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Lightning in a Flash: A Cloud-Based, Open-Source Capability to Support Data Access and Analysis of Space-Based Lightning Observations

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NASA's Earth Science DAACs and GHRC

- **Distributed Active Archive Centers (DAAC)**
  - NASA's Earth Observing System Data and Information System (EOSDIS)
- **Role**
  - Process, archive, document, and freely distribute Earth Science data
  - Enable the use of these data by users in their research
- **GHRC**
  - Global Hydrometeorology Resource Center
  - 1 of 12 NASA DAACs
  - Collaboration between NASA Marshall Space Flight Center and the University of Alabama in Huntsville

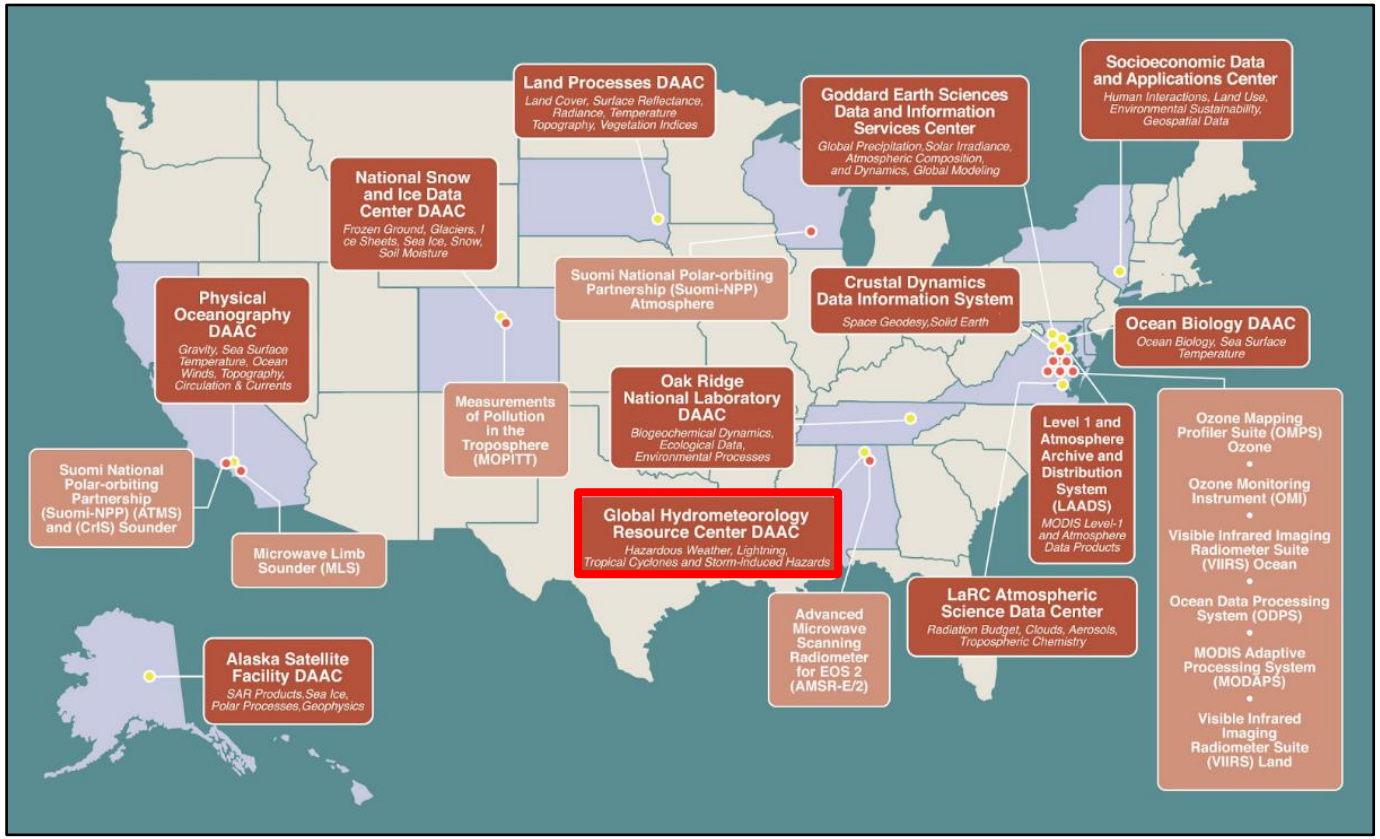

Image courtesy NASA EOSDIS

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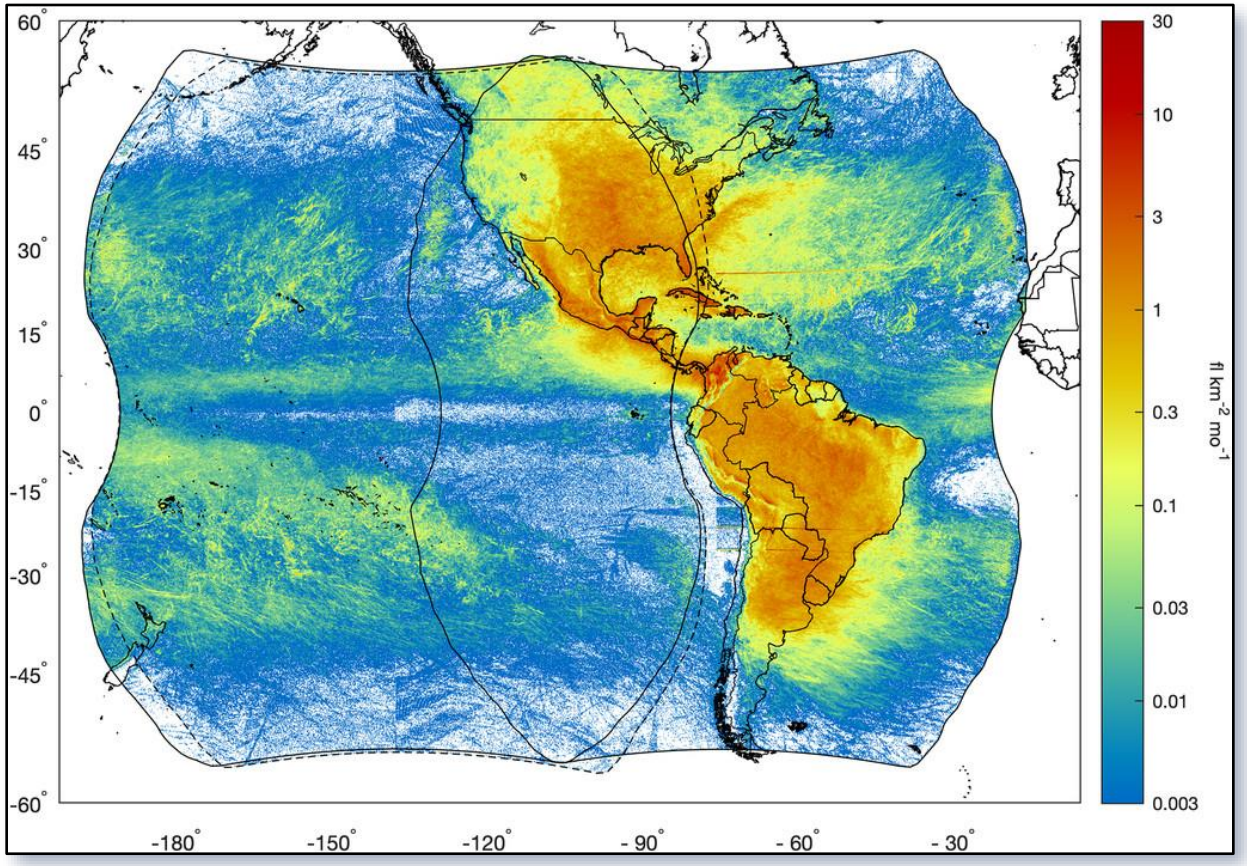
Value of Lightning Observations

