

Lightning Detection and Prediction Using Remote Sensing

Total lightning (in-cloud plus cloud-to-ground) activity is related to the updraft strength and the amount of ice in the mixed phase region of thunderstorms. By monitoring lightning frequency in thunderstorms, one can infer storm kinematic and microphysical structure and, therefore, changes in storm severity. This can provide forecasters another severe weather warning tool. Currently, most forecast offices only have access to cloud-to-ground lightning observations. However, some storms produce little or no cloud-to-ground lightning but significant amounts of in-cloud lightning.

Real-time total lightning data from the National Aeronautics and Space Administration's (NASA) Marshall Space Flight Center (MSFC) North Alabama Lightning Mapping Array (NALMA) have been used by forecasters at the Huntsville, AL (HUN); Birmingham, AL (BMX); and Nashville, TN (OHX) National Weather Service Offices since 2003. The NALMA is comprised of ten VHF receivers deployed across northern Alabama and a base station located at the National Space Science and Technology Center (NSSTC). The NSSTC is co-located with the HUN forecast office on the campus of the University of Alabama in Huntsville.

The NALMA locates sources of impulsive VHF radio signals from lightning by accurately measuring the time that the signals arrive at the different receiving stations. The lightning sources located by NALMA are summed onto a 2 km by 2 km horizontal, 1 km vertical 3-D grid every 2 minutes. The rapid update cycle enables changes in storm severity to be monitored more quickly than is possible with radar or other observations. The 460 by 460 km (horizontal) by 17 km (vertical) grid is then provided to the NWS forecasters for display on AWIPS workstations. The lightning data are made available through NASA's Short-term Prediction Research and Transition (SPoRT) Center. The SPoRT Center seeks to accelerate the infusion of NASA research and technology into the operational environment.

The primary use of total lightning data from the NALMA network has been for severe weather. Prior studies suggest a rapid increase in the 'in-cloud' lightning frequency is associated with intensification of the storm updraft followed by a rapid decrease in lightning activity associated with updraft weakening and descent of angular momentum from aloft (Fig 1.). This lightning 'jump' signature prior to severe weather events has been found in studies in both Florida and Alabama. A study of the lightning jump signatures in 20 Alabama storms associated with 106 severe weather events found a Probability of Detection of 0.985 with a False Alarm Rate of .446. The surveys completed by NWS forecasters indicate that they do find the data useful in severe weather situations. A compilation of the survey results find that the forecasters estimate the average increase in warning lead time attributable to use of NALMA data as 2.9 minutes, with estimates ranging from 0 to 9 minutes. The surveys indicate that the total lightning data are most useful in marginal severe situations (i.e., non-tornadic), although the data are used in many tornadic cases as well. In addition to severe weather, HUN uses NALMA data to help issue warnings for the local airports and to develop aviation and terminal forecasts.

All NWS offices will be able to use total lightning products available from GLM observations on GOES-R, allowing them to take advantage of applications of total lightning measurements. Direct information on total lightning initiation, propagation, extent, and rate will capture the updraft dynamics and life cycle of convective storms, as well as internal ice precipitation processes.

Other VHF total lightning systems are located in the Kennedy Space Center, FL; Dallas-Fort Worth, TX; Houston, TX; Norman, OK; White Sands, NM; and the Washington, DC area.

Further NALMA information can be accessed at http://weather.msfc.nasa.gov/sport/sport_products_lightning.html. Two case studies on how the NWS forecasters in HUN use the NALMA data have been sent to the Southern Region WES case library at http://www.srh.noaa.gov/ssd/DRT-AWIPS/html/Available_Cases.html.

A VISIT View training module put together by HUN NWS personnel can be found at: http://weather.msfc.nasa.gov/sport/training/LMA_Lightning.zip. The NWA provides additional links to lightning information at <http://www.nwas.org/committees/rs/ltng.html>.

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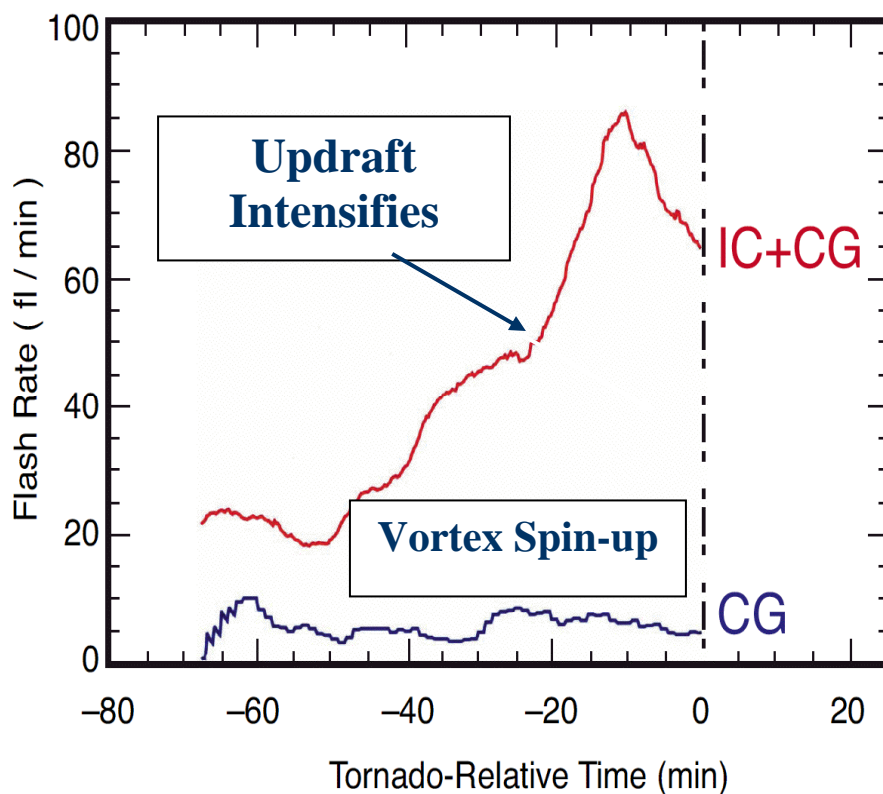


Figure 1. Example of a lightning 'jump' signature.