Evaluation of NASA SPoRT's Pseudo Geostationary Lightning Mapper Products

***Geoffrey T. Stano**—ENSCO, Inc./NASA SPoRT, **Kristin M. Kuhlman**—NOAA/OAR/LCI & CIMMS , **Christopher Siewert**—CIMMS, **Brian Carcione**—NWS Huntsville, AL*

Introduction - Poster 501

New lightning observations for forecasters

- **Total Lightning** (both cloud-to-ground & intra-cloud lightning)
  - Typically rapid increase in activity ahead of severe weather (Figure 1) - **Lightning Jump**(Schultz et al. 2009; Gatlin and Goodman 2010)
  - Improves warnings, situational awareness and lightning safety (Bridenstine et al. 2005; Goodman et al. 2005; Nadler et al. 2009)
  - Space-based observations provide hemispheric coverage vs. limited coverage of ground-based Lightning Mapping Arrays (LMAs)
- Current operational lightning observations
  - National Lightning Detection Network (NLDN)
  - Provides cloud-to-ground strikes
  - Cloud-to-ground strikes a small percentage of lightning activity (MacGorman et al. 1989; Stano et al. 2010)

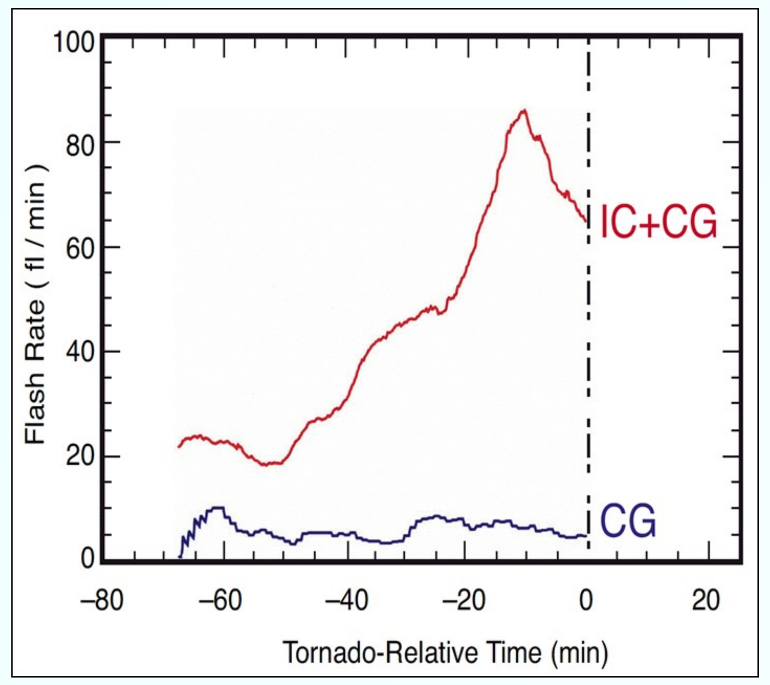


Figure 1 - Comparison of total lightning trends (red) versus cloud-to-ground trends (blue) ahead of a tornado touchdown.

Geostationary Lightning Mapper

Total lightning observations from space

- Geostationary Lightning Mapper (GLM) will be on GOES-R
  - Full disc domain, 8-12 km spatial resolution (Figure 2)
  - Greater than 90% detection efficiency (day and night)
  - NASA SPoRT affiliated with the GOES-R Proving Ground (PG) to assist preparing forecasters for the GLM
  - Collaborates with the Hazardous Weather Testbed and National Severe Storms Laboratory in the Spring Program in Norman, OK

