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Verification of the FSU/FPL Lightning Model and Analysis of the Meteorological Conditions Leading to the Highest Frequency of Lightning during the 2012 Convective Season

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Reasons for Study

- National Severe Storms Laboratory states 62 people die and 300 are injured from being struck by lightning on average in the United States every year.
  - There were 74 recorded deaths in the state of Florida alone from 1998 to 2008 ("Lightning Deaths 1998-2008")
  - In 2012, the National Weather Service reported 5 deaths that occurred due to lightning in Florida, two of them in South Florida ("Lightning Safety")
- Project will verify accuracy of the FSU/FPL statistical model to predict lightning for the 2012 convective season in South Florida
- Meteorological analysis describing the atmospheric conditions that were present for high number of lightning strike days and for days with few strikes
- Give forecasters a more quantitative basis of:
  - Knowledge of atmospheric conditions suitable for more active lightning days
  - Increased understanding of the model and how it performs in predicting lightning for different situations

Methods

Cloud to ground lightning observations are obtained from the NLDN run by Vaisala Inc .

This project is to verify the day 1 forecast from the SREF 15Z model run valid for the 15-18Z, 18-21Z, and 21-00 periods. For this project will only look at the probability of 1 or more cloud to ground lightning strikes in a three-hour period.

The model verification is done for the active days (>2000 strikes).

The model file is placed into ArcMap and the symbology is changed to display the probability of one or more strikes. The data is interpolated by an inverse distance weighted (IDW) interpolation to display the probabilities as a surface rather than gridded points.

The observed lightning data layer for the correct times are placed over the interpolated guidance layer. From this, it is seen where the guidance lines up most with the observed lightning. Maps are made for each forecast time.

The probabilities produced by the SREF model are arranged into the following ranges: 0-10%, 10-20%, 20-40%, 40-60%, and 60-80%.

Probability ranges are normalized by Lightning Density (Number of Strikes/Area of Probability Range (km^2).

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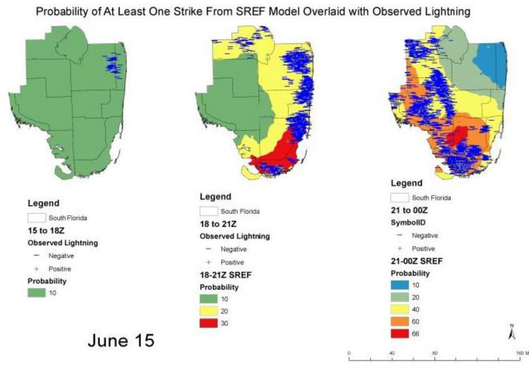
Abstract

The results presented in this study will allow forecasters in the NWS Miami Weather Forecast Office, in a more quantitative basis, to increase their knowledge on the atmospheric conditions suitable for active lightning days and provide a better understanding of the performance of the Florida State University/Florida Power and Light Corporation (FSU/FPL) model in predicting lightning. The FSU/FPL model produces statistically-derived forecast spatial fields of categorical lightning occurrence at various times throughout the day using meteorological parameters as input. This presentation will outline how the lightning forecasts for the 2012 convective season (1 June-30 September) were analyzed in two ways: 1) comparing the forecast lightning from the FSU/FPL SREF model to the observed lightning from the National Lightning Detection Network in South Florida; and 2) analyzing the weather conditions that caused the highest frequency of lightning.

The FSU/FPL model predicted 53% of all the lightning in the highest probability range for 15Z, 67% of all the lightning for 18Z, and 57% of all the lightning for 21Z in the highest probability range indicating that the model was able to predict the general area where lightning was observed for the 2012 convective season. Large fluctuations in 500 mb temperature can explain one of the important physical processes related to lightning activity over South Florida. Decreases in 500 mb temperatures were generally correlated with an increase in lightning activity. However, a decrease in 500 mb temperature did not result in an increase in lightning activity if sufficient moisture was not available, if cloud cover inhibited surface heating, or if the surface wind speeds were too strong to allow for intensification of sea breeze fronts. Diagnosing the 500 mb temperatures alone was not sufficient to explain why lightning occurred on certain days but not others, as there are many atmospheric variables to consider. The combination of low 500 mb temperatures with a moist airmass at the leading edge of a Saharan air mass led to increases in lightning activity in South Florida. In addition to these results, images of detailed weather patterns intended to help the NWS Miami forecasters identify the days with the greatest potential of active lightning will be presented.

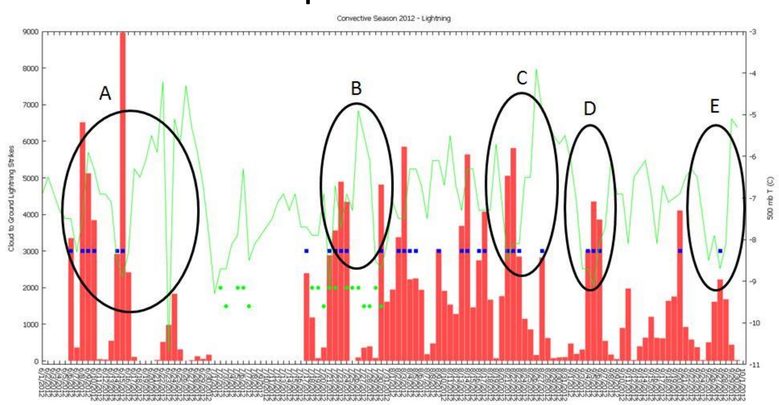
Example Verification Maps for June 15th



Results – Model Verification

- Results for 15Z:
  - 15 out of 19 days- second highest probability range predicted greatest number of lightning
  - Highest model probability range: 21.10% of all observed lightning strikes
  - Second highest: 78.95%
- Results for 18Z:
  - 24 out of 30 days- second highest probability range predicted greatest number of lightning
  - Highest: 20.00%
  - Second highest: 80.00%
- Results for 21Z:
  - 16 out of 28 days- second highest probability range predicted greatest number of lightning
  - Highest: 42.86%
  - Second highest: 57.14%

Results – Atmospheric Conditions



- The changes in the 500 mb temperatures were examined-
  - Correlated with a relative increase or decrease in the lightning activity over South Florida and adjacent waters
  - Conveys the overall trend well but it does not explain the entire physical process
- Lower pressure across the northeastern United States and higher pressure in the central United States at the mid-levels
  - Funnel in colder air into South Florida to bring instability in the middle atmosphere and increase the lightning activity
- Saharan Dust Data from July 2012
  - Lightning activity increases prior to dust event and after dust event is over
  - Combination of still present moisture and the incoming dust and dry air