Satellite Proving Ground for the GOES-R Geostationary Lightning Mapper (GLM)

Steven J. Goodman & James Gurka, NOAA/NESDIS/ORA, Camp Springs, MD; and E. C. Bruning, J., R. Blakeslee, Robert Rabin, NOAA/NSSL, and D. Buechler

The key mission of the Satellite Proving Ground is to demonstrate new satellite observing data, products and capabilities in the operational environment to be ready on Day 1 to use the GOES-R suite of measurements. Algorithms, tools, and techniques must be tested, validated, and assessed by end users for their utility before they are finalized and incorporated into forecast operations. The GOES-R Proving Ground for the Geostationary Lightning Mapper (GLM) focuses on evaluating how the infusion of the new technology, algorithms, decision aids, or tailored products integrate with other available tools (weather radar and ground strike networks; nowcasting systems, mesoscale analysis, and numerical weather prediction models) in the hands of the forecaster responsible for issuing forecasts and warning products. Additionally, the testing concept fosters operation and development staff interactions which will improve training materials and support documentation development. Real-time proxy total lightning data from regional VHF lightning mapping arrays (LMA) in Northern Alabama, Central Oklahoma, Cape Canaveral Florida, and the Washington, DC Greater Metropolitan Area are the cornerstone for the GLM Proving Ground. The proxy data will simulate the 8 km Event, Group and Flash data that will be generated by GLM. Tailored products such as total flash density at 1-2 minute intervals will be provided for display in AWIPS-2 to select NWS forecast offices and national centers such as the Storm Prediction Center. Additional temporal / spatial combinations are being investigated in coordination with operational needs and case-study proxy data and prototype visualizations may also be generated from the NASA heritage Lightning Imaging Sensor and Optical Transient Detector data. End users will provide feedback on the utility of products in their operational environment, identify use cases and spatial/temporal scales of interest, and provide feedback to the developers for adjusted or new products.

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Steven Goodman
James Gurka
NOAA/ NESDIS

Eric Bruning
CICS/University of Maryland

Richard Blakeslee
NASA/MSFC

Robert Rabin
NOAA/NSSL

Dennis Buechler
SPoRT/University of Alabama in Huntsville

AMS Annual Meeting, Jan. 13, 2009
Phoenix, AZ

Proving Ground Mission Statement

The GOES-R Proving Ground engages NWS in pre-operational demonstrations of selected capabilities of next generation GOES

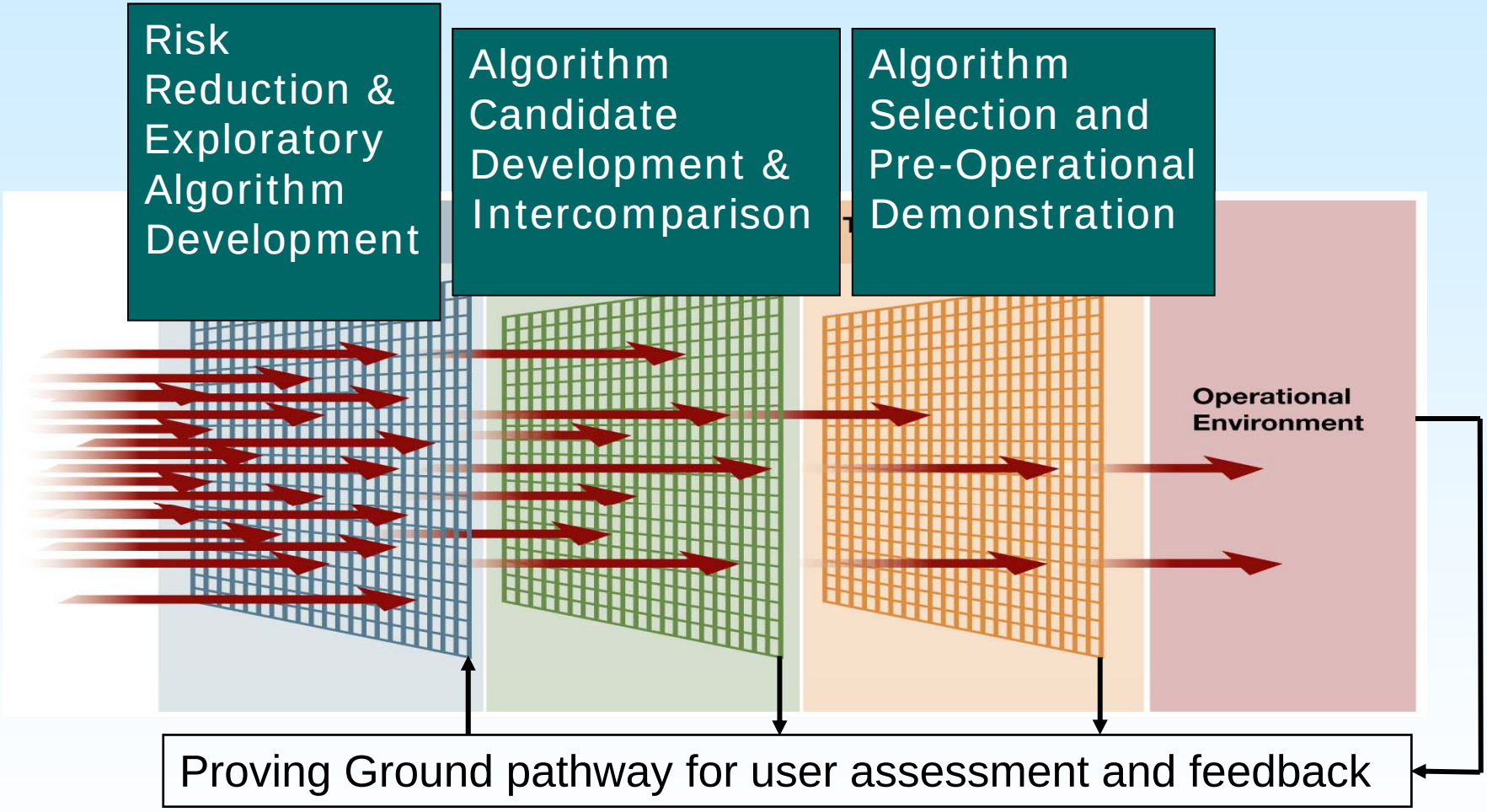
- Proving Ground objective is to bridge the gap between research and operations by:
  - » Utilizing current systems (satellite, terrestrial, or model/synthetic) to emulate future GOES-R capabilities
  - » Infusing GOES-R products and techniques into NWS operations with emphasis on AWIPS and transitioning to AWIPS-II.
  - » Engaging in a dialogue to provide feedback to developers from users
- The Proving Ground accomplishes its mission through:
  - » Sustained interaction between developers and end users for training, product evaluation, and solicitation of user feedback.
  - » Close coordination with GOES-R Algorithm Working Group (AWG) and Risk Reduction programs as sources of demonstration products, promoting a smooth transition to operations

