VISAGE
Visualization for Integrated Satellite, Airborne and Ground-based data Exploration
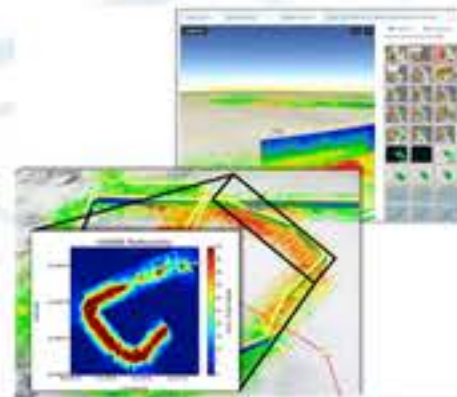
AIST 2016 Award

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The primary goal of the VISAGE project is to facilitate more efficient Earth Science investigations via a tool that can provide visualization and analytic capabilities for diverse coincident datasets. This proof-of-concept project will be centered around the GPM Ground Validation program, which provides a valuable source of intensive, coincident observations of atmospheric phenomena. The data are from a wide variety of ground-based, airborne and satellite instruments, with a wide diversity in spatial and temporal scales, variables, and formats, which makes these data difficult to use together. VISAGE will focus on "golden cases" where most ground instruments were in operation and multiple research aircraft sampled a significant weather event, ideally while the GPM Core Observatory passed overhead. The resulting tools will support physical process studies as well as satellite and model validation.

Expected outcomes:
» Interactive user interface providing visualization and analytic capabilities for diverse coincident datasets
» VISAGE repository containing data specific to the selected use cases – GPM GV observations, higher level products from SIMBA and VN, WRF model simulations
» Support for target user community – NASA Precipitation Measurement Mission Science Team

Long term vision: a robust multi-sensor, multi-format integration system suitable for a wide array of applications

PI: Helen Conover[1] (helen.conover@uah.edu)
Co-Is: Todd Berendes[1], Aaron Naeger[1]
Manil Maskey[2], Patrick Gatlin[2]
Stephanie Wingo[4]
Technical Lead: Ajinkya Kulkarni[1]
Students: Sriraksha Nagaraj[1], Shivangi Gupta[1]
Collaborators: David Wolff[3]
Walt Petersen[2]

[1]The University of Alabama in Huntsville,
[2]NASA Marshall Space Flight Center,
[3]NASA Goddard Space Flight Center / Wallops Flight Facility,
[4]Universities Space Research Association / NASA Postdoctoral Program

Science value:
» Field experiments are key for intensive observation of particular phenomena such as hurricanes, or for ground validation of satellite observations. Diverse data include:
  ‣ wide variety of airborne and ground-based instruments
  ‣ different spatial and temporal scales
  ‣ often in unique formats due to instrument peculiarities and community conventions
    › *This diversity makes it challenging for scientists to rapidly collect and analyze them for physical process studies and validation of satellite algorithms and numerical models*

» VISAGE can bring together these diverse measurements into a common framework to
  ‣ facilitate selection of weather events or features for study
  ‣ improve the data discovery process
  ‣ assist with both qualitative and quantitative analysis of the measurements
  ‣ facilitate more efficient research and analysis

» VISAGE will be applicable to other areas of Earth Science – beyond precipitation science - that have a need for analyzing diverse datasets.

TECHNOLOGY BASIS:
FIELD CAMPAIGN EXPLORER

» A data visualization tool for exploring a variety of field campaign data
» Developed around the Hurricane and Severe Storm Sentinel (HS3) Earth Venture mission
» Allows users to
  ‣ Explore missions reports
  ‣ Re-enact mission flights by visualizing data within an interactive environment
  ‣ Subset and preview data on the fly
» Web-based, no software installation required

KEY TECHNICAL CHALLENGES

» 3D data rendering and visualization, including cross-sectional views
» Temporal alignment of data with diverse time scales and resolutions
» Data interrogation via map user interface, especially 3D data
» Computations on data fields across instruments and platforms
» Cloud-native data services for subsetting and interrogation

