



Data User Guide

International Space Station (ISS) Lightning Imaging Sensor (LIS) Provisional datasets

Introduction

The International Space Station (ISS) Lightning Imaging Sensor (LIS) datasets were collected by the LIS instrument on the ISS used to detect the distribution and variability of total lightning occurring in the Earth's tropical and subtropical regions. These datasets consist of non-quality controlled science data, non-quality controlled background data, near-real time science data, and near-real time background data. This data collection can be used for severe storm detection and analysis, as well as for lightning-atmosphere interaction studies. The LIS instrument makes measurements during both day and night with high detection efficiency. The data are available in both HDF-4 and netCDF-4 formats, with corresponding browse images in GIF format.

Notice:

These ISS LIS data **are considered provisional files** indicating that the algorithm is still under development and the data may contain errors. Use the data with caution and do not use for research leading to publications or presentations without consent. Please provide feedback to the data provider. **Quality controlled data are currently unavailable, but will be coming soon.**

Citations:

There are four citations, one for each data file type - Science or Background and NRT or Non-Quality Controlled product data. Please select the appropriate one for the data you are using:

NRT Lightning Imaging Sensor (LIS) on International Space Station (ISS) Provisional Science Data Citation

Blakeslee, Richard J., D.M. Mach, M.F. Stewart, D.E. Buechler, and H.J. Christian. 2017. NRT Lightning Imaging Sensor (LIS) on International Space Station (ISS) Provisional Science Data [indicate subset used]. Dataset available online from the NASA EOSDIS Global Hydrology Resource Center Distributed Active Archive Center, Huntsville, Alabama, U.S.A. doi: <http://dx.doi.org/10.5067/LIS/ISSLIS/DATA205>

NRT Lightning Imaging Sensor (LIS) on International Space Station (ISS) Provisional Backgrounds Citation

Blakeslee, Richard J., D.M. Mach, M.F. Stewart, D.E. Buechler, and H.J. Christian. 2017. NRT Lightning Imaging Sensor (LIS) on International Space Station (ISS) Provisional Backgrounds [indicate subset used]. Dataset available online from the NASA EOSDIS Global Hydrology Resource Center Distributed Active Archive Center, Huntsville, Alabama, U.S.A. doi: <http://dx.doi.org/10.5067/LIS/ISSLIS/DATA105>

Non-Quality Controlled Lightning Imaging Sensor (LIS) on International Space Station (ISS) Provisional Science Data Citation

Blakeslee, Richard J., D.M. Mach, M.F. Stewart, D.E. Buechler, and H.J. Christian. 2017. Non-Quality Controlled Lightning Imaging Sensor (LIS) on International Space Station (ISS) Provisional Science Data [indicate subset used]. Dataset available online from the NASA EOSDIS Global Hydrology Resource Center Distributed Active Archive Center, Huntsville, Alabama, U.S.A. doi: <http://dx.doi.org/10.5067/LIS/ISSLIS/DATA204>

Non-Quality Controlled Lightning Imaging Sensor (LIS) on International Space Station (ISS) Provisional Backgrounds Citation

Blakeslee, Richard J., D.M. Mach, M.F. Stewart, D.E. Buechler, and H.J. Christian. 2017. Non-Quality Controlled Lightning Imaging Sensor (LIS) on International Space Station (ISS) Provisional Backgrounds [indicate subset used]. Dataset available online from the NASA EOSDIS Global Hydrology Resource Center Distributed Active Archive Center, Huntsville, Alabama, U.S.A. doi: <http://dx.doi.org/10.5067/LIS/ISSLIS/DATA104>

Keywords:

GHRC, NASA, International Space Station, ISS, Lightning Imaging Sensor, LIS, Lightning, lightning density

Mission/Instrument Description

The LIS instrument was placed on the ISS in February 2017 as a hosted payload on the Space Test Program-Houston (STP-H5) mission managed by the Department of Defense Space Test Program. The STP-H5 is expected to have a 2 year mission. The position of LIS on the ISS allows for latitudinal data coverage extending poleward up to 54°. The goals of LIS on the ISS are to determine the relationship between clouds, lightning, and precipitation, to extend the global lightning climatology record, to examine the physics of lightning discharge, to examine the uses of lightning for improving severe weather warnings, and to estimate lightning nitrogen oxides to improve air-quality modeling. More information about the ISS LIS is available in Blakeslee et al., 2016.

