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Using Total Lightning Observations to Enhance Lightning Safety

Geoffrey T. Stano—*ENSCO, Inc./NASA SPoRT, Huntsville, Alabama*

IMPORTANCE OF LIGHTNING SAFETY

- Cloud-to-ground lightning strikes 2nd leading cause of lightning casualties (Holle et al. 1992; Curran et al. 2000)
  - Second only behind flooding
  - Majority of casualties occur around initiation and cessation of storms (Holle et al. 1992)
  - Southeast and Gulf Coast at greatest risk, but all parts of country face lightning risks (Figure 1)
- Cloud-to-ground lightning posses other risks
  - Damage to property, utilities, and fire risks
- Cloud-to-ground lightning does not provide all the information
  - Cloud-to-ground strikes a small percentage of lightning activity (MacGorman et al. 1989; Stano et al. 2010)
  - Can use **total lightning** observations to support lightning safety

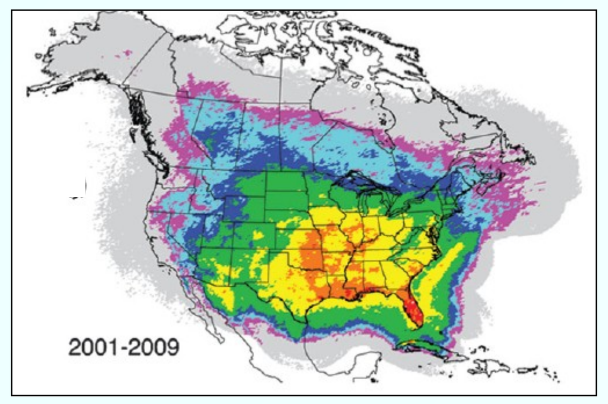

Figure 1 *— Mean annual cloud-to-ground flash densities (flashes km⁻¹ year⁻¹ from 2001-2009. (After Orville 2011)*

WHAT IS TOTAL LIGHTNING (AND HOW IT AIDS LIGHTNING SAFETY)

- **Total Lightning** is both cloud-to-ground and intra-cloud lightning
  - Figure 2 demonstrates differences in cloud-to-ground versus intra-cloud lightning
  - Observed with short-ranged, ground-based Lightning Mapping Arrays (LMAs)
  - Improves warnings, situational awareness and lightning safety (Bridenstine et al. 2005; Goodman et al. 2005; Nadler et al. 2009)
- How does total lightning help with lightning safety?
  - More than a point source—Provides spatial extent as flashes can extend many tens of kilometers
  - Intra-cloud flashes make up ~90% of all flashes on average—Gives more observations to know when storms are electrically active
  - Intra-cloud flashes typically precede the first cloud-to-ground strike
    - 5-10 min lead time for majority of storms
  - Operational examples given to right