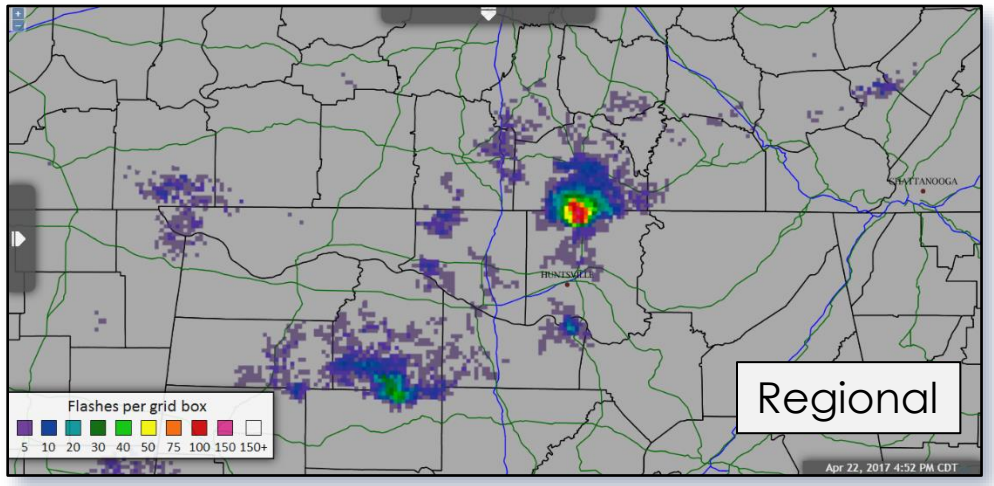
Lightning Fast Facts

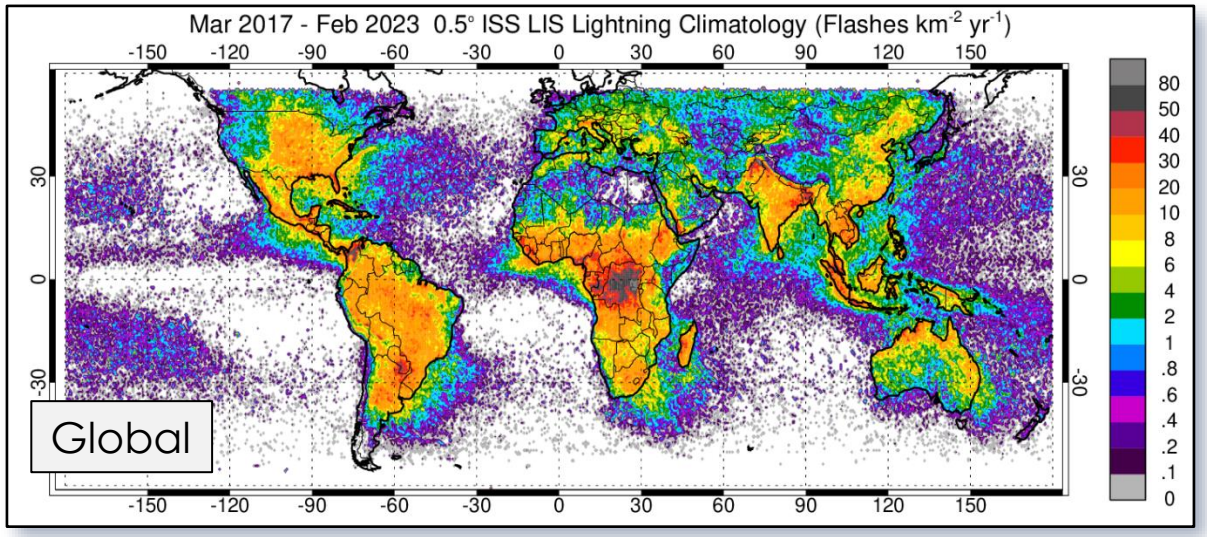
- **~45 flashes, globally, every second**
- **~25 million strikes in the U.S. per year**
- **Safety**
  - Significant progress in the U.S.
    - < 30 deaths per year
  - Major issue globally
    - ~24 thousand killed per year
    - Upwards of a quarter million injured
- **Damages – Difficult to quantify**
  - $451 million per year in U.S.
  - 9,000 wildland fires from 2008-2012



GOES-East / -West Geostationary Lightning Mapper
Courtesy: https://doi.org/10.1175/MWR-D-20-0242.1