The LIS instrument was designed by the GHRC Lightning Team and manufactured at the NASA Marshall Space Flight Center in Huntsville, Alabama. LIS contributes to several mission objectives by providing a global lightning and thunderstorm climatology from

which changes (even subtle temperature variations) might be easily detected.

The LIS sensor contains a staring imager which is optimized to locate and detect lightning with a storm-scale resolution of 4-8 km over a large region (about 80 km) of the Earth's surface. The Field-of-View (FOV) is sufficient to observe a point on the Earth or a cloud for 90 seconds, long enough to estimate the flashing rate of many storms. The LIS instrument records the time of lightning event occurrence, the amount of radiant energy, and the lightning event location.

The calibrated lightning sensor uses a wide FOV expanded optics lens with a narrow-band filter (centered at 777 nanometers) in conjunction with a high speed charge-coupled device detection array. A Real-Time Event Processor (RTEP) is used to determine when a lightning flash occurs, even in the presence of bright sunlit clouds. Weak lightning signals that occur during the day are hard to detect because of background illumination. The RTEP removes the background signal, thus enabling the system to detect the weak lightning with a 90% detection efficiency. More information about LIS can be found at <https://ghrc.nsstc.nasa.gov/home/micro-articles/earth-observations-lightning-imaging-sensor>.

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Data Characteristics

The International Space Station (ISS) Lightning Imaging Sensor (LIS) datasets contain measured lightning flashes from March 1, 2017 onward as the LIS instrument continues to collect data in near-real time. The data are **currently only available as provisional files** in both HDF-4 and netCDF-4 formats, with corresponding browse images for the science

data in GIF format. There are currently 4 types of data within this dataset: science data and background data for near-real time and non-quality controlled data. **Quality controlled data are currently unavailable, but will be coming soon.**

Near-real time data are available within two minutes of observation. These data are appropriate for applications requiring low latency data. Non-quality controlled data are standard products that are created daily. These data are more completed than the near-real time data; however, these data have not had a manual review to assure data quality. Quality controlled data have had quality control steps to ensure that all bad data are flagged. These data are most appropriate for scientific research and publications.

These data contain orbit data, as well as a browse images showing the data plotted on a map. The browse images can be found on the dataset's landing page. Also, the Non-Quality Controlled International Space Station (ISS) Lightning Imaging Sensor (LIS) Science Data browse images can be found at the [ISS LIS NQC Browse Imagery webpage](#).

NRT data and browse images age off the server and are not a static archived data collection.

In January 2018, these data were updated to a new version (p1). This update fixed timing issues in the original data files (p0).

Table 1: Data Characteristics

Characteristic	Description
Platform	International Space Station (ISS)
Instrument	Lightning Imaging Sensor (LIS)
Projection	n/a
Spatial Coverage	N: 54 , S: -54 , E: 180 , W: -180
Spatial Resolution	4-8 km
Temporal Coverage	March 1, 2017 - ongoing
Temporal Resolution	NRT: 2 minutes NQC: Daily
Sampling Frequency	2 milliseconds
Parameter	lightning, lightning density
Version	p1
Processing Level	1B (Background Data) and 2 (Science Data)

File Naming Convention

The International Space Station (ISS) Lightning Imaging Sensor (LIS) datasets have the following naming convention:

Data: ISS_LIS_TT_Mv.v_YYYYMMDD_ssssss_[NRT|NQC]_xxxxx.[hdf|nc]

NQC Browse: ISS_LIS_BR_Mv.v_YYYYMMDD.gif

NRT Browse: ISS_LIS_BR_Mv.v_YYYYMMDD_ssssss_NRT_xxxxx.[gif|patch.gif|view.gif]

Table 2: File naming convention variables

Variable	Description
TT	Type of file: SC = science BG = background
M	Product maturity: P = Provisional
v.v	Processing algorithm version number
YYYY	Four-digit year of data
MM	Two-digit month
DD	Two-digit day
sssss	Seconds since midnight in UTC
[NRT NQC]	Latency of file: NRT = near real-time NQC = Not quality-controlled
xxxxx	5-digit ISS LIS orbit number
.[hdf nc]	Hierarchical Data Format or Network Common Data Form
.[gif patch.gif view.gif]	Graphics Interchange Format .gif = 2 min swath piece/ daily total of lightning data image .patch.gif = image of 2minute NRT data and legend (no map) .view.gif = image of 2 minute swath outline on map(no data) <i>.patch.gif and .view.gif files have no value to users and are available for image construction use only. We describe here so that you know what they are since they are located in the public directory.</i>