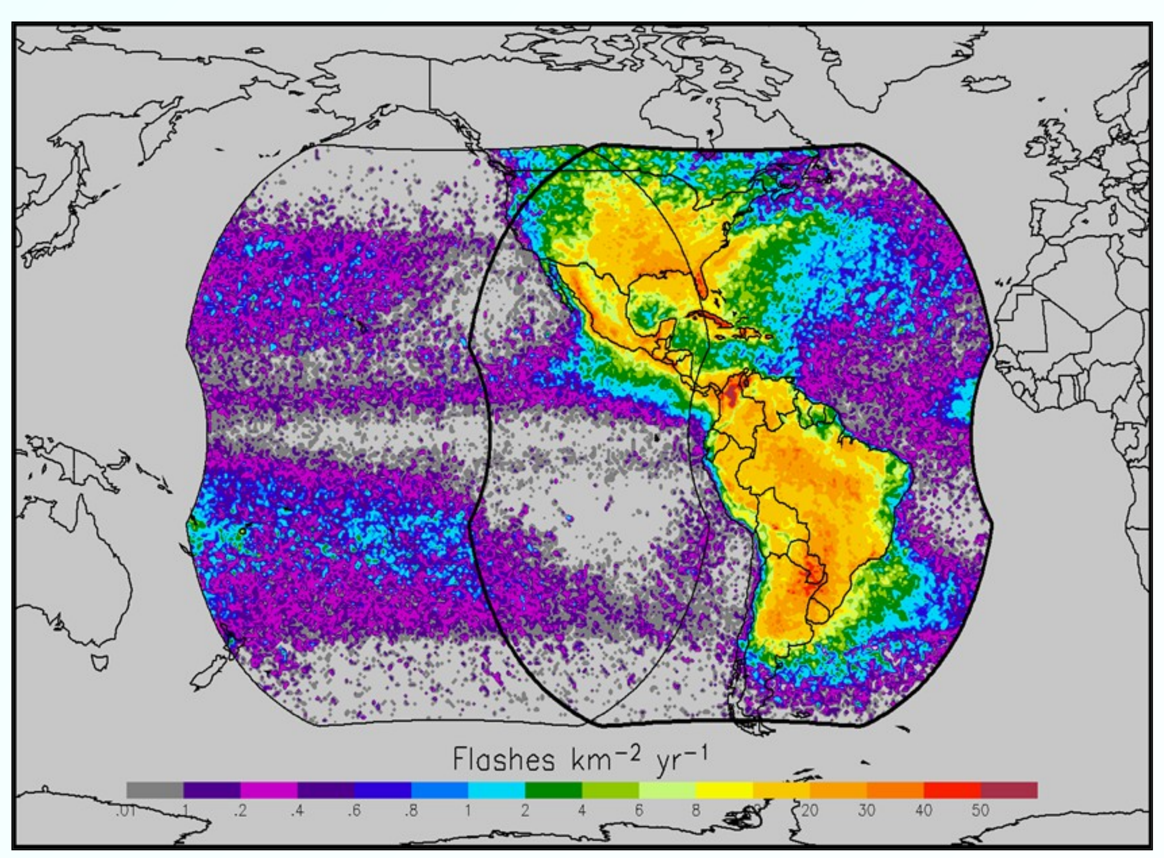


Figure 2 — A lightning density map derived from 1995-2005 OTD and LIS data shows the GOES-East and West fields of view of the Geostationary Lightning Mapper.

NASA SPoRT's Pseudo Geostationary Lightning Mapper (PGLM)

Preparing forecasters ahead of GOES-R launch

- NASA's Short-term Prediction Research and Transition (SPoRT) Center developed the PGLM (Figs. 3 and 4; Stano et al. 2011)
  - Developed in 2009—Derived from any available LMA network
  - Demonstrates representation of GLM-resolution data
  - Use until official Algorithm Working Group proxy available
  - Provided to Hazardous Weather Testbed / NSSL for GOES-R Proving Ground collaboration (2010, 2011, and set for 2012)
- Purpose
  - Demonstration tool to prepare forecasters
  - Facilitate discussion to use total lightning operationally
  - Develop visualization tools, such as with AWIPS II

