# VISAGE Framework for Interactive Exploration of Diverse Precipitation Data

## (Visualization for Integrated Satellite, Airborne and Ground-based data Exploration)

AIST 2016 Award

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**Authors:** Helen Conover (helen.conover@uah.edu), Todd Berendes, Ajinkya Kulkarni (ajinkya.kulkarni@uah.edu), Brian Ellingson, Lihua Wang, Abdelhak Marouane, Bibek Dahal, Khomsun Singhirunnusorn, Sara Graves

The University of Alabama in Huntsville (UAH) Information Technology and Systems Center (ITSC)

## POTENTIAL SCIENCE IMPACT

VISAGE (Visualization for Integrated Satellite, Airborne, and Ground-based data Exploration) helps researchers quickly locate interesting weather phenomena using 4-dimensional visualization of weather processes and structures in an interactive user interface. The VISAGE framework enables intercomparison of data from multiple sources (i.e., airborne, ground, model), both visually and statistically. Proof-of-concept use cases are centered around the Global Precipitation Measurement (GPM) mission's Ground Validation (GV) program, which provides a wealth of intensive, coincident observations of atmospheric phenomena from a wide variety of ground-based, airborne and satellite instruments. These data have diverse temporal and spatial scales, variables, and data formats and organization. The VISAGE's data framework stores this wide variety of data in an analysis optimized form with a common query interface.

### EXAMPLE SCIENCE QUESTION:

What are the characteristics of convective precipitation that result in non-uniform beam filling effects on GPM satellite retrievals of precipitation?

### Integrated Precipitation and Hydrology Experiment

Warm season orographic precipitation regimes and hydrologic processes in regions of complex terrain.

**Event Focus: Warm-season convective storm with severe hail; observations from ground-based radars, ER-2, Citation, and GPM Core overpass with very good GMI and DPR coverage**

**Location:** W North Carolina & S Appalachia
**Operations:** April – June 2014
**Use Case:** 23-24 May 2014, 2100-0200 UTC
**Region:** 36°N, 83°W, 34°N, 80°W

Map showing IPHEx ground instruments

**Data Available for this use case:**

- Ground radars including **NPOL**
- **ER-2** and Citation aircraft:
  - **HIWRAP, EXRAD**
- **GPM** overpass at 23:16 UTC (check-out phase)
  - Both **GMI** & DPR swaths
- Select **SIMBA** columns – maybe NPOL
- **NMQ** precipitation products
- **DPR and ground radar match-ups**

*(Data in **bold** in VISAGE repository)*

### EXAMPLE SCIENCE QUESTION:

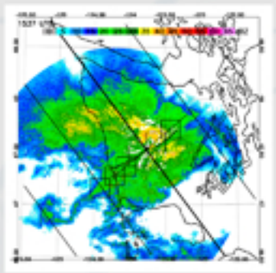
How well does the WRF model (P3 microphysics) depict the precipitation enhancement from the ocean to the land and across the Olympic mountains?

### Olympic Mountains Ground Validation Experiment

Evaluating space-based observations of rain & snow in **extreme coastal & topographic gradients.**

**Event Focus: Complex baroclinic system with orographic enhancement; excellent sampling coordination with simultaneous satellite, airborne, & ground-based observations**

**Location:** Olympic Mountains of Washington State
**Operations:** November 10, 2015 - February 16, 2016
**Use Case:** 3 Dec 2015, 1400-1700 UTC
**Region:** 50°N, 126°W, 46°N, 122°W



3 Dec NPOL reflectivity at 1637, showing GPM DPR and GMI overpass swaths (bold line is nadir track) and select SIMBA column locations

**Data Available for this use case:**

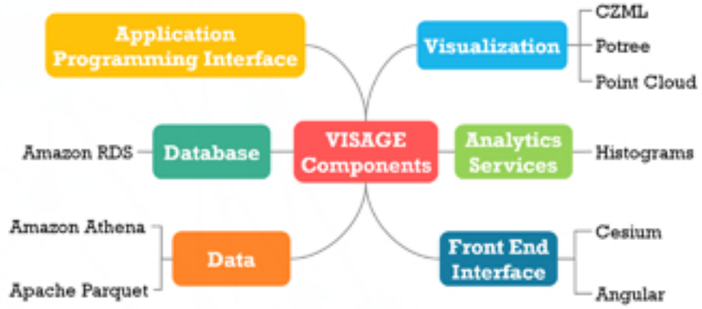
- Most ground instruments, including:
  - Radars: **NPOL**, KLGX, D3R, DOW
  - **Disdrometers, gauges**, profilers, soundings
- **ER-2**, **DC-8** and **Citation** aircraft:
  - **AMPR**, CRS, **APR-3**, CoSMIR, **particle probes**, etc.
- **GPM** overpass at 15:22 UTC
  - Both **GMI** & DPR Swaths
- Select **SIMBA** columns
- **DPR and ground radar match-ups**
- **Select WRF model subsets - reflectivity**

