ABoVE

October 2, 2015

Randy Albertson
Airborne Science Program
Deputy Director

Airborne Science Program Mission

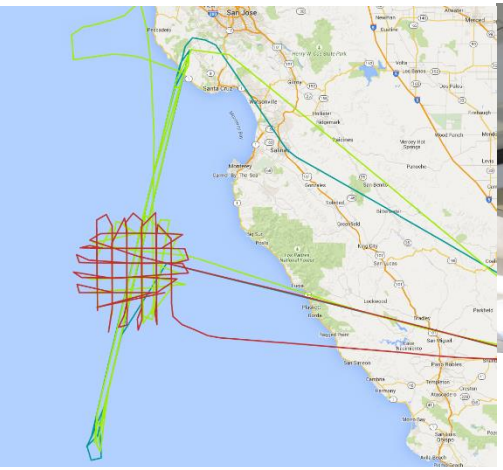
The NASA Airborne Science Program exists to enable scientists to achieve NASA Earth science objectives and answer science questions that require the use of airborne platforms, services and infrastructure. The Airborne Science Program does this by providing the Earth Science community access to a pre-eminent suite of airborne capabilities.

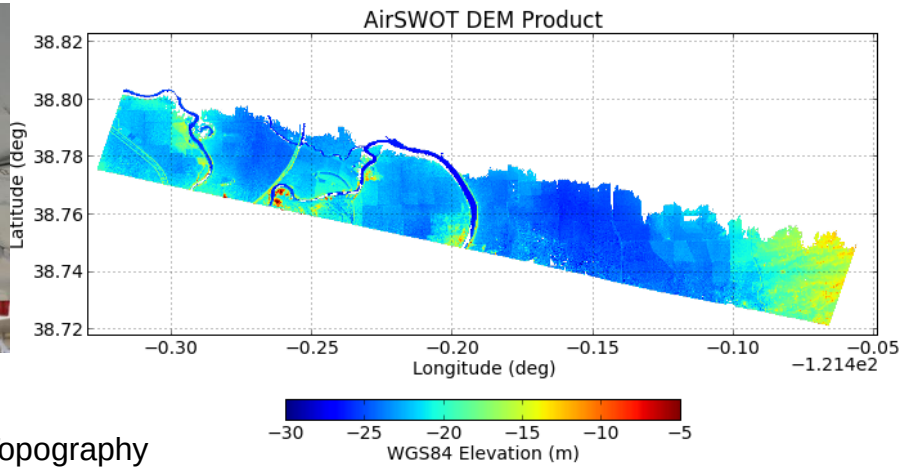
- **Science and platform agnostic**
- **Right tool for the job**

Program Objective 1

Satellite Calibration and Validation

Provide platforms to enable essential calibration measurements for the Earth observing satellites, and the validation of data retrieval algorithms.