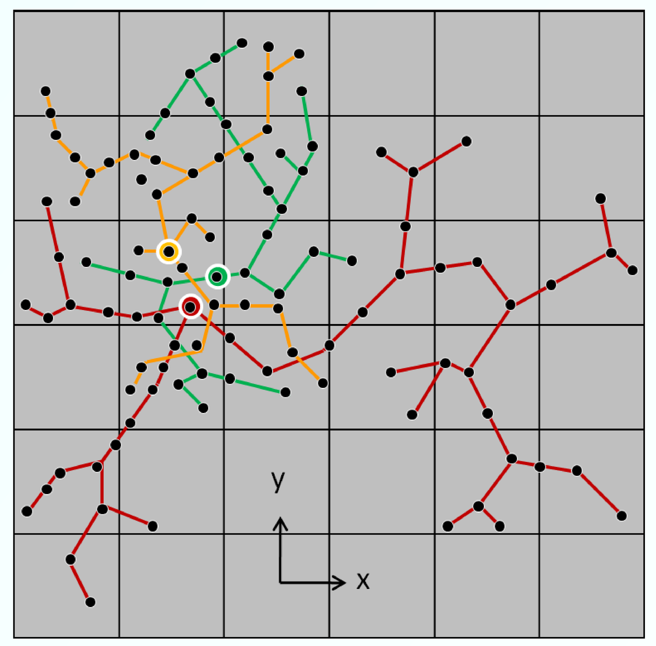


Figure 3 — Raw LMA sources (dots) are combined into flashes (red, green, orange) and placed on a grid.

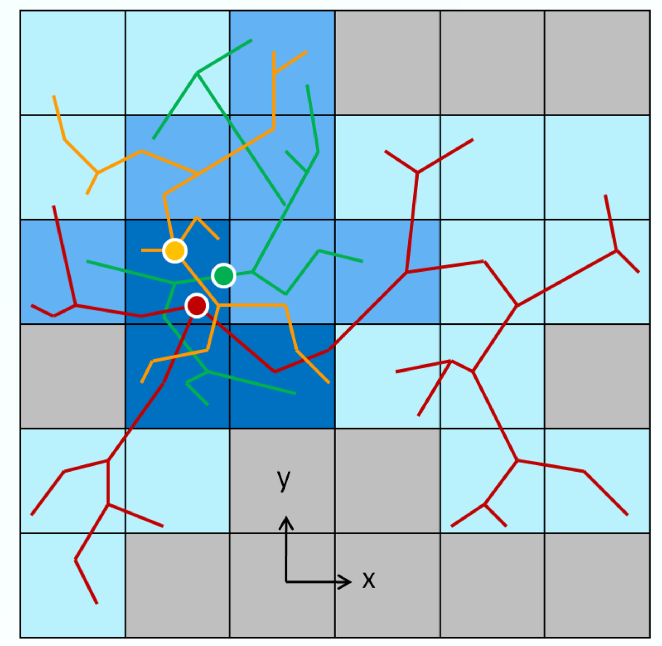


Figure 4 — The PGLM sums the number of flashes in each grid box for the 8km flash density product.

