



Earth System Science Pathfinder Program

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

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May 14, 2012

MSFC Seminar
Huntsville, AL



Outline



- Decadal Survey
- EV-1 Overview
- What's Different about EV-1
- Roles and Responsibilities
- EV-1 Investigations
- Future Opportunities



Decadal Survey: 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 Earth System Science Pathfinder (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



What's Different?



- Investigators in the R&A Program have supported successful campaigns and are well respected in the airborne community
- EV-1 has presented a different challenge and role for our Principal Investigators. eg.
 - Level 1's, Confirmation Review, reserve management, and 5 year duration
 - PI is fully responsible for the investigation (manage science, aircraft logistics, and programmatics – cost/schedule/risk management)
 - All these functions performed by PS under R&A programs
- Program Office management
 - Use of a tailored project management best practices for this type of mission
 - ESD/PO wants to see a minimum set of information from the investigators to provide confidence of their success, allow proper advocacy and to provide insight to ESD/PO



Example of Level 1 Requirements



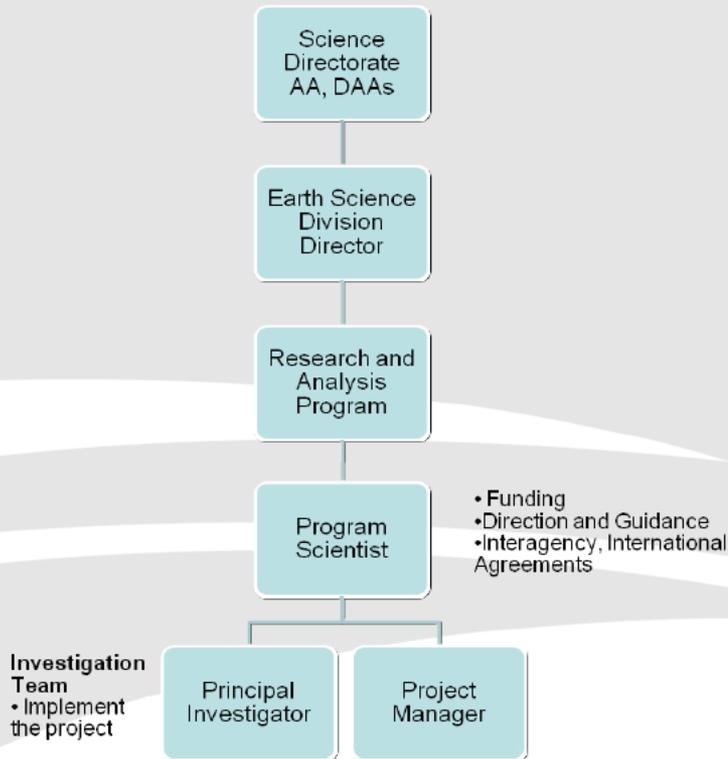
- conduct three (3) deployments with at least 600 aircraft flight hours total over the entire investigation
- conduct deployments in three different years during the August – September time frame with environmental and in-storm instrumented aircraft as described in 4.1.1 c), d) and e)
- sample six (6) tropical cyclones and four (4) passes over the Saharan air layer or easterly wave disturbances
- obtain measurements of temperature, humidity, wind and dust profiles in the hurricane's surrounding environment with the measurement characteristics in Section 4.1.3
- measure precipitation structure, in-precipitation wind structure and surface winds in precipitating tropical storms with the measurement characteristics in Section 4.1.3
- validate environmental temperature, humidity and wind profile measurements using *in situ* sensors on dropsondes
- record, validate, publish and deliver science data records and calibrated geophysical data products to the scientific community as described in Section 4.5