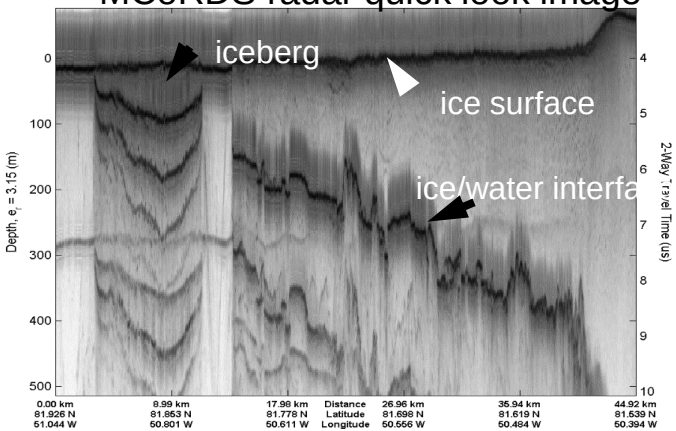


AirSWOT

Airborne Surface Water & Ocean Topography

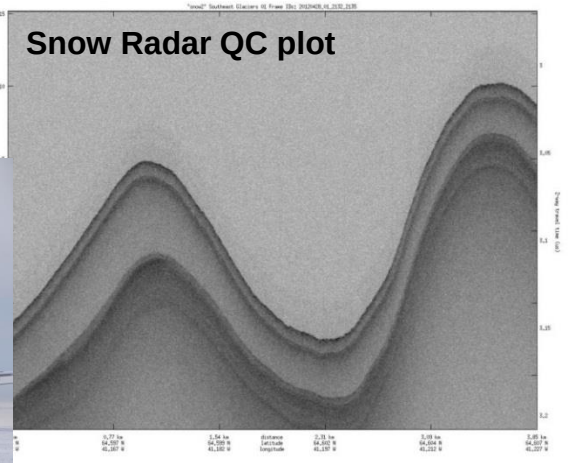
Millimeter-wave radar interferometry used to map ocean surface topography and surface water heights and slopes. Designed to support SWOT mission: instrument and algorithm development, calibration/validation, ocean and hydrology science

MCoRDS radar quick look image



Operation IceBridge

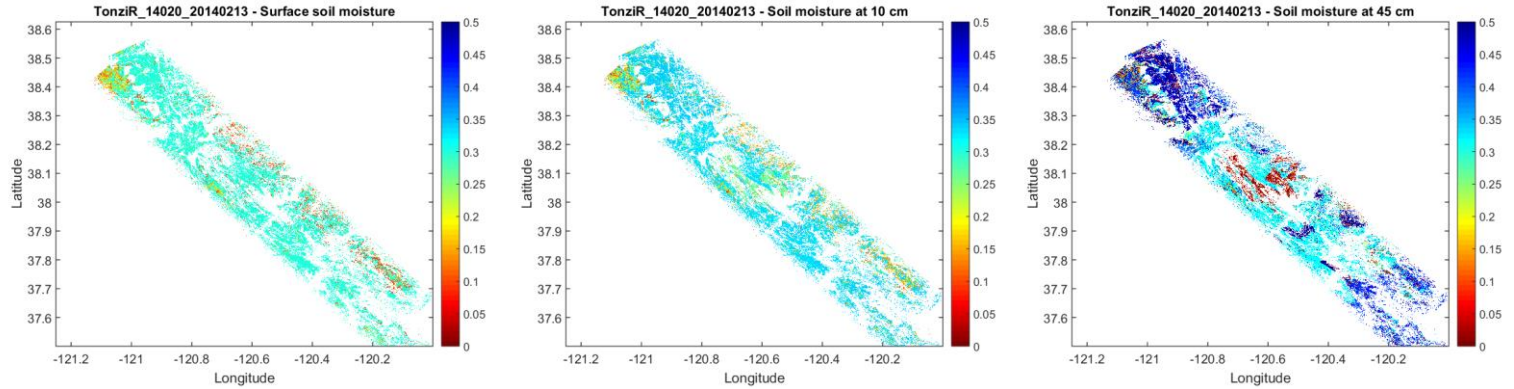
ICESat to ICESat 2 data gapfiller mission



