Post Launch Calibration and Testing of The Geostationary Lightning Mapper on GOES-R Satellite

Dr. Marc Rafal | Ms. Ruth Cholvibul | Mr. Jared Clarke

Mission Overview

The GOES system is the United States operational geosynchronous meteorological constellation. GOES provides continuous, real-time monitoring of Western hemisphere weather.

GLM Instrument Objectives

- Provide continuous full disk lightning measurements for storm warning and nowcasting.
- Provide longer (advance) warnings of tornado activity.
- Accumulate a long-term database to track decadal changes in lightning activity.

Theory of Operation

<table>
<thead>
<tr>
<th>Phenomenon</th>
<th>Instrument</th>
<th>Ground Processing</th>
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</thead>
<tbody>
<tr>
<td>O* optical transients</td>
<td>Narrow band near IR</td>
<td>False event filtering</td>
</tr>
<tr>
<td>2 ms event duration</td>
<td>503 Hz Frame Rate</td>
<td>Correlate in space / time</td>
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<tr>
<td>500+ events / second</td>
<td>Background subtraction</td>
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Post Launch GPA Tuning

- Image Navigation & Registration
  - Coarse / Dynamic alignment characterization
  - Coastline identification and tracking for dynamic navigation

- Second Level Threshold
  - Software defined threshold for known "hot" pixels in ground processing

- Contrast Leakage
  - Mechanical jitter-induced false lightning events on high-contrast boundaries (bright clouds)

- Radiation Filter
  - Phenomenological filter removes "streaks" of radiation induced events

- Solar Glint Filter
  - Removes false events from specular reflection

- Coherence Filter
  - Identifies real lightning events based on close space / time correlation to other events

- Persistency parameter (time)
- Adjacency threshold (pixel distance)
- Clustering Product
- Collects events into Groups and Flashes

Ground Test

Static Response
- Integrating sphere
- Measured for each CCD sub-array
- Measure background tracking
- Measure static response in high-albedos environment

Transient Response
- Integrating sphere with triggered LED pulse
- Pixel-by-pixel response
- Simulates lightning in the presence of high background

Electronics Noise
- Shot noise
- ICCD Analog / Digital Converter (14-bit Noise)
- RTEP pre-processing event threshold over weighted average background

Post Launch Hardware Tests

- Real Time Event Processor (RTEP) onboard event threshold setting
  - Optimize Threshold to Noise (TNR) ratio [counts]
  - Stray light / gain characterization
  - Instrument throughput
  - Saturation headroom by season (detected total radiance = event + background)

- Navigation alignment characterization with ground control beacons
  - Tuned lasers targeted at the instrument aperture
  - Monument Peak, CA
  - NASA GSFC Greenbelt, MD

Analysis Objectives

- Set thresholds for each RTEP
- Validate camera timing parameters
- Verify / validate optical throughput and sensitivity
- Science validation of Clustering Product based on correlation from other sources
  - Lightning UHF signature detecting ground-based networks
  - Lightning Imaging Sensor aboard International Space Station
- Weather forecasters, using lightning rate data, more accurately predict severe storm escalation, Air Traffic Control and public alerts

Further Reading