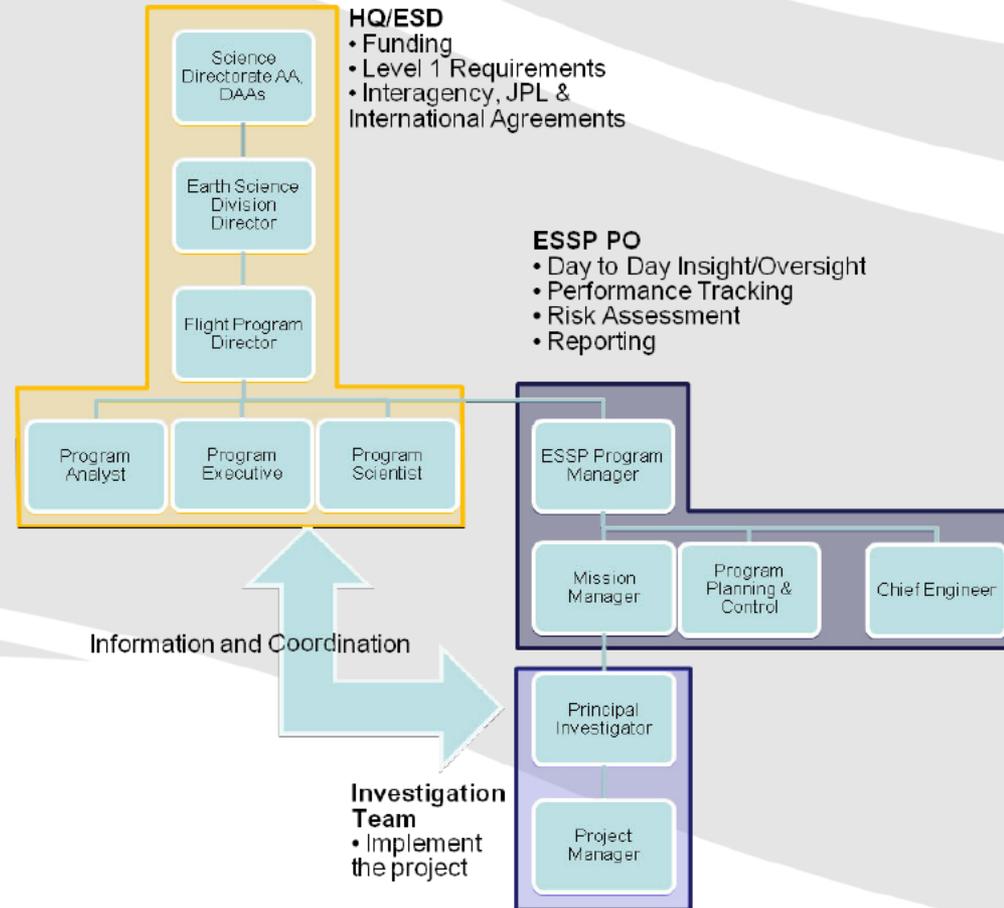
R&A vs. EV1 Management



R&A Management



EV-1 Management





Roles and Responsibilities



- **ESSP Program Office (All functions coordinated with PE and PS):**
 - The ESSP PO delegates authority and responsibility to the Mission Managers (MM) for their respective missions.
 - Primary interface between the PO and PI's is via the MM
 - Coordinate development of PPBE products
 - Coordinate funding according to agreed upon plan as identified in most recent PPBE
 - Review and evaluate risk mitigation approaches to PI-identified risks
 - Help investigations develop recovery plans if problem occurs
 - Assess schedule/cost performance at a top level using progress on project plan milestones, major milestones and high risk items.
 - If issues occur, may conduct independent assessment of EV-1 investigations for PS, PE and ESD
 - Assess budget reserve usage
 - Capture and then pass along lessons learned, for use as Investigations desire
 - Advocate for investigations and represent them accurately to HQ and other outside organizations.
 - Attends selected investigation lead reviews



