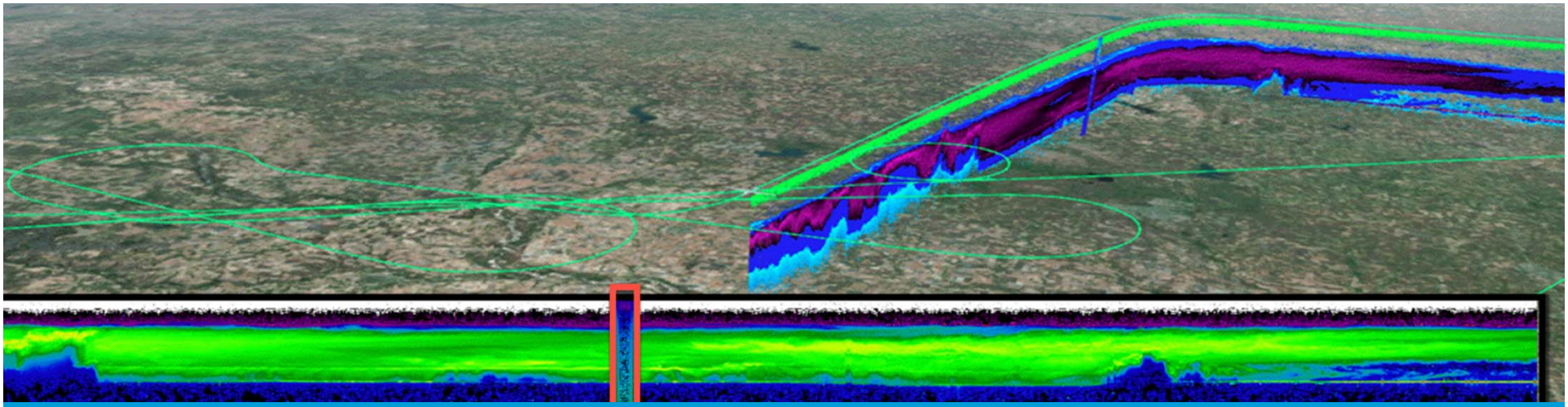


GHRC Development

Ajinkya Kulkarni
Technical Lead
ajinkya.kulkarni@uah.edu

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)

Development Staff

- Brian Ellingson (Jan 19)
- Navaneeth Selvaraj (Sep 19)

Support Staff

- Abdelhak Marouane
- Charles Collins

Science

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

PI/Advisors

- Manil Maskey
- Helen Conover
- Todd Berendes

Lead

- Ajinkya Kulkarni

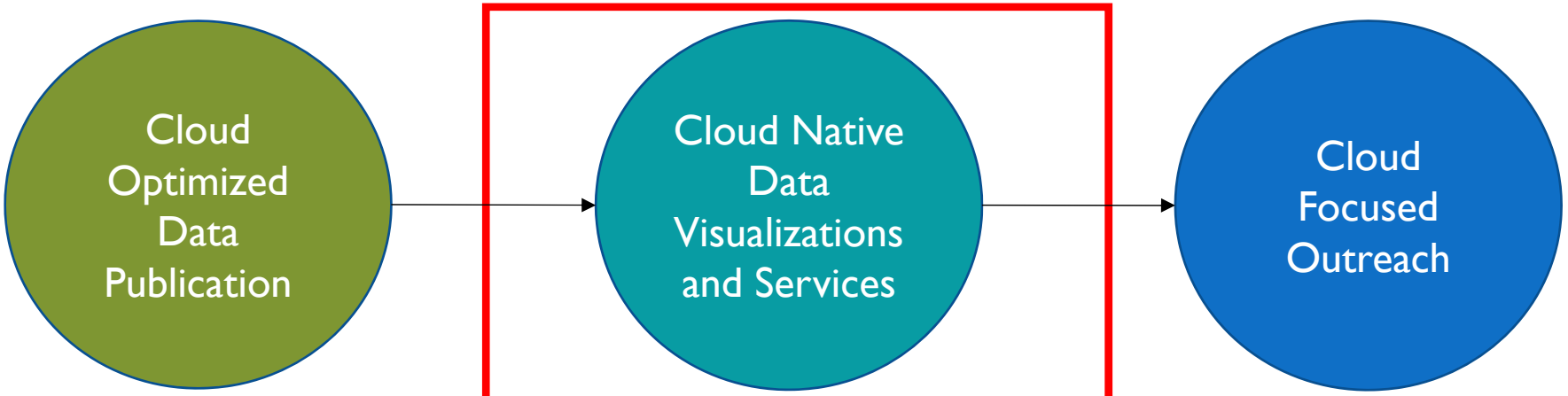
Operations/Product Owner

- 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



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

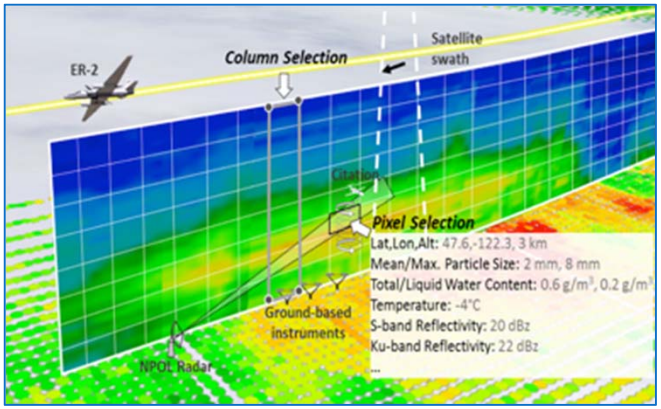
- Field Campaign Explorer (Focus on Airborne Data Use Cases)
- Lightning Data Tools
- Data Visualization Gallery
- Virtual Reality
- Other Science Use Cases

