GHRC Development

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Outline

• Team Members
• Introduction and Focus Areas
• Revisiting Field Campaign Explorer
  • Recent developments
  • Current science use cases
  • Demonstrations
  • Future Plans
# Team Members

## Students
- Bibek Dahal (Jan 19)
- Navaneeth Selvaraj
- Khomsun Singhirunnusorn
- Pooja Khanal (Aug 19)
- Slesa Adhikari (May 19)
- Sravani Koppala (May 19)

## Science
- Lucy Wang
- Geoffrey Stano (Jan 19)
- Yuling Wu (Oct 19)

## Development Staff
- Brian Ellingson (Jan 19)
- Navaneeth Selvaraj (Sep 19)

## PI/Advisors
- Manil Maskey
- Helen Conover
- Todd Berendes

## Support Staff
- Abdelhak Marouane
- Charles Collins

## Lead
- Ajinkya Kulkarni

## Operations/Product Owner
- Will Ellett
Introduction

• GHRC is the first DAAC to operate fully in the cloud.

• Data from other DAACs will also be available in the cloud and co-located with software.

• GHRC has developed expertise in cloud native data processing, cloud native architectures, and cloud based science tools/services.

• GHRC is well positioned to take advantages of this expertise and previous experience in developing data visualization services.
Focus areas

Cloud Optimized Data Publication
- Cumulus
- Earthdata Pub
- Cloud-only Data Publications (IMPACTS)

Cloud Native Data Visualizations and Services
- Field Campaign Explorer (Focus on Airborne Data Use Cases)
- Lightning Data Tools
- Data Visualization Gallery
- Virtual Reality
- Other Science Use Cases

Cloud Focused Outreach
- Webinars
- Jupyter Notebooks
- Cloud Primers
- Flash Talks
- Data Recipes
- Micro Articles
- Bulk Download Tool
FCX: Field Campaign Explorer

- FCX is a data exploration tool to provide visualization and analytic capabilities for diverse coincident datasets with the focus on airborne field campaigns.

- Features:
  - Cloud native architecture
  - Web based – no need to download large files
  - Interactive user interface for visualization and analytics
  - Repository containing data specific to the selected use cases

FCX concept to visualize and interrogate diverse, fused field campaign datasets.
FCX: Field Campaign Explorer

• Initially developed towards The Hurricane and Severe Storm Sentinel (HS3) mission

• Expanded to support a target user community - NASA Precipitation Measurement Mission Science Team (under VISAGE - NASA AIST-16-0094)

• Long term vision – a robust multi-sensor, multi-format integration system suitable for a wide array of visual analytics applications

User interface showing multiple datasets from the GPM GV Olympic Mountains Experiment in 2015.
Main Exploration Areas

- **Serverless Cloud-native technologies**
  - Amazon Web Service (AWS) Athena serverless query service for searching data stored in S3 buckets
  - Data framework with ingest and access APIs to Parquet files via the Athena query interface or cloud native data storage technologies such as Zarr and Cloud Optimized GeoTIFF (COG)
  - AWS Step Functions and Lambdas to orchestrate and run data processing and rendering code without provisioning or managing servers, automatically scaling resources as needed
  - Scalable, efficient data access to support on-the-fly rendering and analytics

- **3D data visualization and exploration of large data volumes on a web-based platform**
  - Evaluation of different 3D data rendering approaches (visual appeal, memory usage, etc.)
  - Time based animation
  - Exploration, sub-setting and download
Technical Challenges

- Incorporation of diverse data into a common analytics framework
- Efficient rendering and visualization of multiple high-volume, diverse three-dimensional datasets on a web-based platform
- Temporal alignment of data with diverse time scales and resolutions
- 3D data interrogation via map user interface
- Computations on data fields across instruments and platforms
## FCX Status Update

### 2016 (Alpha)

**Use Case:** HS3

**Datasets:**
- HAMSR
- HIWRAP
- CPL

**Visualization Type:** 2D image curtains

**Architecture:** On-prem

**No. flights:** 1  
**No. of aircrafts:** 1

### 2019 (Beta)

**Use Case:** GOES-R PLT

**Datasets:**
- ISS LIS
- CRS
- FEGS
- LIP
- LMA
- CPL
- ABI

**Visualization Type:** 3D point cloud based curtains, CZML based 3D entities, Potree (Three.js) point cloud

**Architecture:** Cloud-native

**No. flights:** 17  
**No. of aircrafts:** 1

**Use Case:** OLYMPEX

**Datasets:**
- SIMBA
- VN
- NPOL
- HIWRAP
- Disdrometers
- WRF Model

**No. flights:** 1  
**No. of aircrafts:** 3
Currently Supported Field Campaigns


- Use Case: complex baroclinic system with orographic enhancement on 3 Dec 2015; excellent sampling coordination with simultaneous satellite, airborne, & ground-based

