



# Earth System Science Pathfinder Program

NASA's Earth Venture-1  
(EV-1) Airborne  
Science Investigations

Anthony Guillory

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ICCAGRA Spring Meeting

Lafayette, LA



## VENTURE CLASS MISSIONS



- Earth Venture program recommended by National Research Council (NRC) in the 2007 Decadal Survey: *Earth Science and Applications from Space: National Imperatives for the Next Decade and Beyond*
  - Low cost research and application missions
  - Foster revolutionary innovation
  - Train future leaders
- Venture class different than existing ESSP missions
  - Include stand alone missions using simple, small to medium sized instruments, spacecraft, and launch vehicles
  - More complex instruments of opportunity
  - Complex sets of instruments on suborbital platforms to address focused sets of scientific questions
- Priority will be given to cost-effective, innovative missions
- Earth Venture-1 (EV-1) is first of venture class missions
  - Temporally sustained suborbital earth science investigations



## ***EARTH VENTURE-1***



- Solicited proposals for complete suborbital, principal investigator-led investigations to conduct innovative, integrated, hypothesis or scientific question driven approaches to pressing Earth system science issues
- Opportunity for investment in innovative Earth system science to enhance our capability to better understand the current state of the Earth and predict future change
- Earth Venture-1 (EV-1) is suborbital and has the following characteristics:
  - Sustained, science-based data acquisition
  - Mature technology
  - Competitive selection
  - Cost and schedule constraints
- Domestic and International partnerships are encouraged
- Five selections were made on May 27, 2010



## Team

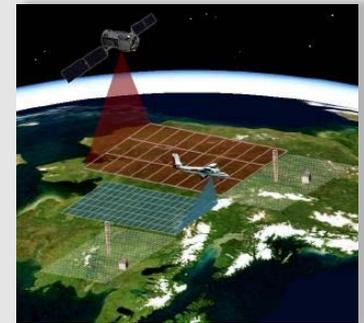
- Principal Investigator: Charles Miller (JPL)
- Project Manager: Steve Dinardo (JPL)

## Goal

- Bridge critical gaps in our knowledge and understanding of Arctic ecosystems, linkages between the Arctic hydrologic and terrestrial carbon cycles, and the feedbacks from fires and thawing permafrost

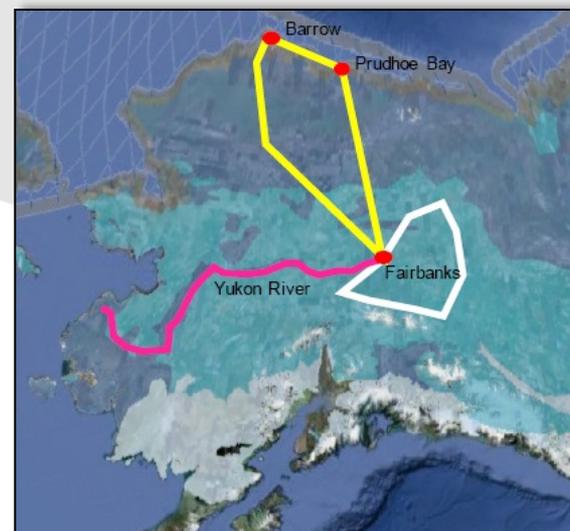
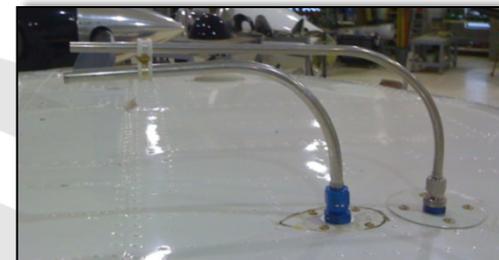
## Objectives

- Test hypotheses attributing mobilization of carbon reservoirs to climate change
- First direct measurements of CO<sub>2</sub> and CH<sub>4</sub>
- Demonstrate new remote sensing and modeling methods



### Implementation

- De Havilland DHC-6 Twin Otter flying:
  - Passive-Active L-band System (PALS)
  - Fourier transform spectrometer (FTS)
  - In Situ Gas Analyzer (Picarro, Flask Packs)
- Strategically located ground base sites
- Deploy from Fairbanks, AK
  - Test flights in 2011
  - Spring, summer and early fall of each year from 2012-2014
  - North Slope
  - The interior
  - Yukon River valley
- Deploy to Oklahoma
  - Test Flights in 2011