- 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***

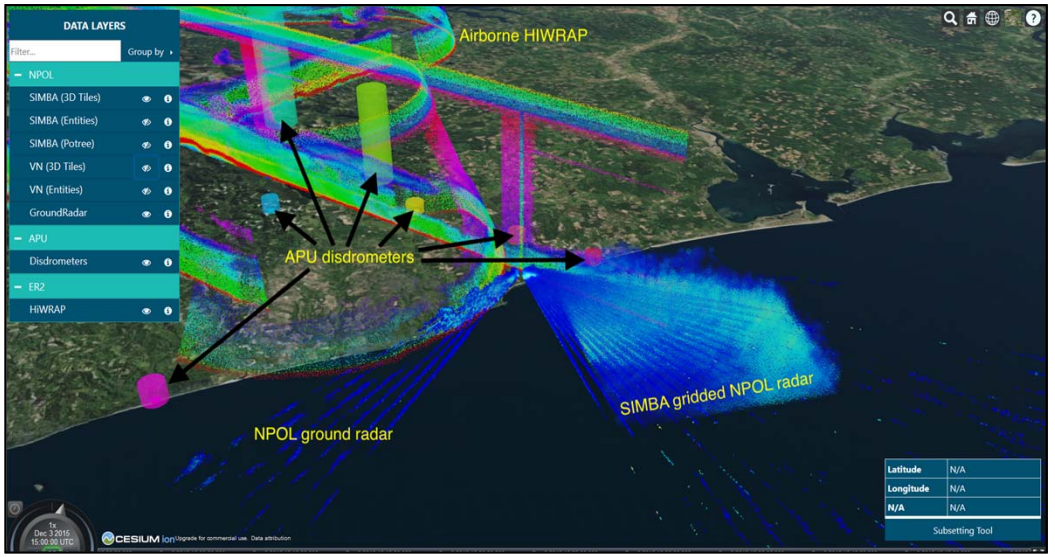
- Features:
  - Cloud native architecture
  - Web based – no need to download large files
  - Interactive user interface for visualization and analytics
  - Repository containing data specific to the selected use cases



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

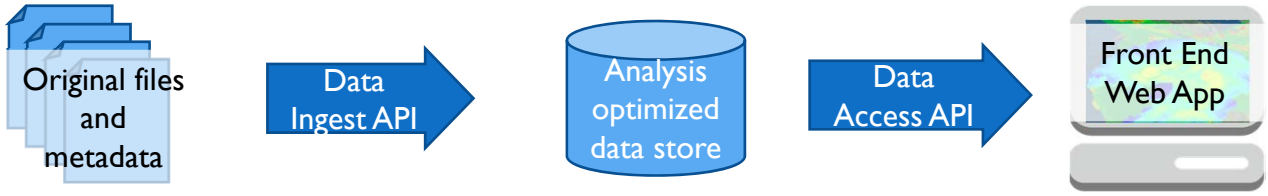
- **Serverless Cloud-native technologies**
  - Amazon Web Service (AWS) Athena serverless query service for searching data stored in S3 buckets
  - Data framework with ingest and access APIs to Parquet files via the Athena query interface or cloud native data storage technologies such as Zarr and Cloud 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

High Level Architecture:



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

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

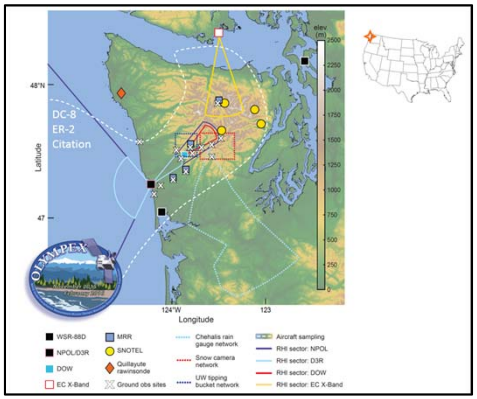
Visualization Type: 3D point cloud based curtains, CZML based 3D entities, Potree (Three.js) point cloud

Architecture: Cloud-native

Currently Supported Field Campaigns

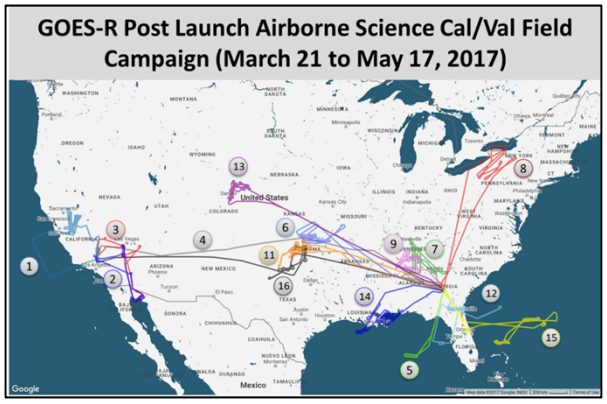
Olympic Mountains Experiment (OLYMPEX) - Rain & snow in extreme coastal & topographic gradients (NW Washington, Nov 2015 – Feb 2016)

- *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)

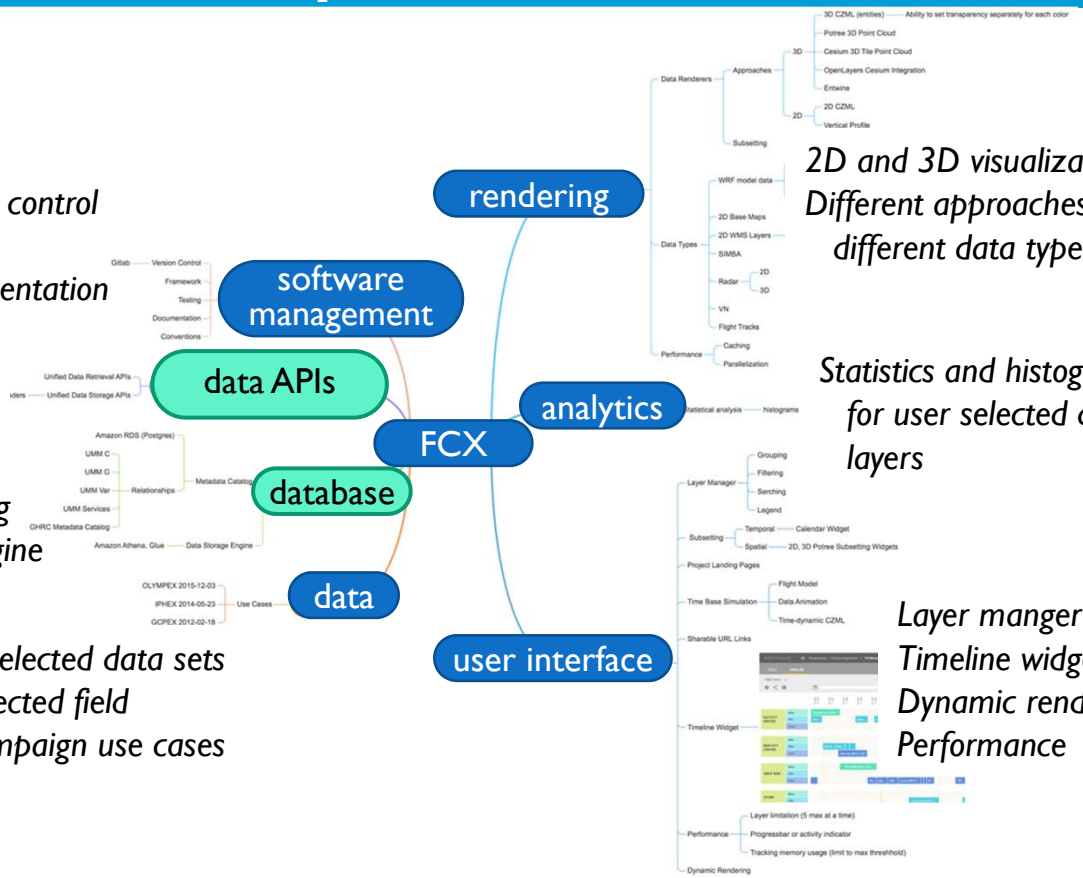
- *Use Case: validation of the GLM instrument over Oklahoma on 17 May 2017; variety of observations from aircraft, ground-based lightning mapping array, and ISS Lightning Imaging Sensor*