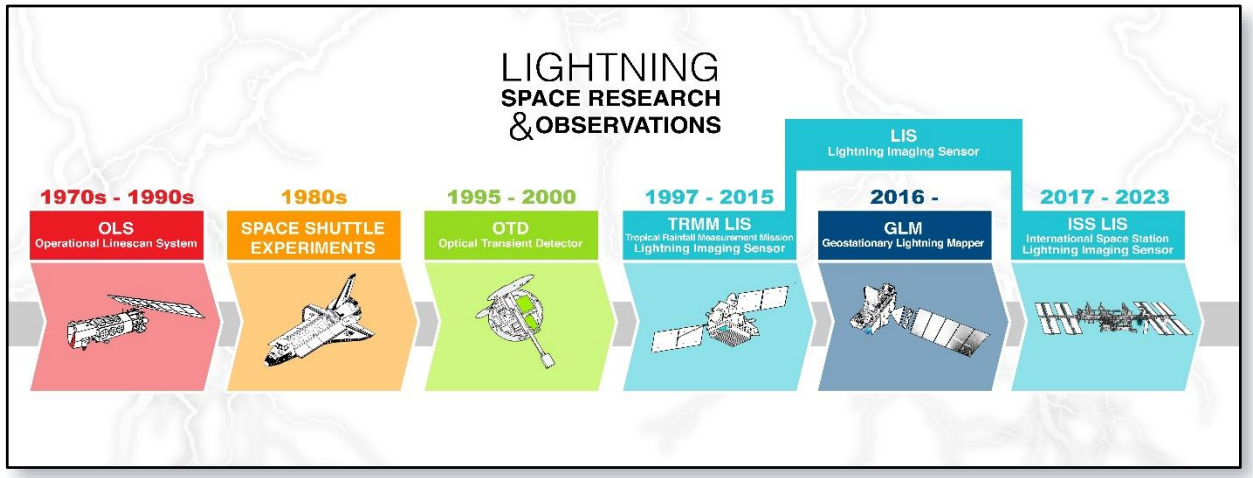
Uses of Lightning Data

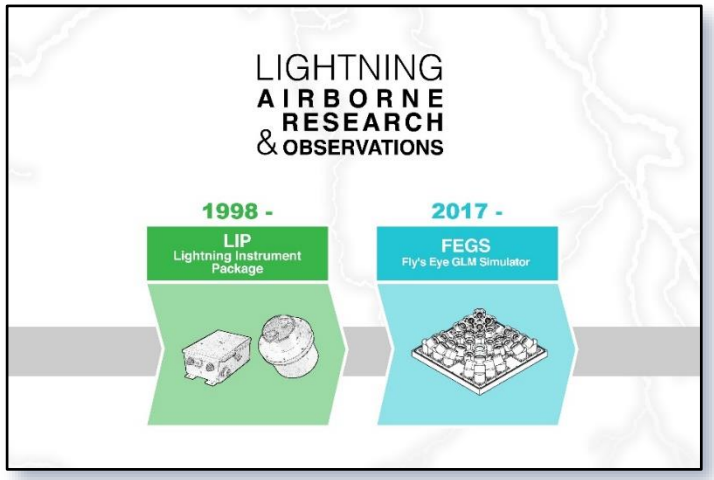


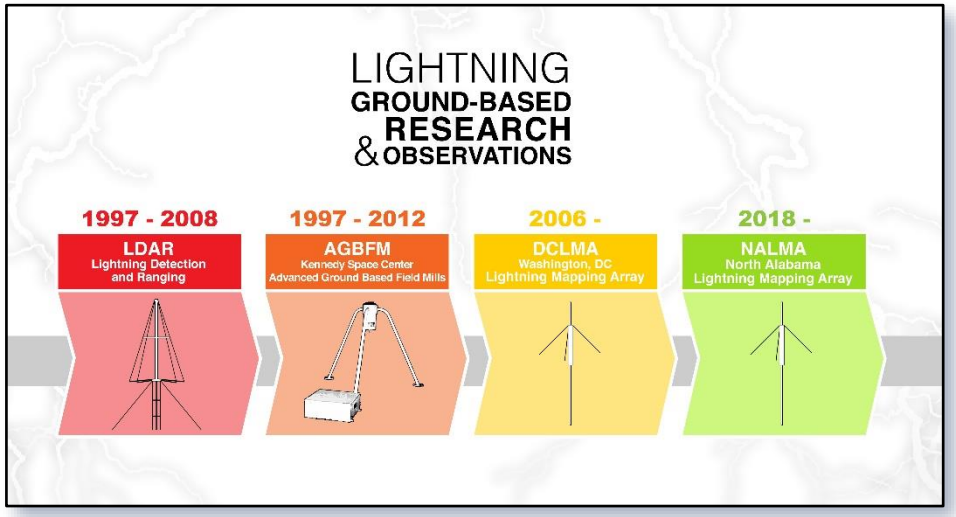


- **Improving observing abilities**
  - Ground (high resolution, but smaller area or privately owned for global data)
  - Satellite (wider coverage, lower resolution)
  - Can see intra-cloud flashes that can make up to 90% of all flashes in some storms
- **Safety and Decision Support**
  - Identify flash extent and megaflashes (>100 km in length)
  - Lightning jumps for severe weather
- **Proxy for Microphysics**
  - Can infer convection (i.e., vertical motion) with lightning observations
  - Highlights regions of greater precipitation where radars are unavailable

Lightning Data at GHRC







- **Wide Variety of Lightning Data**
  - 6-8 of GHRC's top 10 datasets per year
  - Lightning Imaging Sensors most popular
- **Continuing to Grow**
  - Anticipate a new global dataset from the World Meteorological Organization
- https://search.earthdata.nasa.gov/portal/ghrc/
  - Use 'lightning'

Using GHRC Lightning Data

Cloud Transition

- **Rapid Growth of Earth Science Data**
  - 600 PB by the end of the decade
  - GHRC increasing by 240 TB this year
  - NASA embracing open science
- **Shifting to Cloud Services**
  - NASA Earthdata - Amazon Web Services
  - Reducing local computer storage
  - Opportunity for cross-DAAC and cross-agency data sharing
- **GHRC – Cloud Pathfinder**
  - Pathfinder for DAAC Cloud Ops in 2019
  - First DAAC with all data in cloud in 2020
  - All operations in cloud by 2024