Intended outcomes are Day-1 readiness and maximum utilization for both developers and users of GOES-R products, and an effective transition to operations.

Key Components of Proving Ground

- Ability to fully test individual components
- Ability to fully test integrated components
- Testing which simulates routine low-end events
- Testing which simulates high-end non-routine events
- Testing using archived events and simulation
- Testing using live events
- Test team independence
- Test team membership made up of test experts, trainers, and operational users
- Ability to make recommendations to the decision maker based on impacts noted in test findings

GOES-R Proving Ground in the Transition from Research to Operations Framework



As new ideas and algorithms are developed, validation, testing, and pre-operational assessments winnow the mature candidate list to the most promising algorithms that will be transitioned into operations.

GOES-R Product List (Total: 68)
Product Set Number: 1-4

Set 1/2 - September 2010 Set 3/4 - September 2011

1 Aerosol Detection (including Smoke & Dust)
3 Aerosol Particle Size
1 Suspended Matter / Optical Depth
2 Volcanic Ash: Detection and Height
4 Aircraft Icing Threat
3 Cloud Imagery: Coastal
1 Cloud & Moisture Imagery (KPPs)
3 Cloud Layers / Heights & Thickness
3 Cloud Ice Water Path
3 Cloud Liquid Water
1 Cloud Optical Depth
1 Cloud Particle Size Distribution
1 Cloud Top Phase
1 Cloud Top Height
1 Cloud Top Pressure
1 Cloud Top Temperature
3 Cloud Type
3 Convective Initiation
4 Enhanced "V" / Overshooting Top Detection
2 Hurricane Intensity
3 Low Cloud & Fog
2 Lightning Detection- events, groups, flashes
3 Turbulence
4 Visibility

2 Geomagnetic Field
4 Probability of Rainfall
4 Rainfall Potential
2 Rainfall Rate / QPE
1 Legacy Vertical Moisture Profile
1 Legacy Vertical Temperature Profile
2 Derived Stability Indices (5)
1 Total Precipitable Water
3 Total Water Content
1 Clear Sky Masks
1 Radiances
3 Absorbed Shortwave Radiation: Surface
3 Downward Longwave Radiation: Surface
2 Downward Solar Insolation: Surface
2 Reflected Solar Insolation: TOA
3 Upward Longwave Radiation: Surface
3 Upward Longwave Radiation: TOA
3 Ozone Total
3 SO_2 Detection
2 Derived Motion Winds
2 Fire / Hot Spot Characterization
4 Flood / Standing Water
2 Land Surface (Skin) Temperature