Data Format and Parameters

The International Space Station (ISS) Lightning Imaging Sensor (LIS) datasets are obtained from measurements made by the LIS onboard the ISS. These datasets contain lightning flashes from March 1, 2017 onwards as LIS continues to collect data in near-real time. These ISS LIS datasets are considered **provisional data**, which means the algorithm is still under development and the data may contain errors. Use the data with caution and do not use in research leading to publications or presentations without provider consent. Please provide feedback on the data files directly to the data provider. Tables 3 - 12 describe each parameter in each ISS LIS beta data file. More information about these parameters can be found in Christian, et al., 2000.

Near-real time data (NRT) are available within two minutes of observation. These data are appropriate for applications requiring low latency data. Non-quality controlled (NQC) data are standard products that are created daily. The NQC data are more complete than the NRT data, and both datasets have not had a manual review to assure data quality. Quality-controlled data have had quality control steps applied to ensure that all bad data are

flagged. These data are most appropriate for scientific research and publications. **Quality controlled data are currently unavailable, but will be coming soon.**

The datasets contain orbit data and a browse image showing the data plotted on a map. The browse images can be found on the dataset landing page. Also, the Non-Quality Controlled International Space Station (ISS) Lightning Imaging Sensor (LIS) Science Data browse images can be found at the [ISS LIS NQC Browse Imagery webpage](#).

Table 3: Orbit Summary Attribute Parameter Field Descriptions, the orbit summary, which consists of a summary of important orbit attributes

HDF Field Name	netCDF Field Name	Description	Unit
id_number	orbit_summary_id_number	The number of this orbit, where the orbit count starts with LIS installation on ISS	-
TAI93_start		Orbit start time in International Atomic Time	Leap seconds in TAI93
UTC_start(28)	orbit_summary_UTC_start	UTC start time	-
GPS_start	orbit_summary_GPS_start	Orbit start time for the Global Positioning System	seconds
TAI93_start	orbit_summary_TAI93_start	TAI93 start time	Seconds since 1993-01-01 00:00:00.000
TAI93_end	orbit_summary_TAI93_end	TAI93 end time	Seconds since 1993-01-01 00:00:00.000
start_longitude	orbit_summary_start_longitude	longitude boundary defining start of this orbit	Degrees East
end_longitude	orbit_summary_end_longitude	longitude boundary defining end of this orbit	Degrees East
point_data_count	orbit_summary_point_data_count	number of point data records	counts
point_data_address	orbit_summary_point_data_address	point data child record number	-
one_second_count	orbit_summary_one_second_count	number of one second records	counts
one_second_address	orbit_summary_one_second_address	address of the first element in the one-second data	-

summary_image_count	orbit_summary_summary_image_count	Number of summary GIF images	count
summary_image_address	orbit_summary_summary_image_address	Summary GIF image record number	-
inspection_code	orbit_summary_inspection_code	code indicating which problem scenarios were checked by the QA inspector	-
configuration_code	orbit_summary_configuration_code	code indicating which code configuration scenario was used when processing the data	-

Table 4: One Second Field Descriptions, which show the one second sets. These measurements provides information regarding the status of the LIS instrument in a series of one second snapshots of external and internal instrument parameters, which are depended on by LIS data.

HDF Field Name	netCDF Field Name	Description	Unit
alert_summary	one_second_alert_summary	bit masked summary of alert flags. Bit1 is the least significant bit (LSB). bit1=1: instrument_fatal_flag; bit2=1: instrument_warning_flag; bit3=1: platform_fatal_flag; bit4=1: platform_warning_flag; bit5=1: external_fatal_flag; bit6=1: external_warning_flag; bit7=1: processing_fatal_flag; bit8=1: processing_warning_flag	-
instrument_alert	one_second_instrument_alert	bit masked status of instrument. Bit1 is the least significant bit (LSB). bit1=1:Fatal_instrument_off; bit2=1:Indifferent_instrument_command_executed; bit3=1:Fatal/Warning_FIFO_buffer_overflow; bit4=1:Warning_threshold_set_very_high; bit5=1:Fatal_instrument_warning_up; bit6=1:Warning_improper_operating; bit7=1:Fatal_Packet_gap; bit8=1:Warning_data_handling_problem	-
platform_alert	one_second_platform_alert	bit masked status of platform. Bit1 is the least significant bit (LSB). bit1=1:Warning_no_attitude_or_ephemeris_quality_flags_available; bit2=1:Fatal_ephemeris_not_available;	-