**GOES-R Post Launch Test** – Post-launch product validation of the Advanced Baseline Imager (ABI) and Geostationary Lightning Mapper (GLM) (Continental U.S., March – May 2017)

- Use Case: validation of the GLM instrument over Oklahoma on 17 May 2017; variety of observations from aircraft, ground-based lightning mapping array, and ISS Lightning Imaging Sensor

Credits: Geoffrey Stano, Helen Conover
Implementation Design 1

Original Files & Metadata → Data Readers → Data Layers in Parquet Format → Metadata Catalog → Amazon RDS → Front-end Web App

AWS Lambdas → Glue Crawler → Parallel SQL GIS Queries → Glue Data Catalog → Amazon Athena

Selected Data Layers → AWS Step Function → On-the-fly 3D Tile Generation

3D Tiles → AWS Lambdas → Tileset.json → S3

Credits: Abdelhak Marouane
Zarr is a Python package providing an implementation of chunked, compressed, N-dimensional arrays.

Dask provides advanced parallelism for analytics, enabling performance at scale for the tools you love.

Credits: Bibek Dahal, Brian Ellingson
3D Tile Point Clouds

GPM Validation Network of coincident satellite and ground radar reflectivity averages within a cylindrical GPM view volume were rendered using an adjustable spatial density of points in 3D tile point cloud files.

Gridded ground radar subset demonstrates point cloud with stippling (each point offset by a small random distance and direction) and variable transparency (higher values are less transparent to accentuate "hot spots")

Credits: Todd Berendes
Different 3D Rendering Approaches

NPOL radar reflectivity, gridded in a SIMBA column; wide variation in appearance depending on rendering approach

3D Tile Point Cloud, with points on a regularly spaced grid. Note the appearance of artifacts – lines between the points depending on the user’s point of view with respect to the point grid.

Cesium entities with transparency defined using Cesium’s native CZML

Point cloud with stippling (each point offset by a small random distance and direction) and variable transparency (higher values are less transparent to accentuate “hot spots”)

Grid cells rendered as 2D “billboard” entities

Credits: Khomsun Singhirunnusorn & Todd Berendes
Animating Data Through Time

Point data: cylinder height and diameter vary with rain rate and drop size; graph displays 10 minute time window

Airborne vertical curtain data rendered as time-dynamic 3D Tile Point Clouds with 30 minute linger time

Credits: Brian Ellingson
Timeline View

- Timeline view allows users find co-located datasets easily
- Allows grouping data availability by flights
- Provides ability to quickly jump to a given point in time in FCX interface
Demos

**GOES-R PLT Demo**

GOES-R Post Launch Airborne Science Cal/Val Field Campaign (March 21 to May 17, 2017)

https://ghrc.nsstc.nasa.gov/home/projects/fcx

**OLYMPEX Demo**
Future Work
Data access API also provides:

- Spatial and temporal subsetting
  - Filter data on lat, lon, time, height, etc.
- Statistics and histogram generation for analysis
  - Max, min, mean, std deviation, histogram

Radar reflectivity from DPR (for a given ground radar match-up)

Credits: Brian Ellingson
Basic Analytics (2)

Comparison across different data fields

Dynamically generated map showing differences between ground radar reflectance and GPM radar reflectance

Credits: Todd Berendes
FCX Playground

- **FCX Playground** is a place where students are exploring new techniques for data visualizations.

- Few notable demos -
  - HIWRAP and NPOL - Virtual Reality (Credits: Bibek Dahal)
  - 3D Data Visualization Video Gallery of GHRC datasets (Credits: Selsa Adhikari)
  - 3D LMA dataset visualization (Credits: Selsa Adhikari, Michael Peterson)
  - Cloud based interactive ISS LIS Visualization & Subsettings (Credits: Pooja Khanal)
  - Custom Timeline Widget (Credits: Bibek Dahal)
Science Use Case Focused Development

• Future plan is to evolve FCX beyond just a visualization platform to support answering relevant science questions as well

• For example, following are some of the science questions for GOES-R PLT field campaign that we are planning to explore—
  
  • Validate GLM lightning flash detection efficiency over land and ocean
    
    • comparing GLM lightning detection with that by the FEGS aboard the PLT aircraft (NASA’s ER-2) and by the LMA ground network
  
  • Validate the spatial and temporal accuracy of GLM flash detection
  
  • Provide surface and aircraft measurements for validation products

Comparison of GLM-LIS detected lightning on top of IR (ch14)

From FCX Playground: GLM - ISS LIS comparison (Credits: Pooja Khanal)
Conclusion

- Support additional GHRC field campaigns
- Build a single cohesive cloud based data visualization and analysis platform for GHRC
- Develop interactive data recipes and micro articles based on FCX platform & APIs
- Start discussion about about making FCX a cross-DAAC tool – currently going to work with ASDC DAAC
- Continue investigating better ways to use cloud native technologies, optimize client side data visualization performance issues, client side data subsetting, and client-side point cloud generation
THANK YOU!
QUESTIONS?