as seen at lower right. This occurred approximately 12 minutes prior to touchdown.