3 Surface Albedo
3 Surface Emissivity
4 Vegetation Fraction: Green
4 Vegetation Index
4 Currents
4 Currents: Offshore
4 Sea & Lake Ice: Age
4 Sea & Lake Ice: Concentration
4 Sea & Lake Ice: Extent
4 Sea & Lake Ice: Motion
4 Ice Cover / Landlocked: Hemispheric
2 Snow Cover
4 Snow Depth (Over Plains)
2 Sea Surface Temps
2 Energetic Heavy Ions
2 Mag Electrons & Protons: Low Energy
2 Mag Electrons & Protons:Med & High Energy
2 Solar & Galactic Protons
2 Solar Flux: EUV
2 Solar Flux: X-Ray
2 Solar Imagery: X-Ray

ABI – Advanced Baseline Imager

Continuity of GOES Legacy Sounder Products from ABI

SEISS – Space Env. In-Situ Suite

EXIS – EUV and X-Ray Irradiance Sensors

GLM – Geostationary Lightning Mapper

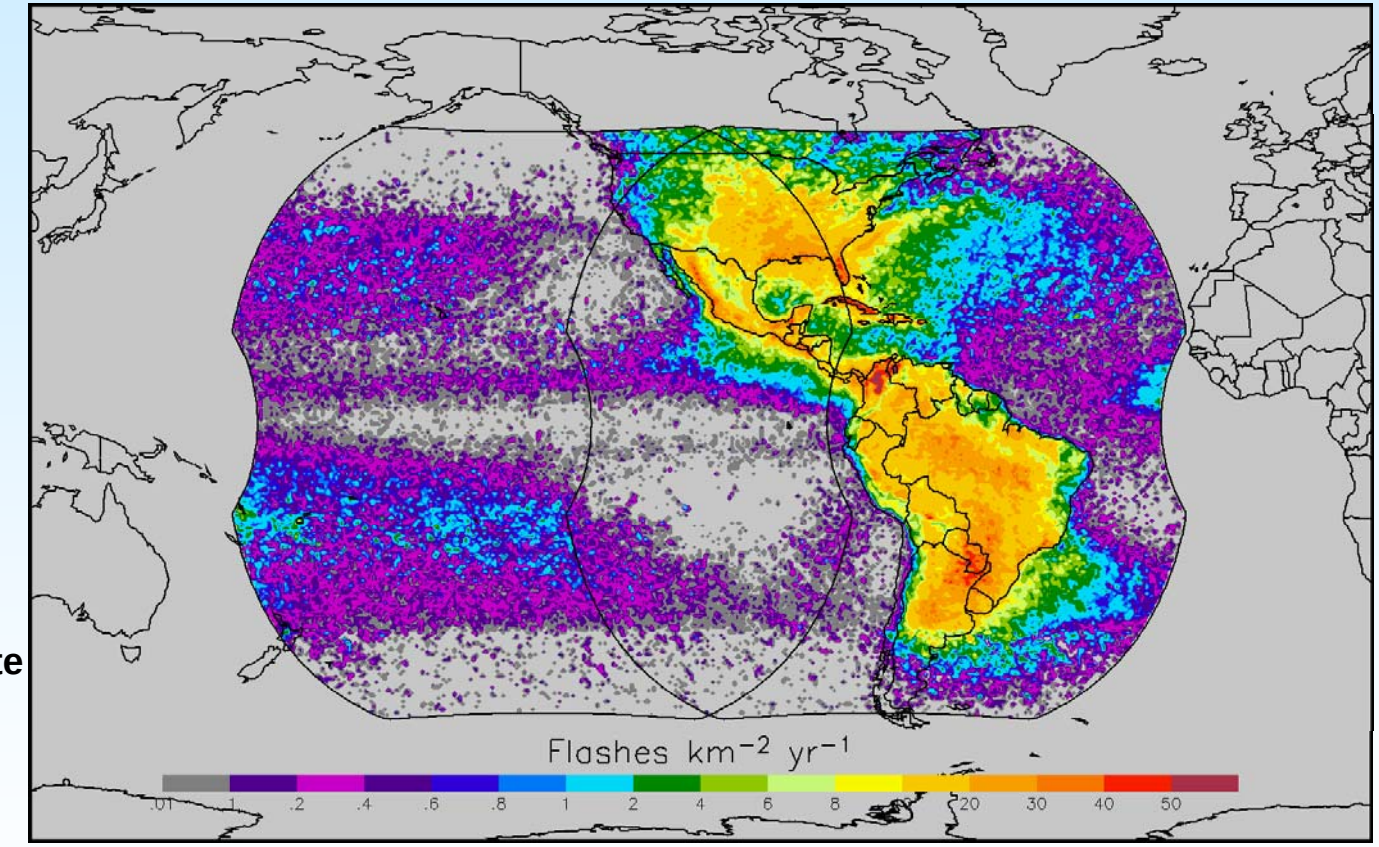
Magnetometer

SUVI – Solar extreme UltraViolet Imager

GOES-R+S Combined FOV

GLM Characteristics

- **Staring CCD imager (1372x1300 pixels)**
- **Near uniform spatial resolution**
  - **8 km nadir**
  - **12 km edge fov**
- **Single band 777.4 nm**
- **Simple commanding**
- **Adaptive thresholding**
- **2 ms frame rate**
- **5 Mbps downlink data rate**
- **15 sec product latency**