TECHNICAL APPROACH

Extend and scale FCX to support SIMBA, VN and model data with new visualization and analysis capabilities
  ‣ Allow the user to interactively interrogate data values
  ‣ Perform basic analytics such as ratios and differences across data fields
» Test the new VISAGE data and software suite for utility, flexibility and versatility
» Implement standards based data services for SIMBA, VN and selected model data
» Pre-generate imagery and 3D data tiles for use with FCX
» Automate data feeds to SIMBA for routine generation of gridded column product
» Explore infusing VISAGE data and software into existing GHRC architecture
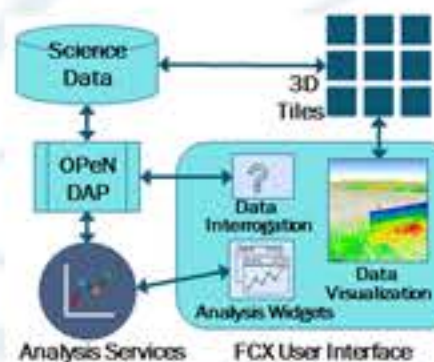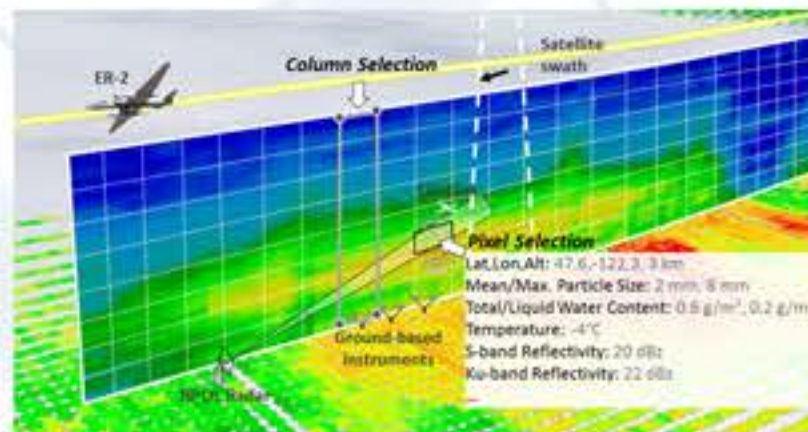
SCIENCE USE CASES
FROM THE GPM GV PROGRAM

Olympic Mountains Ground Validation Experiment
Evaluating space-based observations of rain & snow in **extreme coastal & topographic gradients.**

Location: NW Washington's Olympic Peninsula
Operations: Nov 2015 - Feb 2016

USE CASE

Date: 3 Dec 2015, 1400-1700 UTC
Region: 50°N, 126°W, 46°N, 122°W

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

Data Available:
- ER-2, DC-8 and Citation aircraft
- Most ground instruments
- GPM overpass at 15:22 UTC (operational)
- Select SIMBA columns
- DPR and ground radar match-ups
- Select WRF model subsets

Integrated Precipitation and Hydrology Experiment
Warm season orographic precipitation regimes and hydrologic processes in regions of complex terrain.

Location: W North Carolina & S Appalachia
Operations: April – June 2014

USE CASE

Date: 23-24 May 2014, 2100-0200 UTC
Region: 36°N, 83°W, 34°N, 80°W

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

Data Available:
- ER-2 and Citation aircraft
- Limited ground instruments
- GPM overpass at 23:16 UTC (check-out phase)
- Select SIMBA columns
- DPR and ground radar match-ups

GPM Cold-season Precipitation Experiment
Microphysical properties, remote sensing observations, and model simulations of **precipitating snow.**

Location: S Ontario, CA
Operations: Jan – Feb 2012

USE CASE

Date: 18 Feb 2012, 0900-2000 UTC
Region: 45°N, 80°W, 44°N, 79°W

Microphysical observation & simulation of the entire life cycle of a significant precipitation band along a warm front

Data Available:
- Citation aircraft
- Most ground instruments
- Select WRF model subsets
- Select SIMBA columns will be generated

*GPM launched Feb 2014 so no overpass or DPR/ground radar matchups for this campaign.