### Team

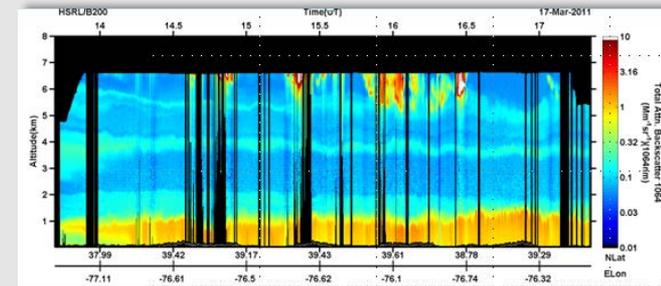
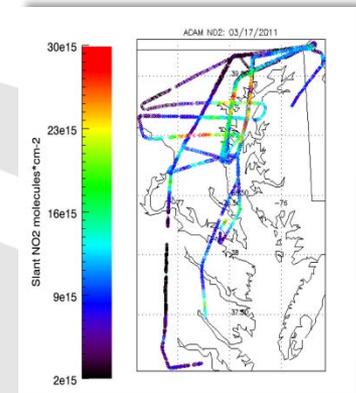
- Principal Investigator: James Crawford (NASA Langley)
- Project Manager: Mary Kleb (NASA Langley)

### Goal

- Improve the interpretation of satellite observations to diagnose near-surface conditions relating to air quality

### Objectives

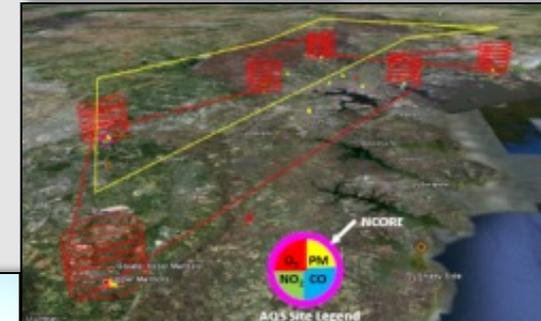
- Relate column observations to surface conditions
  - Aerosols, O<sub>3</sub>, NO<sub>2</sub> and CH<sub>2</sub>O
- Characterize differences in diurnal variation of surface and column observations
- Examine horizontal scales of variability satellites and model calculations





### Implementation

- UC-12 Aircraft
  - High Spectral Resolution Lidar (HSRL) and the Airborne Compact Atmospheric Mapper (ACAM)
- Ground sites
  - 12 Pandora sun tracking spectrometers
  - 5 AERONET sun-photometers
  - 2 aerosol lidars (AQS sites)
  - Vaisala Ceilometer
  - Leosphere Windcube
- P-3B Aircraft
  - 7 instruments providing in-situ trace gas and aerosol observations
- 30 day deployments in 2011, 2013, and 2014
  - Baltimore, MD; Houston, TX; Sacramento, CA; TBD (Los Angeles, Birmingham or Atlanta)



### Team

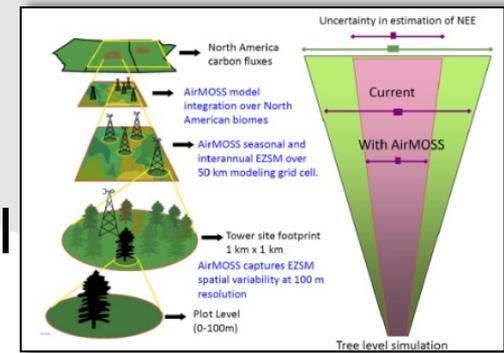
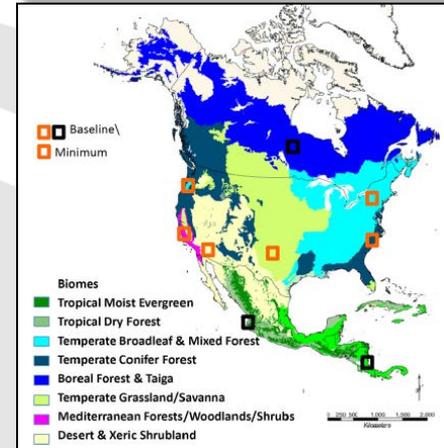
- Principal Investigator: Mahta Moghaddam (University of Michigan)
- Project Manager: Yunling Lu (JPL)

### Goal

- Minimize root zone soil moisture (RZSM) uncertainty and spatial heterogeneity in net ecosystem exchange (NEE) estimates

