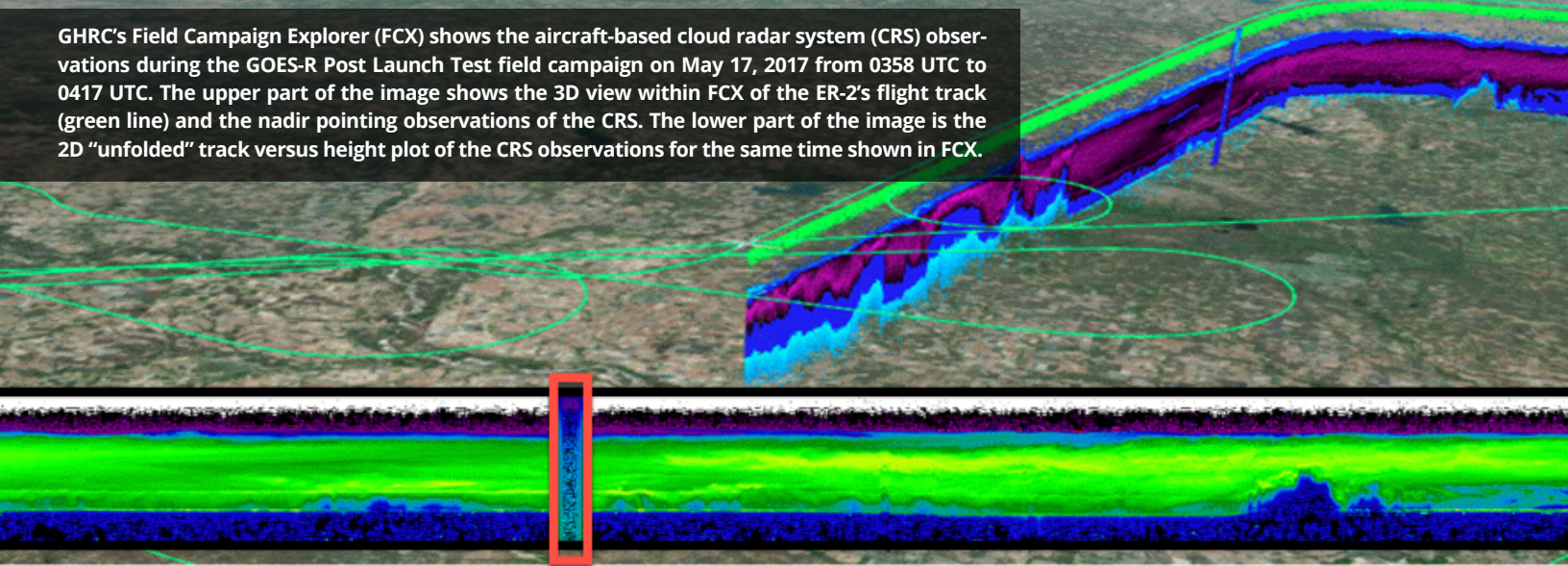


2019 ANNUAL REPORT

GHRC's Field Campaign Explorer (FCX) shows the aircraft-based cloud radar system (CRS) observations during the GOES-R Post Launch Test field campaign on May 17, 2017 from 0358 UTC to 0417 UTC. The upper part of the image shows the 3D view within FCX of the ER-2's flight track (green line) and the nadir pointing observations of the CRS. The lower part of the image is the 2D "unfolded" track versus height plot of the CRS observations for the same time shown in FCX.



Throughout the year, GHRC provides NASA with banner images, known as mastheads, for the Earthdata Website. GHRC uses the masthead to showcase unique activities, including lightning and the most recent example demonstrating the Field Campaign Explorer here. The mastheads remain on Earthdata.org for approximately two weeks. We also place images on the GHRC website for a month or two, changing the banner at regular intervals. This image was featured on the GHRC website, and on the Earthdata Website for two weeks in September 2019.

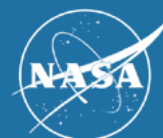


EST **1991**

MISSION STATEMENT

The **Global Hydrology Resource Center (GHRC)** is one of NASA's Distributed Active Archive Centers (DAACs) and is managed jointly by the Earth Science Department at NASA's Marshall Space Flight Center and the University of Alabama in Huntsville's Information Technology and Systems Center. The NASA GHRC DAAC is a member of national and international data organizations including NASA's Earth Science Data and Information System (ESDIS), the Federation of Earth Science Information Partners (ESIP), and the International Council for Science (ICSU) World Data System (WDS).