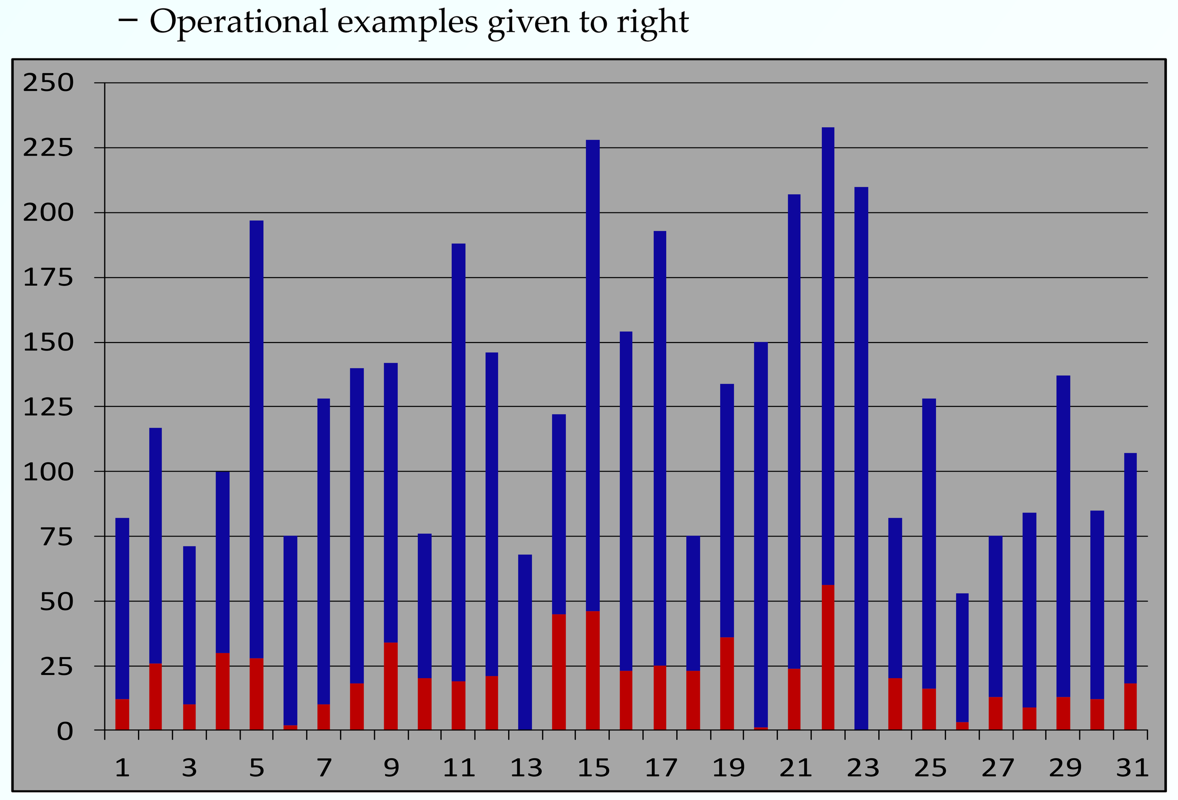

Figure 2 *— A comparison of cloud-to-ground strikes (red) versus intra-cloud flashes (blue) for 31 thunderstorms observed in Central Florida. Note the differences in magnitude.*

OPERATIONAL EXAMPLES

First Cloud-to-Ground Strike Lead time with an Airport Weather Warning—WFO Huntsville, AL (Figures 3-6)

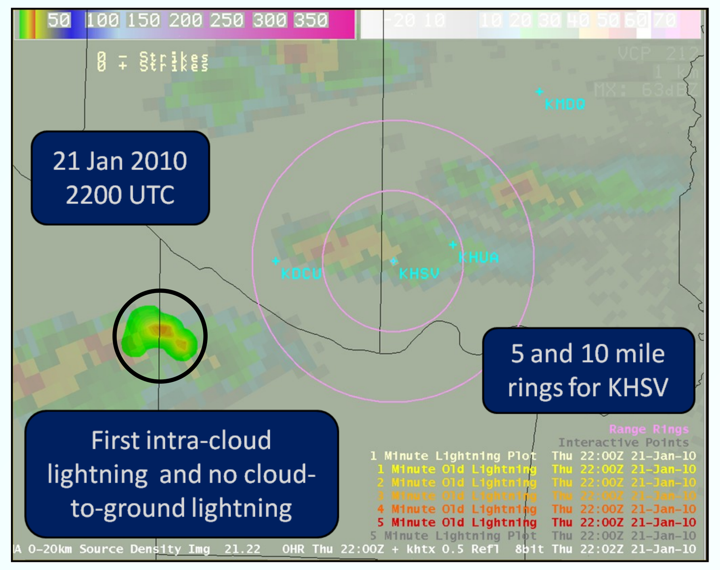

Figure 3 *— Radar reflectivity (background) and LMA total lightning observations (circled-foreground depicting a storm approaching the Huntsville, AL airport. No observed cloud-to-ground lightning strikes.*

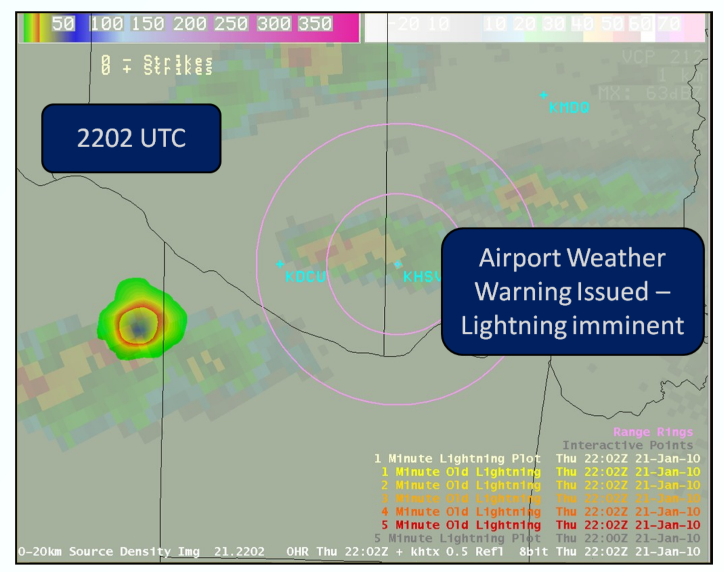

Figure 4 *— Same as Figure 3, but now at 2202 UTC. Total lightning activity has increased and no cloud-to-ground observations. The forecast office issues an Airport Weather Warning to alert airport of imminent threat of lightning.*