Credits: Geoffrey Stano, Helen Conover

Framework Components

- Self Contained
- Lightweight
- Serverless
- Open Source
- Easy to Install



Version control
Testing
Documentation

Data storage & retrieval

Metadata catalog
Data storage engine

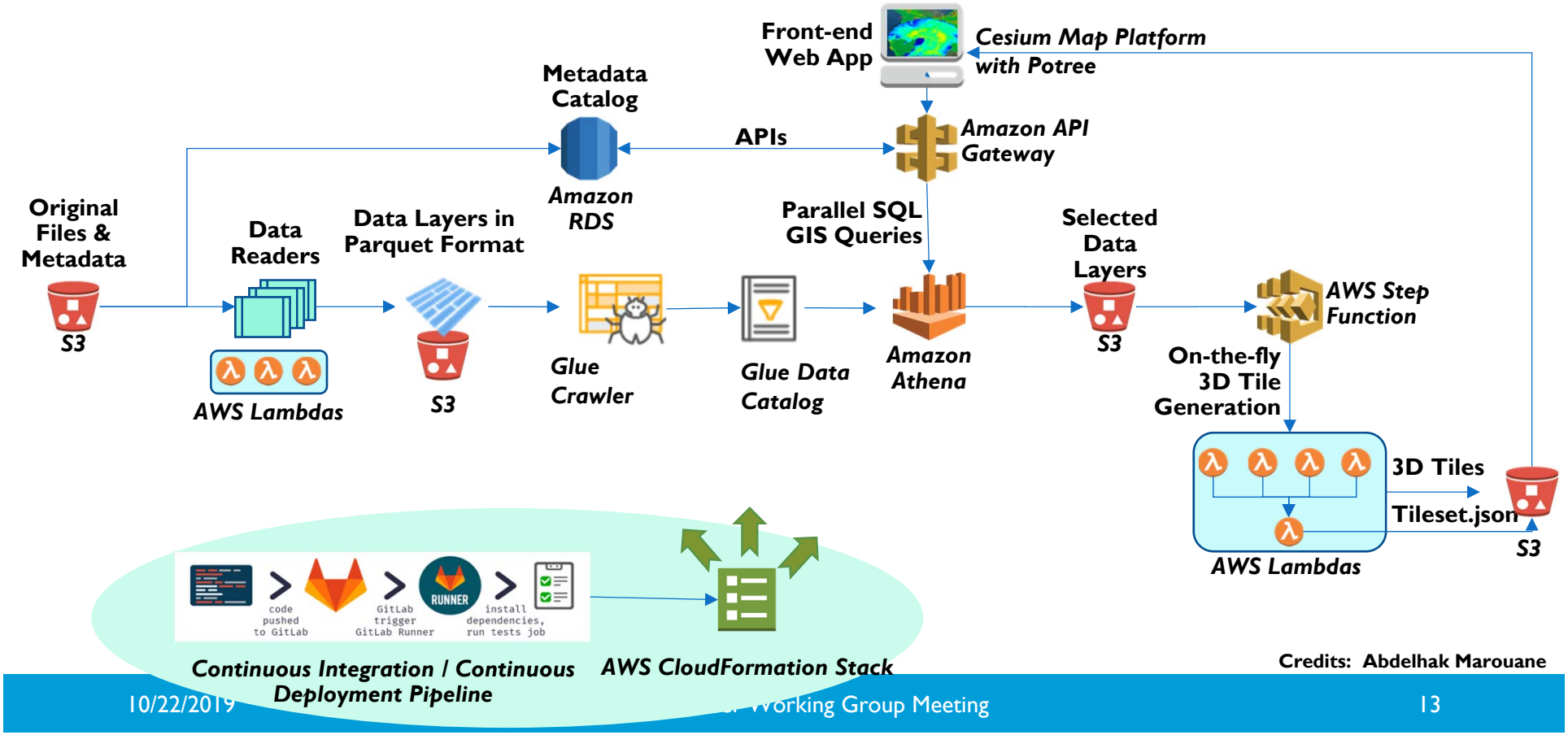
Key selected data sets
selected field
campaign use cases