Roles and Responsibilities



Investigation Team

- Principal Investigator is responsible for all activities, but may delegate tasks to the other parties
 - Reports programmatically to the Mission Manager and reports science related information to the Program Scientist
 - Fully and wholly responsible for Investigation
 - Planning the investigation activities
 - Manage the details of the investigation to ensure delivery of Level 1 requirements on schedule and within budget.
 - Assess progress against plan and make adjustments as needed to meet cost, schedule and technical/science constraints
 - Document investigation data as needed
 - Provide MM, PS and PE insight into the details of the Investigation when requested
 - Conceives and ensures scientific integrity of the Investigation
 - Has authority, as described in the solicitation, over the direction and conduct of the mission
 - Supports the PPBE process
- Project Manager supports the PI in the execution of his or her duties and executes authority as delegated from the PI
 - Reports to the Principal Investigator and to the Mission Manager – PI can delegate any and all implementation responsibilities to Project Manager
 - Accountable for the safety, technical integrity, performance, and mission success of the project, while also meeting programmatic (technical, cost, and schedule) commitments as delegated by the PI



Earth Venture-1

Carbon in Arctic Reservoirs Vulnerability Experiment (CARVE)



Team

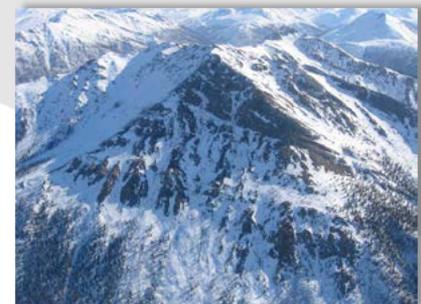
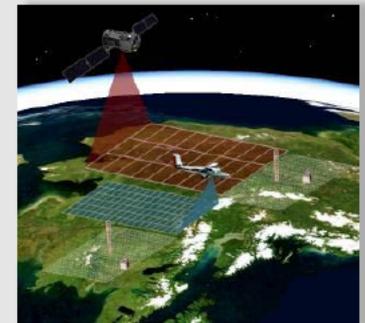
- Principal Investigator: Charles Miller (JPL)
- Project Manager: Steve Dinardo (JPL)

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

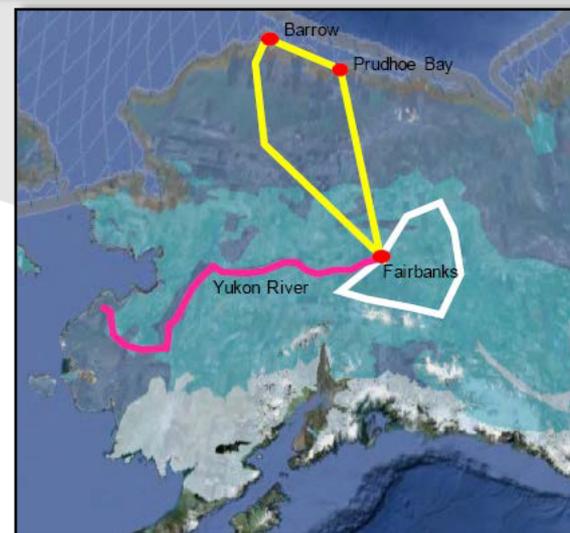
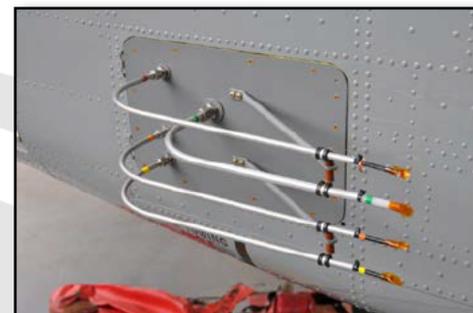
Objectives

- Test hypotheses attributing mobilization of carbon reservoirs to climate change
- First direct measurements of CO₂ and CH₄
- Demonstrate new remote sensing and modeling methods



Implementation

- C-23 Sherpa aircraft carrying:
 - Passive-Active L-band System (PALS)
 - Fourier transform spectrometer (FTS)
 - In Situ Gas Analyzer (Picarro, Flask Packs)
 - Ozone
- Strategically located ground base sites
- Deployments from Fairbanks, AK
 - Flew test flights in 2011
 - Spring, summer and early fall of each year from 2012-2014
 - North Slope
 - The interior
 - Yukon River valley
- Deployed to Oklahoma
 - Flew Test Flights in 2011