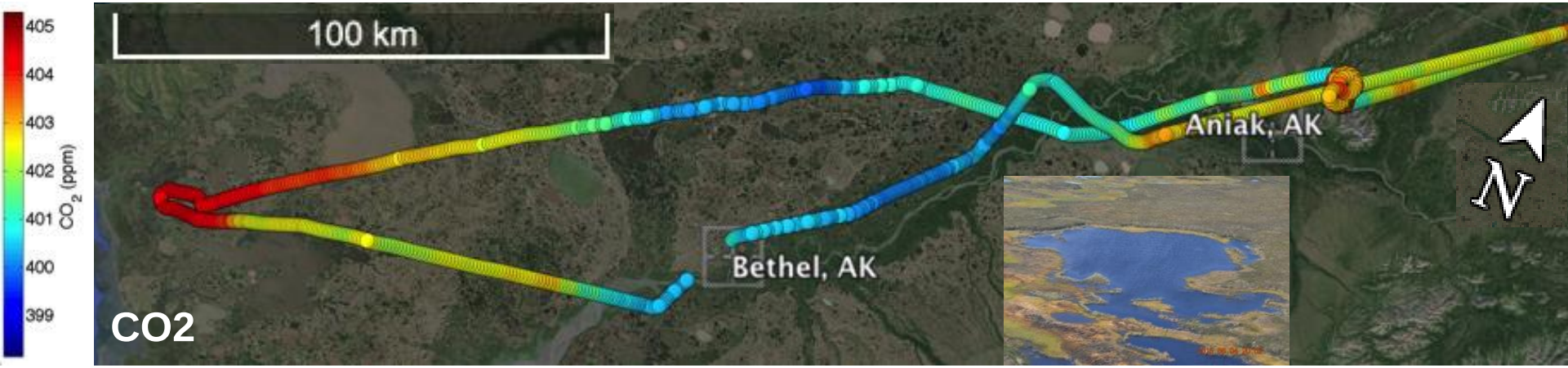
Program Objective 2

Process Studies

Obtain high-resolution temporal and spatial measurements of complex local processes, which can be coupled to global satellite observations for a better understanding of the complete Earth system.



Tonzi Ranch wet season soil water maps from AirMOSS, February 12,2014



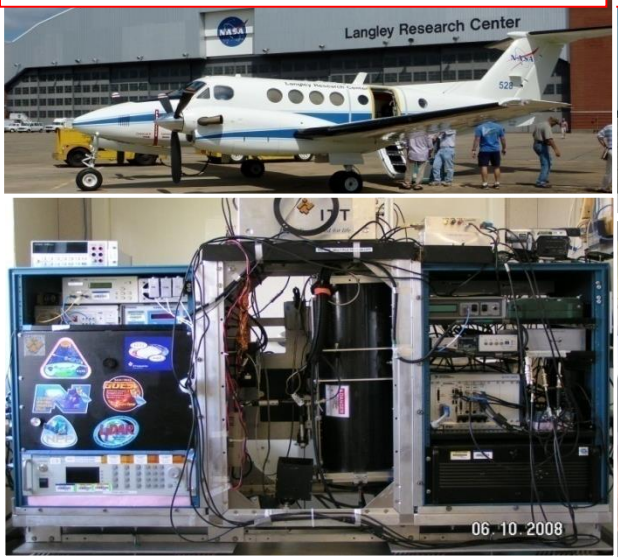
4 June 2015 CARVE Science Flight Yukon-Kuskokwim Delta

Program Objective 3

Support New Sensor Development

Provide sub-orbital flight opportunities to test and refine new instrument technologies/algorithms, and reduce risk prior to committing sensors for launch into space.

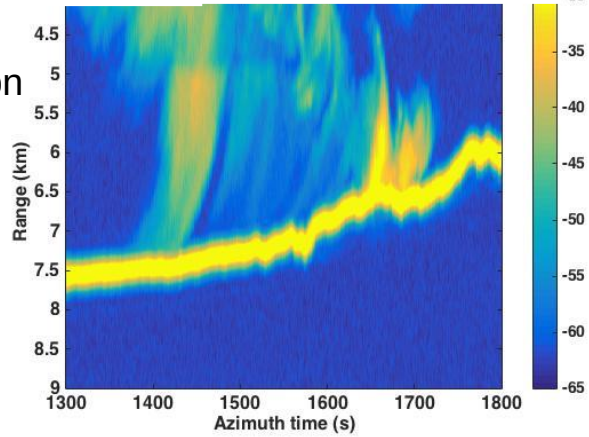
LaRC/ITT ACCLAIM lidar instrument in NASA UC-12



