

WFO La Crosse Seminar Series #5

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Lightning Trends and Their Relationship to Severe Weather

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1. Introduction

This study was conducted in order to determine if the number of cloud-to-ground lightning strikes had any correlation to the timing of severe weather. Lightning strike trends were tracked on radar for isolated cells in which severe weather occurred. Since this study was limited, only a small number of cases were analyzed. If a correlation exists in lightning trends alone, it would be possible to increase lead time on warnings.

2. Methodology

A list of severe weather events, dating back to 2001 taking place in the La Crosse National Weather Service (ARX) warning area, was used to identify the type of event associated with each cell analyzed. A severe weather event was defined as hail greater than or equal to 0.75" in diameter and/or a tornado. Each event was then reviewed using both WSR-88D radar and five minute cloud-to-ground (c-g) lightning data. If the report was associated with an isolated cell on radar, the number of positive and negative c-g strikes from forty minutes before an event to forty minutes after the event, was recorded in a database. Only isolated cells depicted by radar which produced a severe weather event were used in this study to ensure that the lightning strikes were native to that specific cell. For each event, seven parameters were recorded into a database: positive c-g strikes, negative c-g strikes, total c-g strikes, what type of severe weather was reported, the time of the severe weather, if there was a merge or split and the date of the event.

A total of forty-one events were identified: fifteen of these events had either a cell merge or a split and twenty-six were isolated cells through the entire 80 minute time period investigated. There was a total of seven tornado events, fifteen events with hail greater than one inch and nineteen events with hail less than or equal to an inch. After collecting the event data, the values of positive and negative c-g strikes were averaged for the entire database to determine an average storm strike profile. Severe event types were also broken down into three groups: tornadoes, hail greater than an inch and hail less than or equal to an inch and lightning strikes were totaled up for each event and also averaged. Events were also segregated into those that had experienced a cell merge or cell split, and the lightning activity was compared to those that remained isolated.

3. Data Analysis and Results

There was an obvious difference in lightning activity between the cells in which a merge or split occurred and cells which remained isolated for the whole 80 minute period investigated. For the cells that remained isolated the entire 80 minute period (Fig.1) it is difficult to see a definite pattern to the lightning strike activity, but the cell merge/split family (Fig.2) shows a general upward trend in lightning strikes after the severe weather was observed at the surface.

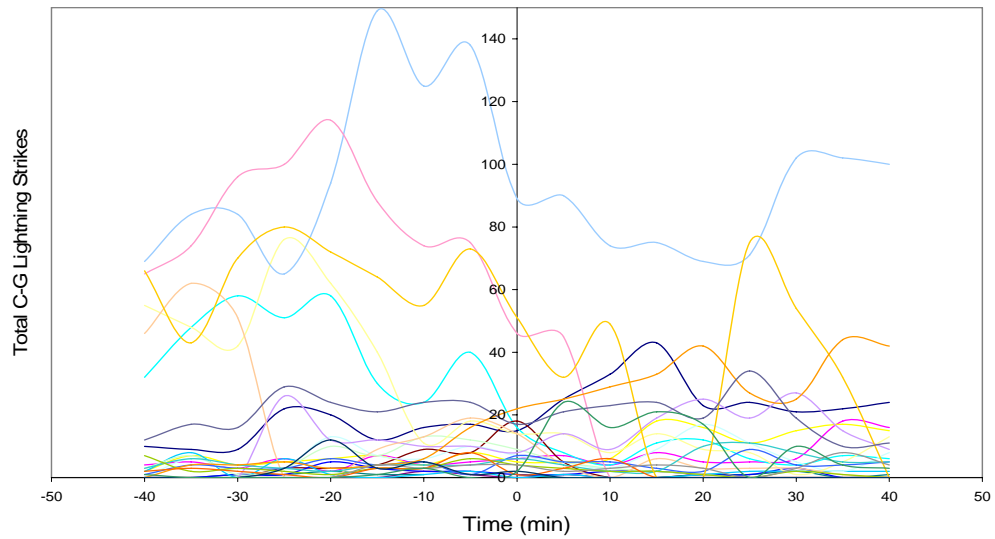


Fig. 1 The total number of c-g lightning strikes for cells that were isolated for the entire 80 minute time period examined. Time equals zero minutes indicates the time of the severe event.