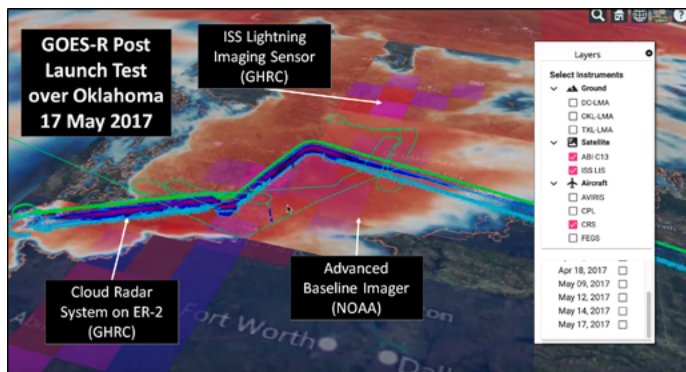
"The GHRC provides a comprehensive active archive of both data and knowledge augmentation services with a focus on **hazardous weather, its governing dynamical and physical processes, and associated applications.** Within this broad mandate, GHRC focuses on **lightning, tropical cyclones and storm-induced hazards** through integrated collections of satellite, airborne, and in-situ data sets."



COVER STORY - FIELD CAMPAIGN EXPLORER

The Field Campaign Explorer (FCX) system was originally designed to help users discover and visualize data collected during, as the name suggests, field campaigns. More recently the FCX system will be extended to serve as an excellent general-purpose platform with which to support visualizations of many of GHRC's datasets. This year's efforts have focused on shifting FCX to a flexible visualization software solution, as well as incorporating the best practices from Visualization for Integrated Satellite, Airborne, and Ground-based data Exploration (VISAGE), an Advanced Information Systems Technology project.

A top priority has been to make FCX a cloud-native system. This improves the expandability of the software by enabling additional resources during intensive processing requests and improving efficiency. Also, with the software co-located in the cloud with the data, it saves time for end users who would have to download and display data, and more effectively incorporates related datasets from other DAACs. For the initial **demonstrations of cloud-native FCX**, the emphasis has been to focus on the GOES-R Post Launch Test (PLT) field campaign, with a variety of datasets from ground-, airborne-, and space-based platforms. The design architecture allows users to select the time frame and datasets they wish to observe. The FCX system will automatically indicate which datasets are available for a certain flight or which flights a specific instrument is on. Furthermore, links to the GHRC archive are provided, where user guides, mission flight reports, and data download options will be available.



CLOUD MIGRATION

Cloud-based ingest, archival, and distribution is quickly growing in scope and capability. The GHRC DAAC is one of the first NASA DAACs operating in the cloud. As of the end of fiscal year 2019, the GHRC is projected to be the first NASA data center to have all of its holdings in the cloud. GHRC is leading activities to develop the procedures necessary to effectively carry out the DAACs' mission in the cloud. GHRC has migrated its on-premise legacy workflows to the NASA Next Generation Application Platform (NGAP), which runs on the Amazon Web Services (AWS).

GHRC has worked to ensure robust, cloud-based data operations, as well as help guide what the future looks like for other NASA data archive centers. This has been accomplished using a common data ingest and archive framework, called Cumulus, and utilizing a continuous integration and deployment pipeline provided by NASA Earthdata. Combined, this will build a verifiable and trustworthy cloud infrastructure.

Becoming a cloud-native DAAC offers our end-users a number of advantages. First, users can develop cloud-based analysis software to interrogate DAAC holdings. This saves users time by not having to download data to a local machine, where space and processing constraints may limit activities. Secondly, GHRC can provide basic analysis tools. While these do not replace user-specific analysis code, these basic capabilities can be established for all available datasets so that end-users do not have to worry about downloading data and having the proper libraries and system configurations. In other words, these will become cloud-based data recipes. GHRC will focus on providing cloud-based services to analyze, manipulate, and visualize (e.g., Field Campaign Explorer) dataset holdings.