Team

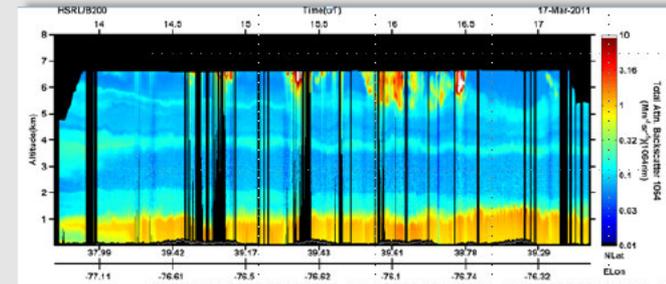
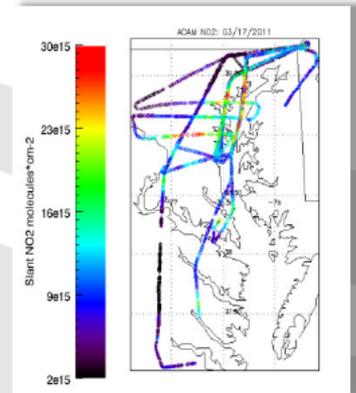
- Principal Investigator: James Crawford (NASA Langley)
- Project Manager: Mary Kleb (NASA Langley)

Goal

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

Objectives

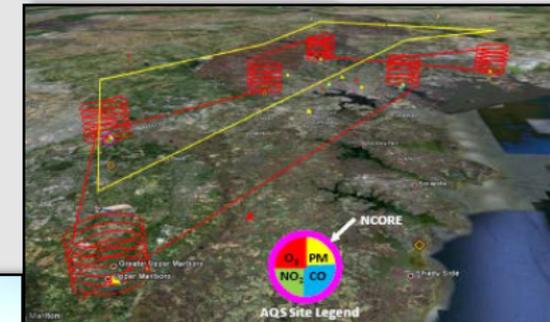
- Relate column observations to surface conditions
 - Aerosols, O₃, NO₂ and CH₂O, NH₃
- Characterize differences in diurnal variation of surface and column observations
- Examine horizontal scales of variability satellites and model calculations





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
 - Tethered Balloon
- P-3B Aircraft
 - 8 instruments providing in-situ trace gas and aerosol observations
- 30-day deployments in 2011, 2013, and 2014
 - Baltimore, MD (completed in 2011); Houston, TX (Summer 2013); Sacramento, CA (Winter 2013); TBD (Los Angeles, Birmingham or Atlanta)



Team

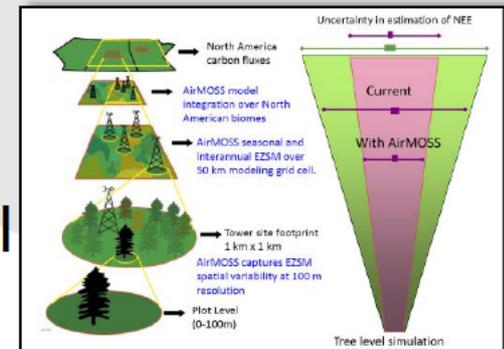
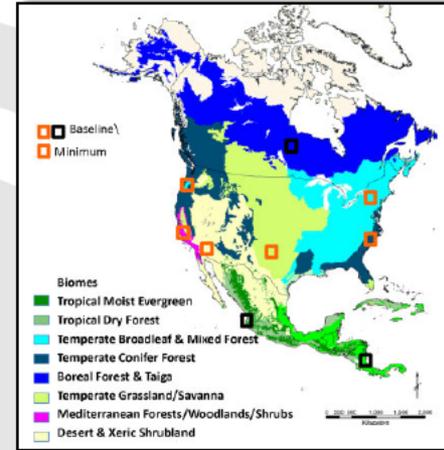
- Principal Investigator: Mahta Moghaddam (University of Southern California)
- Project Manager: Yunling Lu (JPL)