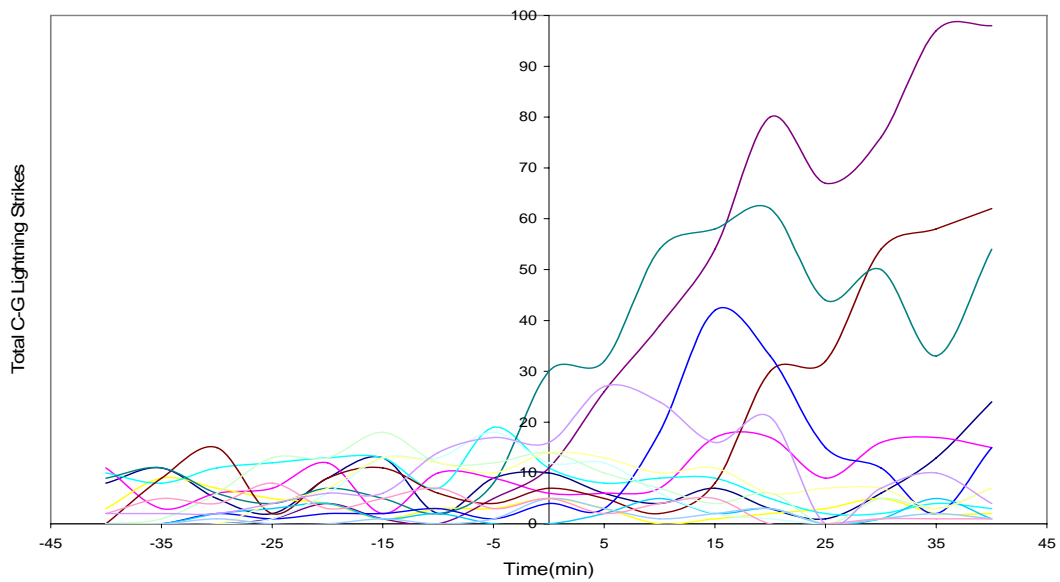


Fig. 2 The number of c-g lightning strikes associated with cells that were initially isolated but had a merge or split occur sometime during the 80 minute time period examined. Time equals zero minutes indicates the time of the severe event.

When looking at negative and positive c-g strikes for cells that remained isolated the entire 80 minute period (Fig.3), a trend of steady-decreasing-steady is noticed. This decrease begins approximately five minutes before the event and lasts about ten to fifteen minutes through the severe report. There were slightly more negative strikes than positive strikes through the decrease. After the decrease, the positive strikes were more numerous than the negative strikes.

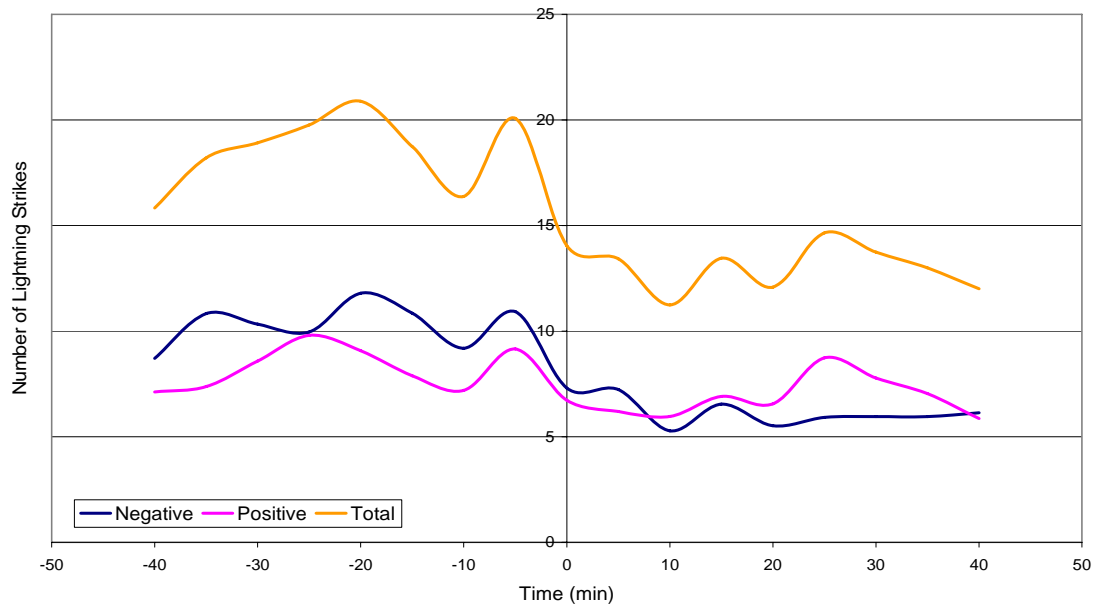


Fig. 3 Compares the averaged values of total, positive and negative c-g lightning strikes for cells that were isolated the entire 80 minute time period examined. Time equals zero minutes indicates the time of the severe event.

Looking at the averaged positive and negative c-g strikes for cell merges and splits (Fig. 4), a similar upward trend was observed when compared to Fig. 2. Before the event occurred the positive and negative strikes were near equal in number. After the event, though, there was a jump in positive strikes while the negative strikes did not increase until twenty minutes later.