NASA Earthdata Spotlights GHRC User Working Group Chair, Dr. Pierre Kirstetter

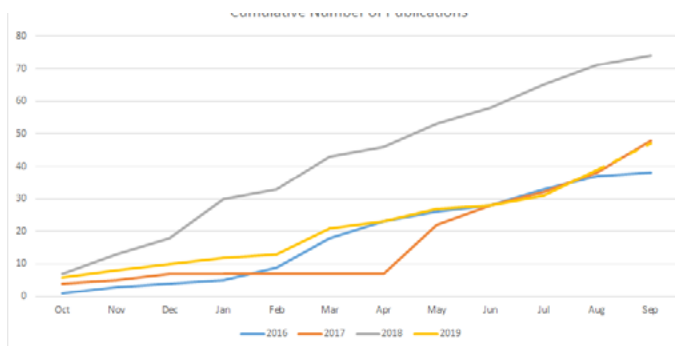
NASA Earthdata promotes the efforts of the DAACs by highlighting individuals who work with the DAACs. This year, GHRC recommended **Dr. Pierre Kirstetter** for a user profile for his role as a DAAC user and serving as the chair for GHRC's User Working Group. Dr. Kirstetter discussed his efforts in improving our understanding of precipitation and flooding. Dr. Kirstetter is an Associate



Professor at the School of Meteorology and School of Civil Engineering and Environmental Science at the University of Oklahoma. In addition, he is a faculty member of the Advanced Radar Research Center at the University of Oklahoma and an affiliate with the National Severe Storms Laboratory in Norman, Oklahoma. Thank you Dr. Kirstetter for volunteering your time!

GHRC DATASET PUBLICATIONS – A YEAR OF CHANGE

The past year has been eventful, particularly with the government shutdown. In spite of the changes, GHRC personnel maintained steady progress, thanks to the efforts from 2018 to establish a well-defined data publication process. Cross-training additional GHRC personnel has been another focus for 2019. Thanks to these efforts, GHRC has published 48 datasets for the year.



In addition, GHRC has received almost all of the datasets from the [GOES-R Post Launch Test](#) and GPM Ground Validation [ICE-POP](#) field campaigns. These publications will be completed in early 2020. This has allowed GHRC to update 15 user guides of older datasets to the latest format, as well as improving the metadata for 49 datasets. These metadata updates should be completed in early fiscal year 2020.

The Global Precipitation Measurement (GPM) Mission Ground Validation Validation Network (VN)



This year marks another major milestone in the collaboration between GHRC and GPM with the publication of the GPM Ground Validation Validation Network ([GPM VN](#)). This provides over four-and-a-half years of direct match-ups between the GPM's Dual-frequency Precipitation Radar and Microwave Imager with ground radar, particularly over the continental United States.

This data set will see updates every 6-12 months.

Major Update to IPHEX



The PIs for the Integrated Precipitation and Hydrology Experiment ([IPHEX](#)) have provided a major update to this data collection. The campaign was conducted in North Carolina during April to June 2014 to characterize warm season orographic precipitation regimes and the relationship

between these regimes and hydrological processes in complex terrain. Many of the instruments have been in place both before and after the campaign, allowing GHRC to publish an expanded dataset covering 10 years of observations for this region.

A New Mission: IMPACTS



This summer, GHRC submitted a proposal and was selected to be the host DAAC for the Investigation of Microphysics and Precipitation for Atlantic Coast-Threatening Snowstorms (IMPACTS), one of NASA's third group of Earth Venture Suborbital (EVS-3) missions. IMPACTS will encompass

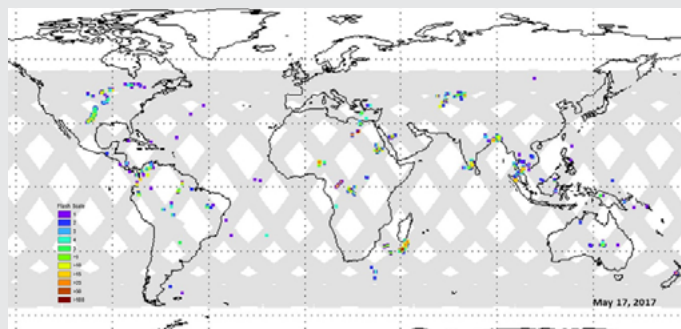
three airborne field campaigns to take place in January through March of 2020-2022. GHRC has been actively participating with the IMPACTS team to assess the data to be archived and to coordinate with the PIs.

MAJOR MILESTONE FOR THE INTERNATIONAL SPACE STATION LIGHTNING IMAGING SENSOR







Launched in February 2017 as part of the Space Test Program-Houston (STP-H5) mission, the Lightning Imaging Sensor (LIS) aboard the International Space Station (ISS) has become a key, ongoing dataset for the GHRC. The instrument has been managed locally in Huntsville, Alabama in a joint effort by the Lightning Science Team and GHRC. The mission achieved a major milestone in June when it successfully completed its End-of-Mission Program Review. Due to this success, the ISS LIS has been approved for an extended mission and will remain a key asset of the GHRC archive for at least the upcoming fiscal year.