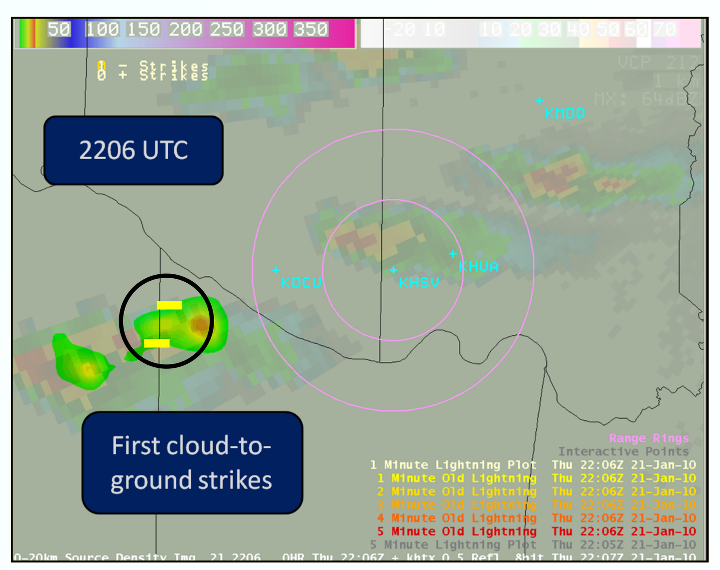

Figure 5 *— Same as Figure 3, but at 2206 UTC. First cloud-to-ground strikes observed at 2205. Total lightning provided 5 minute lead time on first cloud-to-ground strike.*

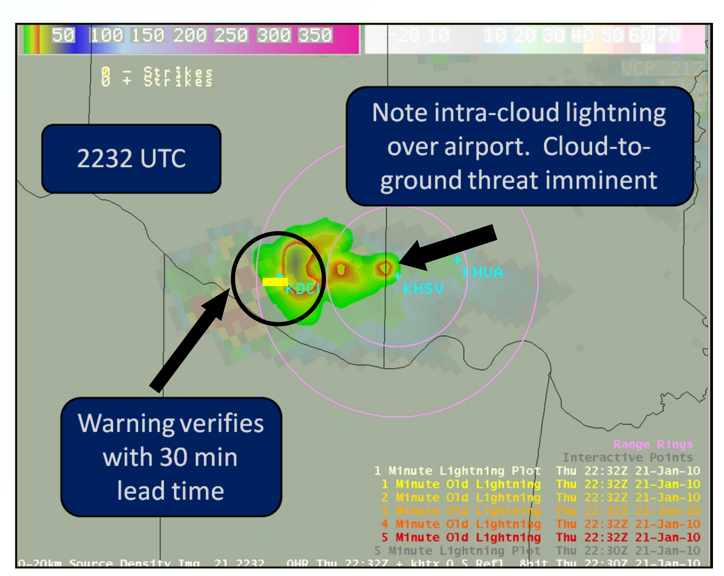

Figure 6 *— Same as Figure 3, but now 2232 UTC. First cloud-to-ground strike observed within 10 miles of airport. Total lightning provided 30 minute lead time on the warning and 5 minutes more than cloud-to-ground observations alone.*