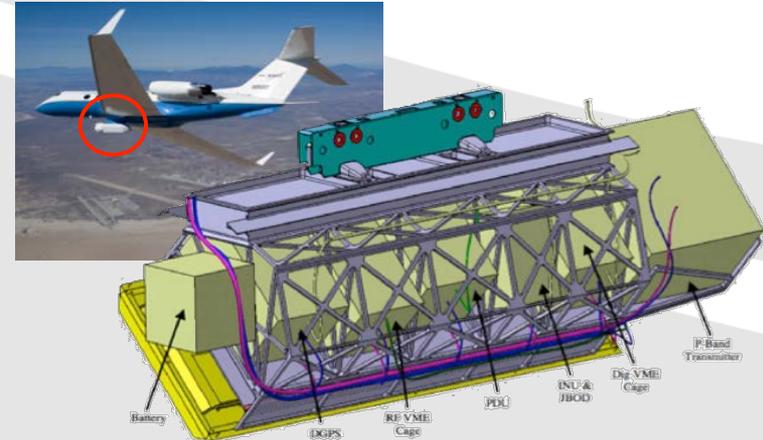
### Objectives

- High resolution RZSM
- Quantify impact of RZSM on estimation
- Upscale regional estimates to continental scale



### Implementation

- Gulfstream-III
  - Airborne ultra high frequency (UHF) synthetic aperture radar (SAR)
- Extensive ground and in-situ measurements
- Field operation spring through fall of 2012, 2013 and 2014
  - Canada
  - Central Eastern US
  - Western US
  - Central America





### **Team**

- Principal Investigator: Eric Jensen (NASA Ames)
- Project Manager: Dave Jordan (NASA Ames)

### **Goal**

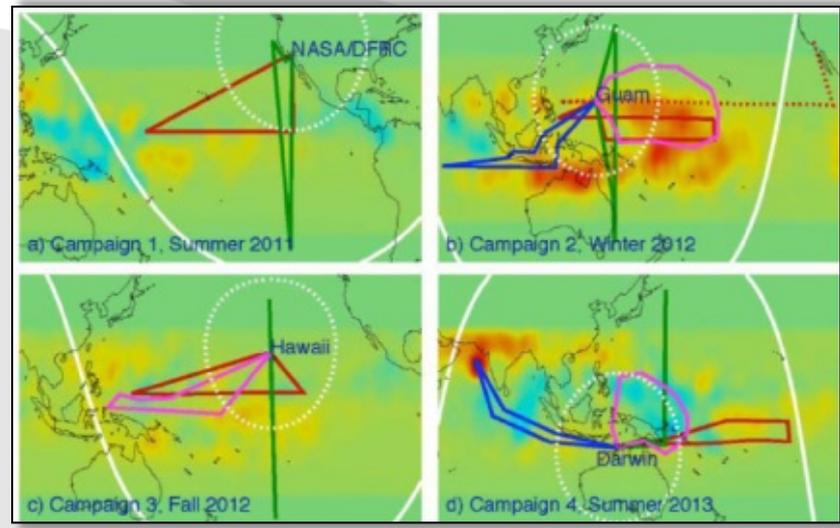
- To improve our understanding of the processes that control the flow of atmospheric gases into stratosphere, this investigation will launch from four different bases around the world to study the chemical and physical processes at different times of the year.

### **Objectives**

- Investigate chemical and physical drivers in the Tropical Tropopause Layer (TTL) that affect stratospheric water vapor and ozone
  - Trace the movement of reactive halogen-containing compounds and other important chemical species, the size and shape of cirrus cloud particles, water vapor, and winds in three dimensions through the TTL.
  - Measure bromine-containing gases to improve our understanding of stratospheric ozone.
- Reduce uncertainty in model predictions of future changes in earth's climate and stratospheric ozone

### Implementation

- Global Hawk:
  - Cloud Physics Lidar
  - Advanced Whole Air Sampler
  - Chromatograph for Tracers
  - Multiple hygrometers
  - Radiometers
  - Temperature profilers
  
- Four Campaigns
  - NASA Dryden (summer, winter)
  - Pacific Deployment Site(s) TBD (summer, winter)