		bit3=1:Warning_ephemeris_possibly_inaccurate; bit4=1:Fatal_attitude_not_available; bit5=1:Warning_attitude_possibly_inaccurate; bit6=1:Fatal_clock_not_available; bit7=1:Warning_clock_possible_inaccurate; bit8: (reserved)	
external_alert	one_second_external_alert	bit masked status of external factors. Bit1 is the least significant bit (LSB). bit1=1:Warning_Satellite_within_SAA_Model1; bit2=1:Warning_satellite_within_SAA_Model2; bit3=1:Warning_direct_solar_reflection_possible_within_FOV; bit4=1:Indifferent_TRMM_Microwave_imager_on; bit5=1:Indifferent_Precipitation_Radar_on; bit6=1:Indifferent_Visible_Infrared_Scanner_on; bit7=1:Indifferent_Clouds_and_Earth_Radiant_Energy_System_sensor_on; bit8: (reserved)	-
processing_alert	one_second_processing_alert	bit masked status of processing algorithms. Bit1 is the least significant bit (LSB). bit1=1:Warning_QA_inspector_warning_flag; bit2=1:Fatal_QA_inspector_fatal_flag; bit3=1:Fatal_data_too_garbled_for_software_to_read; bit4=1:Fatal_data_set_too_large_to_process; bit5=1:Fatal/Warning_unforseen_software_error_caused_improper_reporting_of_data; bit6=1:Warning_grouping_algorithm_buffer_limitation_problem; bit7=1:Warning_viewtime_algorithm_failure_to_accurately_determine_FOV; bit8: (reserved)	-
position_vector(3)	one_second_position_vector	one second granule platform coordinates	m
velocity_vector(3)	one_second_velocity_vector	one second granule platform velocity	m/s
transform_matrix(9)	one_second_transform_matrix	components of transform from pixel plane-boresight coordinates to ECR coordinates of boresight and pixel plane	-
solar_vector(3)	one_second_solar_vector	unit vector from center of earth to sun in ECR coordinates	-
ephemeris_quality_fl	one_second_ephemeris_	one second granule ephemeris quality flag	-

ag	quality_flag		
attitude_quality_flag	one_second_attitude_quality_flag	one second granule attitude quality flag	-
boresight_threshold	one_second_boresight_threshold	one second granule threshold estimate	-
thresholds(16)	one_second_thresholds	values of the instrument threshold settings for each 256 count background interval	-
noise_index	one_second_noise_index	one second granule noise index	%
event_count(6)	one_second_event_count	One second granule event count	counts
TAI93_time	one_second_TAI93_time	whole second value starting before and continuing beyond one orbit	Seconds since 1993-01-01 00:00:00.000

Table 5: Point Summary Parameter Field Descriptions. These measurements allows a user to quickly get to point datasets, such as addresses, which are the HDF addresses of each parameter, and counts, which are the total number of each point data in the HDF.

HDF Field Name	netCDF Field Name	Description	Unit
parent_address	point_summary_parent_address	Parent record number	-
event_count	point_summary_event_count	Number of events	counts
event_address	point_summary_event_address	Event record number	-
group_count	point_summary_group_count	Number of groups	counts
group_address	point_summary_group_address	Group record number	-
flash_count	point_summary_flash_count	Number of flashes	counts
flash_address	point_summary_flash_address	Flash record number	-
area_count	point_summary_area_count	Number of areas	counts
area_address	point_summary_area_address	Area record number	-
bg_count	point_summary_bg_count	Number of backgrounds	counts
bg_address	point_summary_bg_address	Background image summary record number	-
vt_count	point_summary_vt_count	Number of viewtime granules	counts
vt_address	point_summary_vt_address	Viewtime granule record number	-

Table 6: Viewtime Parameter Field Descriptions, which consists of viewtime parameters that are required in order to determine flashing rates on the Earth.

