Lightning Observations from the International Space Station (ISS) for Science Research and Operational Applications


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Introduction and Overview

**Mission**
- Fly a space-qualified, flight-spare LIS on ISS to take advantage of unique capabilities provided by the ISS (e.g., high inclination, real-time data).
- Integrate LIS as hosted payload on DoD Space Test Program Houston 5 (STP-H5) mission and launch on SpaceX Falcon in January 2016 for a minimum 2 year mission.

**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 (>70%) during day.
- Also, LIS globally detects TOTAL (both cloud and ground) lightning with no land-ocean bias.

**LIS Hardware (Heritage and New)**

**LIS Flight Heritage**
- Lightning Imaging Sensor
  - Sensors Unit
    - Optical Assembly: 128x128 CCD Focal Plane - Lightning and Background detection
  - Electronics Unit: Real Time Event Processor and Background removal - Control & Data Handling (C&DH) - Power conversion and control
  - Interface Unit: Power conversion - 1 PPS Time Signal - C&DH Formatting - ISS interface

**LIS Launch, Installation and Operation on ISS**
- Launch on a SpaceX Falcon with Dragon cargo vehicle in January 2016.
- Robotically installed on an external truss (ELL-1) in position shown.
- Operated for 2 years, but will seek mission extension from NASA.

**Science and Applications from LIS Lightning**

**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).
- ISS LIS (or LIs as Hugh Christian prefers) will extend TRMM time series observations, expand latitudinal coverage, provide real-time data to operational users, and enable cross-sensor calibration.

**LIS Performance Parameters**
- 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 to allow robotic installation on ISS.

**Unique Science Contributions from ISS Platform**
- Lightning coverage at higher latitude missed by TRMM - TRMM LIS missed 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
- Inter-calibrate ISS LIS, TRMM LIS, GOES-R GLM and MTG LI for range lightning system validation, hurricane rapid intensification evaluations
- Desired by NASA and strongly endorsed by NOAA partners
- Provide critical daytime lightning to better understand mechanisms leading to TGFs and TLEs
- Enable simultaneous/complementary observations with other LIS, OP, and vertical velocity (bottom) illustrate strong lightning-storm coupling
- Lightning NOx also impacts ozone, an important greenhouse gas.
- Climate most sensitive to ozone in upper troposphere, exactly where lightning is the most important source of NOx.
- Other: ISS LIS observations will help unravel the mechanisms leading to terrestrial gamma-ray flashes (TGFs) and Transient Luminous Events (TLEs)

**Summary**
- There exist several core science applications of LIS lightning observations, that range from weather and climate to atmospheric chemistry and lightning physics due to strong quantitative connections that can be made between lightning and other geophysical processes of interest.
- The space-base vantage point, such as provided by ISS LIS, still remains an ideal location to obtain total lightning observations on a global basis.