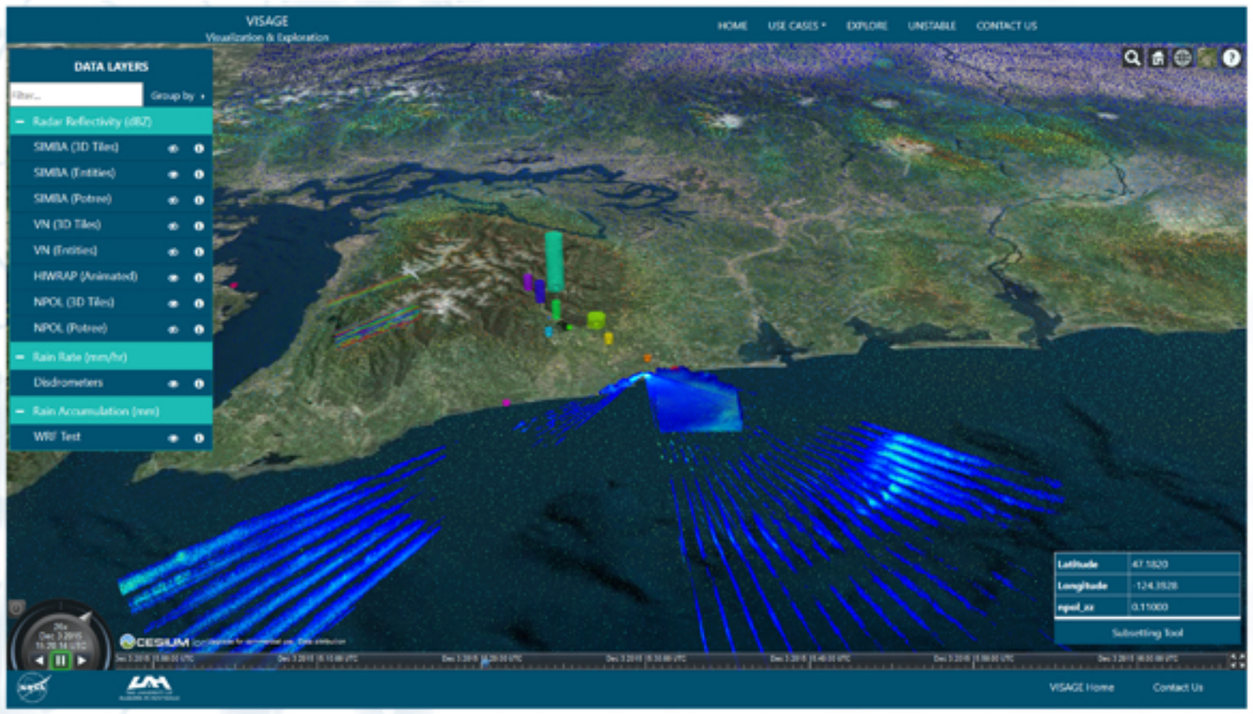
*(Data in **bold** in VISAGE repository)*

## VISAGE ARCHITECTURE

### High Level Architecture

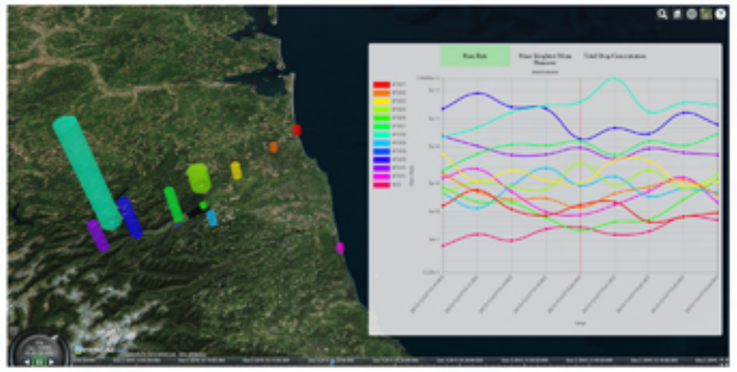

### Components




## TECHNICAL CHALLENGES / RESEARCH AREAS

- **Serverless cloud-native technologies**
  - Amazon Web Service (AWS) Athena stateless query service for searching data stored in S3 buckets
  - AWS Step Functions and Lambdas to orchestrate and run data processing and rendering code without provisioning or managing servers, automatically scaling resources as needed
- **Analysis optimized data store**
  - Scalable, efficient data access to support on-the-fly rendering and analytics
  - Data framework with ingest and access APIs to Parquet files via the Athena query interface
- **3D data visualization and exploration of large data volumes on a web-based platform**
  - Cesium and Potree visualization engines
  - Evaluation of different 3D data rendering approaches (visual appeal, memory usage, etc.)
  - 3D data interrogation via map user interface
  - Basic analytics across different data sources (e.g., statistics, histograms)
- **Temporal alignment of diverse data sets**
  - Time-dynamic visualization specifications (CZML or 3D Tiles)
  - Metadata to to define window around user interface time that the data should be displayed (lead time and linger time)

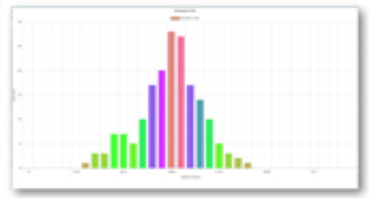


### Basic Analytics

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

This will serve as the basis for comparison across different data fields



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VISAGE & Visualization Exploration