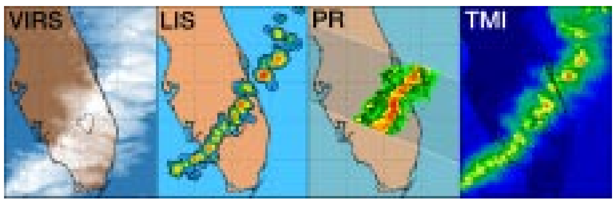
nism in driving global atmospheric circulation. The global images show the difference in tropical lightning distribution between the northern hemisphere winter and summer.

A markedly greater amount of lightning activity is observed over land areas as opposed to oceans. This is due to the greater surface heating and atmospheric instability occurring over the land areas, resulting in stronger storm updrafts and more frequent lightning.

Why Study Lightning from Space?

Lightning activity is closely coupled to storm dynamics and microphysics, and can be related to the global rates, amounts, and distribution of convective precipitation and the release and transport of latent heat. Tropical convection is important because of its role in large scale atmospheric circulations, including El Niño and La Niña. In addition, the high temperatures reached within lightning channels provide a mechanism for chemical reactions that form tropospheric ozone and nitrous oxide compounds.



LIS identifies the most vigorous storms in this March 9, 1998, Florida overpass of a line of storms producing heavy rainfall, frequent lightning, and severe weather. The Visible/Infrared Scanner (VIRS, far left) identifies the clouds with the coldest cloud tops, the Precipitation Radar (PR) provides an estimate of instantaneous rainfall within its more narrow swath of coverage, and the TRMM Microwave Imager (TMI) identifies the clouds having a high concentration of ice, hail, and liquid water.

A space-based lightning sensor provides many benefits from its ability to detect and locate all lightning, in-cloud and cloud-to-ground, over a large area of the earth, day and night. A lightning sensor in low earth orbit can measure lightning activity globally, allowing seasonal and inter-annual distributions to be examined. A sensor in geostationary orbit also permits continuous measurements of the thunderstorm life-cycle.

LIS data are analyzed by a team at NASA's Global Hydrology and Climate Center in Huntsville, Ala., and co-investigators at other institutions. Data are available on line.

Obtaining LIS Data

LIS data, as well as many other Earth Science data sets, are available from the Global Hydrology Resource Center (GHRC), the Information Technology component of the Global Hydrology and Climate Center. For more information contact the GHRC User Services Office at:

Phone: (256) 922-5932

E-mail: *ghrc@eos.nasa.gov*

URL: *http://ghrc.msfc.nasa.gov/*

Further Information

For more information on the Worldwide Web:

Lightning Team
http://thunder.msfc.nasa.gov/

Global Hydrology & Climate Center
http://www.ghcc.msfc.nasa.gov/

TRMM Home Page
http://trmm.gsfc.nasa.gov/

National Aeronautics and Space Administration

George C. Marshall Space Flight Center

Photo credits: Francisco Lucena; storm over Cabo Rojo, P.R. (cover; ©1998 Francisco Lucena). SSM/I images derived from Naval Research Laboratory data. All others, NASA.

NP-1998-12-86-MSFC

The Instrument

NASA's Lightning Imaging Sensor (LIS) is a small, highly sophisticated instrument that detects and locates lightning over the tropics within a band

The LIS sensor (top left, and in cylinder above) and its electronics box are one of five instruments on the TRMM spacecraft (left).

from 35˚ N to 35˚ S latitude. From its vantage point aboard the Tropical Rainfall Measuring Mission (TRMM) observatory 350 km above the Earth, the sensor provides information on the dynamics and physics of clouds that could lead to future advanced lightning sensors capable of significantly improving short-term weather "nowcasting." The LIS promises to expand scientists' capability for examining the distribution and variability of lightning and thunderstorm activity throughout much of the world.