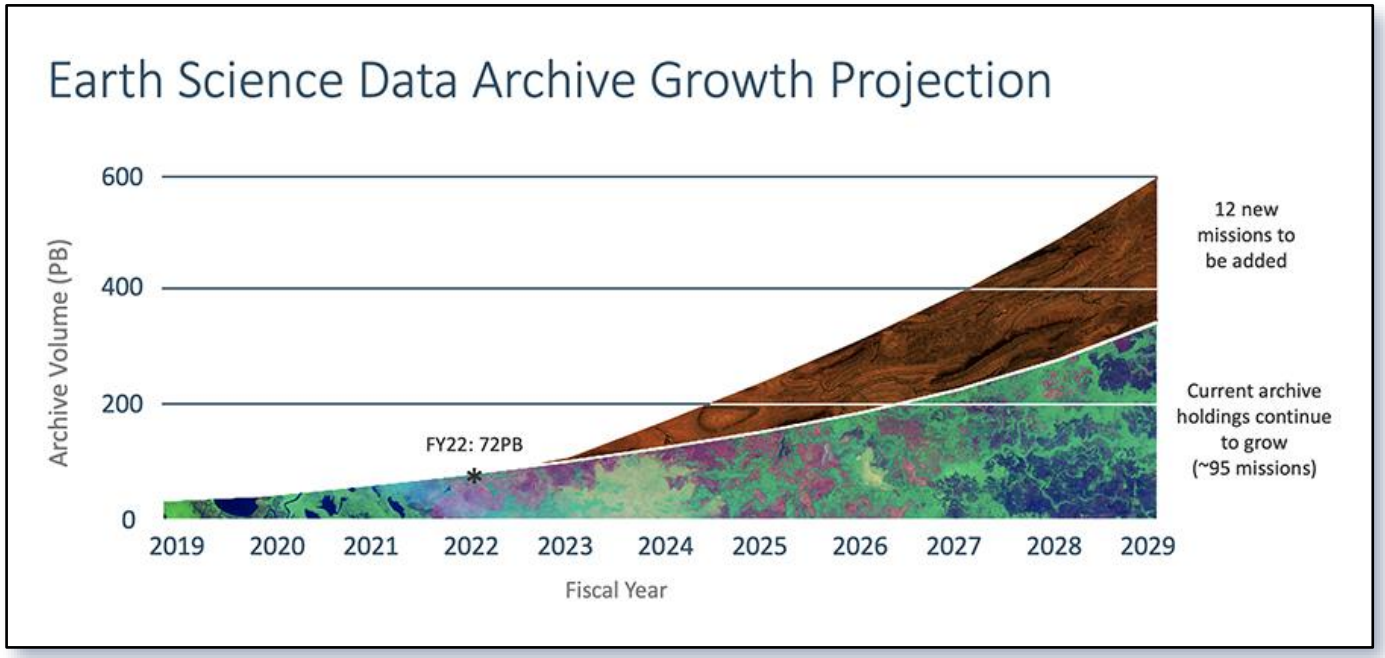
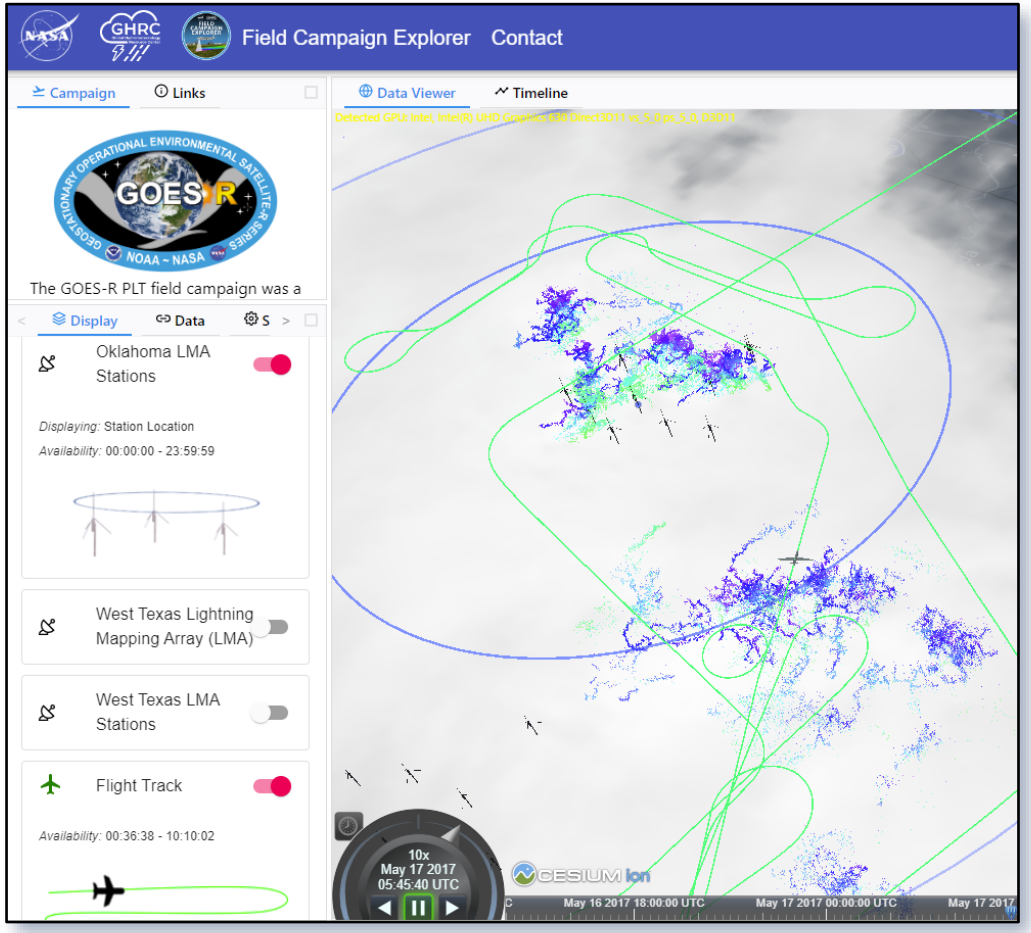