TARGETED DATA PRODUCTS:

GPM GROUND VALIDATION ARCHIVE

GPM GV data are archived at the GHRC DAAC. Dataset publication is ongoing. This collection includes:
» Series of field campaigns collecting detailed measurements of precipitation and related physical processes in a variety of diverse metrological regimes
» Ground and airborne precipitation datasets supporting validation of satellite-based precipitation retrieval algorithms
» Related extended observations from additional sites
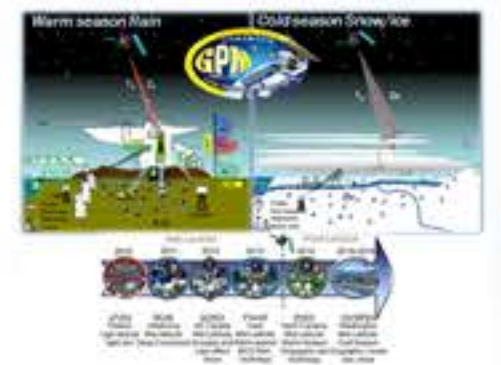
GPM VALIDATION NETWORK

» Compares data from satellite radars (GPM DPR, TRMM PR) and microwave imagers (GMI, TMI and others) to ground-based scanning weather radar observations
» Subsets satellite and ground radar (GR) data for coincident observations of precipitation
» Generates vertical profiles with matching coincident DPR and GR data for precipitation events

Example of DPR gate averaging at GR sweep intersections. Shaded areas show individual DPR gates intersecting the vertical extent of two GR sweeps (dashed) at different elevation angles. The reflectivity values of the individual DPR gates are averaged over the vertical extent of the GR sweeps, resulting in two matching volumes for the single DPR ray shown in this case.

SIMBA: System for Integrating Multi-platform data to Build the Atmospheric column

» Higher-level data product, fusing GPM satellite and ground-based observations into a gridded atmospheric column data file
» Interpolates and/or resamples observations from various scales to set data into a common, user-specified 3D grid
» Encodes observations from diverse data formats into unified netCDF file
» Attributes preserve key operation parameters for each sensor
» Location, operation mode, timestamps, algorithms, product versions, etc.
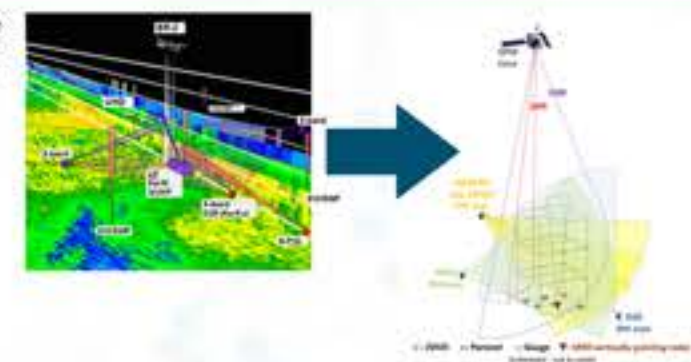
SIMBA fuses targeted satellite- and ground-based observations collected in various formats & coordinate systems to a single, used-defined 3D column grid

NUMERICAL WEATHER PREDICTION MODELS

Researchers can use VISAGE to examine the performance of numerical weather prediction models, especially those studies requiring high resolution. For example, model resolutions as small as 1 km are needed in order to resolve mesoscale processes associated with the complex terrain of the OLYMPEx domain and model simulations of precipitation at such a high resolution require sophisticated microphysical parameterization schemes. To evaluate the performance of each scheme for the OLYMPEX use case, selected output from Weather Research and Forecasting (WRF) simulations need to be evaluated against relevant microphysical and thermodynamic observations. VISAGE will provide a unique integration of field observation and model output to a consistent grid in order to facilitate such model validation efforts.

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