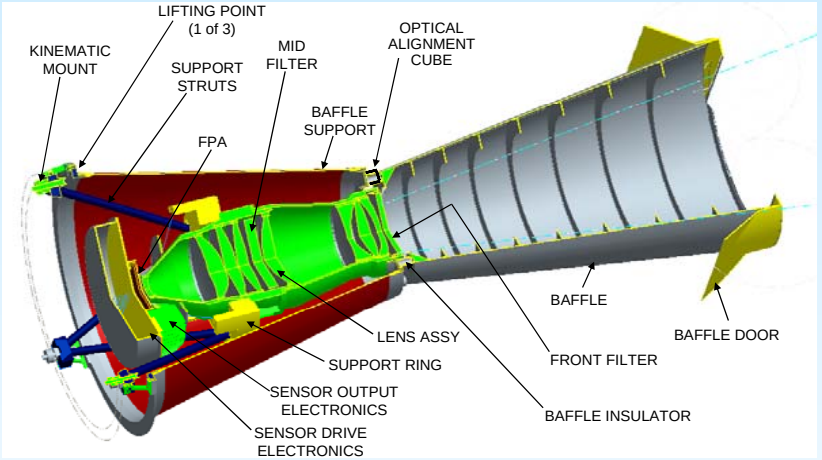
LIS/OTD Combined Lightning 1997-2005

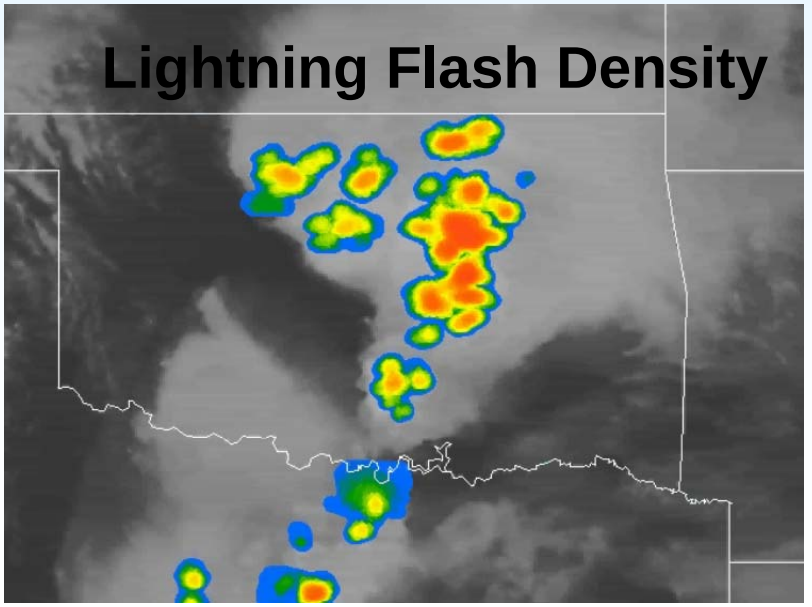
GOES-R GLM Mission Objectives

Provide continuous **Full-Disk** lightning measurements	Provide longer warning lead times of tornadic activity			Accumulate decadal lightning data
	False Alarm Probability <5%	Detection Probability >70%	Track lightning flash to storm cell; Calculate optical center over time	