HDF Field Name	netCDF Field Name	Description	Unit
Location(2)	viewtime_location	lat/lon of the center of the grid cell of dimensions 0.5 deg x 0.5 deg	degrees
TAI93_start	viewtime_TAI93_start	TAI93 whole second when location was first within FOV	Seconds since 1993-01-01 00:00:00.000
TAI93_end	viewtime_TAI93_end	TAI93 whole second when location was	Seconds since

		last within FOV	1993-01-01 00:00:00.000
Effective_obs	viewtime_effective_obs	time of observation of the grid cell, adjusted by the percentage of area in the grid cell within the FOV	seconds
Alert_flag	viewtime_alert_flag	reflects status of instrument, platform, external factors and processing algorithms. Bit1 is the least significant bit (LSB). bit1=1: instrument_fatal_flag bit2=1: instrument_warning_flag bit3=1: platform_fatal_flag bit4=1: platform_warning_flag bit5=1: external_fatal_flag bit6=1: external_warning_flag bit7=1: processing_fatal_flag bit8=1: processing_warning_flag	-
approx_threshold	viewtime_approx_threshold	threshold of instrument corresponding with grid cell position, proxied from solar zenith angle at a time halfway between start and end time	-
-	viewtime_lat	Viewtime latitude	Degrees North
-	viewtime_lon	Viewtime longitude	Degrees East

Table 7: Bg_Summary Parameter Field Descriptions, which consists of parameters that describe details of the background images, although they are stored separately due to the large file sizes.

HDF Field Name	netCDF Field Name	Description	Unit
TAI93_time	bg_summary_TAI93_time	TAI93 time of the background image	Seconds since 1993-01-01 00:00:00.000
Address	bg_summary_address	Background image number within orbit	-
Boresight	bg_summary_boresight	lat/lon location of center pixel (63, 64)	degrees
Corners	bg_summary_corners	lat/lon locations of corner pixels	degrees
-	bg_summary_lat	Background image boresight latitude	Degrees North
-	bg_summary_lon	Background image boresight longitude	Degrees East

Table 8: Area (LIS06) Parameter Field Descriptions, which consists of data associated with each area identified during the orbit. An area is defined as a contiguous region on the surface of the Earth that has produced lightning during a single orbit of the LIS instrument.

HDF Field Name	netCDF Field Name	Description	Unit
TAI93_time	lightning_area_TAI92_time	TAI93 times of 1st event in area	Seconds since 1993-01-01 00:00:00.000
delta_time	lightning_area_delta_time	Time between first and last event that compose the area	seconds
Observe_time	lightning_area_observe_time	Duration of observation of the region where the area occurred	seconds
Location(2)	lightning_area_location	Latitude/Longitude radiance-weighted centroid	degrees
net_radiance	lightning_area_net_radiance	Sum of event radiances composing this area	uJ/sr/m ² /um
Footprint	lightning_area_footprint	Area footprint extent	km ²
Address	lightning_area_address	Area record number	-
parent_address	lightning_area_parent_address	Area parent record number	-
child_address	lightning_area_child_address	Area child record number of 1st flash in a sequential list	-
child_count	lightning_area_child_count	Area child record number of flashes	count
grandchild_count	lightning_area_grandchild_count	Number of groups in area	count
greatgrandchild_count	lightning_area_greatgrandchild_count	Number of events in area	count
approx_threshold	lightning_area_approx_threshold	Estimated value of 8-bit threshold for the area determined from background level or solar zenith angle	-
Alert_flag	lightning_area_alert_flag	Bit masked status of instrument, platform, external factors and processing algorithms. Bit1 is the least significant bit (LSB) bit1=1: instrument_fatal_flag bit2=1: instrument_warning_flag bit3=1: platform_fatal_flag bit4=1: platform_warning_flag bit5=1: external_fatal_flag bit6=1: external_warning_flag bit7=1: processing_fatal_flag bit8=1: processing_warning_flag	-

Cluster_index	lightning_area_cluster_index	Pixel density metric; higher numbers indicate area is less likely to be noise	%
Density_index	lightning_area_density_index	spatial density metric; higher if area geolocated in a region of high lightning activity	-
Noise_index	lightning_area_noise_index	Signal-to-signal plus noise ratio	%
Oblong_index	lightning_area_oblong_index	Eccentricity of the area	-
grouping_sequence	lightning_area_grouping_sequence	Time sequence of area used when grouping algorithm is applied	-
grouping_status	lightning_area_grouping_status	End status of the area	-
-	lightning_area_lat	Area latitude	Degrees North
-	lightning_area_lon	Area longitude	Degrees East

Table 9: Event (LIS03) Parameter Field Descriptions, which consists of data that are associated with events recorded during the ISS orbit. An event is defined as a single pixel exceeding the background threshold.