Can assist with Terminal Aerodrome Forecasts (TAFs) and other special events

Flash Extent Awareness—WFO Melbourne, FL

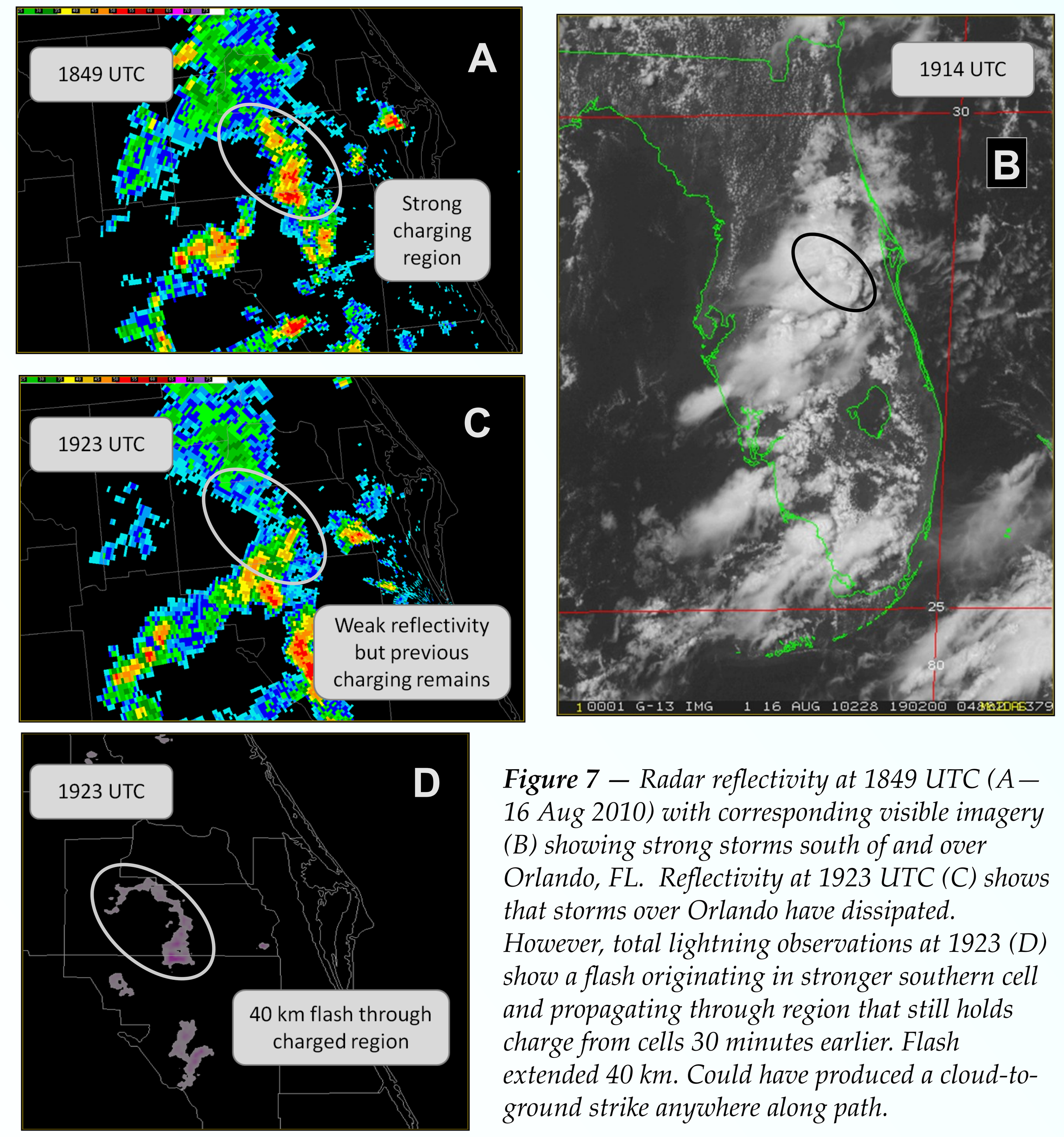

Figure 7 *— Radar reflectivity at 1849 UTC (A—16 Aug 2010) with corresponding visible imagery (B) showing strong storms south of and over Orlando, FL. Reflectivity at 1923 UTC (C) shows that storms over Orlando have dissipated. However, total lightning observations at 1923 (D) show a flash originating in stronger southern cell and propagating through region that still holds charge from cells 30 minutes earlier. Flash extended 40 km. Could have produced a cloud-to-ground strike anywhere along path.*

More Than Point Data (Spatial Extent)