2D and 3D visualizations
Different approaches for different data types

Statistics and histograms for user selected data layers

Layer manger
Timeline widget
Dynamic rendering
Performance

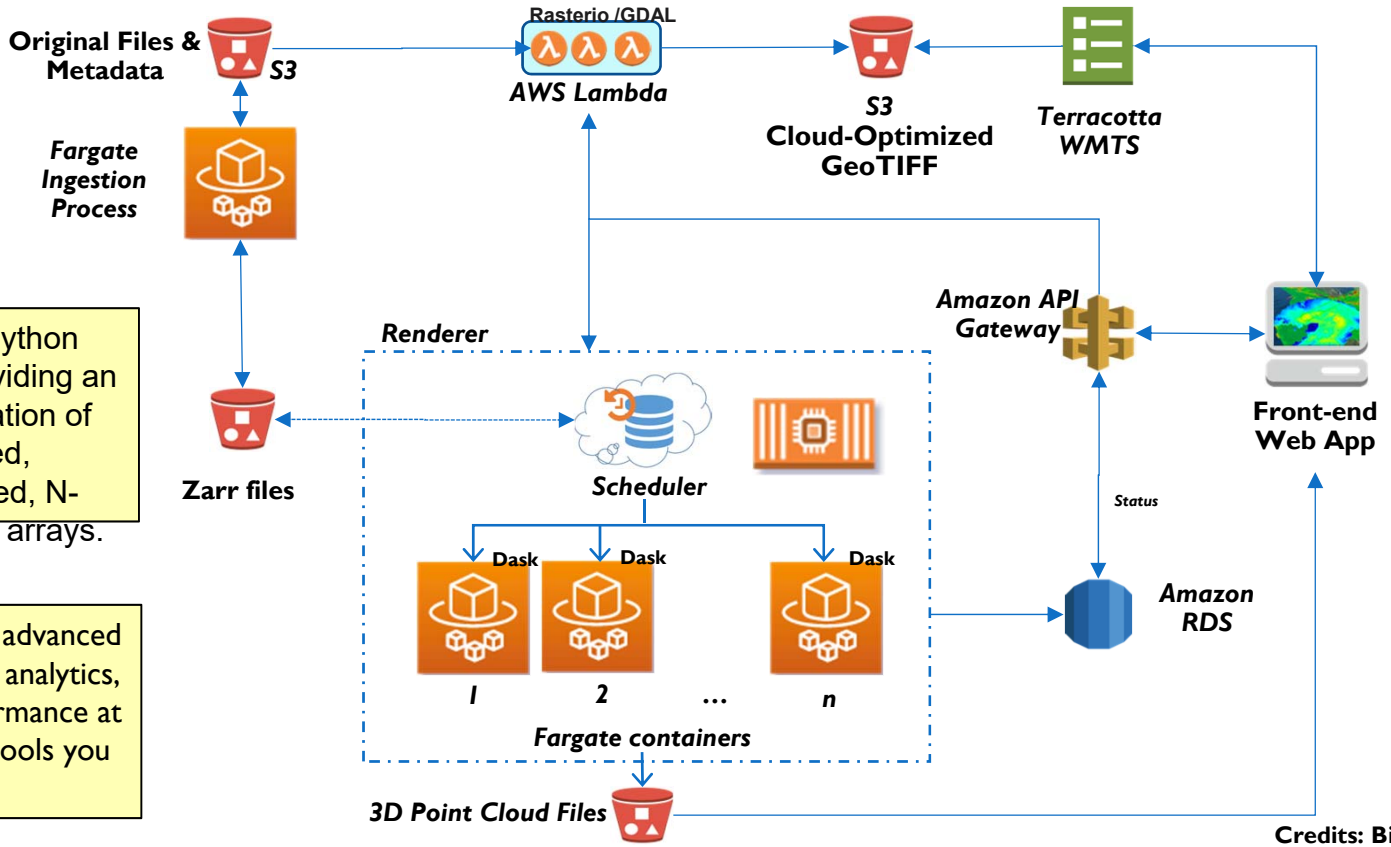
Implementation Design I



Credits: Abdelhak Marouane

Implementation Design 2

Inspired from **https://pangeo.io/**



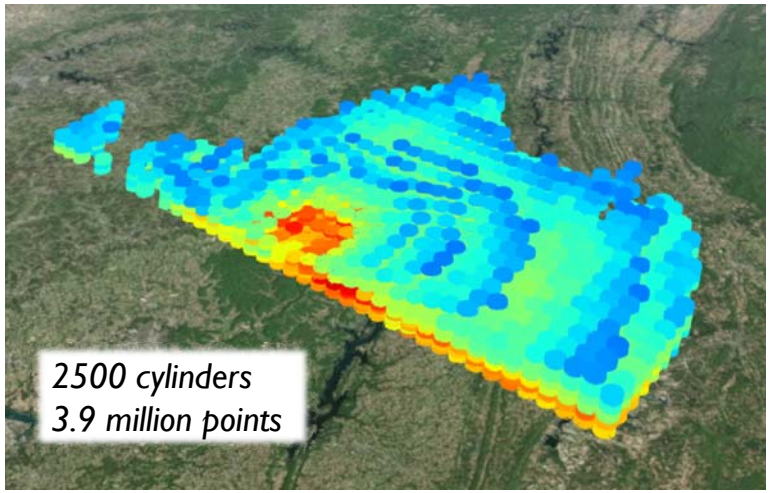
Zarr is a Python package providing an implementation of chunked, compressed, N-dimensional arrays.

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

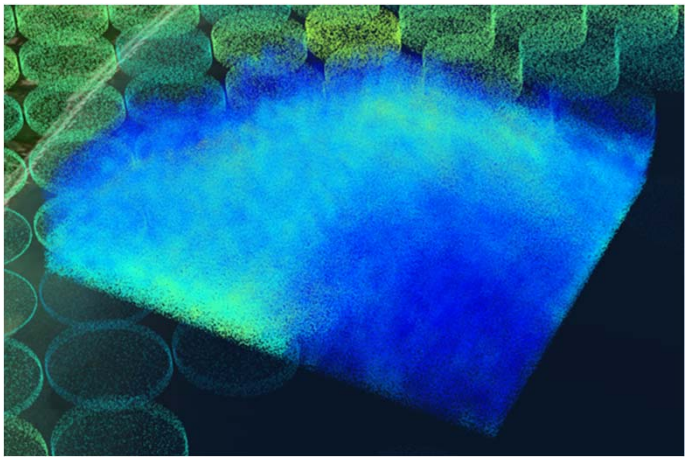
Credits: Bibek Dahal, Brian Ellingson

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.



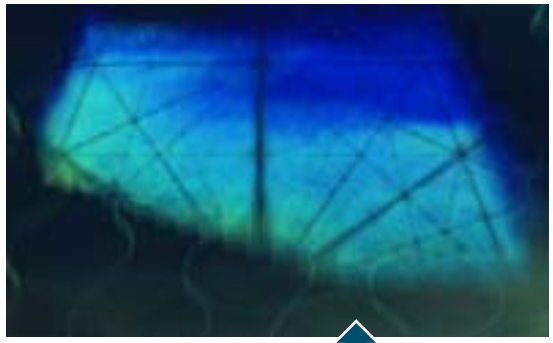
Gridded ground radar subset demonstrates point cloud with stippling (each point offset by a small random distance and direction) and variable transparency (higher values are less transparent to accentuate "hot spots")