Pseudo GLM Flash Product Examples

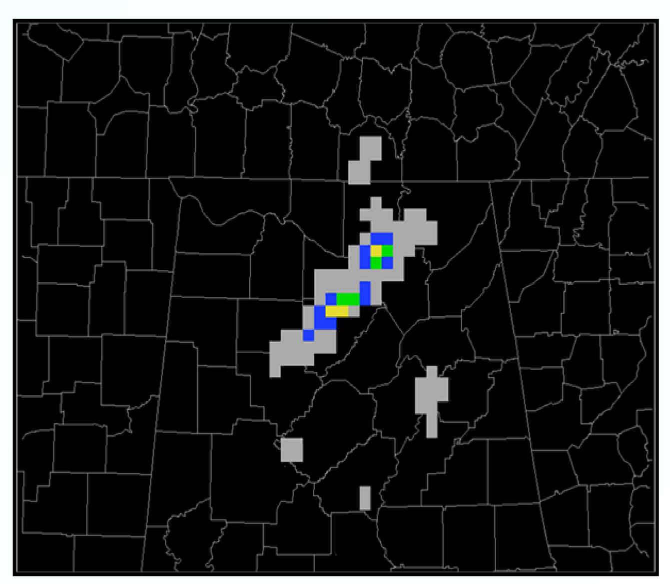
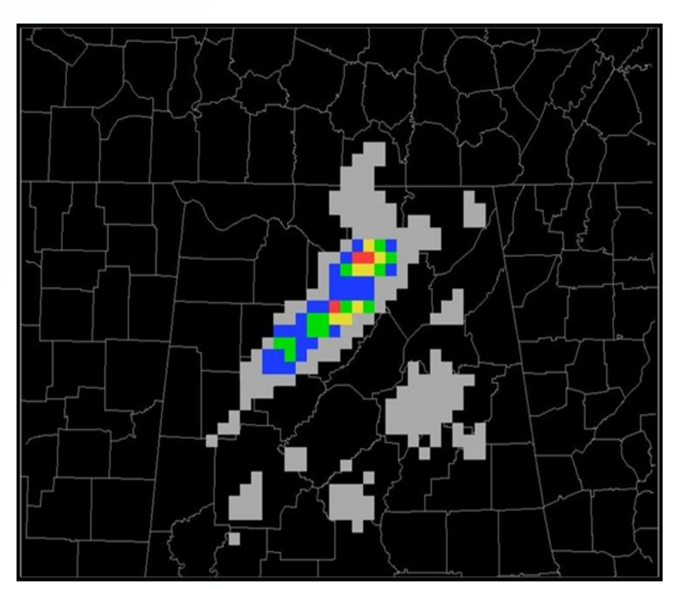


Figure 5 (left) — PGLM flash extent density
- *1 or 2 minute updates*
- *Spatial extent of flashes*
- *Rapid increases indicate storm strengthening*
- *Improved situational awareness*
- *Often precedes first cloud-to-ground strike*

Figure 6 (right) — PGLM max flash density
- *1 or 2 minute updates*
- *Spatial extent of all flashes for past 30 min*
- *Improved lightning safety*
- *Simple trend tool*
- *Compare current PGLM flash extent to this*
- *Indicates strengthening or weakening*



Operational Example #1 (Figs. 7-10)

- **Severe Weather Warning—Hazardous Weather Testbed (2011)**
  - Large lightning jump occurs at 2220 UTC and directly leads to severe thunderstorm warning at 2226 UTC (Forecaster waited for radar)
  - Severe hail at 2238 UTC verified warning with 18 min lead time since jump

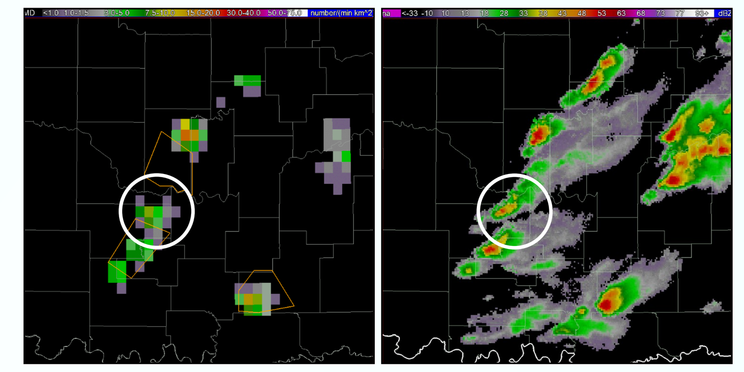


***Fig. 7** — PGLM (left-2211 UTC), reflectivity (right-2209) and existing severe thunderstorm warnings. PGLM only 9 flashes (circle).*