Goal

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

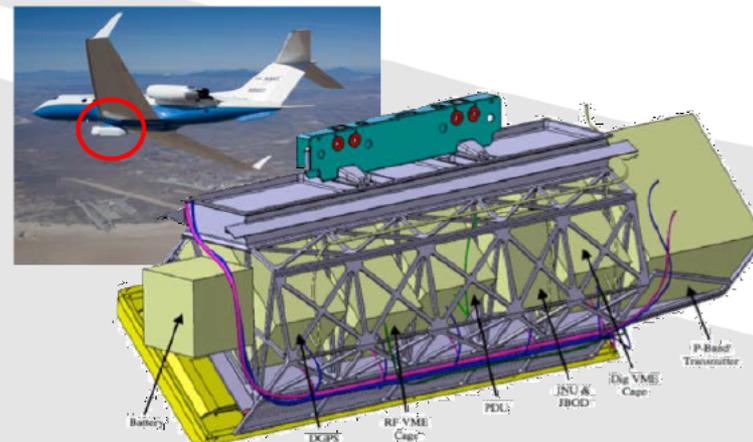
Objectives

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



Implementation

- JSC/DFRC Gulfstream-III
 - Airborne ultra high frequency (UHF) synthetic aperture radar (SAR)
- Extensive ground and in-situ measurements
- Field operation Summer 2012 through Spring 2015
 - Canada
 - 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 three different bases around the world to study the chemical and physical processes at different times of the year.

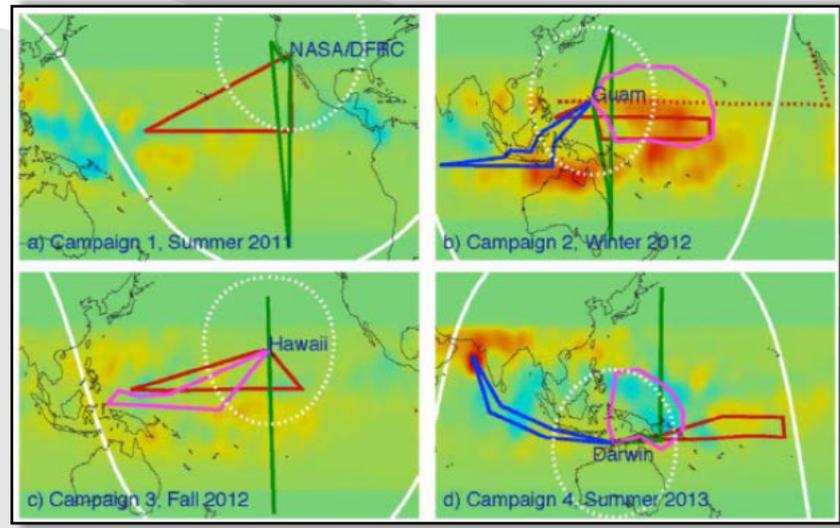
Objectives

- 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 2011, spring 2013)
 - Pacific Deployment Site(s) TBD (summer 2014, winter 2013-2014)