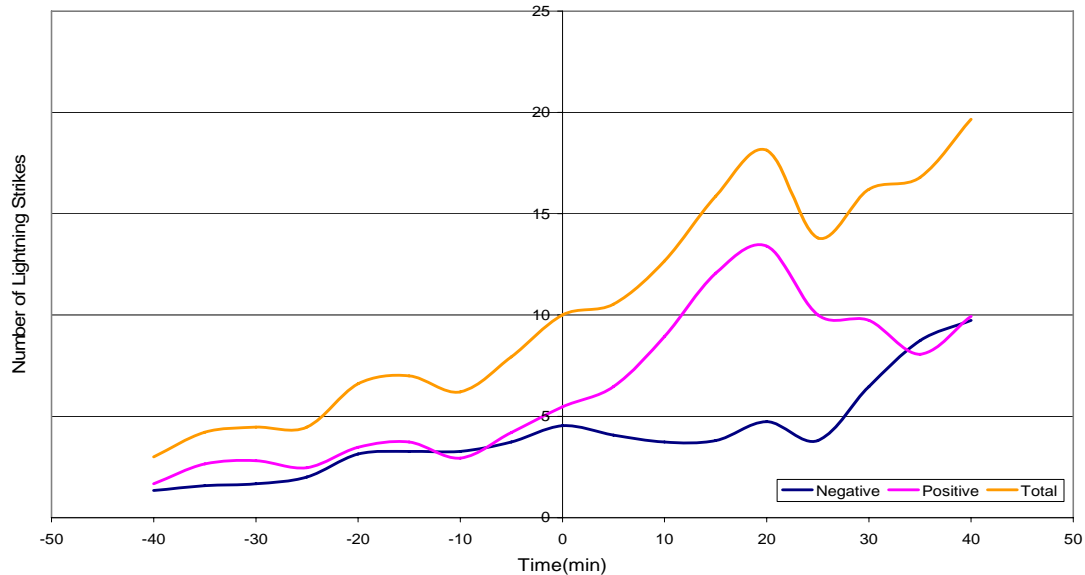


Fig. 4 Same as Fig. 3, except that for initially isolated cells either a cell merge or split occurred. Time equals zero minutes indicates the time of the severe event.

When looking at the different types of severe events for isolated cells (Fig. 5) the same general trend exists for the hail events as in Fig. 3: steady-decreasing-steady. However, tornado events had a higher number of lightning strikes overall and also were nearly constant for the entire period. When looking ten minutes before and after the event, though, there was a decrease in the number of lightning strikes. This is similar to that of the hail events.

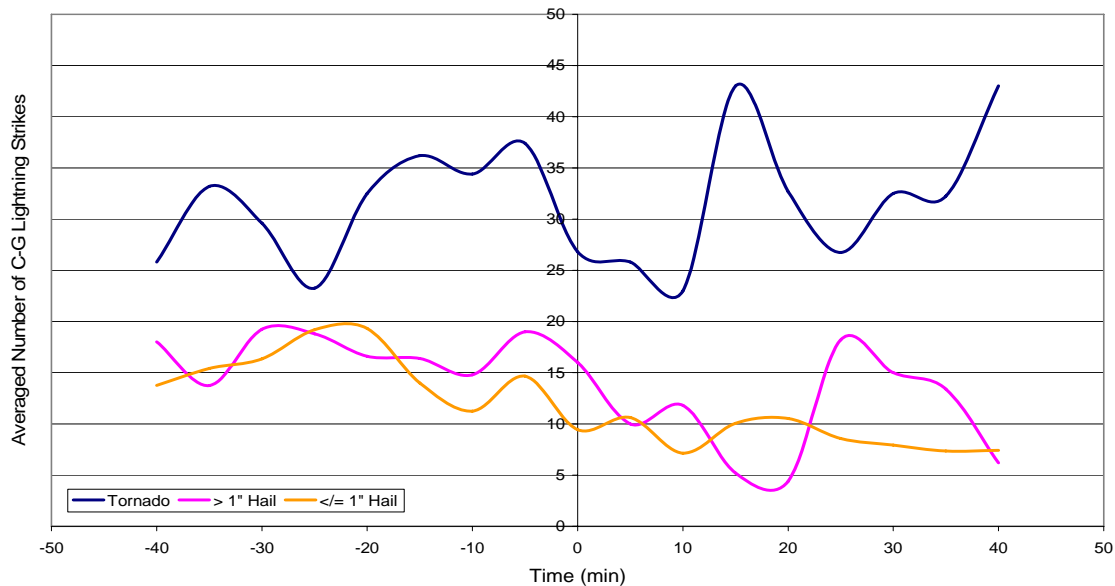


Fig. 5 The averaged number of c-g lightning strikes for tornado events, hail events great than an inch and hail events less than or equal to an inch. Time equals zero minutes indicates the time of the severe event.

4. Summary

Overall, the number of lightning strikes in cells isolated for the entire 80 minute period examined was higher before a severe weather event and lower after the event takes place. This decrease seems to take place in a five to ten minute span centered on the severe event. This steady-decreasing-steady trend changed if the initial isolated cell merged or split and the lightning strikes generally increased from forty minutes before the event to forty minutes after the event.

Looking at the type of event, tornadoes averaged a nearly steady 30 c-g strikes per 5 minutes during the 80 minute sample period. However, hail events averaged 17 c-g strikes per 5 minutes before the severe event, dropping to 10 c-g strikes per 5 minutes after the severe event occurred. Hail events show the steady-decreasing-steady trend the entire 80 minutes while tornado events only show this trend in a 10 minute span centered on the event.

. Forecasting before a severe weather event based on lightning activity would be difficult since the decrease in strikes does not happen until right before the event occurs (5 to 10 minutes). Therefore, this limited study suggests little potential in increasing warning lead time based on c-g trends alone.