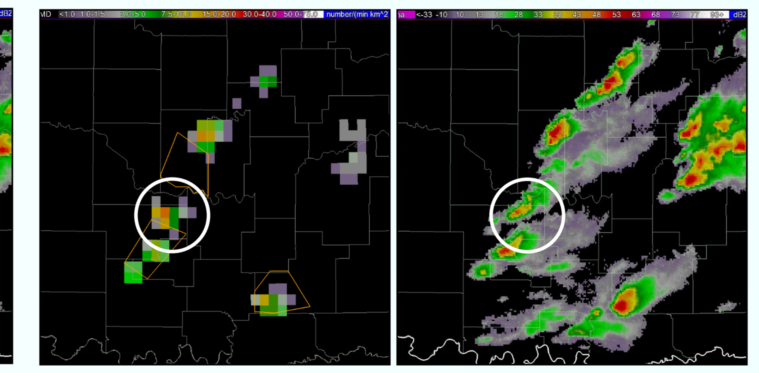


***Fig. 8** — PGLM (left-2212), reflectivity (right-2211) and existing warnings. PGLM now 16 flashes (circle).*

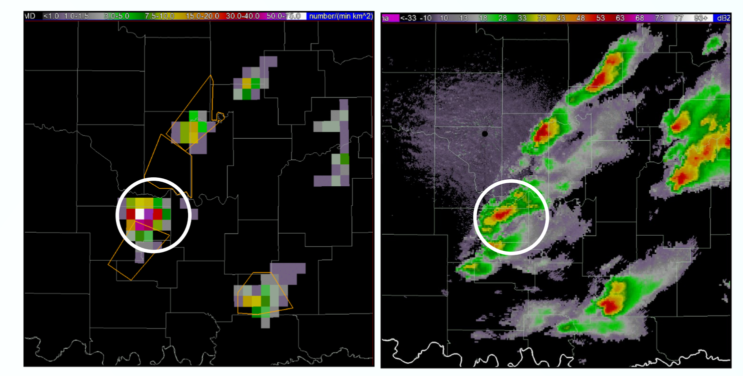


***Fig. 9** — PGLM (left-2220), reflectivity (right-2219) and existing warnings. PGLM jumped over 75 flashes (circle).*

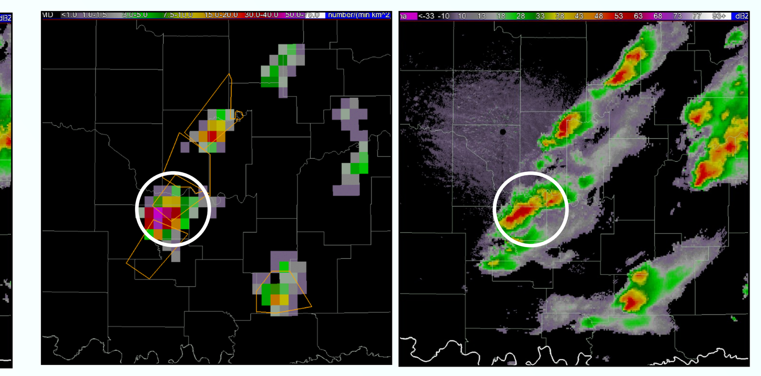


***Fig. 10** — PGLM (left-2226), reflectivity (right-2225) and existing warnings. Forecaster issues new warning after observing lightning jump and waiting for radar confirmation.*

Operational Example #2 (Figs. 11-13)

- **Lightning Safety—Hazardous Weather Testbed (2011)**
  - PGLM observations precede first NLDN observed cloud-to-ground strike by 29 min. (Average total lightning lead time is 5-10 min.)

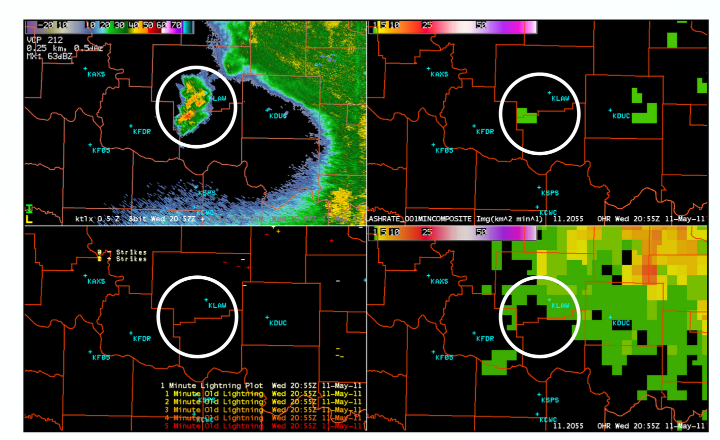
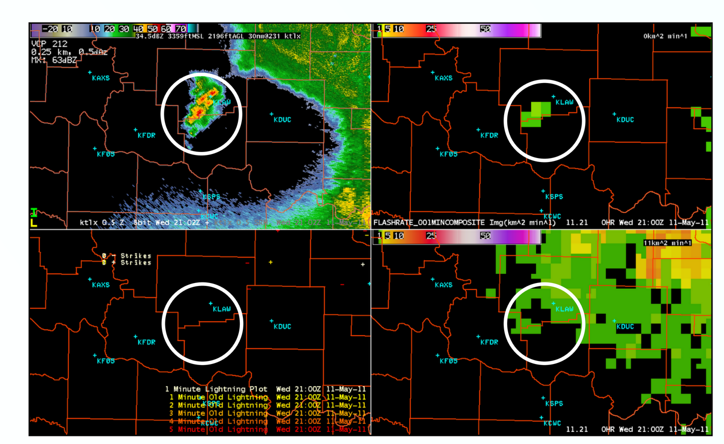