## Hurricane and Severe Storm Sentinel (HS3)

### Team

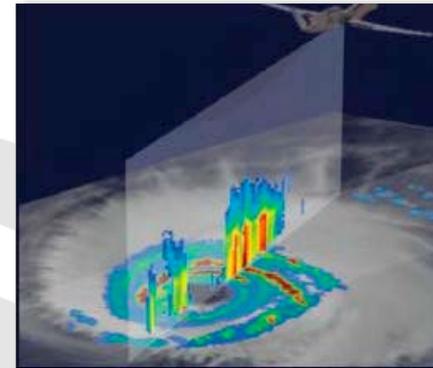
- Principal Investigator: Scott Braun (NASA Goddard)
- Project Manager: Marilyn Vasques (NASA Ames)

### Goal

- Enhance our understanding of the processes that underlie hurricane intensity change in the Atlantic Ocean basin

### Objectives

- Obtain critical measurements in the hurricane environment, including the Saharan Air Layer (SAL)
- Observe and understand the three dimensional mesoscale and convective scale internal structure and their role in intensity change

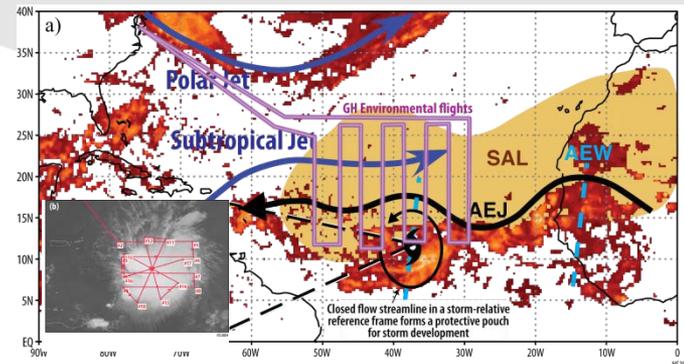
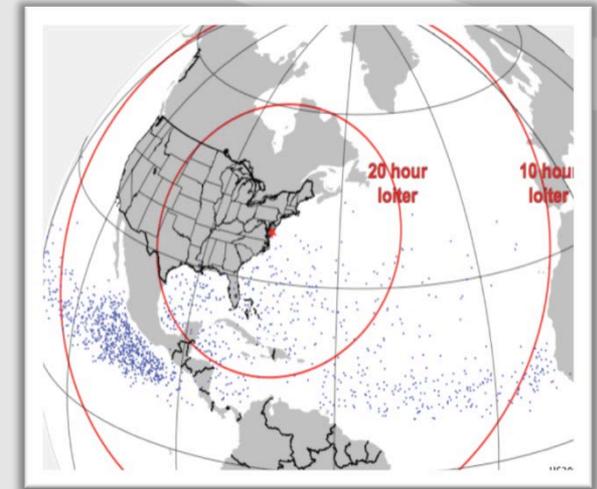




## Hurricane and Severe Storm Sentinel (HS3)

### Implementation

- Environmental Global Hawk
  - High-resolution Interferometer Sounder (HIS)
  - Advanced Vertical Atmospheric Profiling System (AVAPS)
  - TWiLiTE Doppler wind Lidar
  - Cloud Physics Lidar (CPL)
- Over Storm Global Hawk
  - HIWRAP conically scanning Doppler radar
  - Hurricane Imaging Radiometer (HIRAD)
  - HAMSr microwave sounder
- One month deployments each year during 2012-2014
  - Mid August to Mid September of each year
  - Deploy out of NASA Wallops Flight Facility (tentative)