Credits: Todd Berendes

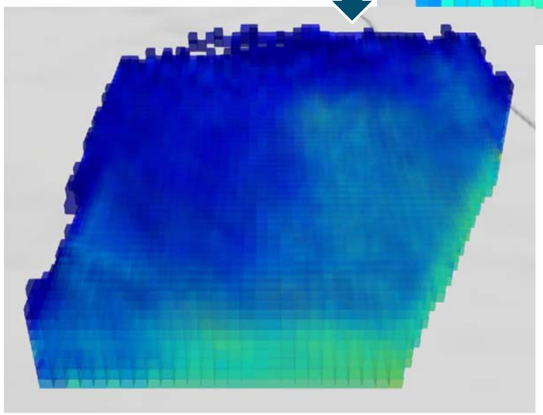
Different 3D Rendering Approaches

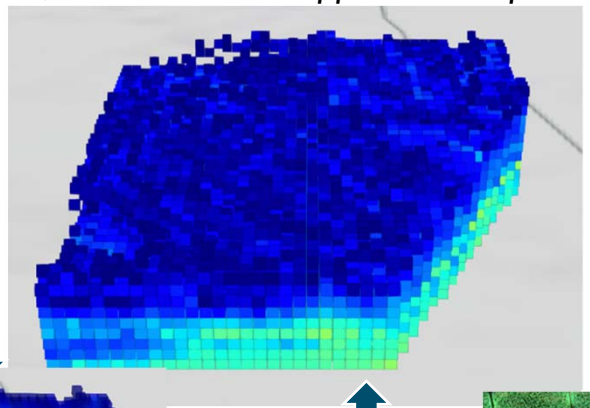
NPOL radar reflectivity, gridded in a SIMBA column; wide variation in appearance depending on rendering approach



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.

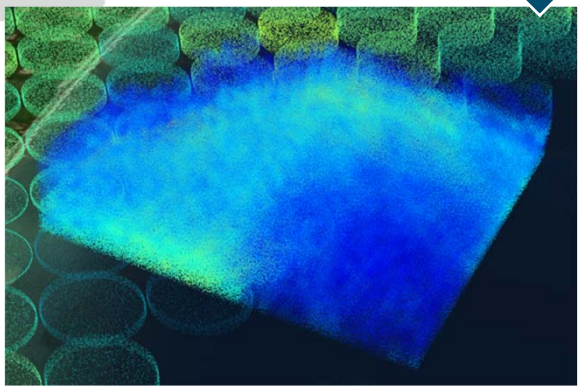
Cesium **entities** with transparency defined using Cesium's native **CZML**





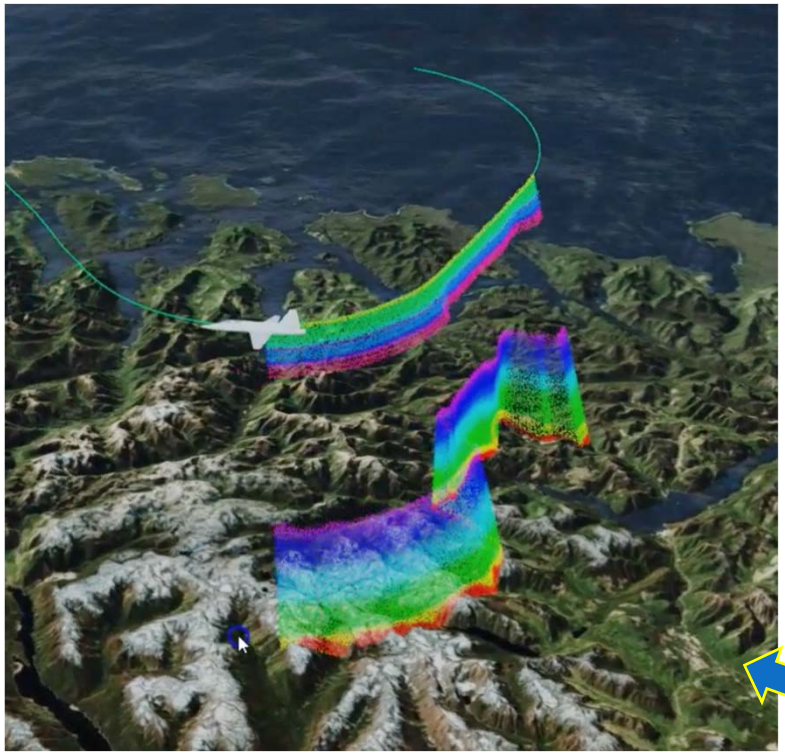
Grid cells rendered as 2D "billboard" **entities**

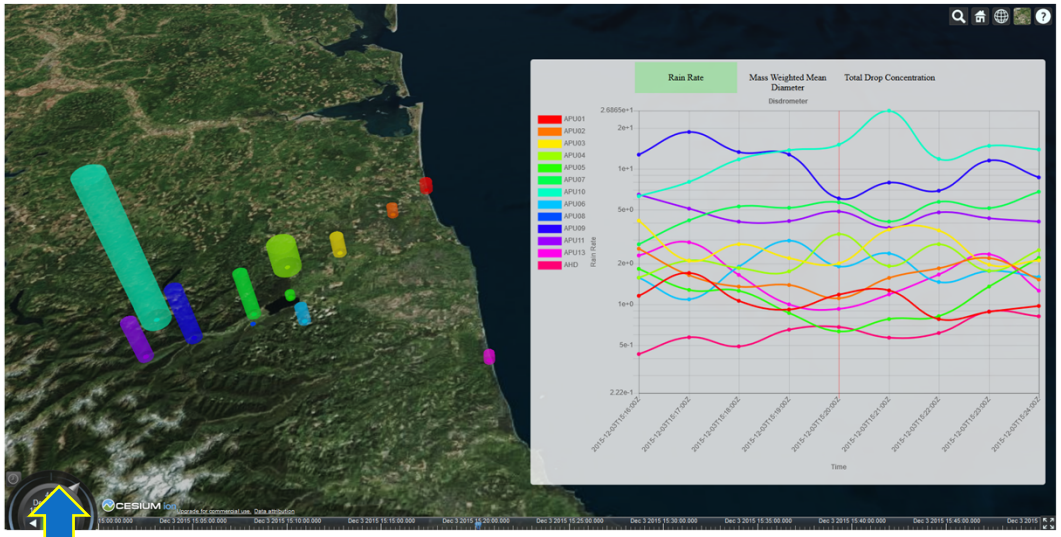
Point cloud with stippling (each point offset by a small random distance and direction) and **variable transparency** (higher values are less transparent to accentuate "hot spots")



