Flow Regime Based Climatologies of Lightning Probabilities for Spaceports and Airports

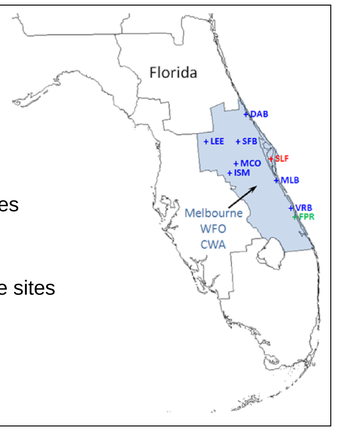
William H. Bauman III
ENSCO, Inc. / Applied Meteorology Unit

Matthew Volkmer, David Sharp, and Scott Spratt
National Weather Service, Melbourne, FL

Richard A. Lafosse
Spaceflight Meteorology Group, Houston, TX

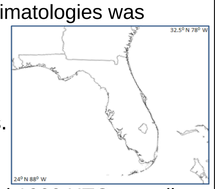
OBJECTIVES:

- Provide forecasters with a warm season climatological probability of one or more lightning strikes within a circle at a site within a specified time interval.
- Create climatologies based on Florida flow regimes for TAFs and shuttle landings for:
  - 9 sites
  - 5-, 10-, 20-, and 30-n mi circles around the sites
  - 1-, 3-, and 6-hour increments.
- Develop an easy to use GUI to display data.



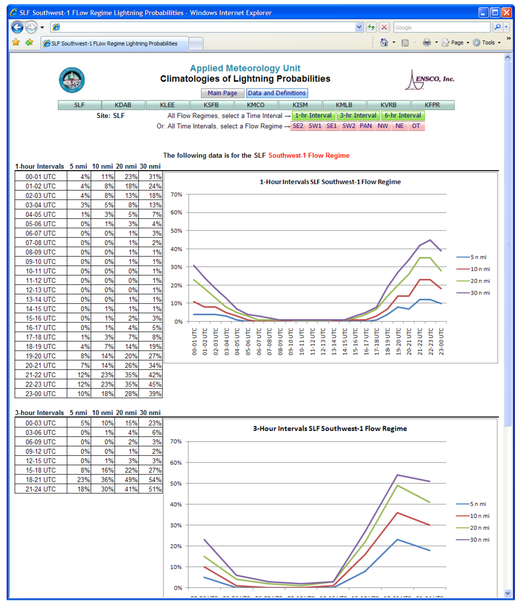
DATA

- The period of record (POR) was the warm season months of May – September in the years 1989 – 2004.
- All the data and code needed for development of the gridded climatologies was provided by FSU and NWS Tallahassee. The data included:
  - Lightning data grids created from NLDN data containing hourly CG strike counts in 2.5 x 2.5 km grid boxes. Grids encompass the entire state of Florida and adjacent waters.
  - Flow regime dates of occurrence for the POR.
- 1200 UTC soundings in the POR from MFL, TBW, and JAX; and 1000 UTC soundings from Cape Canaveral Air Force Station (XMR) for the sounding climatologies.
- The grids and soundings were stratified by flow regime prior to the creation of the climatologies.



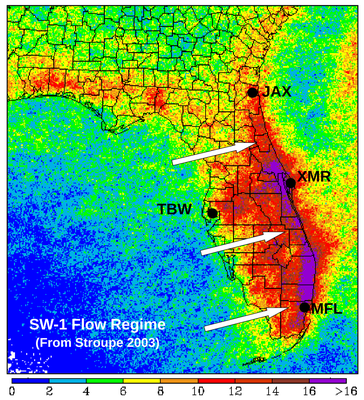
USER FRIENDLY FORMAT

- Generated 864 spreadsheets in Excel© containing climatological probabilities of lightning for:
  - 9 sites
  - 3 time intervals
  - 4 different size circles
  - 8 flow regimes
- Merged the data from multiple spreadsheets into data tables grouped by time interval and flow regime
- Created graphs from the tables to provide a "quick look" tool for forecasters
- Built a GUI using HTML
  - Easily navigable web site
  - Platform independent
- Navigation
  - Data and Definitions
  - Nine sites
  - Flow regime or time interval
- Displays both tables and corresponding graphs



FLOW REGIMES

- Studies at Florida State University (FSU) identified large-scale flow regimes over Florida, and found a strong relationship between the regimes and the spatial distribution of CG lightning across the peninsula (Lericos et al. 2002).
- The FSU studies yielded 7 distinct flow regimes.
- The average wind directions in the 1000 – 700 mb layer from the 1200 UTC soundings taken at Miami (MFL), Tampa (TBW), and Jacksonville (JAX) were used in combination to determine the flow regime of the day.