Candidate Algorithms

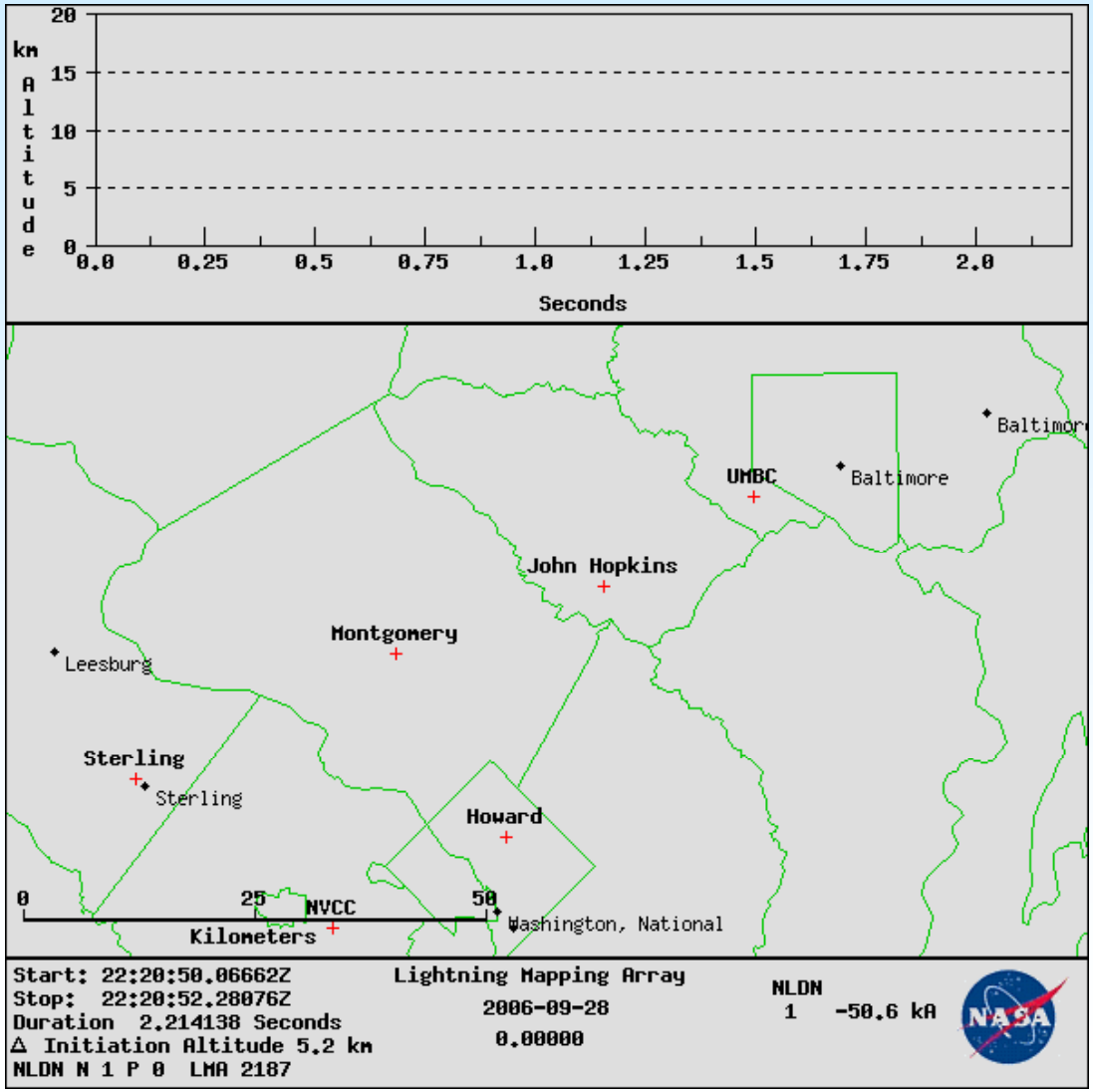
- **Clustering Algorithm**
  - » Description: takes lightning events at the pixel level (8 km at nadir)
    - – Creates groups and flashes (15 sec latency)
    - – TRMM LIS and OTD heritage
- **Cell Tracking Algorithm**
  - » Implementation in AWIPS 2
- **Flash Trending "Jump" Algorithm**
  - » Description: trends flash rates with time for individual storms
- **Other Uses of GLM**
  - » **Hydrology**-Precipitation, Flash Flood
  - » **Air Quality**-NOx/Ozone, Forest Fires
  - » **Clouds**-Cloud Type/TRW, Severe Storm, Hurricane Intensification
  - » **Aviation**-Turbulence, Convective Initiation, Volcanoes