Image courtesy NASA EOSDIS

Specific Needs for Lightning

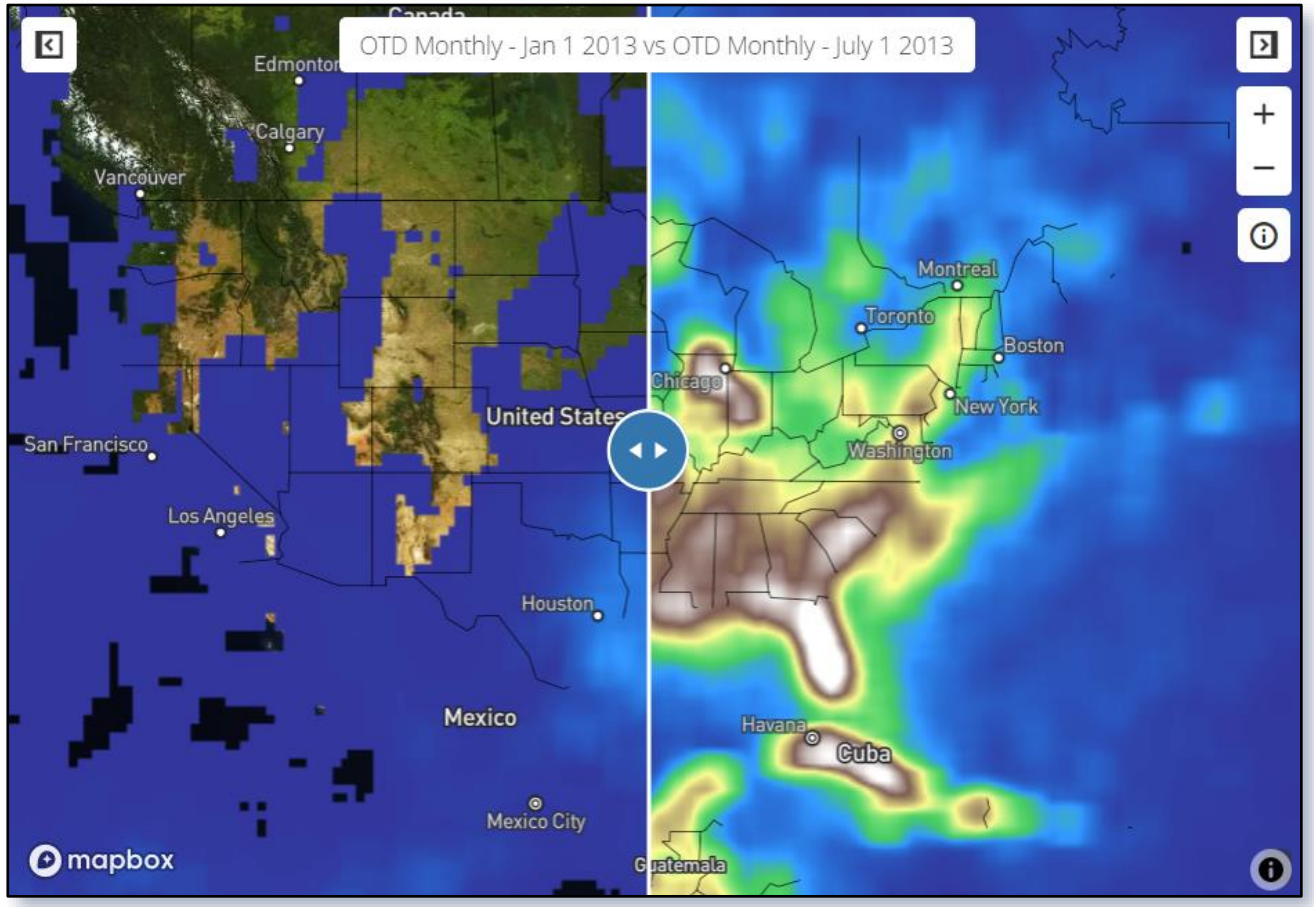
- **Complex data files**
  - Large volume of individual observations
  - Multiple platforms with different abilities
  - Derived products can take time to process
- **GHRC aims to support users**
  - Data recipes – Code to do basic manipulation and processing
  - Field Campaign Explorer (FCX) – Coincident with other data
  - Want to create basic analysis abilities
- **Lightning Dashboard**
  - Quickly visualize multiple lightning datasets
  - Offer basic analyses