GSFC Airborne CO2 lidar instrument in NASA Lear-25

JPL Airborne CO2 lidar instrument in Twin Otter

RainCube is a technology demonstration mission that will enable Ka-band precipitation radar technologies to be flown on a 6U Cubesat



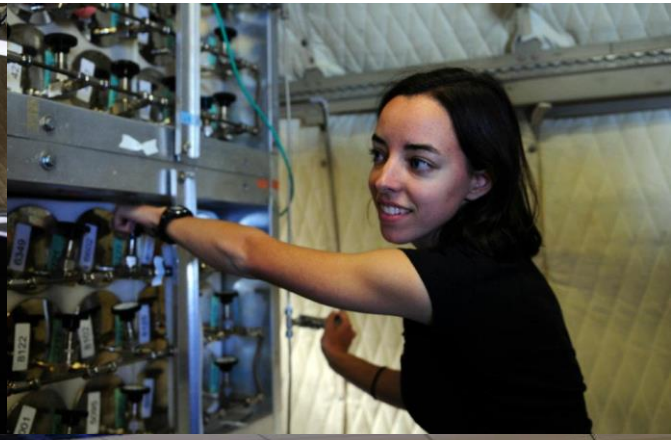
Rain return signal, 6/28/15

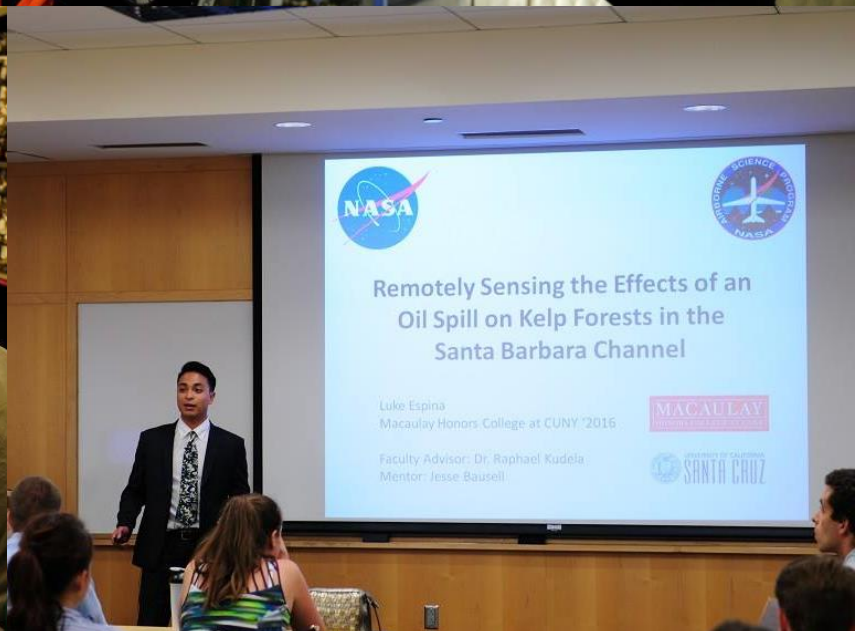
RainCube engineering team in cargo hold on board NASA DC-8

Program Objective 4

Develop the Next-Generation of Scientists and Engineers

Foster the development of our future workforce with the hands-on involvement of students, and young scientists/engineers in all aspects of ongoing Earth science investigations.