HDF Field Name	netCDF Field Name	Description	Unit
TAI93_time	lightning_event_TAI93_time	TAI93 time of event	Seconds since 1993-01-01 00:00:00.000
Observe_time	lightning_event_observe_time	duration of observation of the region where the event occurred	seconds
Location	lightning_event_location	lat/lon radiance-weighted centroid	degrees
radiance	lightning_event_radiance	Event calibrated radiance	$\mu\text{J}/\text{sr}/\text{m}^2/\mu\text{m}$
Footprint	lightning_event_footprint	Event footprint extent	km^2
Address	lightning_event_address	Event record number	-
parent_address	lightning_event_parent_address	event parent record number	-
x_pixel	lightning_event_x_pixel	Event CCD pixel column	-
y_pixel	lightning_event_y_pixel	Event CCD pixel row	-
bg_value	lightning_event_bg_value	level of background illumination (16-bit) at time of event	-
bg_radiance	lightning_event_bg_radiance	background radiance associated with pixel at time of event	$\mu\text{J}/\text{sr}/\text{m}^2/\mu\text{m}$
amplitude	lightning_event_amplitude	Uncalibrated optical amplitude reported by instrument (a 7-bit digital count)	-
sza_index	lightning_event_sza_index	event solar zenith angle	degrees

glint_index	lightning_event_glint_index	angle between line of sight vector and direct solar reflection vector	degrees
approx_threshold	lightning_event_approx_threshold	Estimated value of 8-bit threshold for the event; from bg level or solar zenith angle	-
alert_flag	lightning_event_alert_flag	Bit masked status of instrument, platform, external factors and processing algorithms. Bit1 is the least significant bit (LSB). bit1=1: instrument_fatal_flag; bit2=1: instrument_warning_flag; bit3=1: platform_fatal_flag; bit4=1: platform_warning_flag; bit5=1: external_fatal_flag; bit6=1: external_warning_flag; bit7=1: processing_fatal_flag; bit8=1: processing_warning_flag	-
cluster_index	lightning_event_cluster_index	pixel density metric; higher numbers indicate event less likely to be noise	%
density_index	lightning_event_density_index	spatial density metric; higher if event geolocated in a region of high lightning activity	-
noise_index	lightning_event_noise_index	signal-to-signal plus noise ratio	%
bg_value_flag	lightning_event_bg_value_flag	Background (bg) radiance has been 0: estimated from sza 1: interpolated from bgs	-
grouping_sequence	lightning_event_grouping_sequence	time sequence of event used when grouping algorithm is applied	-
-	lightning_event_lat	Event latitude	Degrees North
-	lightning_event_lon	Event longitude	Degrees East

Table 10: Flash (LIS05) Parameter Field Descriptions, which consists of data associated with each area or flash identified during the orbit. A flash is defined as one to multiple pulses that occur in the same storm cell within a specified time and distance corresponding to several related groups in a limited area.

HDF Field Name	netCDF Field Name	Description	Unit
TAI93_time	lightning_flash_TAI93_time	TAI93 time of 1st event in flash	Seconds since 1993-01-01

			00:00:00.000
delta_time	lightning_flash_delta_time	time between first and last group that compose the flash	seconds
Observe_time	lightning_flash_observe_time	duration of observation of the region where the flash occurred	seconds
Location(2)	lightning_flash_location	lat/lon radiance-weighted centroid	degrees
radiance	lightning_flash_radiance	flash calibrated radiance	uJ/sr/m ² /um
Footprint	lightning_flash_footprint	flash footprint size	km ²
Address	lightning_flash_address	flash record number	-
parent_address	lightning_flash_parent_address	flash parent record number	-
child_address	lightning_flash_child_address	address of 1st group in a sequential list	-
child_count	lightning_flash_child_count	flash child record count	count
grandchild_count	lightning_flash_grandchild_count	flash grandchild record count	count
approx_threshold	lightning_flash_approx_threshold	estimated value of 8-bit threshold for the flash determined from background level or solar zenith angle	-
Alert_flag	lightning_flash_alert_flag	bit masked status of instrument, platform, external factors and processing algorithms. Bit1 is the least significant bit (LSB). bit1=1: instrument_fatal_flag; bit2=1: instrument_warning_flag; bit3=1: platform_fatal_flag; bit4=1: platform_warning_flag; bit5=1: external_fatal_flag; bit6=1: external_warning_flag; bit7=1: processing_fatal_flag; bit8=1: processing_warning_flag	-
Cluster_index	lightning_flash_cluster_index	pixel density metric; higher numbers indicate flash is less likely to be noise	%
Density_index	lightning_flash_density_index	spatial density metric; higher if flash geolocated in a region of high lightning activity	-
Noise_index	lightning_flash_noise_index	signal-to-signal plus noise ratio	%
glint_index	lightning_flash_glint_index	flash solar glint cosine angle	-
Oblong_index	lightning_flash_oblong_index	Eccentricity of the flash	-
grouping_sequence	lightning_flash_grouping_sequence	time sequence of flash used when grouping algorithm is	-