https://ghrc.earthdata.nasa.gov/fcx/index.html

FCX in GHRC's 2022 webinar: https://youtu.be/tqiklJm3rbI

Development of the Lightning Dashboard

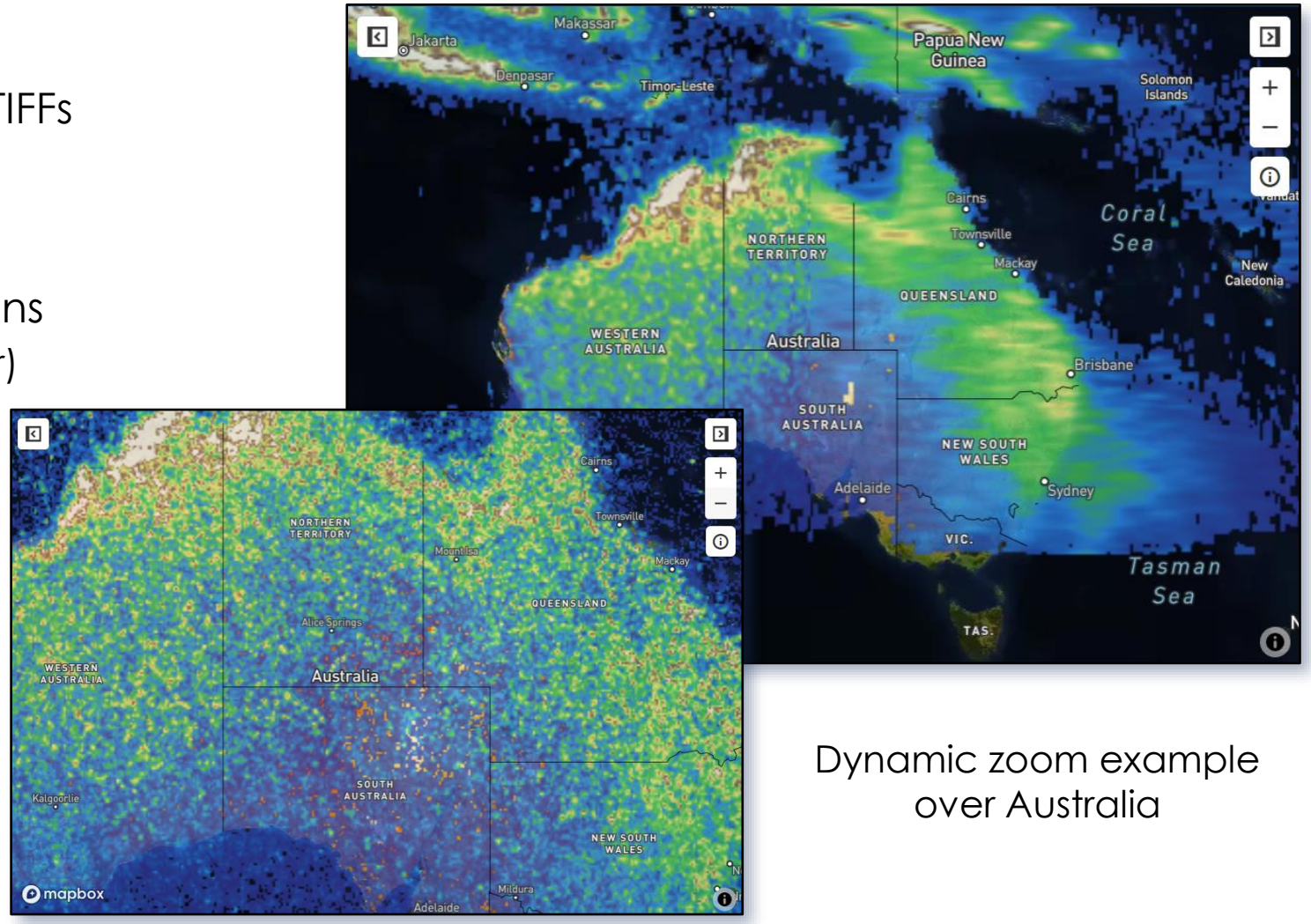


Sample Dashboard: OTD January (left) and July (right)

- **Use cloud expertise / open science**
  - Use FCX experience for a cloud-based tool
  - Use NASA's Covid-19 dashboard as foundation
    - Highlights open science advantages
- **Development approach**
  - Provided funding for one year
  - Goal: Functional minimum viable product (MVP)
  - Expanded MVP this year
- **Goals**
  - Cloud-based (no downloads)
  - Use most popular GHRC lightning data
  - Basic visualization
  - Several, simple analyses