Team

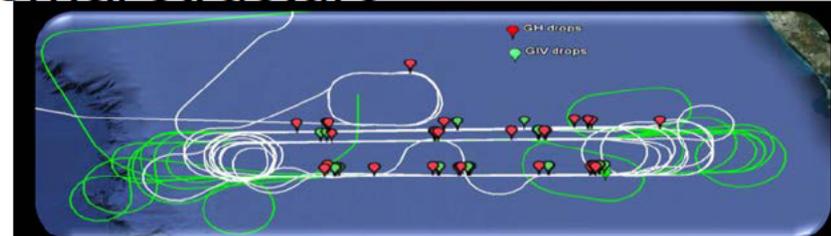
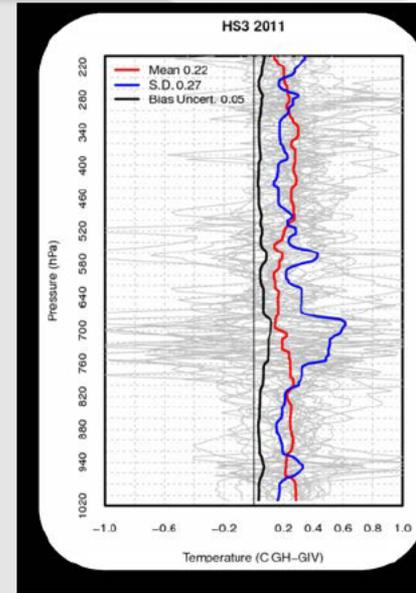
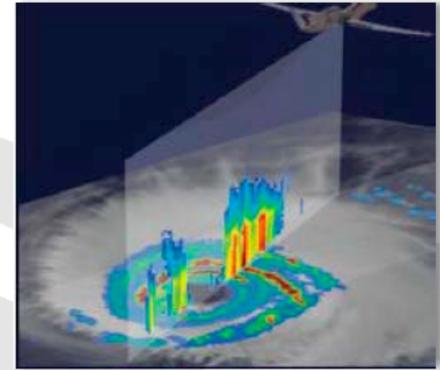
- Principal Investigator: Scott Braun (NASA Goddard)
- Project Manager: Marilyn Vasques (NASA Ames)

Goal

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

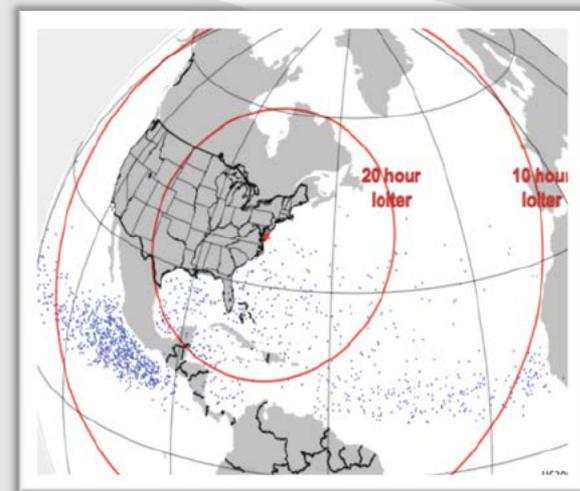
Objectives

- 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

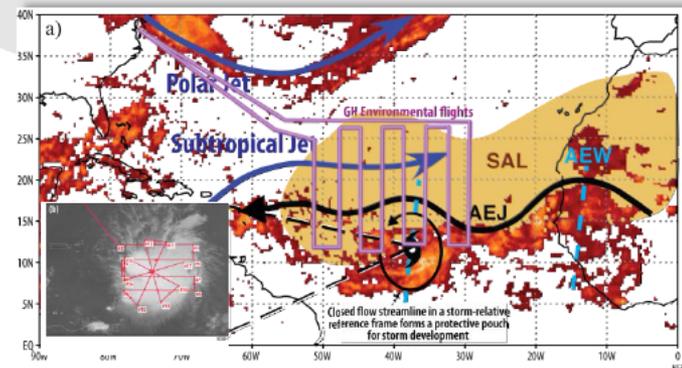




Implementation



- 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
 - Late August to Late September of each year
 - Deploy out of NASA Wallops Flight Facility