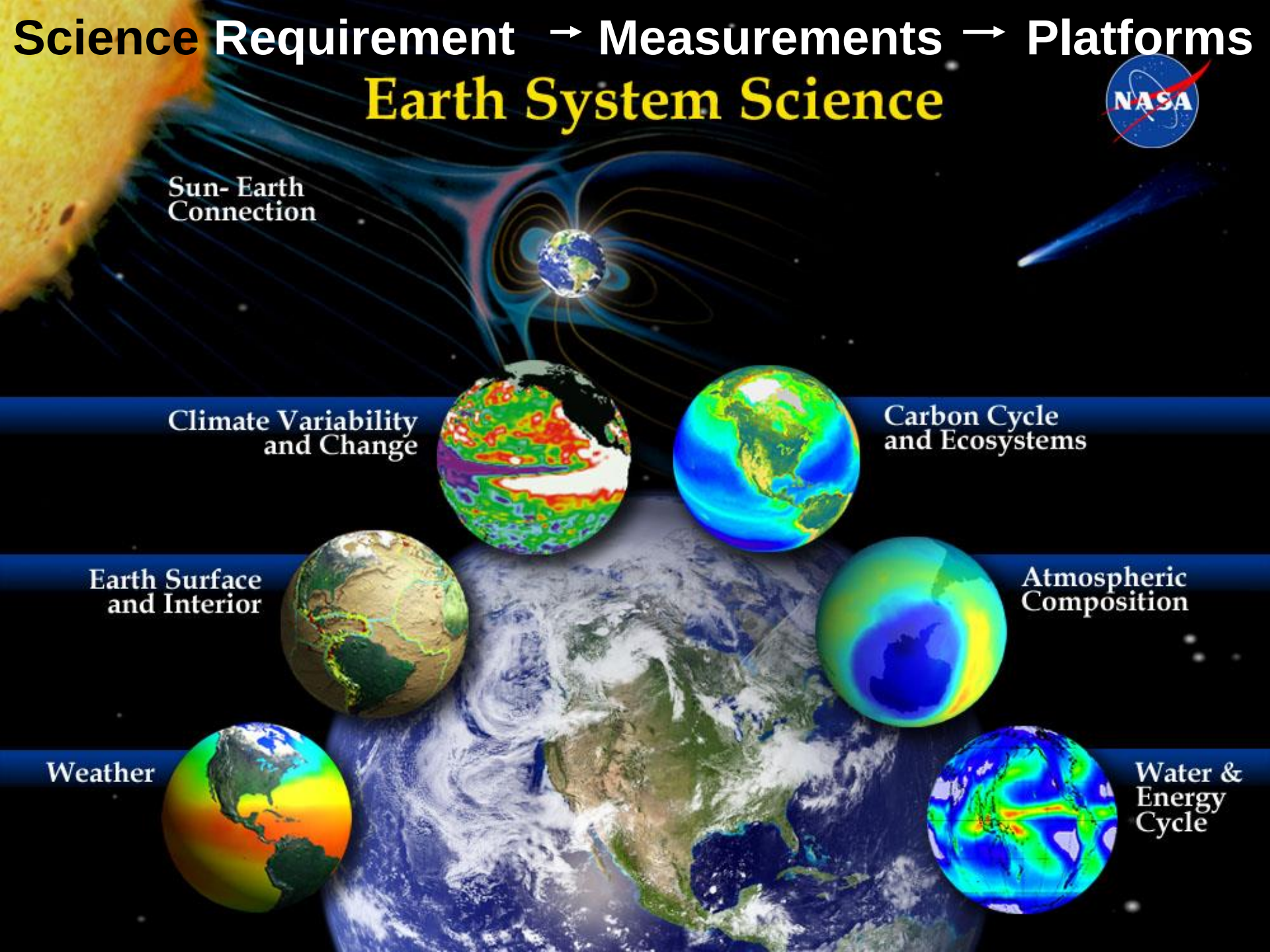




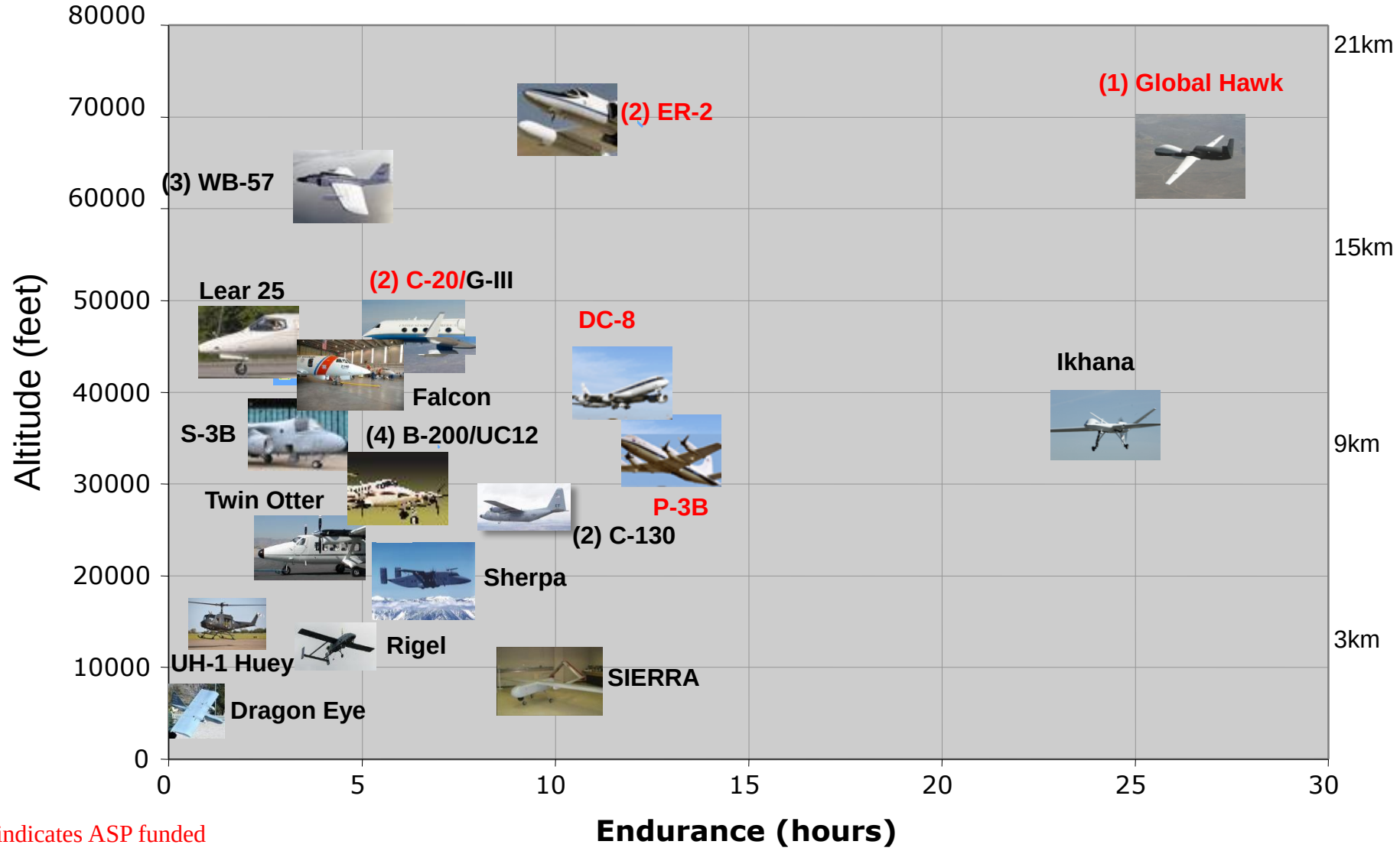
What does Airborne Science do?

- **Facilitate access to airborne assets capable of supporting NASA's scientific measurements**
  - Core, Catalog, Cooperative and New technology
  - Help get through acquisition, process and regulatory wickets.
- **Provide capabilities to enhance/enable scientific measurements**
  - Mission/Project Management and Logistics
  - Science support systems
  - Airborne networks
  - Approvals for Laser and Radiation, dropsonde release, pressure vessel safety, HAZMAT safety, EMI, foreign clearances, etc
- **Optimize the use of resources**