		applied	
grouping_status	lightning_flash_groupng_status	flash grouping_status	-
-	lightning_flash_lat	Flash latitude	Degrees North
-	lightning_flash_lon	Flash longitude	Degrees East

Table 11: Group (LIS07) Parameter Field Descriptions, which consists of data associated with each group identified during the orbit. A group is defined as one or more simultaneous events that register in adjacent pixels in the focal plane array, which may consist of only one or many events.

HDF Field Name	netCDF Field Name	Description	Unit
TAI93_time	lightning_group_TAI93_time	TAI93 time of all events in group	Seconds since 1993-01-01 00:00:00.000
Observe_time	lightning_group_observe_time	length of observation of the region where the group occurred (viewtime approximation at group centroid)	seconds
Location(2)	lightning_group_location	lat/lon radiance-weighted centroid	degrees
radiance	lightning_group_radiance	group calibrated radiance	uJ/sr/m ² /um
Footprint	lightning_group_footprint	group footprint size	km ²
Address	lightning_group_address	group record number	-
parent_address	lightning_group_parent_address	group parent record number	-
child_address	lightning_group_child_address	group child record number	-
child_count	lightning_group_child_count	group child record count	counts
approx_threshold	lightning_group_approx_threshold	estimated value of 8-bit threshold for the group determined from background level or solar zenith angle	-
Alert_flag	lightning_group_alert_flag	bit masked status of instrument, platform, external factors and processing algorithms. Bit1 is the least significant bit (LSB). bit1=1: instrument_fatal_flag; bit2=1: instrument_warning_flag; bit3=1: platform_fatal_flag; bit4=1: platform_warning_flag; bit5=1: external_fatal_flag; bit6=1: external_warning_flag; bit7=1: processing_fatal_flag; bit8=1: processing_warning_flag	-
Cluster_index	lightning_group_cluster_index	pixel density metric; higher numbers indicate group is less likely to be noise	%
Density_index	lightning_group_density_index	spatial density metric; higher if	-

		group geolocated in a region of high lightning activity	
Noise_index	lightning_group_noise_index	signal-to-signal plus noise ratio	%
glint_index	lightning_group_glint_index	group solar glint cosine angle	-
Oblong_index	lightning_group_oblong_index	Eccentricity of the group	-
grouping_sequence	lightning_group_grouping_sequence	time sequence of group used when grouping algorithm is applied	-
grouping_status	lightning_group_grouping_status	Group grouping status	-
-	lightning_group_lat	Group latitude	Degrees North
-	lightning_group_lon	Group longitude	Degrees East

Table 12: Raster Images Parameter Field Descriptions, which consists of image plot of the orbit and the associated color table.

HDF Field Name	netCDF Field Name	Description	Unit
raster_image	raster_image	Raster image plot of the orbit in each file. It is included for quick examination and manual identification of specific orbits of interest.	-
raster_image_color_table	raster_image_color_table	color table for raster image plot of the orbit in each file	-

Algorithm

The LIS software produces lightning data and corresponding background data. The software decodes, filters, clusters, and then outputs the data in HDF-4 and netCDF-4 files. Table 13 shows the steps needed to create the data products. More detailed information about LIS software is available in Christian et al., 2000.

The original beta algorithm data were released in August 2017. Several improvements have been made since, especially corrections of false lightning detections and timing issues. These improved provisional algorithm data products became publicly available as of Dec 8, 2017 onwards.

Table 13: Software Tasks

Step	Task
1	ISS to native lightning/background format converting
2	Pixel based filtering
3	ISS to native ephemeris format converting
4	Ephemeris filtering
5	Geo-Locating
6	Determining LIS viewtime
7	Flash clustering
8	Flash based filtering

9	Area clustering
10	Area based filtering
11	HDF-4 and netCDF-4 file creation

Quality Assessment

In January 2018, these data were updated to a new version (p1). This update fixed timing issues in the original data files (p0).