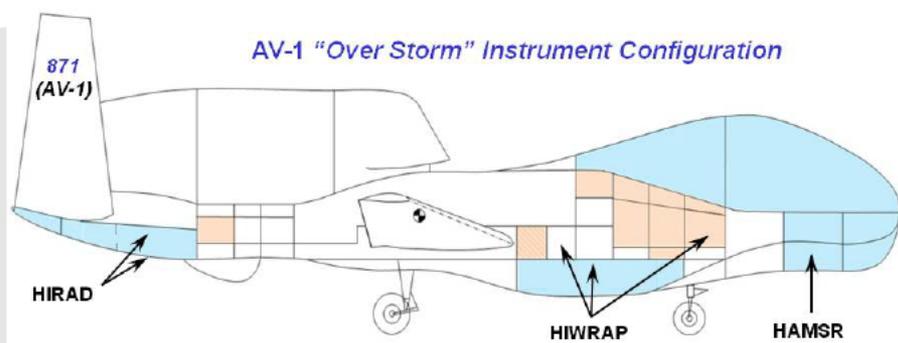


Earth Venture-1

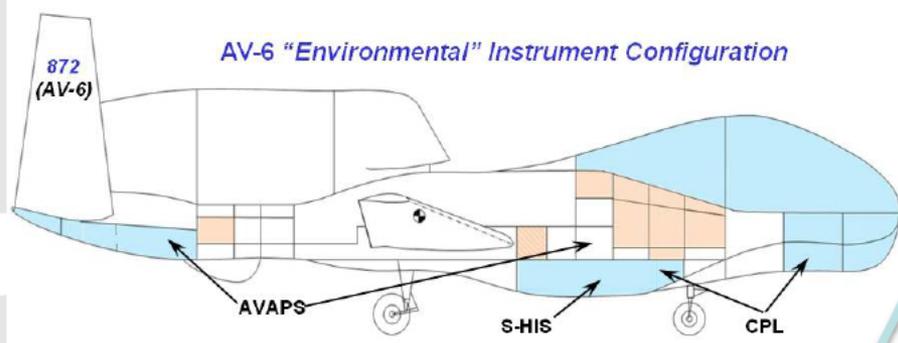


HS3 Payload Installation Plan

AV-1 "Over Storm" Instrument Configuration



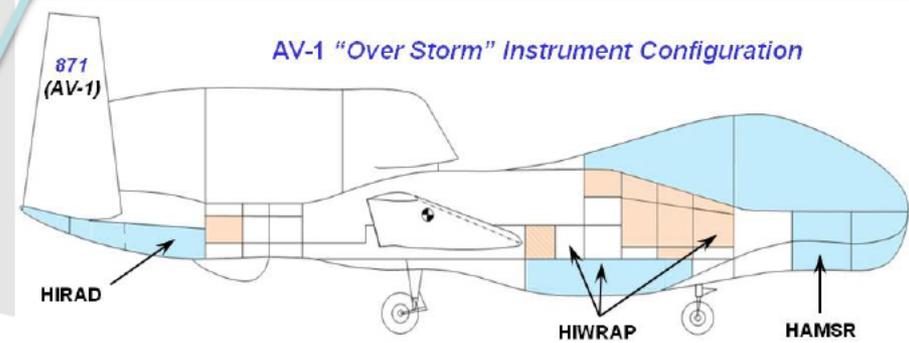
AV-6 "Environmental" Instrument Configuration



