Lightning Imaging Sensor (LIS) on the International Space Station (ISS)

Presented by

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ISS Lightning Imaging Sensor (LIS) Overview

Mission

• The LIS instrument used is a space-qualified, flight-spare LIS built for the Tropical Rainfall Measuring Mission (TRMM) and maintained in storage.
• Integrate LIS as hosted payload on DoD Space Test Program STP-H5 mission and launch on SpaceX rocket in November 2016.

Measurement

• NASA, the University of Alabama in Huntsville (UAH) and their partners developed and demonstrated effectiveness and value of space-based lightning observations as a remote sensing tool.
• LIS measures total lightning (amount, rate, radiant energy) during both day and night, with storm scale resolution, millisecond timing, and high, uniform detection efficiency.
  – LIS daytime detection is especially unique and scientifically important (~60% occurs during day).
  – Also LIS globally detects TOTAL (both cloud and ground) lightning with no land-ocean bias.

Need and Benefit

• Lightning is quantitatively coupled to both thunderstorm and related geophysical processes, and therefore provides important science inputs across a wide range of disciplines (e.g., weather, climate, atmospheric chemistry, lightning physics – including TGF investigations).
• The LIS on ISS will extend TRMM time series observations, expand latitudinal coverage, provide real time data to operational users, and enable cross-sensor calibration.
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LIS on ISS builds on a solid foundation of 20 years on-orbit observations of OTD and TRMM LIS.
Core Science Applications from Lightning

Why Lightning Matters

**Weather:** Total lightning is strongly coupled in a quantitative way to thunderstorm processes and responds to updraft velocity and cloud particles (concentration, phase, type, and flux).

- LIS acts like a radar in space: it reveals the heart of the cloud.
- Lightning can improve convective precipitation estimates.
- Lightning is strongly coupled to severe weather hazards (winds, floods, tornadoes, hail, wild fires) and can improve forecast models.

**Climate:** Lightning is an excellent variable for climate monitoring because it is sensitive to small changes in temperature and atmospheric forcing. ISS LIS will:

- Extend 17 year time series of TRMM LIS, expand to higher latitudes.
- Monitor the occurrence and changes in extreme storms.
- Provide much desired cross-sensor calibrations between platforms.

**Chemistry:** ISS LIS will help improve estimates of lightning produced NO$_x$ for climate and air quality studies.

- Lightning NO$_x$ also impacts ozone, an important green house gas.
- Climate most sensitive to ozone in upper troposphere, exactly where lightning is the most important source of NO$_x$.

**Other:** Complementary ISS LIS observations will help unravel the mechanisms leading to terrestrial gamma-ray flashes (TGFs) and Transient Luminous Events (TLEs).
Global Coverage of LIS on ISS

- Global Coverage of LIS/ISS (between red dashed lines) = 81% 98%
- Global Coverage of LIS/TRMM (data shown above) = 62% 90%
- Expanded Areal Coverage gains important mid-latitude storms, CONUS, and Middle and Southern Europe
LIS Integration as Hosted Payload on STP-H5

- LIS is one of thirteen instruments on the STP-H5 payload manifest.
- LIS will be installed on ISS in an Earth viewing (nadir) position.
- Payload built on special structure to allow robotic installation on ISS.
LIS Launch, Installation and Operation on ISS

• Shipped to NASA Kennedy Space Center in November 2015 and placed in storage after test.
• Launch to ISS on a Space X rocket with Dragon cargo vehicle in November 2016 TBD.
• Payload will be robotically installed on ISS.
  – Installed on Express Logistics Carrier-1 (ELC-1)
• LIS will be operated for a minimum of 2 years.
  – Mission extension will be sought from NASA
The mission will leverage existing TRMM LIS infrastructure to quickly get ISS LIS data into the hands of users.

- Key scientists, engineers, and facilities remain in place from recently ended TRMM mission.
- TRMM LIS mission operations and data handling (processing, archival, and distribution) is robust and easily adapted to the Payload Operations Control Center (POCC) model used by ISS.
- Hence, LIS data users should see no change from TRMM LIS (i.e., LIS data products and formats, analysis software, documentation and access will remain unchanged)
- LIS science and data teams have experience delivering real time data to NOAA and other users.

The LIS instrument and its observations are well characterized.

- All indications suggest that the flight-spare ISS LIS will perform exactly like TRMM LIS on orbit.
- LIS observations will be excellent for GLM Cal/Val both because LIS data are well characterized and because GLM’s lightning detection approach traces to LIS heritage.
- LIS data serves as an accepted “benchmark” for global lightning climatology intercomparisons.
Unique Science Contributions from ISS Platform
“New and Improved” Science

• **Higher latitude lightning coverage missed by TRMM**
  - TRMM LIS misses up to 30% lightning in N. Hemisphere summer
  - Enhance regional and global weather, climate, and chemistry studies
  - Provide CONUS coverage (needed for National Climate Assessment)

• **Real time lightning using ISS for operational applications**
  - Provide real time lightning in data sparse regions, especially oceans (storm warnings, nowcasts, oceanic aviation and international SIGMETs, long-range lightning system validation, hurricane rapid intensification evaluations)
  - Desired by NASA and strongly endorsed by NOAA partners (partners include: NWS Pacific Region, Joint Typhoon Warning Center, Ocean Prediction Center, Aviation Weather Center, and National Hurricane Center)

• **Support cross-sensor calibration and validation activities**
  - Inter-calibrate ISS LIS, GOES-R GLM and MTG LI for improved science and applications (strongly endorsed by NOAA and ESA)

• **Enable simultaneous / complementary observations**
  - Provide critical daytime lightning to better understand mechanisms leading to TGFs and TLEs (strongly endorsed by ESA ASIM and JAXA GLIMS)
Questions?