DCLMA Area Lightning Discharge Animation

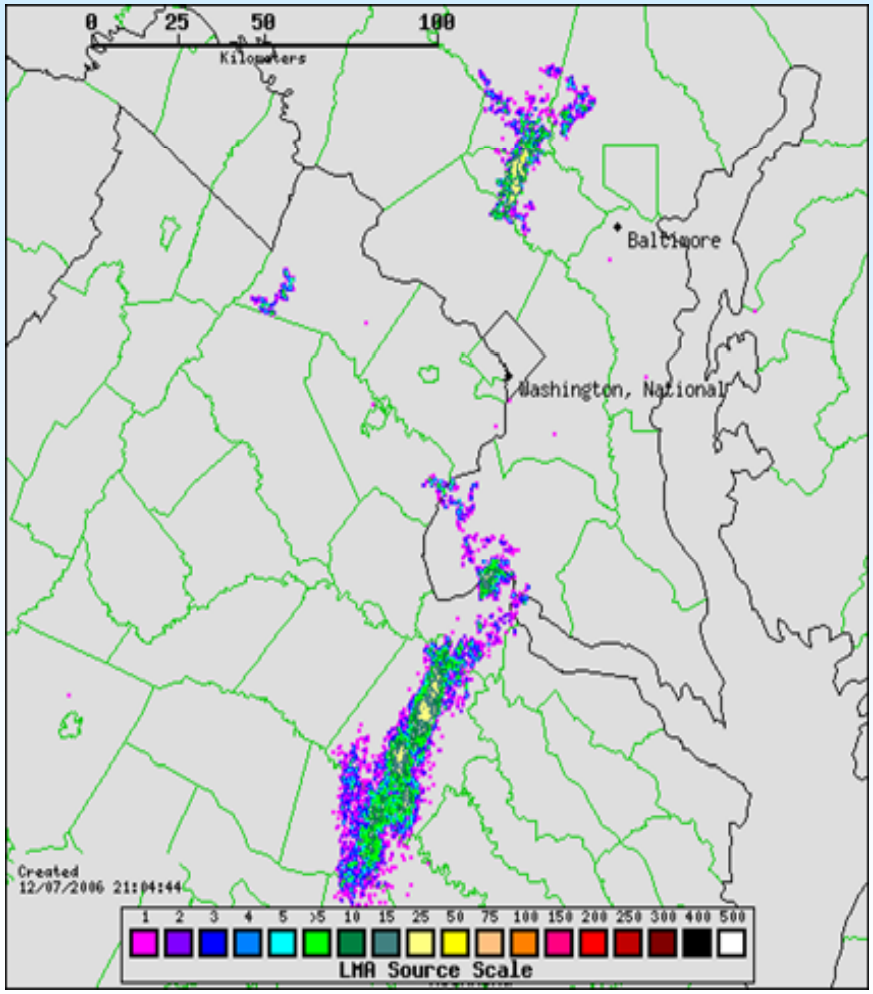
- 2.2 sec hybrid flash
- 50 km horiz extent
- Initiation at 5.2 km
- VHF Sources 2187
- CG strike at 2 s