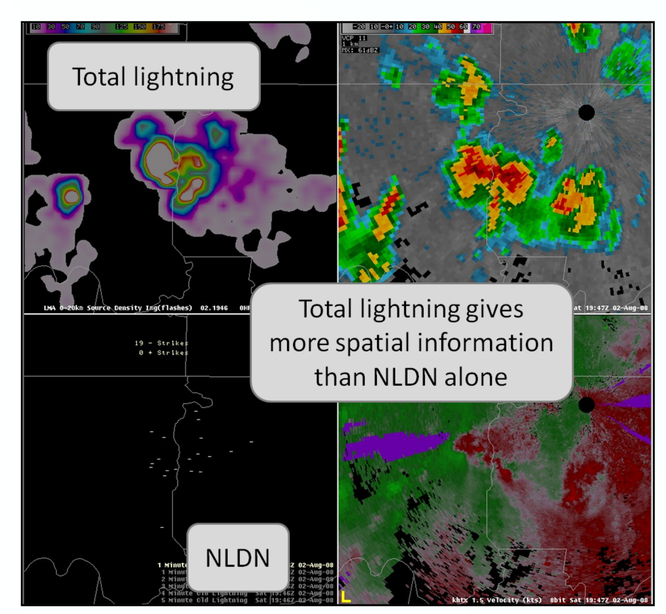

Figure 8 *— Total lightning (upper left), cloud-to-ground strikes (lower left), radar reflectivity (upper right), and radar velocity (lower right). Example showing how total lightning provides more spatial data than cloud-to-ground data alone. Indicates that all storms are highly active and that threat of lightning not confined to high reflectivity locations.*

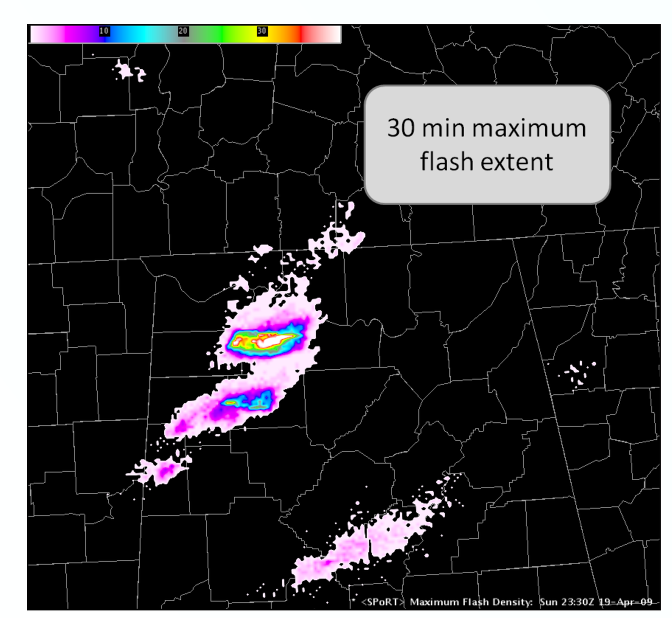

Figure 9 *— Maximum flash density product developed by SPoRT shown in AWIPS II. Displays spatial extent of all flashes for past 30 minutes. Provides visual of where lightning threat is most likely and supports public awareness of how far lightning can reach.*