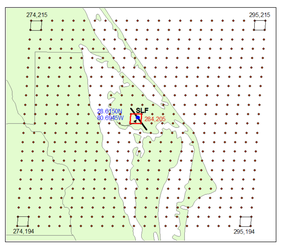


Flow Regime Name	Definition	Days in Regime
SW-1	Ridge from Atlantic High South of MFL	271
SW-2	Ridge from Atlantic High North of MFL and South of TBW	241
SE-1	Ridge from Atlantic High North of TBW and South of JAX	309
SE-2	Ridge from Atlantic High North of JAX	225
NE	Overall Northeast Flow	174
PAN	Ridge from Central Gulf Coast High over Panhandle	109
NW	Overall Northwest Flow	94
Other	Undefined Regime	827

- The first four flow regimes in the table are associated with the latitudinal position of a ridge extending westward from a high pressure center over the Atlantic Ocean, the fifth accounts for a ridge extending eastward from a Gulf Coast high over the Florida Panhandle.
- The sixth and seventh regimes account for general northwest and northeast flow across the peninsula.
- A flow regime could not be defined for a large percentage of the days in the study period, close to 40%. The AMU created an eighth category named 'Other' to account for these days.

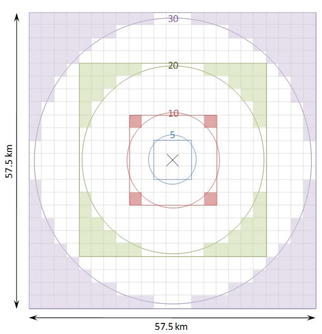
PROBLEMS

- Data
  - Gridded format not individual CG's
- Code designed for:
  - 24 hr intervals
  - Entire (rectangular) domain 954,281 km^2)
  - Not lat/lon based



SOLUTIONS

- Data
  - No change
- Changed code
  - Multiple time intervals and smaller, multiple domains by lat/lon
- Used area of square instead of circle
  - 30-n mi circle:
    - o 529 grid boxes: area of square is 27% larger than area of circle
  - 20-n mi circle
    - o 225 grid boxes: area of square is 23% larger than area of circle
  - 10-n mi circle
    - o 49 grid boxes: area of square is 13% larger than area of the circle
  - 5-n mi circle
    - o 9 grid boxes: area of square is 16% smaller than area of the circle



ISSUES

- Needed to know:
  - Number of CG strikes in given period of time/distance from site
- Had to work with:
  - Code provided by FSU to read National Lightning Detection Network (NLDN) data in gridded format
- Needed to generate:
  - 1-, 3-, and 6-hourly grids for each day/each flow regime
  - 5-, 10-, 20- and 30- n mi circles for each site/each flow regime

SUMMARY:

- Provided warm season climatological probability of one or more lightning strikes within a circle at a site within a specified time interval
  - Focus on Space Shuttle landings and NWS TAFs
  - Four circles around sites: 5, 10, 20 and 30 n mi
  - Three time intervals: 1 hr, 3 hr and 6 hr
- Based on:
  - NLDN gridded data
  - Flow regime
  - Warm season months of May-Sep for years 1989-2004
- Gridded data and available code → squares, not circles
- Over 850 spreadsheets converted into manageable user-friendly web-based GUI

WEBSITES AND REFERENCES

MLB Daily Lightning Threat Index Map: http://www.srh.noaa.gov/mlb/ghwo/lightning.shtml
MLB IMPACT Meteorology Unit: http://www.srh.noaa.gov/mlb/amu_mlb/IMU2.html
Lightning Threat Graphic Descriptions: http://www.srh.noaa.gov/mlb/amu_mlb/LTG/ltgclimothreat.htm and http://www.srh.noaa.gov/mlb/ghwo/lightning_levels.html
Applied Meteorology Unit: http://science.ksc.nasa.gov/amu/

Bauman, W. H., W. P. Roeder, R. A. Lafosse, D. W. Sharp, and F. J. Merceret, 2004: The Applied Meteorology Unit – Operational Contributions to Spaceport Canaveral. Preprints, 11th Conference on Aviation, Range, and Aerospace Meteorology, Amer. Meteor. Soc., Hyannis, MA, 4-8 October 2004, 24 pp.

Cummins, K. L., M. J. Murphy, E. A. Bardo, W. L. Hiscox, R. B. Pyle, and A. E. Pifer, 1998: A combined TOA/MDF technology upgrade of the U.S. National Lightning Detection Network. J. Geophys. Res., 103, 9035-9044.

Lambert, W., D. Sharp, S. Spratt, and M. Volkmer, 2006: Using Cloud-to-Ground Lightning Climatologies to Initialize Gridded Lightning Threat Forecasts for East Central Florida. Preprints, *Second Conf. on Meteorological Applications of Lightning Data,* Paper 1.3, Atlanta, GA, Amer. Meteor. Soc., 4 pp.

Lericos, T. P., H. E. Fuelberg, A. I. Watson, and R. L. Holle, 2002: Warm season lightning distributions over the Florida Peninsula as related to synoptic patterns. *Wea. Forecasting*, **17**, 83 – 98.

Short, D., 2006: Situational Lightning Climatologies for Central Florida, Phase II. AMU Memorandum, 8 pp. [Available by calling 321-853-8203 or from ENSCO, Inc., 1980 N. Atlantic Ave., Suite 230, Cocoa Beach, FL, 32931]

Stroupe, J. R., 2003: *1989-2002 Florida Lightning Climatology.* The Florida State University website: http://bertha.met.fsu.edu/~jstroupe/flclimo.html