As part of the program review, the Lightning Science Team and GHRC focused on releasing version 1.0 of the ISS LIS validated algorithm, replacing the provisional code from June 2018. This includes corrections to the background images, footprint size of flashes, partial orbit files, and reports the radiance values. GHRC has published the validated near-real time ISS LIS data, which is available every two minutes, and the daily non-quality controlled observations. The science level quality controlled data that have undergone extensive, manual checks will be published in early fiscal year 2020. The near real-time data are also available through GHRC's partnership with NASA's Land, Atmosphere Near real-time Capability for EOS (LANCE) site.

The latest ISS LIS data can be found on [GHRC's HyDRO search page](#), the [ISS LIS dataset page](#), and through [LANCE](#).



COMMUNICATING WITH THE COMMUNITY – GHRC OUTREACH AND USER SERVICES

-  Event Micro Articles
-  Instrument Micro Articles
-  Phenomena Micro Articles
-  Publication Micro Articles
-  Field Campaign Micro Articles
-  Application Micro Articles

The most common outreach performed by GHRC is the creation of **Micro Articles**. This is a short document that brings together GHRC data and key science concepts. GHRC has six types of micro articles; Applications, Events, Field Campaigns, Instruments, Phenomena, and Publications. GHRC averaged one micro article per quarter this year. Looking forward to

2020, GHRC will emphasize instruments from the IMPACTS field campaign as well as unique events and phenomena.

- **MA: Field Campaign: GOES-R Post Launch Test (PLT)**
- **MA: Instrument: Lightning Mapping Array (LMA)**
- **MA: Instrument: Cloud Physics Light Detection and Ranging (CPL)**
- **MA: Phenomena: Atmospheric Rivers**
- **MA: Instrument: Cloud Radar System (CRS)**



GHRC also creates **Data Recipes** that are step-by-step instructions on how to read, plot, or convert data. Two were created this year. GHRC plans to utilize efforts for the FCX and cloud migration to begin to establish Data Recipes for more of the DAAC's holdings in the next fiscal year.

- **DR: ISS LIS Lightning Flash Location Quickview using Python 3.0 and GIS**
- **DR: LANCE NRT AMSR2 L2B Global Swath Rain Ocean Data Quickview**

GHRC Supports NASA Earthdata Outreach



GHRC coordinates with NASA's Earthdata group on activities that are supported by all twelve DAACs. Each year each DAAC provides a presentation on relevant activities to share with the larger community. This year GHRC presented **Discover NASA ISS Lightning and Associated Validation Data from GOES-R**. In addition to being an introduction for GHRC's new DAAC Scientist, the presentation provided details about GHRC, the importance of lightning observations, and activities GHRC has supported with lightning safety and the GOES-R Post Launch Test field campaign. The webinar was a great success and GHRC looks forward to participating again next year.

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Conference Involvement

GHRC maintains regular involvement with a number of conferences throughout the year. The two largest are the upcoming American Geophysical Union (AGU) Fall meeting in San Francisco, California (December 2019) and the American Meteorological Society (AMS) annual meeting in Boston, Massachusetts (January 2020). The following topics will be presented:

AGU 100 | FALL MEETING

- Near Real-Time Distribution of Land, Atmosphere Near real-time Capability for EOS (LANCE) ISS LIS Lightning Data available at the Global Hydrology Resource Center (GHRC) Distributed Active Archive Center (DAAC)
- Operating a Cloud-Native Data Center
- A New, Cloud Native Visualization Tool for Earth Science Data at the Global Hydrology Resource Center (GHRC) Distributed Active Archive Center (DAAC): Field Campaign Explorer and Others
- Cloud Native Data Processing and Visualizations Techniques for Earth Science Data



- Near Real-Time Distribution of LANCE ISS LIS Lightning Data available at the Global Hydrology Resource Center (GHRC) Distributed Active Archive Center (DAAC)
- Operating a Cloud-Native Data Center
- Cloud Native Data Processing and Visualizations Techniques for Earth Science Data

GHRC MEMBER HIGHLIGHTS

The GHRC would like to congratulate several of our team members on exciting personal and professional developments this year.

Ajinkya Kulkarni: Congratulations to Ajinkya for winning the NASA Science and Technology Office (ST10) Shark Tank peer award. This is for demonstrating a strong desire to improve operations and software development processes for the Global Hydrology Resource Center.

