Lightning Imaging Sensor (LIS) Science Data Validation Plan

Summary Charts

LIS Science Team
Lightning Imaging Sensor (LIS)

Mission: Tropical Rainfall Measuring Mission (TRMM)

Measurement: Lightning

Features: Detect Lightning Day / Night

- Storm Scale Resolution (~ 5 km @ nadir)
- High Detection Efficiency (~ 90%)
- Low False Alarm Rate (< 10%)
- Time Resolution 2 ms

Lightning Intensity
Background Image / Intensity
LIS Science Objectives

• Acquire and investigate the distribution and variability of total lightning
• Advance understanding of underlying and interrelated processes, e.g.,
  Precipitation and storm processes
  Release and transport of latent heat
  Atmospheric chemistry (e.g., NO$_X$)
  Ionospheric and magnetospheric physics
  Global electric circuit
LIS Measurement Heritage

*Optical Transient Detector (OTD)*

- LIS engineering prototype
- Launched April 1995 (2 year mission)
- Important LIS Science
- Serving as testbed for LIS Validation
  - Development / testing of Ground Truth Analysis System (GTAS)
  - Testing / refinement of the LIS data processing
LIS Validation Strategy

- Laboratory calibration
- Ground truth observations
- Intensive field experiments
- Aircraft studies (e.g., ER-2 underflights)
- Numerical models and simulations
- Statistical and objective analyses
LIS Validation Process

Ground Truth Observations

Field Experiments

Aircraft Studies

Models and Simulations

Laboratory Calibration

Validation Data

Ground Truth Analysis System (GTAS)

Product Generation System (PGS)

Processing & Analysis

Verify
- performance
- algorithms
- products

Determine
- accuracy
- resolution
- variability

Provide
- quality assessment

Improve
- performance
- algorithms
- products

Science Community

Science
Algorithm Validation Process

Algorithm Testing (SCF)

Lab Calibration

On-Orbit Performance Evaluation

Cal/Val Test Code Version

Test LIS Data Products

Ground Truth Data

Data Output Satisfactory ?

Yes

No

LIS Raw Data

Rebuild Test LIS HDF Code

Test HDF

No

Yes

Data Output Correct ?

Code Test Version

Update LIS HDF Code

On-Line Version

Rebuild Test LIS HDF Code

On-Line Processing

Code Testing (SCF)
LIS Validation Categories

• Sensor Performance Parameters
  Lightning Detection Efficiency (LDE)
  False Alarm Rate (FAR)
  Geo-location accuracy
  Timing accuracy
  Event intensity
  Background intensity

• Data Processing Algorithms / Products

• Scientific Retrieval Algorithms / Products
Conditions that may affect Parameter Values

- Sensor detection threshold settings
- Background intensity
- Observation time (e.g., time of day, time of year)
- Storm characteristics (e.g., continental vs. maritime, large vs. small, developing vs. decaying, high flash rate vs. low flash rate, etc.)
- Geographical location
- Analysis software employed
LIS HDF Data Structure

trmm.lis.ver.yyy.ddd.orbit

Metadata

Area Statistics

Flash Statistics

Group Statistics

Event Statistics

area

Flash

Group

Event

Flash Density Statistics

2.5° x 2.5° grid

500 x 500 km grid

Browse Area

Vector Statistics

Image Attributes

Background Image

Orbit Attributes

Threshold Values

Event Rate Sets

Summary Data

Flash Rate Data

Ephemeris Data

Index (indirect) Link

Tag/Reference Pair Link

Vgroup

Vsets

SDS

see ATBD for details
Ground Truth Observations

**Lightning Data**

- Ground-based lightning observations at the TRMM ground truth sites
- Regional lightning networks (e.g., NLDN)
- Time of Arrival (TOA) and sferics networks
- Satellites (e.g., OTD, FORTE, OLS, ALEXIS)
- Interferometers (e.g., SAFIR, NM Tech)
- Airborne (e.g., ER-2) and ground based optical and electrical observations
Ground Truth Observations

**Ancillary Data**

- Radar data and products (e.g., TRMM validation sites, WSR-88D sites, WSI composites)
- Rain gauge data (e.g., TRMM validation sites)
- Satellite data and products (e.g., VIS, IR, microwave imagery, precipitation products, etc.)
- Ancillary observations obtained during intensive ground truth field experiments (including ground-based, aircraft, satellite observations)
- Collaborative observations, e.g., MSX (chemistry), GRO/Batse (gamma rays from Earth)
# LIS Calibration and Validation

Data Sets Being Archived

<table>
<thead>
<tr>
<th>Product</th>
<th>Source</th>
<th>Ingest Period</th>
<th>Recurring Annual Vol</th>
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<tr>
<td>OTD Raw</td>
<td>OSC</td>
<td>Daily</td>
<td>63.0 GB</td>
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<td>OTD Lightning</td>
<td>LIS Science Team</td>
<td>Daily</td>
<td>42.0 GB</td>
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<tr>
<td>NLDN Lightning</td>
<td>GAI</td>
<td>15 minutes</td>
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<td>LIS Ground Truth</td>
<td>LIS Science Team</td>
<td>Monthly</td>
<td>0.4 GB</td>
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<td>US Composite Rainfall</td>
<td>WSI</td>
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<td>US Nexrad site</td>
<td>WSI-NIDS</td>
<td>3 hours/day</td>
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<td>KSC</td>
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<td>SSM/I Tb</td>
<td>MSFC</td>
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**Total** ~305 GB
Field Programs

Pre-Launch

CaPE, Jul-Aug 91, Florida

STORMFEST, Feb-Mar 92, Central U.S.

CAMEX 1, 2, Sep 93, 95, East coast U.S.

TOGA COARE, Jan-Feb 93, Tropical ocean

MCTEX, Nov-Dec 95, Maritime continent, OTD
  ground truth

PEM-Tropics, Aug-Oct 96, NO\textsubscript{x} assoc. with lightning

Post-Launch

EOS and other experiments, TBD (Florida/Texas
  TRMM sites, ER-2 underflights, Kwajalein, Brazil)