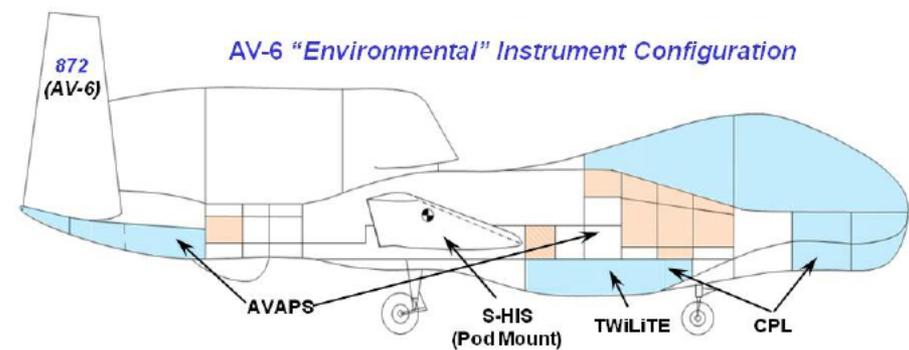
2012

2013 - 2014

AV-1 "Over Storm" Instrument Configuration



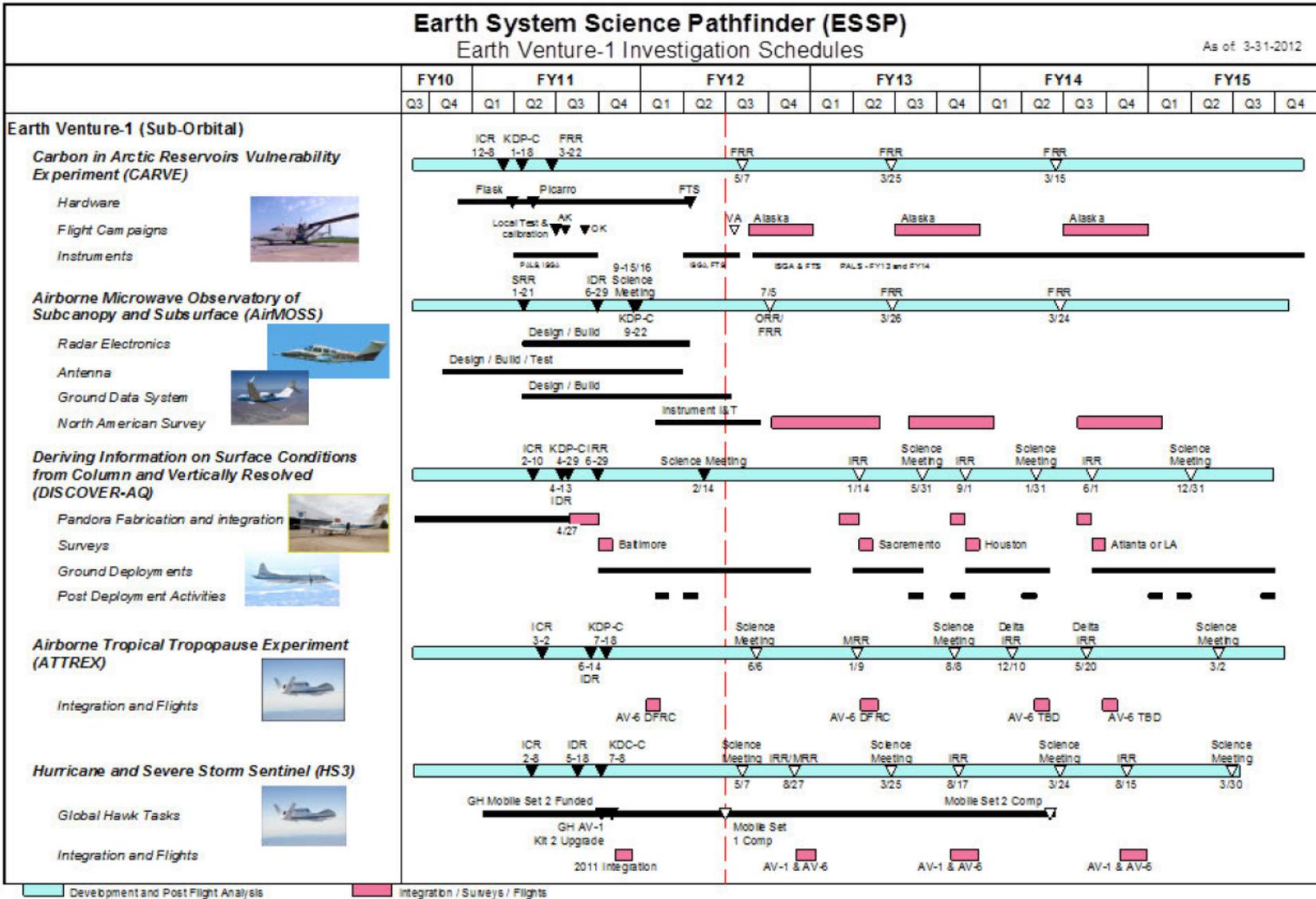
AV-6 "Environmental" Instrument Configuration





Earth Venture-1

5-year Schedule





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





Earth Venture-1



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