Credits: Khomsun Singhirunnusorn & Todd Berendes

Animating Data Through Time





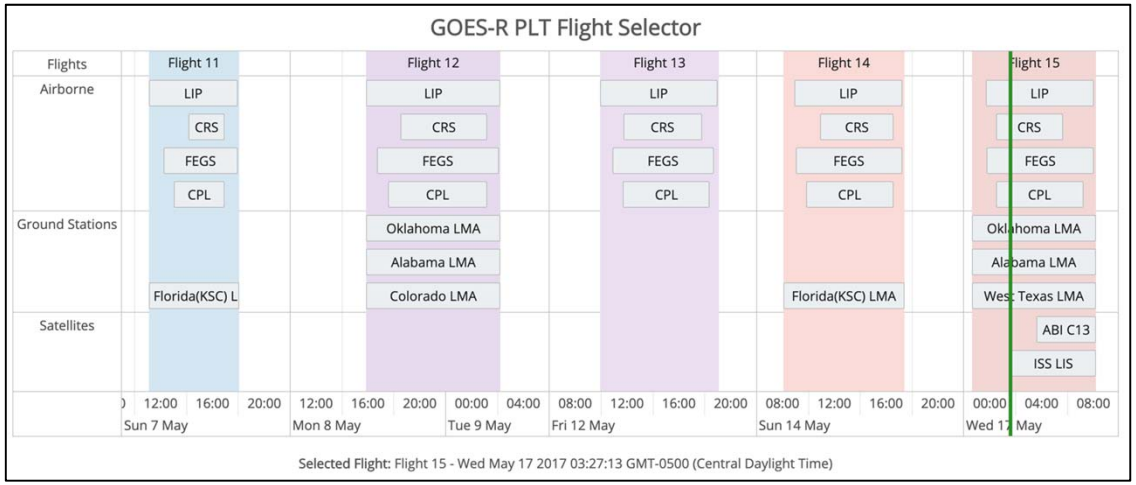
Point data: cylinder height and diameter vary with rain rate and drop size; graph displays 10 minute time window

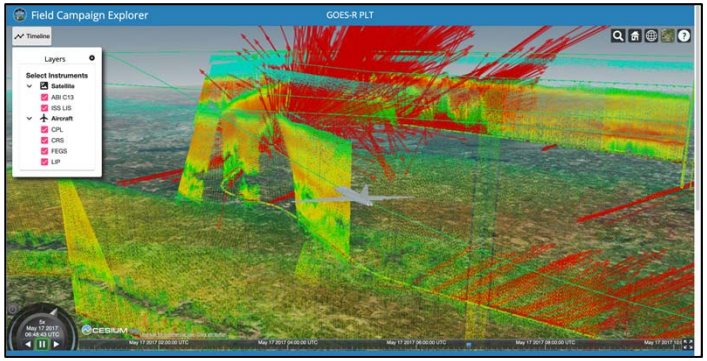
Airborne vertical curtain data rendered as time-dynamic 3D Tile Point Clouds with 30 minute linger time

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

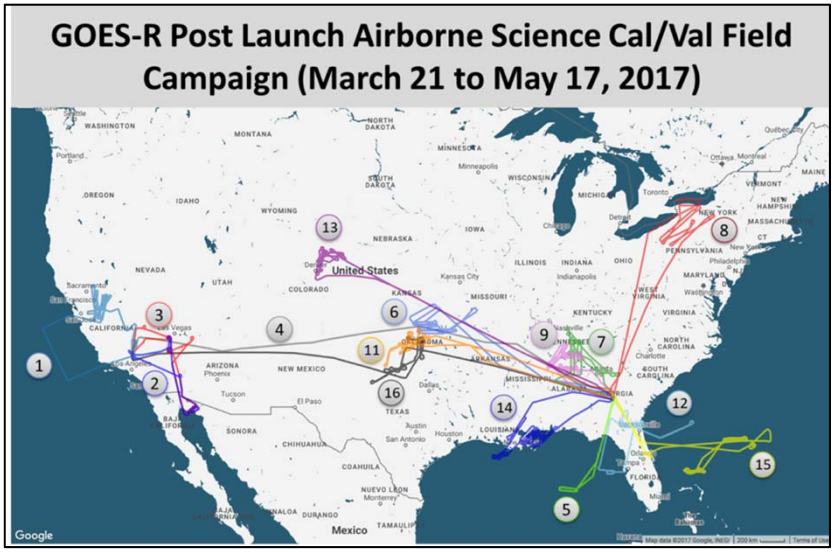




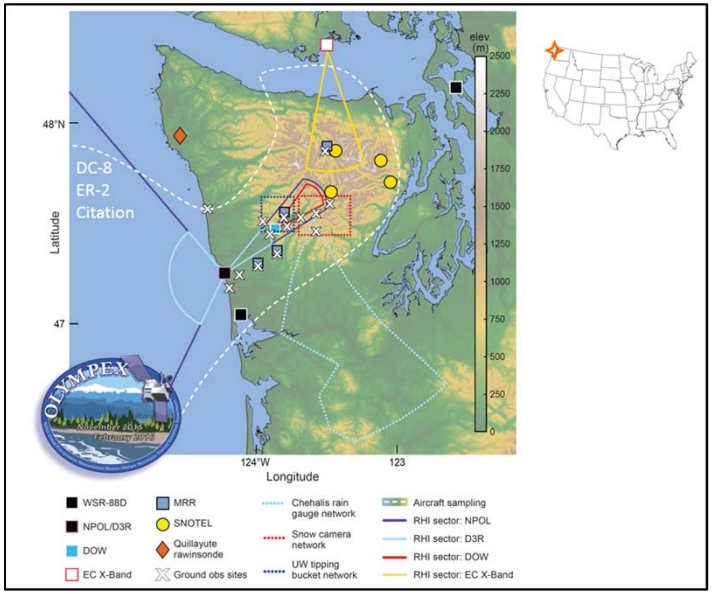
Credits: Navaneeth Selvaraj

Demos

GOES-R PLT Demo



OLYMPEX Demo



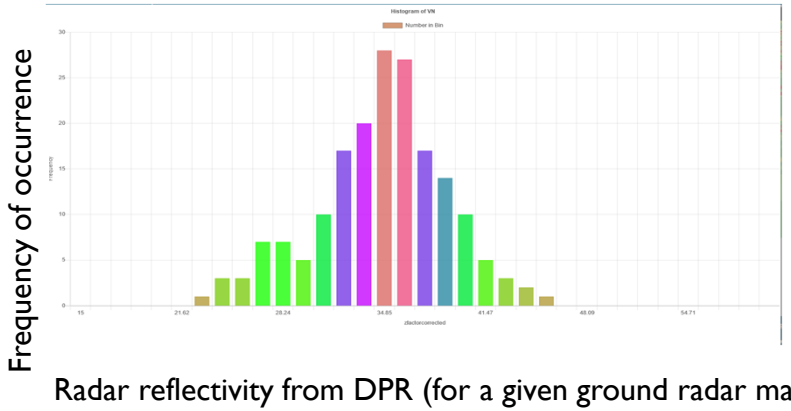
https://ghrc.nsstc.nasa.gov/home/projects/fcx