***Figure 11** — Reflectivity (upper left), PGLM (upper right), max PGLM (60 min, lower right), and NLDN (lower left) at 2055 UTC 11 May 2011. One PGLM flash observed near Lawton, OK—No NLDN observations*

***Figure 12** — Same as Fig. 11, but for 2100 UTC. PGLM has two flashes and reflectivity increased. Still no NLDN observed cloud-to-ground strikes.*



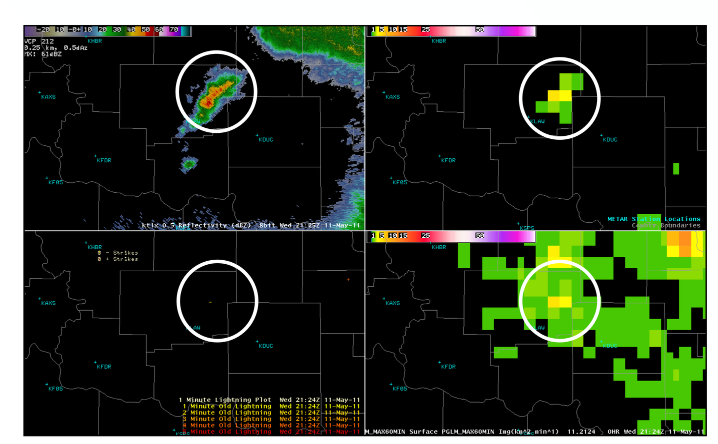


***Figure 13** — Same as Fig. 11 but for 2124 UTC. Strong reflectivity and PGLM shows several flashes. NLDN observes first cloud-to-ground strike for this storm. PGLM preceded first cloud-to-ground strike by 29 minutes.*

Feedback and Evaluation

Forecaster responses from the Hazardous Weather Testbed

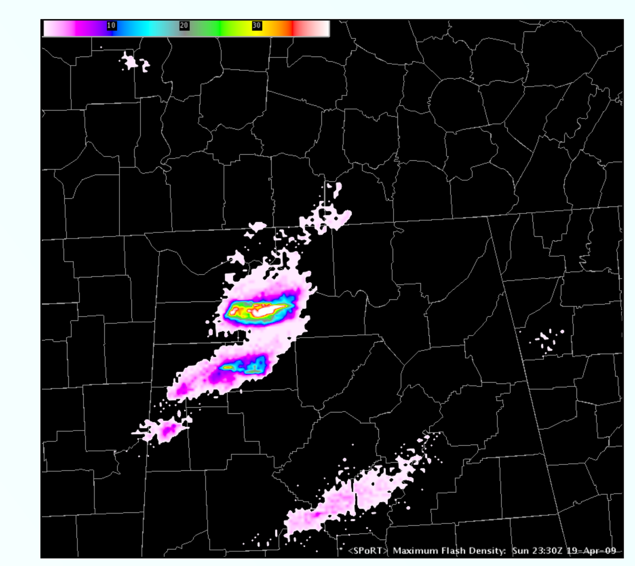
- Evaluations occurred after every event that used the PGLM
- 22 of 33 attendees highly rank the use of total lightning in operations
- 19 ranked total lightning an '8' or higher for amount of use
- Majority of responses positive
  - *"Excellent tool for monitoring convection"*
  - *"Preceded first observations for cloud-to-ground lightning"*
  - *"…heads-up on increase in storm severity"*
  - *"Individual and max density products together enabled a continuity with time awareness"*
  - *"Use as a situational awareness tool to help focus attention"*

