Using Flow Regime Lightning and Sounding Climatologies to Initialize Gridded Lightning Threat Forecasts for East Central Florida

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Each morning, the forecasters at the National Weather Service in Melbourne, FL (NWS MLB) produce an experimental cloud-to-ground (CG) lightning threat index map for their county warning area (CWA) that is posted to their web site (http://www.srh.weather.gov/mlb/ghwo/lightning.shtml). Given the hazardous nature of lightning in East Central Florida, especially during the warm season months of May–September, these maps help users factor the threat of lightning, relative to their location, into their daily plans. The maps are color-coded in five levels from Very Low to Extreme, with threat level definitions based on the probability of lightning occurrence and the expected amount of CG activity. On a day in which thunderstorms are expected, there are typically two or more threat levels depicted spatially across the CWA. The locations of relative lightning threat maxima and minima often depend on the position and orientation of the low-level ridge axis, forecast propagation and interaction of sea/lake/outflow boundaries, expected evolution of moisture and stability fields, and other factors that can influence the spatial distribution of thunderstorms over the CWA.

The lightning threat index maps are issued for the 24-hour period beginning at 1200 UTC each day with a grid resolution of 5 km x 5 km. Product preparation is performed on the AWIPS Graphical Forecast Editor (GFE), which is the standard NWS platform for graphical editing. Currently, the forecasters create each map manually, starting with a blank map. To improve efficiency of the forecast process, NWS MLB requested that the Applied Meteorology Unit (AMU) create gridded warm season lightning climatologies that could be used as first-guess inputs to initialize lightning threat index maps. The gridded values requested included CG strike densities and frequency of occurrence stratified by synoptic-scale flow regime. The intent is to improve consistency between forecasters while allowing them to focus on the mesoscale detail of the forecast, ultimately benefiting the end-users of the product.

Several studies took place at the Florida State University (FSU) and NWS Tallahassee (TAE) in which they created daily flow regimes using Florida 1200 UTC synoptic soundings and CG strike densities, or number of strikes per specified area. The soundings used to determine the flow regimes were taken at Miami (MIA), Tampa (TBW), and Jacksonville (JAX), FL, and the lightning data for the strike densities came from the National Lightning Detection Network (NLDN). The densities were created on a 2.5 km x 2.5 km grid for every hour of every day during the warm seasons in the years 1989–2004. The grids encompass an area that includes the entire state of Florida and adjacent Atlantic and Gulf of Mexico waters. Personnel at FSU and NWS TAE provided this data and supporting software for the work performed by the AMU.

The CG strike density grids were first stratified by flow regime and then by time in 6- and 24-hour increments while maintaining the 2.5 km x 2.5 km resolution. A CG frequency of occurrence was calculated for each flow regime by counting the number of days on which lightning occurred in each grid box and dividing that number by the total number of days in the flow regime. Two types of CG strike density climatologies were calculated: flow regime and conditional. In both cases, the strike density values were first summed in each grid box over all days in a flow regime. The flow regime climatology was calculated by dividing the summed densities by the number of days in the flow regime. This can be interpreted as the average number of strikes in each grid box per flow regime day. The conditional climatology was calculated by dividing the summed densities by the number of lightning days in a flow regime. It is called a conditional climatology because it is conditional on the occurrence of lightning. It can be interpreted as the average number of lightning strikes per lightning day during a flow regime. The NWS MLB forecasters use the frequency climatology values as proxy inputs for lightning probability, and the density climatology values as proxy inputs for CG amount when creating the daily lightning threat index map.

Based on a request from NWS MLB forecasters, the AMU conducted work on a second phase to create composite, or average, soundings for each flow regime using the morning soundings at MIA, TBW, JAX and Cape Canaveral Air Force Station (XMR). The forecasters compare the current and forecast soundings to the composite soundings, allowing them to refine the lightning threat based on the differences between the climatological and current/forecast soundings. The observed and forecast sounding stability parameters are also compared to those of the composite soundings for each regime to assist the forecaster in making adjustments to the lightning threat.

This presentation will describe the lightning threat index map, show examples of the climatological CG lightning densities and frequencies of occurrence based on flow regime and discuss how they were created, and show examples of the composite soundings for each flow regime.