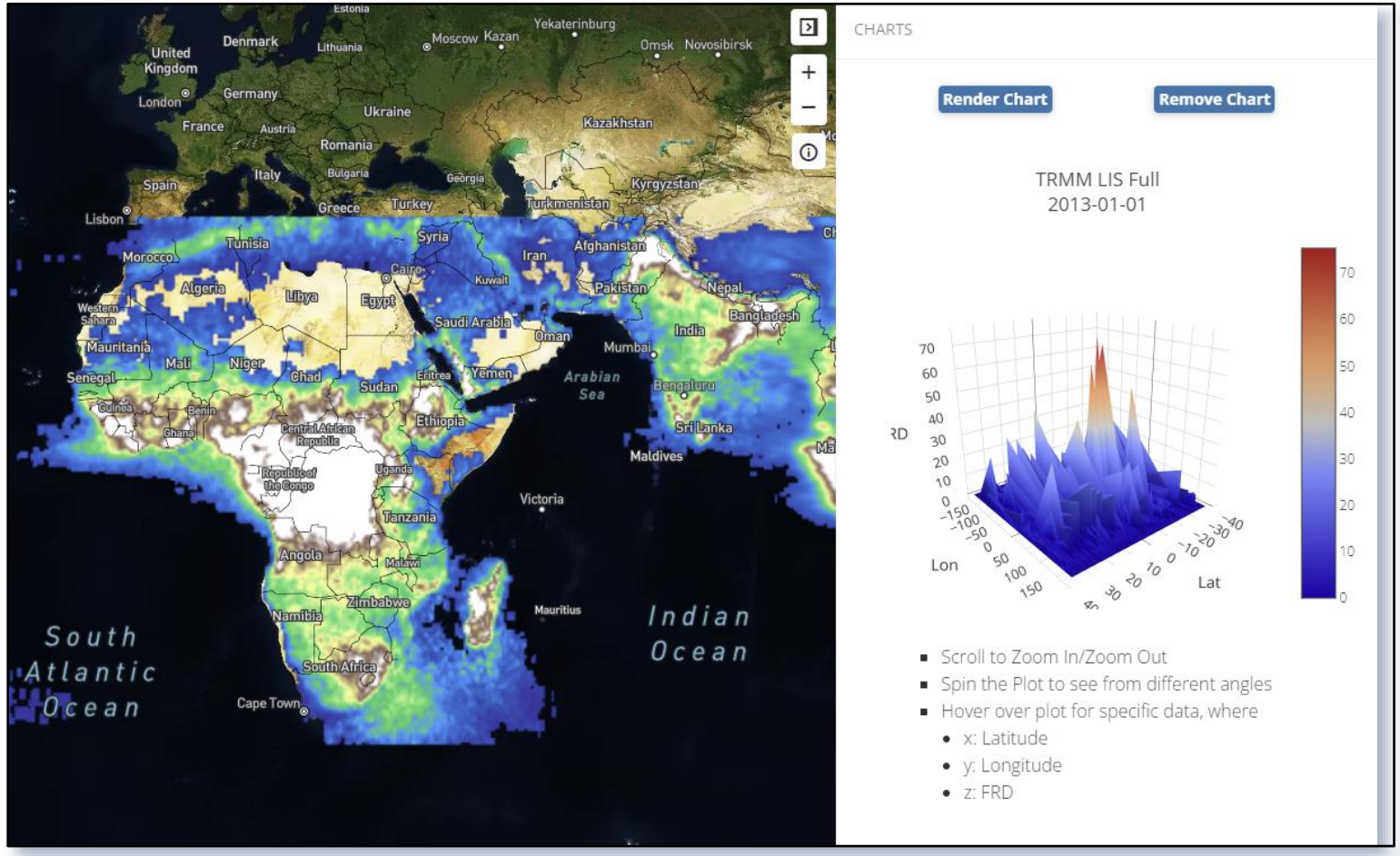
Technical Details

- **Imagery**
  - Convert data to cloud optimized geoTIFFs
- **Software**
  - React for frontend interface
  - Amazon Web Services lambda functions
    - Example is metadata filter (shown later)
  - Terracotta python as tiling server
    - "Heavy lifting" done here
  - Map server is map box
    - Similar to Cesium JS – used for FCX 3D work
    - Map box best known for 2D displays
- **Capabilities**
  - Basic flash rate densities
  - Slider comparison feature
  - Histograms
  - Data analysis



Dynamic zoom example over Australia

Future Work



Lightning Dashboard: https://ghrc.earthdata.nasa.gov/lightdash/index.html

- **Expand Capabilities**
  - Incorporate additional visualizations
    - Density products
    - Update color curves
  - More analysis options
    - Intercompare datasets
  - Incorporate additional lightning datasets
    - More ISS LIS data
    - Ground-based lightning mapping arrays
- **Open Source**
  - Deployed in local cloud instance
  - Aim to prepare open source release

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THANK YOU!

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