Preparing for 2012 Activities

Feedback focuses efforts on what to improve

- Forecasters would like to see the following
  - Improved color curves
    - SPoRT is adding color curves from WFO Huntsville (Fig. 14)
  - Prefer to see a table of histogram of rate of change (top request)
    - SPoRT involved in two efforts to attempt this
    - Manual tracking plug-in tool for AWIPS II
    - Participating with GOES-R Risk Reduction team to implement the **Lightning Jump** algorithm operationally
  - Will add products to the SPoRT web page
- SPoRT creating updated training module
  - Incorporate feedback from 2011 evaluations
- SPoRT developing enhancements to the PGLM

***Figure 14** — Maximum flash density product in AWIPS II using WFO Huntsville color curve.*



References and Web Links

NASA's Short-term Prediction Research and Transition (SPoRT) Center: http://weather.msfc.nasa.gov/sport/

NASA SPoRT Online Training modules: http://weather.msfc.nasa.gov/sport/training/

Wide World of SPoRT Blog: http://nasasport.wordpress.com/

GOES-R Proving Ground: http://www.goes-r.gov/users/provingground.html

NOAA Hazardous Weather Testbed Spring Experiment: http://hwt.nssl.noaa.gov/Spring_2010/

Bridenstine, P. V., C. B. Darden, J. Burks, and S. J. Goodman, 2005: The application of total lightning in thewarning decision making process. 1st *Conf. on Meteorological Applications of Lightning Data*, Amer. Meteor. Soc., San Diego, CA, P1.2.

Gatlin, P. N. and S. J. Goodman, 2010: A total lightning trending algorithm to identify severe thunderstorms. *J. Atmos. Oceanic Tech.*, **27**, 3-22.

Goodman, S. J., R. Blakeslee, H. Christian, W. Koshak, J. Bailey, J. Hall, E. McCaul, D. Buechler, C. Darden, J. Burks, T. Bradshaw, P. Gatlin, 2005: The North Alabama Lightning Mapping Array: Recent severe storm observations and future prospects. *Atmos. Res.*, **76**, 423-437.

MacGorman, D. R., D. W. Burgess, V. Mazur, W. D. Rust, W. L. Taylor, and B. C. Johnson (1989), Lightning rates relative to tornadic storm evolution on 22 May 1981, *J. Atmos. Sci.*, **46**, 221-250, doi: 10.1175/1520-0469(1989)046<0221:LRRTTS>2.0.CO;2.

Nadler, D. J., C. B. Darden, G. T. Stano, and D. E. Buechler, 2009: An operational perspective of total lightning information. *4th Conf. on the Meteorological Applications of Lightning Data*, Amer. Meteor. Soc., Phoenix, AZ, P1.11.

Schultz, C. J., W. A. Petersen, and L. D. Carey, 2009: Preliminary development and evaluation of lightning jump algorithms for the real-time detection of severe weather. *J. Appl. Meteor. Clim.*, **48**, 2543-2563.

Stano, G. T., K. K. Fuell, and G. J. Jedlovec, 2011: NASA SPoRT Prepares for the Geostationary Lightning Mapper. *7th Symposium on Future Operational Environmental Satellite Systems*. Amer. Meteor. Soc., Seattle, WA, 23-27 Jan 11, 5.4, 8 pp.

_____, H. E. Fuelberg, and W. P. Roeder, 2010: Developing empirical lightning cessation forecast guidance for the Cape Canaveral Air Force Station and Kennedy Space Center, *J. Geophys. Res.*, **115**, D09205, doi:10.1029/2009JD013034.