Leigh Sinclair: Congratulations to Leigh and her husband Will who welcomed their first daughter into their family in March.

Abdelhak Marouane: Congratulations to Abdelhak for earning his Master's Degree in Computer Science.

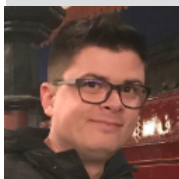
NEW GHRC TEAM MEMBERS

Staff

The GHRC has welcomed several new team members this year supporting a variety of activities.



Brian Ellingson is pursuing a Masters of Science in Computer Science through Georgia Tech, while working as a Research Associate at GHRC. He currently supports VISAGE and FCX researching novel solutions to computing problems.



John Simmons is a research scientist at GHRC with a history of development and DevOps for AWS Cloud and on premises environments. He is currently pursuing a Masters of Science in Cyber Security.



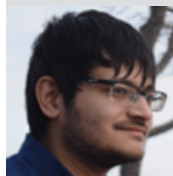
Dr. Geoffrey Stano joined the GHRC after 11 years with NASA's Short-term Prediction Research and Transition Center (SPoRT). His expertise is with operational applications of ground- and space-based lightning data. Dr. Stano will serve as GHRC's DAAC scientist and will lead GHRC's Data Management and Outreach and User Services groups, support activities with the Field Campaign Explorer, and foster collaborations to establish new datasets for publication.

Students

GHRC's affiliation with The University of Alabama in Huntsville (UAH) means we have talented students on our team who can help out in many areas while gaining professional experience.



Slesa Adhikari is completing her Masters Degree in Computer Science while working as a Graduate Research Assistant at ITSC. She's currently responsible for developing web visualizations for various earth-science-related datasets for Field Campaign Explorer.



Bibek Dahal is completing his Masters Degree in Computer Science while working as a Graduate Research Assistant at ITSC. He is currently responsible for developing a cloud architecture for rendering large visualizations of various datasets for Field Campaign Explorer.

Essence Raphael is a graduate student in the UAH Atmospheric Science program. She was a member of the Hindu-Kush Himalayan Disasters research team that partnered with GHRC to assess lightning risk in Nepal and Bangladesh using GHRC's Lightning Imaging Sensor (LIS) datasets. She currently works with the GHRC Outreach/User Services and Data Management teams.



Khomsun Singhirunnusorn is a PhD Candidate in Computer Science (Computer Vision) at UAH. His dissertation is 360 degrees localization using a single camera. He works as a Graduate Research Assistant at ITSC developing 3D visualizations and ingesting diverse datasets for VISAGE.

LOOKING AHEAD TO 2020

Fiscal year 2020 will see GHRC continue its leadership role in cloud-based applications. For fiscal year 2020, GHRC will transition all new data publications directly to the cloud, while simultaneously supporting on-premise efforts for comparison purposes. With the successful demonstration of the FCX in August, efforts will focus on expanding the system's capabilities, such as for cloud-based science applications and a potential tool for event-based applications.

In addition to the cloud efforts, a number of data publication projects will reach their conclusion. This includes the publication of all available ICE-POP and GOES-R PLT field campaign data. Also, the ARC (Analysis and Review of Common Metadata Re-

pository (CMR)) metadata fixes will be completed.

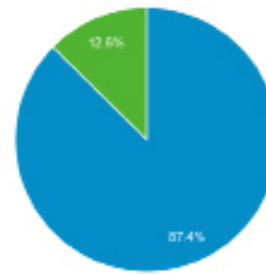
With the conclusion of these projects, new efforts will begin, particularly the IMPACTS mission. GHRC will coordinate with the IMPACTS team to quickly ingest and publish datasets as they become available at the end of the fiscal year. GHRC will coordinate with our User Working Group and NASA ESDIS on expanding GHRC's lightning portfolio, starting with more lightning mapping array data as part of the GOES-R PLT and as ground validation for the ISS LIS. The RELAMPAGO field campaign, and its associated lightning mapping array, will be another dataset to consider. Further options with other instruments will depend on approval. Each effort opens new opportunities for GHRC's end users and in-house projects.

METRICS FROM FISCAL YEAR 2019

For fiscal year 2019 (October 1, 2018 through September 30, 2019) GHRC DAAC had a consistent web usage. Nearly two-thirds of these users came from the United States. The remaining users were predominantly from seven countries; the United Kingdom (7%), China (4%), Spain (3%), Germany (2%), and Brazil, France, and Italy each at 1%. The remaining users are scattered across the globe, but with total percentages of < 1% each.