Future Work

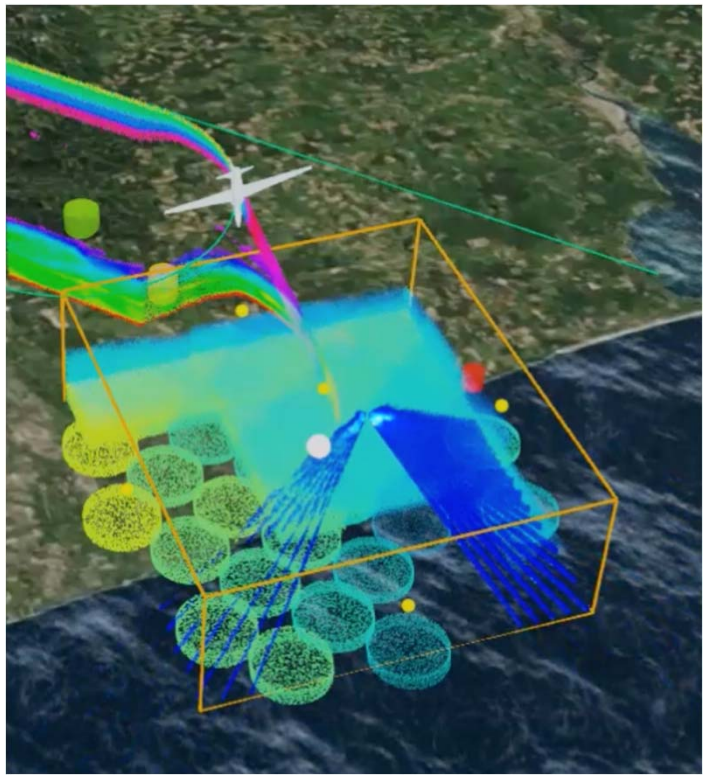
Basic Analytics (1)

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



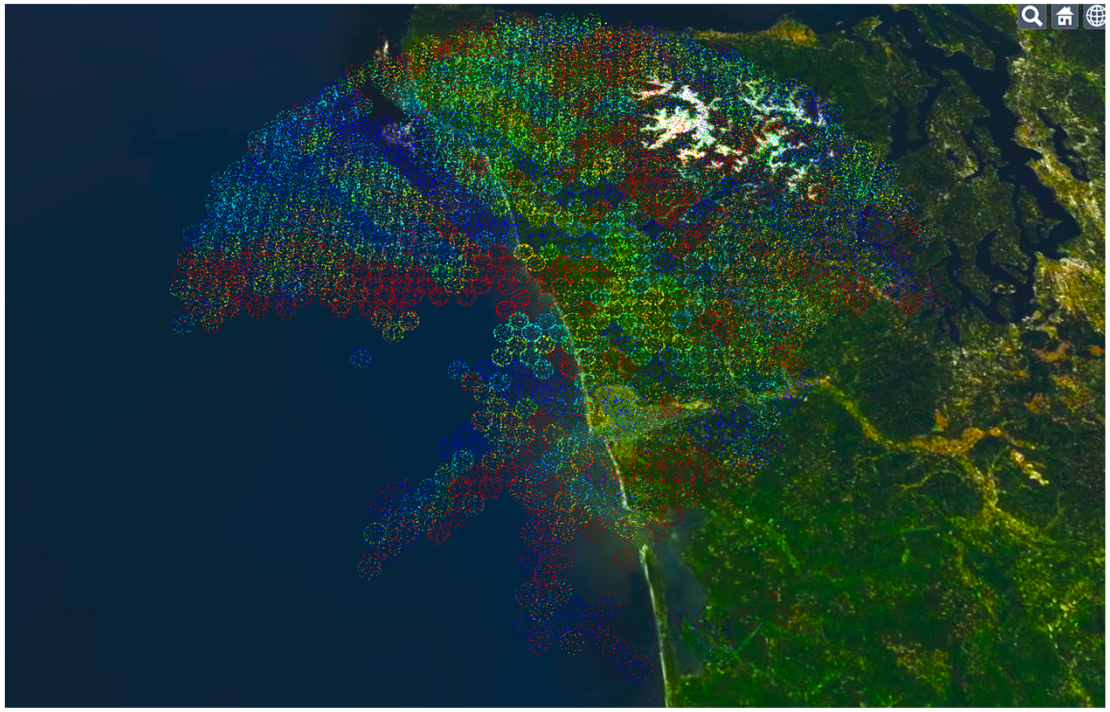
Radar reflectivity from DPR (for a given ground radar match-up)



Credits: Brian Ellingson

Basic Analytics (2)

Comparison across different data fields



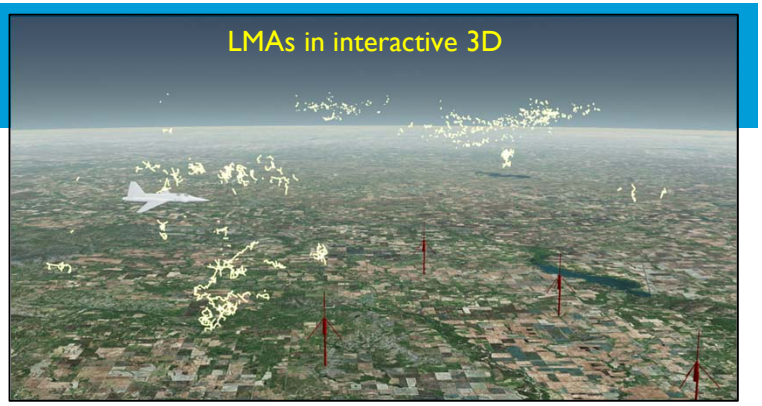
Dynamically generated map showing differences between ground radar reflectance and GPM radar reflectance

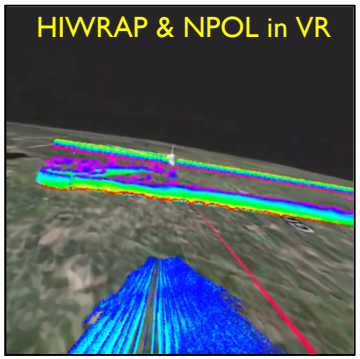
Credits: Todd Berendes

FCX Playground

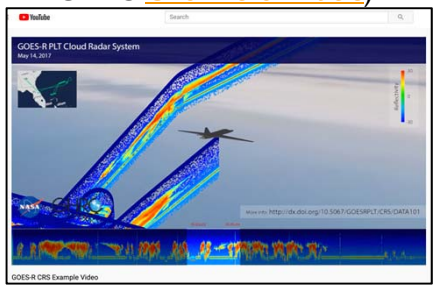
- FCX Playground is a place where students are exploring new techniques for data visualizations