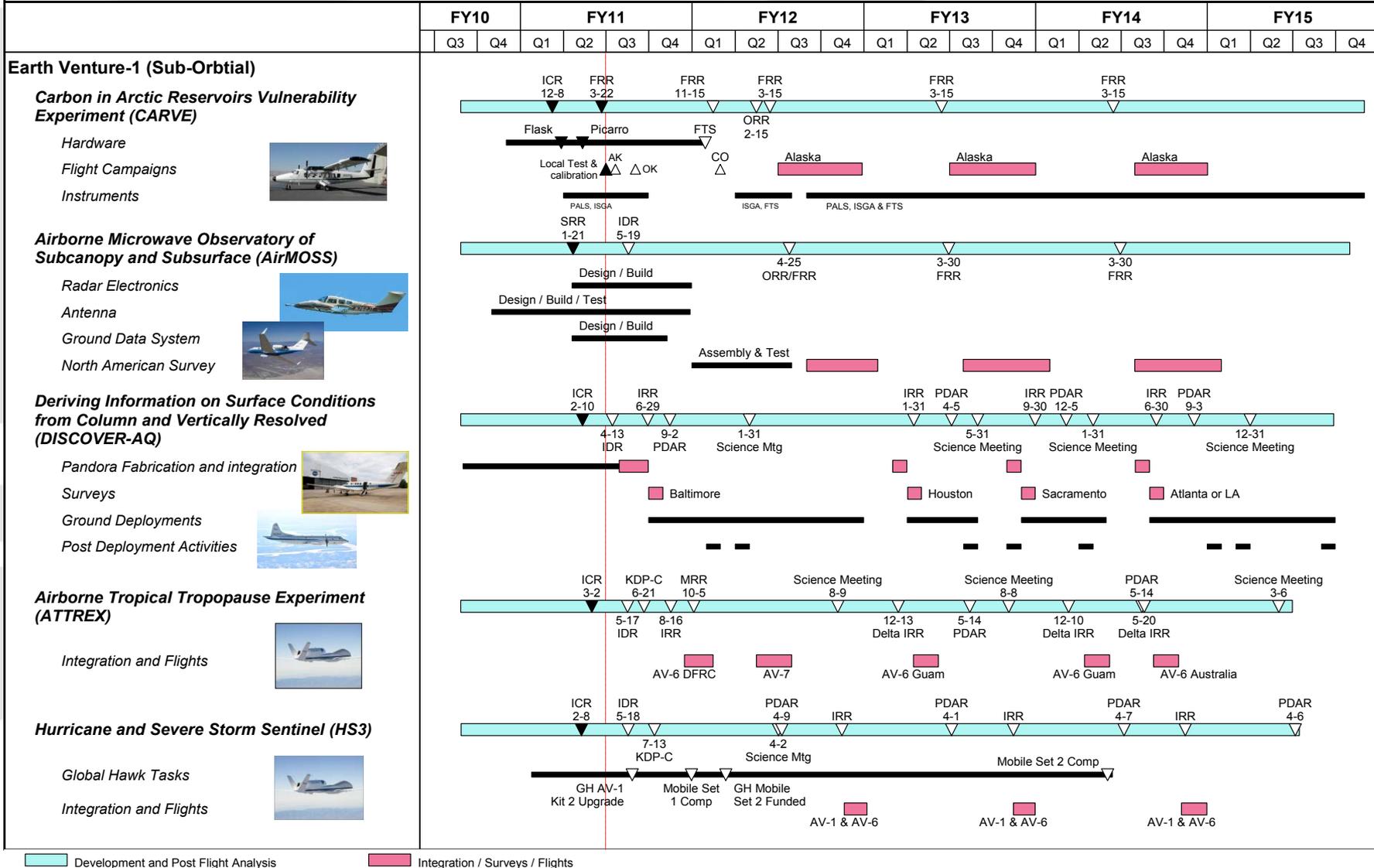
# EARTH VENTURE-1



## 5-year Schedule

### Earth System Science Pathfinder (ESSP) Earth Venture-1 Investigation Schedules

As of: 3-30-2011





# ***EARTH VENTURE-1 SUMMARY***



EV-1 will provide fundamental new qualitative and quantitative knowledge of:

- The sources and sinks of carbonaceous greenhouse gases in a range of biomes as a function of soil moisture,
- Upper atmospheric chemistry and cirrus cloud properties,
- The flux carbonaceous greenhouse gases from thawing permafrost,
- Air quality assessment and tropospheric chemistry using satellite remote sensing in conjunction with airborne and ground-based measurements, and air quality models, and
- Tropical cyclone development, including hurricane intensification.



# Backup





## Partners and Contractors

### AirMOSS

- University of Michigan – Ann Arbor, MI
- NASA JPL – Pasadena, CA
- Picarro – San Jose, CA
- NASA DFRC – Edwards, CA
- Harvard – Cambridge, MA
- Purdue – West Lafayette, IN
- Oregon State University – Corvallis, Oregon
- Massachusetts Institute of Technology – Boston, MA
- USDA – Beltsville, MD – Crow
- USDI/USGS – Sioux Falls, South Dakota
- GSFC – Greenbelt, MD

### ATTREX

- NASA ARC – Moffet Field, CA
- NASA GSFC – Greenbelt, MD
- NASA DFRC – Edwards, CA
- NOAA, Earth System Research Laboratory (ESRL) – Boulder, CO
- Northwest Research Associates Inc. – Boulder, CO
- SPEC Inc. – Boulder, CO
- National Center for Atmospheric Research – Boulder, CO
- University of Colorado – Boulder, CO
- University of Miami – Miami, FL
- Harvard – Cambridge, MA
- NASA JPL – Pasadena, CA
- NASA LaRC – Hampton, VA
- University of California, Los Angeles – Los Angeles, CA
- Northrop Grumman – Redondo Beach, CA
- University of Heidelberg – Heidelberg, Germany