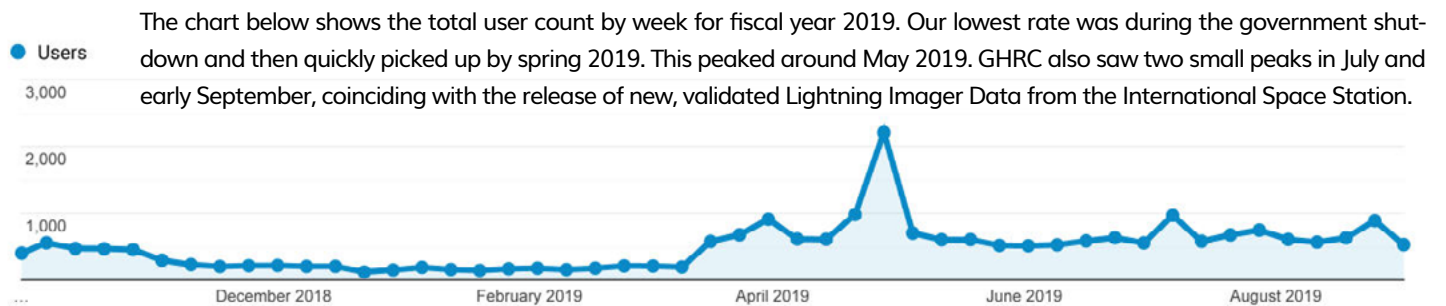
FY2019 GHRC Web Users: New vs. Returning

■ New Visitor ■ Returning Visitor



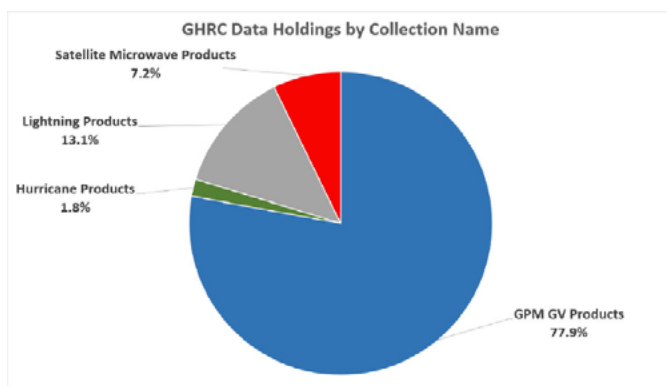
A review of our web users for fiscal year 2019 was remarkably consistent with 2018. As the figure at left shows, about 13% of visitors to the GHRC site were new.

FY2019 GHRC Weekly Total User Count



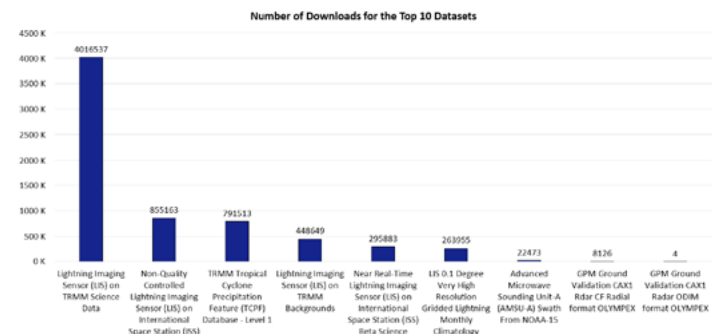
GHRC Data Holdings by Collection Name

GHRC groups its data holdings into various collections. This approach allows for similar data to be discovered by end users even if split across different publications, particularly field campaigns. This year, the primary collection is with the GPM ground validation program, covering nearly 78% of all holdings. Currently, GHRC is evaluating all published data to establish new collections, if necessary.



Top 10 datasets for FY2019

Another way GHRC tracks data usage is by evaluating the number of downloads associated with each dataset. The figure below shows the top 10 most downloaded datasets from the GHRC's holdings for fiscal year 2019. Lightning datasets make up five of the top six datasets, including the top two. The TRMM Tropical Cyclone Precipitation Feature Database is the highest, non-lightning downloaded dataset at number 3.



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

You can contact user and data services by phone or E-mail using the number or address below:

GHRC User Services Office
National Space Science and Technology Center
320 Sparkman Drive
Huntsville, AL 35805

Phone: 256-961-7932

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