THE FUTURE GOES-R ERA

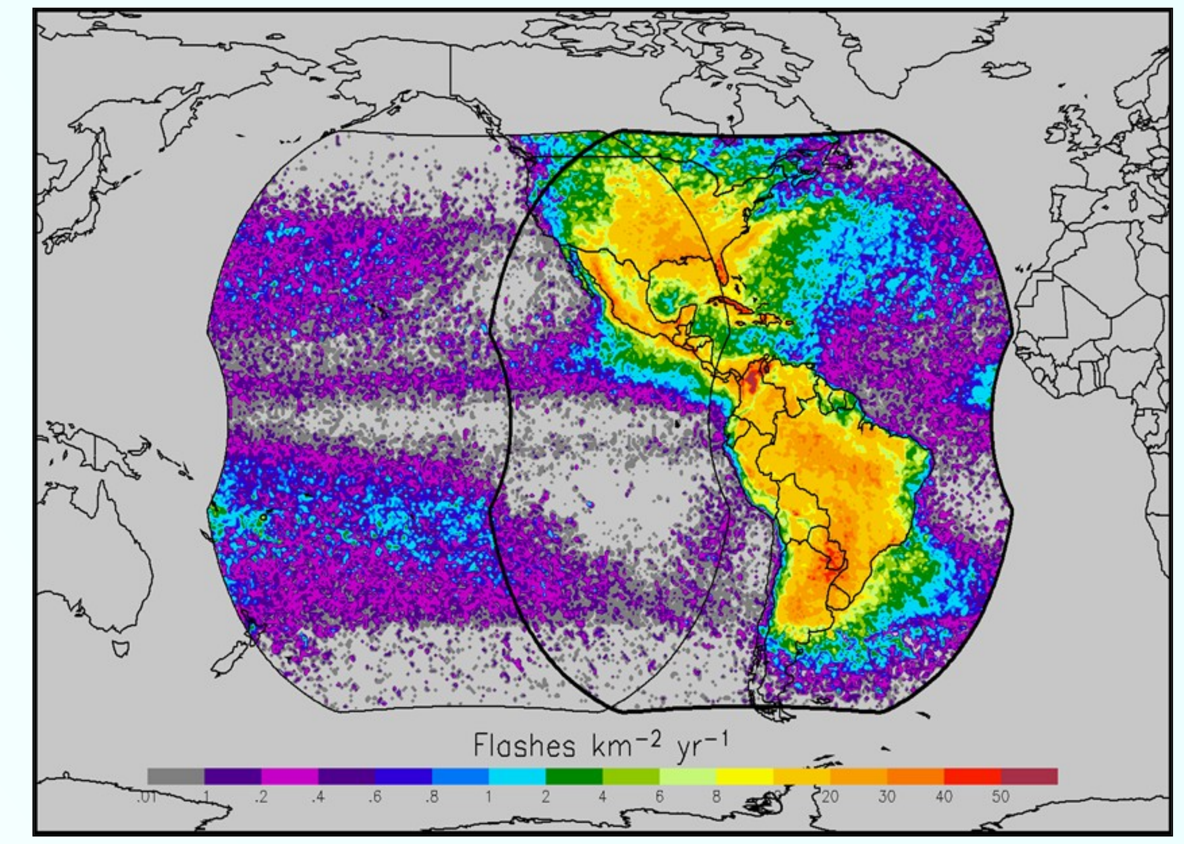

Figure 10 *— A lightning density map derived from 1995-2005 OTD and LIS data shows the GOES-East and West fields of view of the Geostationary Lightning Mapper (GLM).*

- **GOES-R** will greatly expand utility of total lightning data
  - Ground-based networks very short-ranged
  - Geostationary Lightning Mapper (GLM) will provide hemispheric coverage (Figure 10) at a lower resolution for day and night
  - SPoRT participating in GOES-R Proving Ground to prepare end users for the GLM
  - Initial work shows GLM will help with lightning safety (Figure 11) just like current ground-based networks

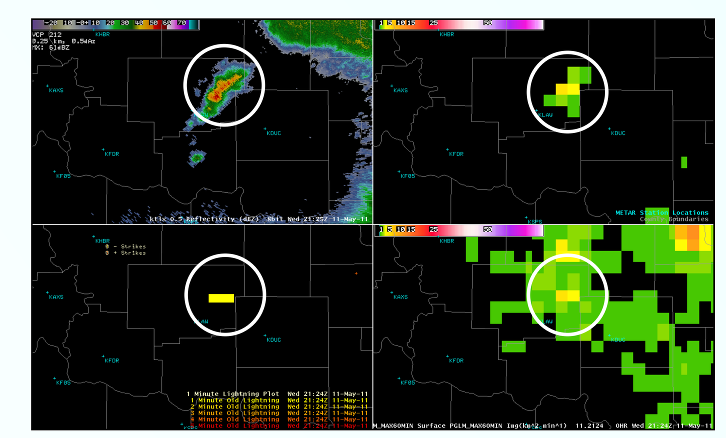

Figure 11 *— SPoRT pseudo GLM example from 2011 Spring Program where total lightning preceded first cloud-to-ground strike by 29 minutes. Image shows radar reflectivity (upper left), cloud-to-ground strikes (lower left), pseudo GLM (upper right), and maximum pseudo GLM (lower right).*

Summary

- Presentation focused on operational aspects of lightning safety with total lightning
  - Provides more than point source observations and observes all lightning and not just small cloud-to-ground percentage
  - Provides lead time for most first cloud-to-ground strikes
  - Visual educational tool demonstrating lightning flash extent
  - Products, like max density, can show where threat of continued lightning exists
  - GOES-R GLM will provide massive area of coverage to support all manner of enhanced lightning activities
  - References in corresponding extended abstract

National Weather Service Lightning Safety
www.lightningsafety.noaa.gov
"When thunder roars, go indoors!"

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