The calibration of LIS data is split into two different categories: an absolute radiometric calibration of the LIS sensor performed in the pre-launch stage, and an in-orbit performance calibration of the LIS sensor once in operation on the ISS. The in-orbit calibration is extremely important for the interpretation and utilization of the LIS data. LIS data are also validated by verifying the true amplitude, location, and time of occurrence of lightning events detected. Verification of background image alignment and brightness, and remote adjustment of threshold settings to minimize false alarms and maximize detection are also performed.

For quality assurance, events, flashes, areas, and groups are all assigned data quality tags, which indicate whether the data are associated with high noise rates, solar glint, or randomly spaced events or are positioned relative to events with high lightning probabilities. More information about the quality assessment of these data are available in Christian et al., 2000.

The original beta algorithm used to produce data available during August - December 2017 has been improved to provide corrections of false lightning detections and timing issues. This provisional algorithm is used to create the provisional data products available from December 2017 onwards.

Software

Data files are in HDF-4 and netCDF-4 format. The browse files within these data can be viewed using [HDFview](#).

Known Issues or Missing Data

The ISS LIS data collection currently only contains data products derived using the provisional algorithm; therefore, the data may contain errors. Please provide feedback to the data provider directly.

Also, near-real time data are available within two minutes of observation. There may be missing data due to the nature of real time data transmission. The NRT data are appropriate for applications requiring low latency data. The most appropriate data to use for scientific research and publications are the final quality controlled data. **Final quality controlled data are currently unavailable, but will be coming soon. If provisional**

data are used for research, please contact the data provider to obtain permission for publication of results.

References

Bitzer, Phillip M. and Hugh J. Christian (2015): Timing Uncertainty of the Lightning Imaging Sensor. *Journal of Atmospheric and Oceanic Technology*, Vol. 32, pp. 453-460.
<http://journals.ametsoc.org/doi/abs/10.1175/JTECH-D-13-00177.1>

Blakeslee, R. and W. Koshak (2016): LIS on ISS: Expanded Global Coverage and Enhanced Applications. *The Earth Observer*, 28, 4-14.
http://eosps.nasa.gov/sites/default/files/eo_pdfs/May_June_2016_color%20508.pdf#page=4.

Christian, H. J., R. J. Blakeslee, and S. J. Goodman (1989): The Detection of Lightning from Geostationary Orbit. *J. Geophys. Res.*, Vol. 94, pp. 13329-13337. doi: 10.1029/JD094iD11p13329.

Christian, H. J., R. J. Blakeslee, S. J. Goodman, and D. M. Mach (2000). Algorithm Theoretical Basis Document (ATBD) For the Lightning Imaging Sensor (LIS), Earth Observing System (EOS) Instrument Product.

Christian, H.J., R.J. Blakeslee, and S.J. Goodman (1992): Lightning Imaging Sensor (LIS) for the Earth Observing System, NASA Technical Memorandum 4350, MSFC, Huntsville, AL, February, 1992.

Related Data

Two LIS instruments were originally built. One was previously installed on the Tropical Rainfall Measuring Mission (TRMM) satellite platform and operated on-orbit from 1998 - 2015. The TRMM LIS is identical to the ISS LIS instrument and is therefore considered a related dataset. Higher level lightning data products exist at GHRC that included TRMM LIS data in their construction, but as of December 2017, all higher level products only include TRMM LIS data. Any products containing LIS data, whether from TRMM or ISS, can be located using the HyDRO 2.0 search tool with the search term "LIS". The following datasets are LIS data onboard the TRMM satellite:

TRMM Lightning Imaging Sensor (LIS) Science Data
(<http://dx.doi.org/10.5067/LIS/LIS/DATA201>)

TRMM Lightning Imaging Sensor (LIS) Backgrounds
(<http://dx.doi.org/10.5067/LIS/LIS/DATA101>)

LIS 0.1 Degree Very High Resolution Gridded Lightning Climatology Data Collection
(<http://dx.doi.org/10.5067/LIS/LIS/DATA306>)

LIS/OTD Gridded Lightning Climatology Data Collection
(<http://dx.doi.org/%2010.5067/LIS/LIS-OTD/DATA311>)

Contact Information

To order these data or for further information, please contact:

NASA Global Hydrology Resource Center DAAC

User Services

320 Sparkman Drive

Huntsville, AL 35805

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E-mail: support-ghrc@earthdata.nasa.gov

Web: <https://ghrc.nsstc.nasa.gov/>

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