Lightning Facts

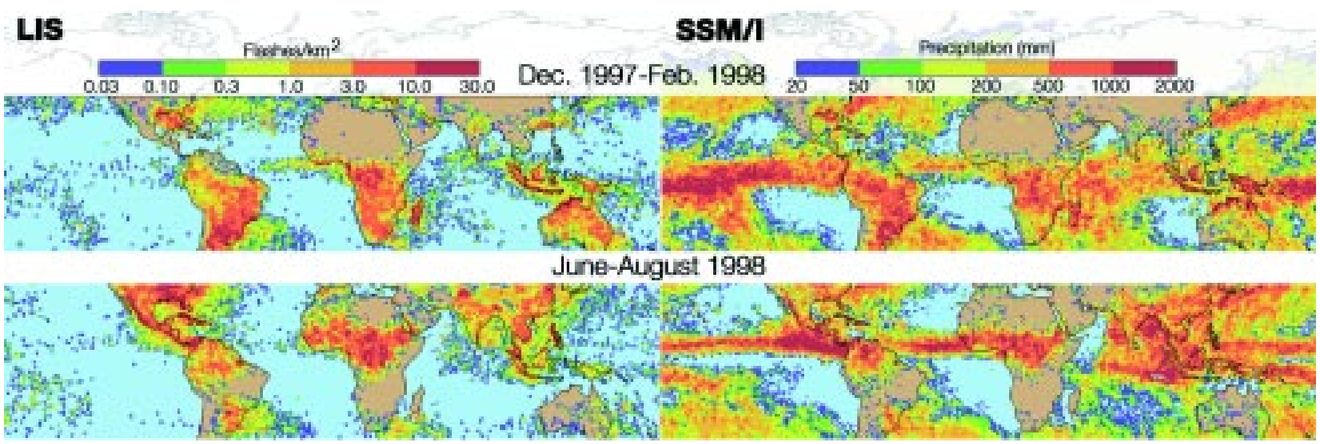
- The global flash rate is approximately 40 flashes per second.
- 85% of global lightning occurs over the land masses.
- 70% of all lightning on Earth occurs in the tropical latitude band 35˚ N to 35˚ S.
- Extreme flash rates in excess of 1 flash per second are common in severe storms. The majority of the lightning produced by severe storms is within the cloud itself — and never reaches the ground.

The LIS is a compact combination of optical and electronic elements including a staring imager capable of locating and detecting lightning within individual storms day and night. The imager's field of view allows the sensor to observe a cloud for 80 seconds, sufficient time to estimate the flashing rate, which tells researchers whether a storm is growing or decaying.

LIS was developed by a team of atmospheric scientists and engineers at the Global Hydrology and Climate Center (GHCC) and NASA's Marshall Space Flight Center in Huntsville Ala.

Future Sensors

The LIS is three times more sensitive than its NASA predecessor, the Optical Transient Detector, still in orbit. LIS and OTD are helping pave the way for future geostationary lightning mapping instruments that could deliver information to any forecaster's workstation within 30 seconds of the lightning occurrence. From their stationary position in orbit, these future lightning sensors will provide continuous coverage of the continental United States, nearby oceans, and Central and South America.



Northern hemisphere winter (top) and summer (bottom) observations of lightning by the TRMM Lightning Imaging Sensor (LIS, left) show a strong tendency for lightning to occur more frequently over land, where surface heating leads to the most vigorous cloud vertical motions. By comparison, seasonal rainfall estimates using the polar orbiting Special Sensor Microwave/ Imager (SSM/I; right) shows broad expanses of significant rainfall covering the tropical oceans as much as it does land. For purposes of comparison, SSM/I coverage beyond the TRMM orbit is not included here.

TRMM

The Tropical Rainfall Measuring Mission, a joint mission with Japan's National Space Development Agency (NASDA), is NASA's first mission dedicated to observing and understanding tropical rainfall, and how this rainfall and related heating of the atmosphere affect the global climate. The primary instruments for measuring precipitation and cloud characteristics are the Precipitation Radar (PR), the TRMM Microwave Imager (TMI), and the Visible and Infrared Scanner (VIRS).

Lightning Impacts

Lightning is one of the most familiar but least understood natural phenomena. Each year, in the United States alone, lightning is responsible for the deaths of about one hundred people, injuries to several hundred more, and millions of dollars of property damage. Lightning is responsible for up to 50% of power failures, costing U.S. electric utilities as much as $1 billion per year in damaged equipment and lost revenue. It is also responsible for igniting thousands of forest and brush fires each year.

Lightning has a direct impact on the operations of aircraft and on rocket launches (like the near hit to the Space Shuttle in 1983, right). Lightning flash rates may also be related to tornadic storm development, which could lead to improved severe weather warnings. Research on this topic is conducted at the GHCC.

Early Observations from LIS

Lightning measurements from LIS and other TRMM instruments can be used together to determine the relationship between lightning, storm structure and precipitation. Global distributions of lightning locate regions of vigorous convection where strong latent heating occurs. The location and distribution of latent heating is an important mecha-