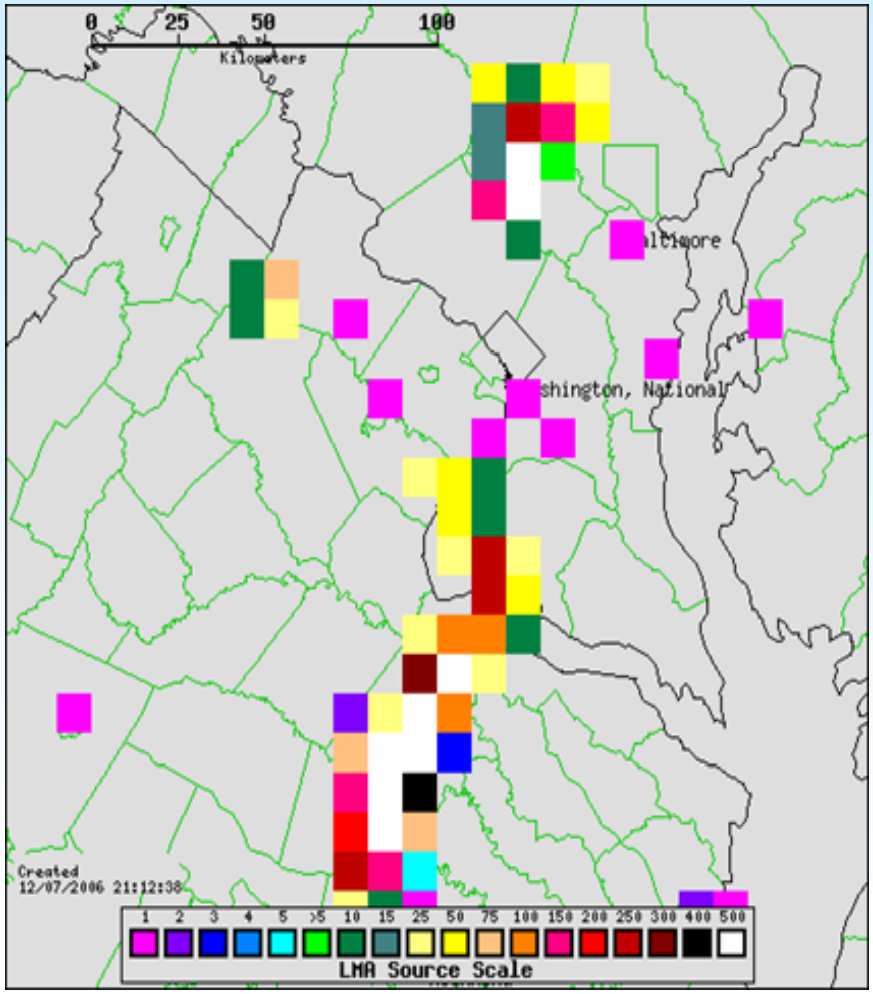
Animated gif

DC Regional Storms November 16, 2006

Resampled 5-min source density at 1 km and 10 km

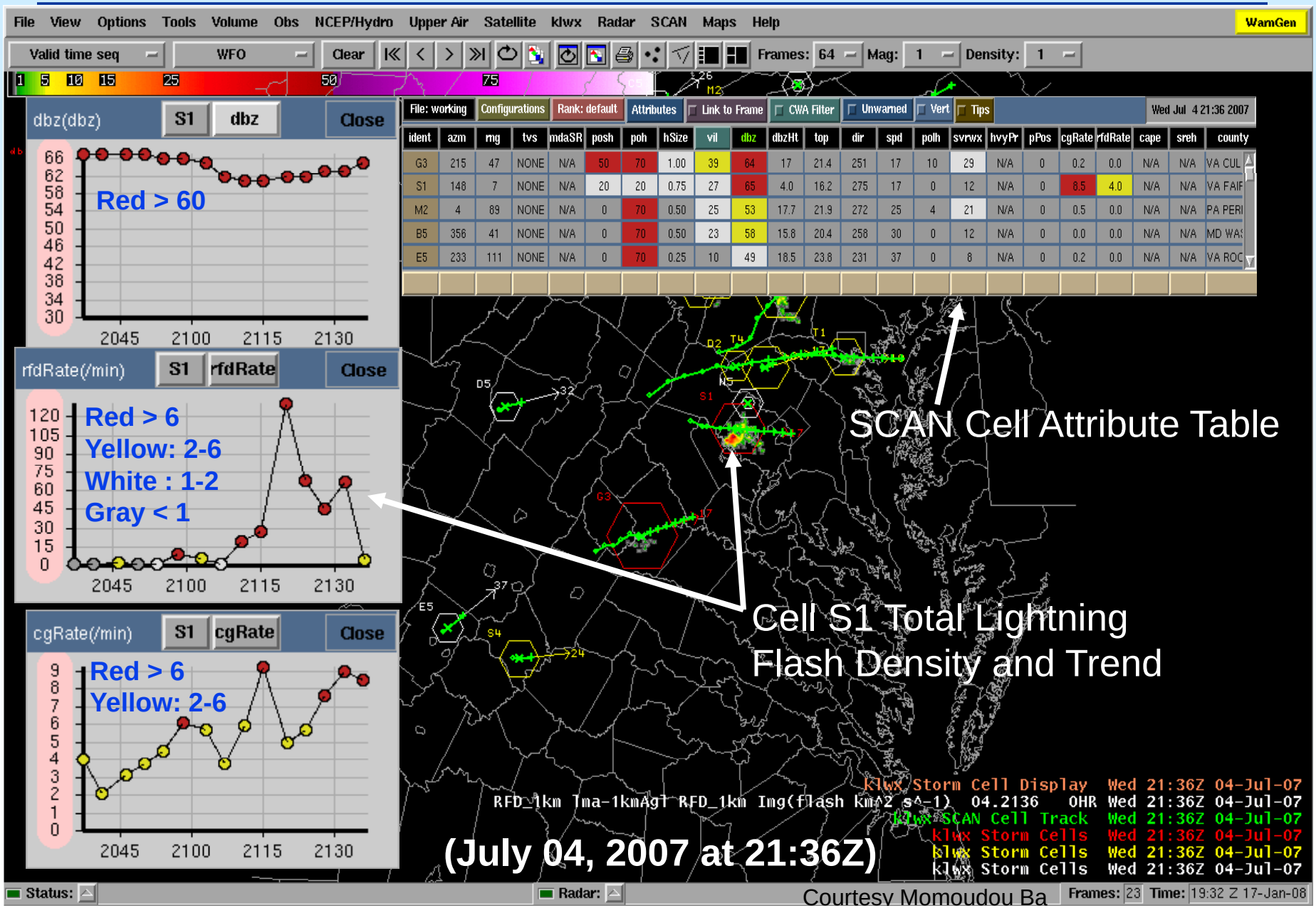


LMA 1 km resolution

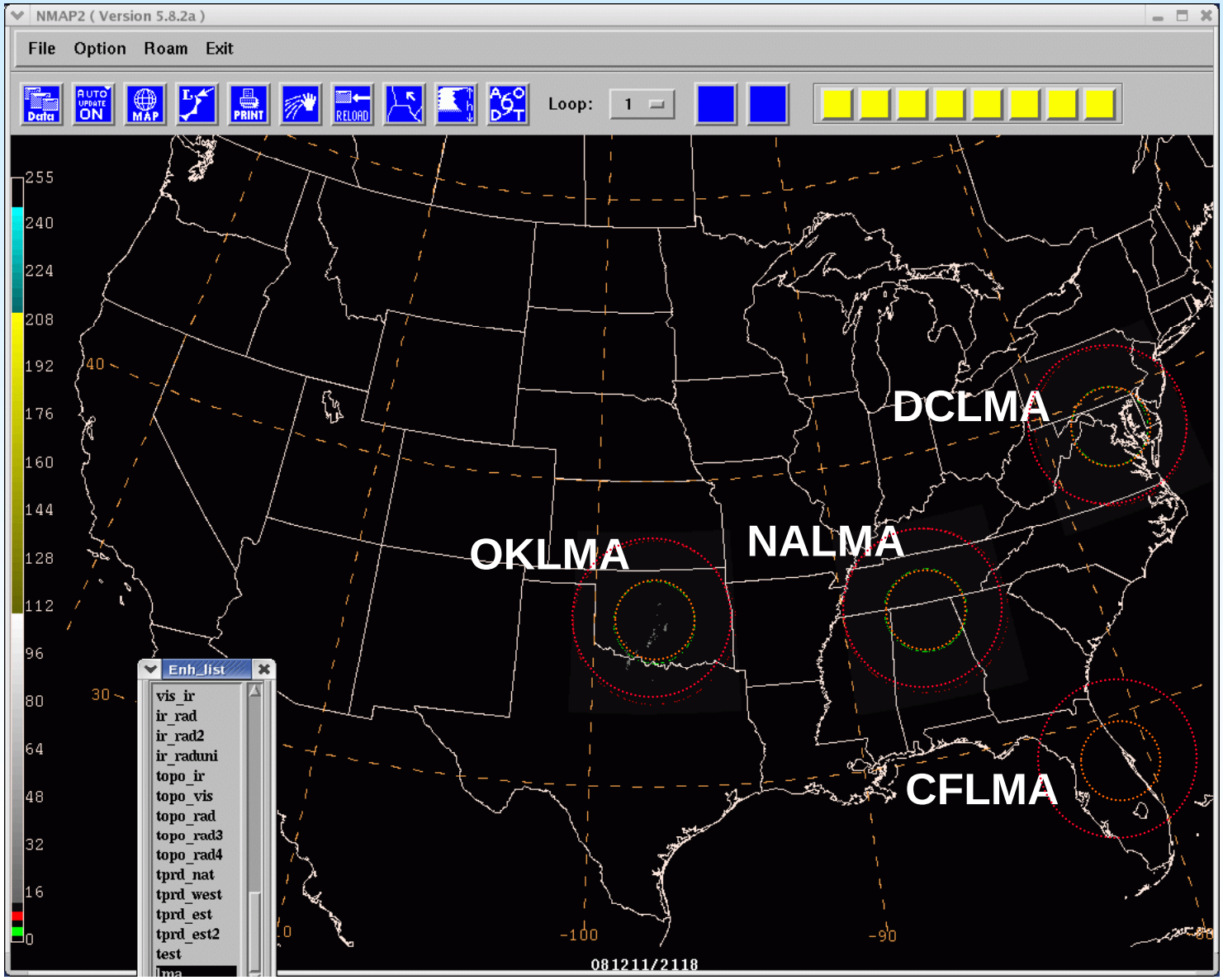


LMA 10 km resolution

Lightning Jump Algorithm:
Experimental Trending Implementation in AWIPS/SCAN



GLM Testbed LMA Proxy Data at NCEP/SPC



Progress and Status of Proving Ground

- Kickoff Meeting held May 15-16, 2008 in Boulder
  - Over 30 participants from GPO, AWG, CIMSS, CIRA, NWS HQ, FSL, OSD, OSDPD, SPoRT, and STAR
  - Key messages: there will not be stovepipe Proving Grounds for CIMSS, CIRA or SPoRT…rather an integrated Proving Ground structure
  - User readiness risk reduction- satellite product ingest, utilization, assessment integrated into the AWIPS 2 development environment
  - Web site for Proving Ground up and running (cimss.ssec.wisc.edu/goes_r/proving-ground.html)
- Organization telecon held June 16, Monthly telecons on-going
  - Key message…for every product, tool or technique developed there must be a clear path to operational implementation
  - NWS HQ and field fully engaged in plans and implementation- briefing to OST and OCWWS Directors January 8
  - Satellite "Champion" located at OU/CIMMS to support NWS user readiness interviews in January, 2009 (GOES-R funded)
  - Candidate products identified for 2009 Hazardous Weather Testbed Spring Experiment forecast and warning assessment at SPC and OUN
  - DCLMA network to be expanded with two more sites resulting in improved network topology geometry
  - Executive Board and Advisory Team membership established, proposals under review