Space Station sensor to capture 'striking' lightning data

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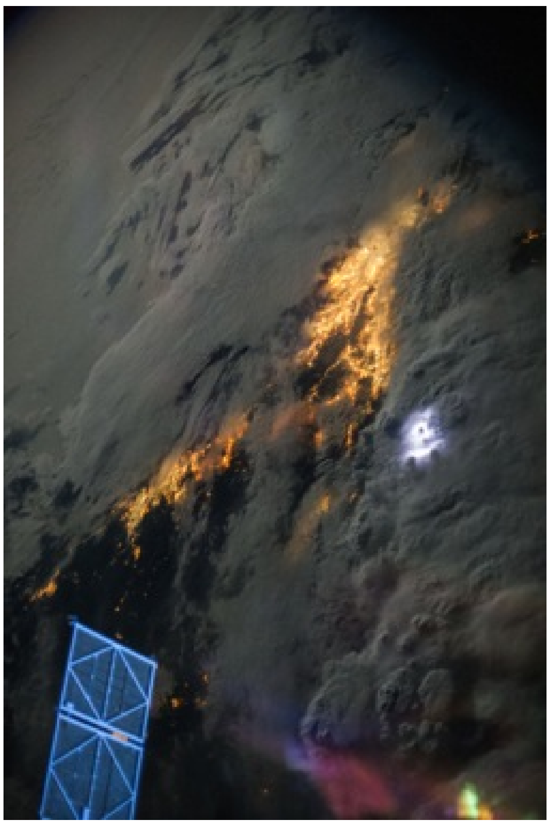

This International Space Station Crew Earth image of storm clouds over California shows lightning as a white glow to the right of center. The yellow lit areas beneath the clouds are the night lights from the highly populated areas of Los Angeles and San Diego. Credit: NASA

Keeping a spare on hand simply makes sense. Just as drivers keep spare tires on hand to replace a flat or blowout, NASA routinely maintains "spares," too. These flight hardware backups allow NASA to seamlessly continue work in the unlikely event something goes down for a repair. When projects end, these handy spares can sometimes find second lives in new areas for use.

Researchers at NASA's Marshall Space Flight Center in Huntsville, Ala., developed a sophisticated piece of flight hardware called a Lightning Imaging Sensor (LIS) to detect and locate lightning over the tropical region of the globe. Launched into space in 1997 as part of NASA's Tropical Rainfall Measuring Mission (TRMM), the sensor undertook a three-year baseline mission, delivering data used to improve weather forecasts. It continues to operate successfully aboard the TRMM satellite today.

The team that created this hardware in the mid-1990s built a spare—and now that second unit is stepping up to contribute, as well. The sensor is scheduled to launch on a Space Exploration Technologies (SpaceX) rocket to the International Space Station in February 2016. Once mounted to the station, it will serve a two-year baseline mission as part of a U.S. Department of Defense (DoD) Space Test Program (STP)-H5 science and technology development payload. STP-H5 is integrated and flown under the management and direction of the DoD's STP.

NASA selected the LIS spare hardware to fly to the space station in order to take advantage of the orbiting laboratory's high inclination. This vantage point gives the sensor the ability to "look" farther towards Earth's poles than the original LIS can aboard the TRMM satellite. Once installed, the sensor will monitor global lightning for Earth science studies, provide cross-sensor calibration and validation with other space-borne instruments, and ground-based lightning networks. LIS will also supply real-time lightning data over data-sparse regions, such as oceans, to support operational weather forecasting and warning.

"Only LIS globally detects all in-cloud and cloud-to-ground lightning—what we call total lightning—during both day and night," said Richard Blakeslee, LIS project scientist at Marshall. "As previously demonstrated by the TRMM mission, better understanding lightning and its connections to weather and related phenomena can provide unique and affordable gap-filling information to a variety of science disciplines including weather, climate, atmospheric chemistry and lightning physics."

LIS measures the amount, rate and radiant energy of global lightning, providing storm-scale resolution, millisecond timing, and high, uniform-detection efficiency—and it does this without land-ocean bias.

This photo shows optics in the Lightning Imaging Sensor telescope. Credit: NASA

The sensor consists of an optical imager enhanced to locate and detect lightning from thunderstorms within its 400-by-400-mile field-of-view on the Earth's surface. The station travels more than 17,000 mph as it orbits our planet, allowing the LIS to observe a point on the Earth, or a cloud, for almost 90 seconds as it passes overhead. Despite this brief viewing duration, it is long enough to estimate the lightning-flashing rate of most storms.

Since more than 70 percent of lightning occurs during the day, daytime detection drove the technical design of the LIS. From space, lightning appears like a pool of light on the top of a thundercloud. During the day, sunlight reflected from the cloud tops completely masks the lightning signal, making it difficult to detect. However, LIS creates a solution by applying special techniques that take advantage of the differences in the behavior and physical characteristics of lightning and sunlight signals. These allow LIS to extract the strikes from bright background illumination.

As a final step in processing, a real-time event processor inside the LIS electronics unit removes the remaining background signal, enabling the system to detect the lightning signatures and achieve 90-percent detection efficiency.

Once the sensor is installed on the space station, the LIS team will operate it remotely. They will then assess the data it produces and disseminate it to forecasters and researchers from the Global Hydrology Resource Center, one of NASA's Earth science data centers.

This instrument also can help our lives on Earth in many ways. The LIS science team has received strong endorsements from several national and international government agencies and university science organizations. These include the National Oceanic and Atmospheric Administration (NOAA), European Space Agency (ESA), Japan Aerospace Exploration Agency (JAXA) and the Geostationary Operational Environmental Satellite R- Series Program (GOES-R). Operational users, such as NOAA's National Weather Service (NWS), Aviation Weather Center

(AWC), Ocean Prediction Center (OPC) and Pacific Region will be interested in the data for their operational weather warning, forecasting and even validation applications. For other users, their science and application investigations will be improved and will benefit from the new lightning observations provided by LIS.

From a research standpoint, LIS data could be very useful to the Federal Aviation Administration (FAA). Randy Bass, a member of the FAA's Aviation Weather Research Team, said the information obtained could help them with validation activities of several oceanic convection ensemble model products they're developing, either in real-time or archive mode.

"It could also be used for validation of detection of convection from other ground- and space-based sensors we will be using at the time," said Bass. "Any data we can use for 'ground truth' over oceanic areas will be extremely helpful in development of better observing and forecasting products used for offshore aviation, especially as we expand our coverage throughout the Atlantic and Pacific oceans."

The end result would be better short-term forecasts of thunderstorms over offshore areas, giving pilots and air traffic controllers a better ability to reroute planes around hazards such as turbulence and lightning strikes. Bass said that while pilots have weather radar aboard, they can only see limited areas ahead of them. The FAA wants to improve their capability and give controllers the opportunity to see the weather activity too, which they don't have right now.

As lightning flashes above our heads, there's a lot to be learned about this electrical phenomena—and the LIS team aims to find the answers to a lot of those questions.

"Measuring lightning is important for knowledge about the weather and also operationally important for aviation safety. By adding an instrument on space station, we can add observations from higher latitudes covering the 48 contiguous states," said International Space Station Chief Scientist Julie Robinson, Ph.D. "This is a prime example of science on the International Space Station benefiting our nation."

Provided by NASA

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