### CARVE

- NASA JPL – Pasadena, CA
- Cal Tech – Pasadena, CA
- Twin Otter International – Las Vegas, Nevada
- Twin Otter International (integration location) – Grand Junction, CO
- NASA Wallops Flight Facility (Twin Otter Contract) – Wallops Island, VA
- NOAA – Boulder, CO
- University of Colorado – Boulder, CO
- ABB Bomem – Quebec, Canada
- Mikron Infrared – Oakland, NJ
- Picarro – San Jose, CA
- Harvard – Cambridge, MA
- San Diego State Univ – San Diego, CA
- University of California Irvine – Irvine, CA
- Alaska Aero fuel (Deployment Hanger) – Fairbanks, AK

### DISCOVER-AQ

- NASA LaRC – Hampton, VA
- NASA WFF – Wallops Island, VA
- NASA ARC – Moffet Field, CA
- NASA GSFC – Greenbelt, MD
- National Center for Atmospheric Research – Boulder, CO
- Pennsylvania State University – University Park, PA
- University of California, Berkeley – Berkeley, CA
- University of Maryland, Baltimore County – Baltimore, MD
- University of Innsbruck – Innsbruck, Austria
- Maryland Department of the Environment
- Environmental Protection Agency (EPA)



## Partners and Contractors (continued)

### HS3

- NASA GSFC - Greenbelt, MD
- NASA MSFC – Huntsville, AL
- NASA ARC – Moffet Field, CA
- NASA DFRC – Edwards, CA
- NASA JPL – Pasadena, CA
- National Oceanic and Atmospheric Administration (NOAA)  
Earth System Research Laboratory– Boulder, CO
- National Oceanic and Atmospheric Administration (NOAA)/  
Hurricane Research Division – Miami, FL
- Naval Postgraduate School – Monterey, CA
- University of Wisconsin – Madison, WI
- State University of New York at Albany – Albany, NY
- University of Maryland, Baltimore County - Baltimore, MD
- University of Utah – Salt Lake City, UT

### HS3 Collaborators

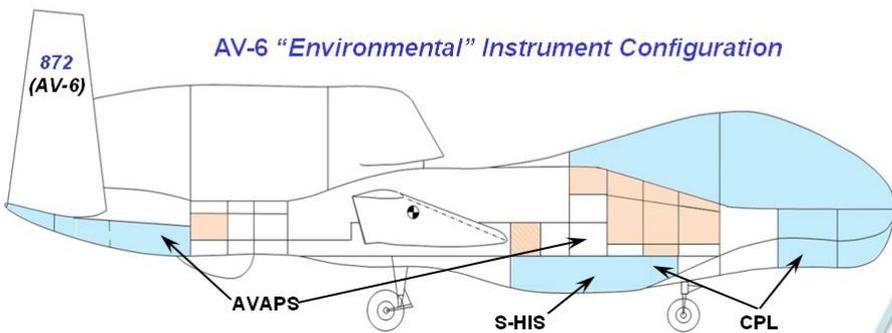
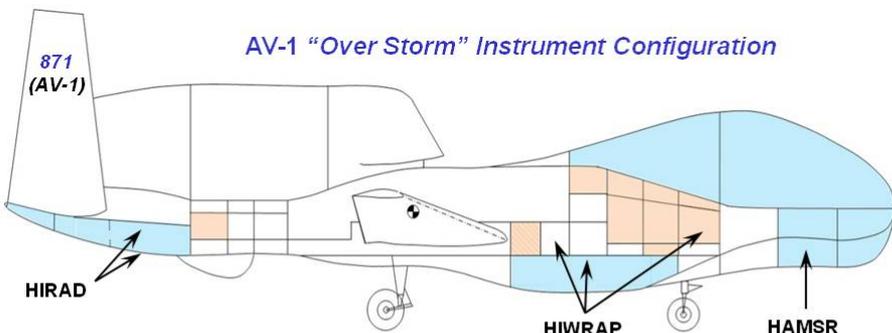
- Naval Research Lab – Monterey, CA
- NOAA/NCEP – Camp Springs, MD
- Northrop-Grumman Corp. – Redondo Beach, CA



# EARTH VENTURE-1



## HS3 Payload Installation Plan



2012

2013 - 2014