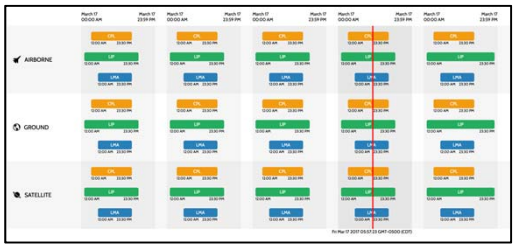
- Few notable demos -
  - HIWRAP and NPOL - Virtual Reality (Credits: Bibek Dahal)
  - 3D Data Visualization Video Gallery of GHRC datasets (Credits: Selsa Adhikari)
  - 3D LMA dataset visualization (Credits: Selsa Adhikari, Michael Peterson)
  - Cloud bsed interactive ISS LIS Visualization & Subsettings(Credits: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





CRS Static 3D Video (linked from GHRC CRS Micro Article)



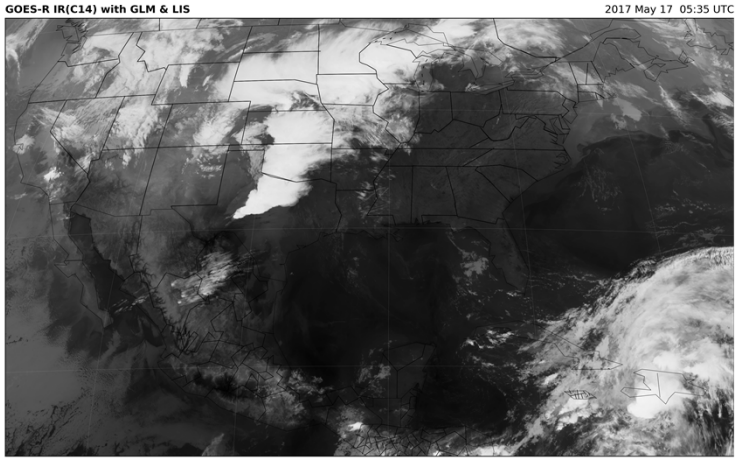


Custom Timeline Widget

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

Credits: Yuling Wu

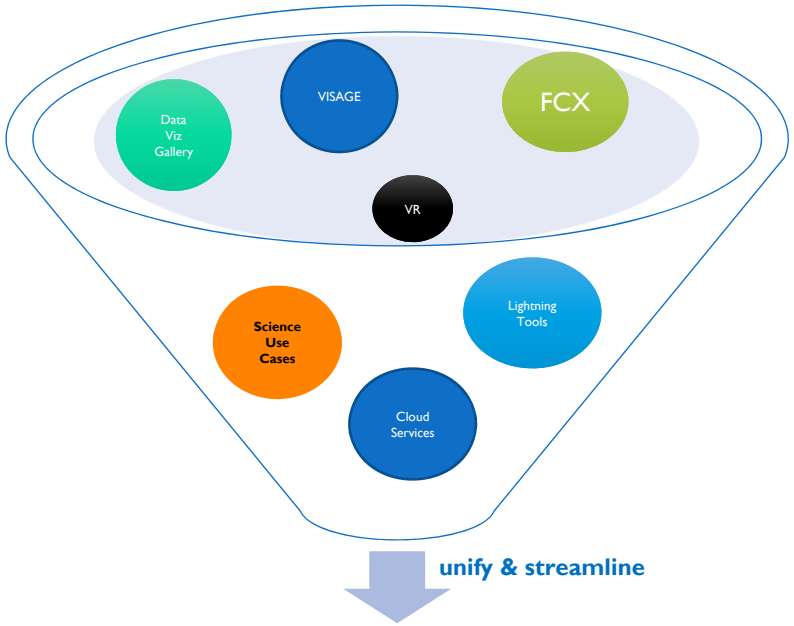


Comparison of GLM-LIS detected lightning on top of IR (ch14)

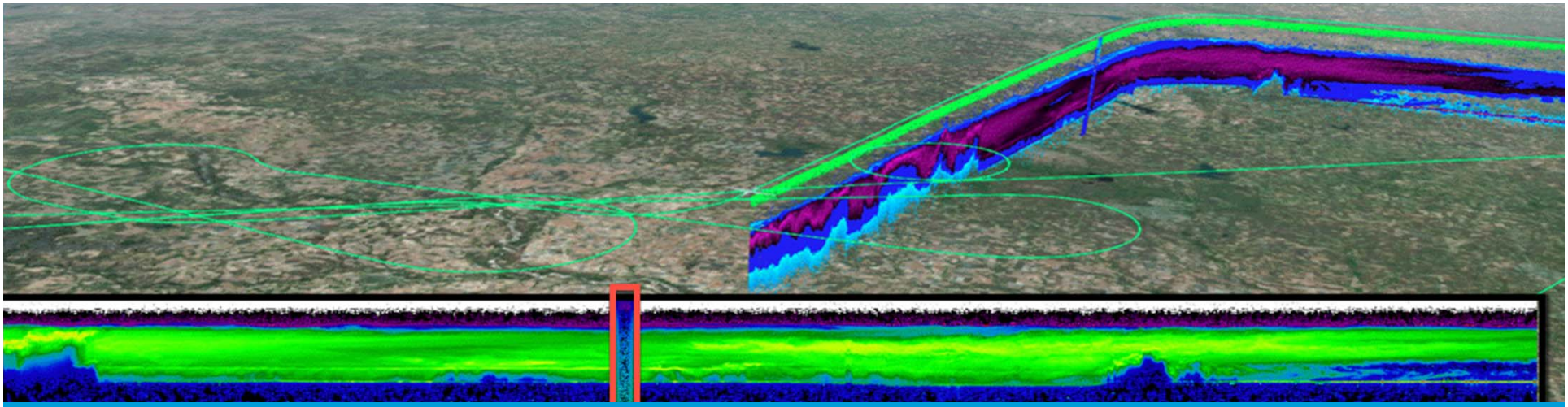
From FCX Playground: GLM - ISS LIS comparison (Credits: Pooja Khanal)

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



In next 5 years - Cross DAAC Science Use Case Focused Cloud Native Data Visualization Platform



THANK YOU!

QUESTIONS?