Science Requirement → Measurements → Platforms

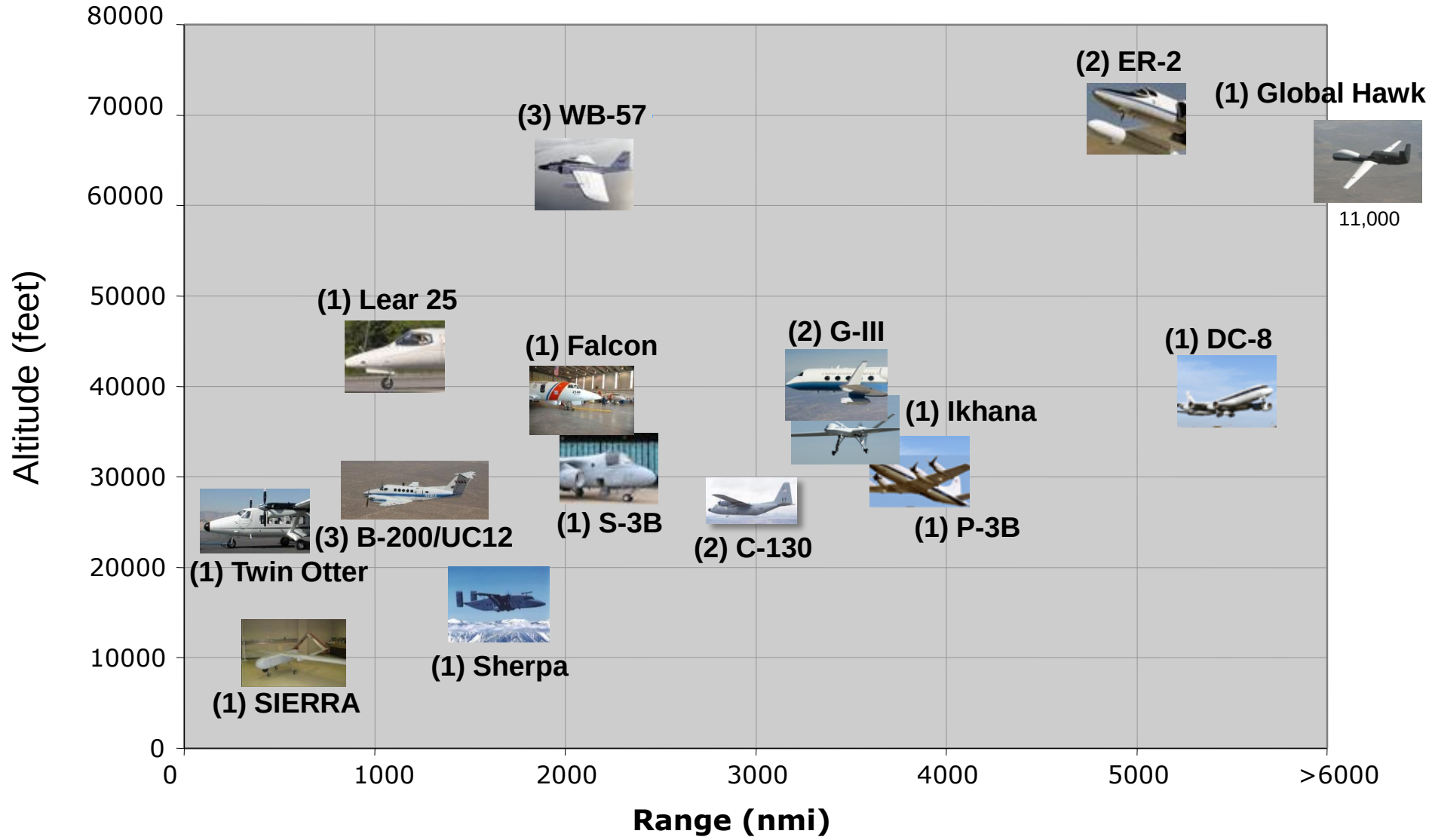


NASA Airborne Science Capable Aircraft



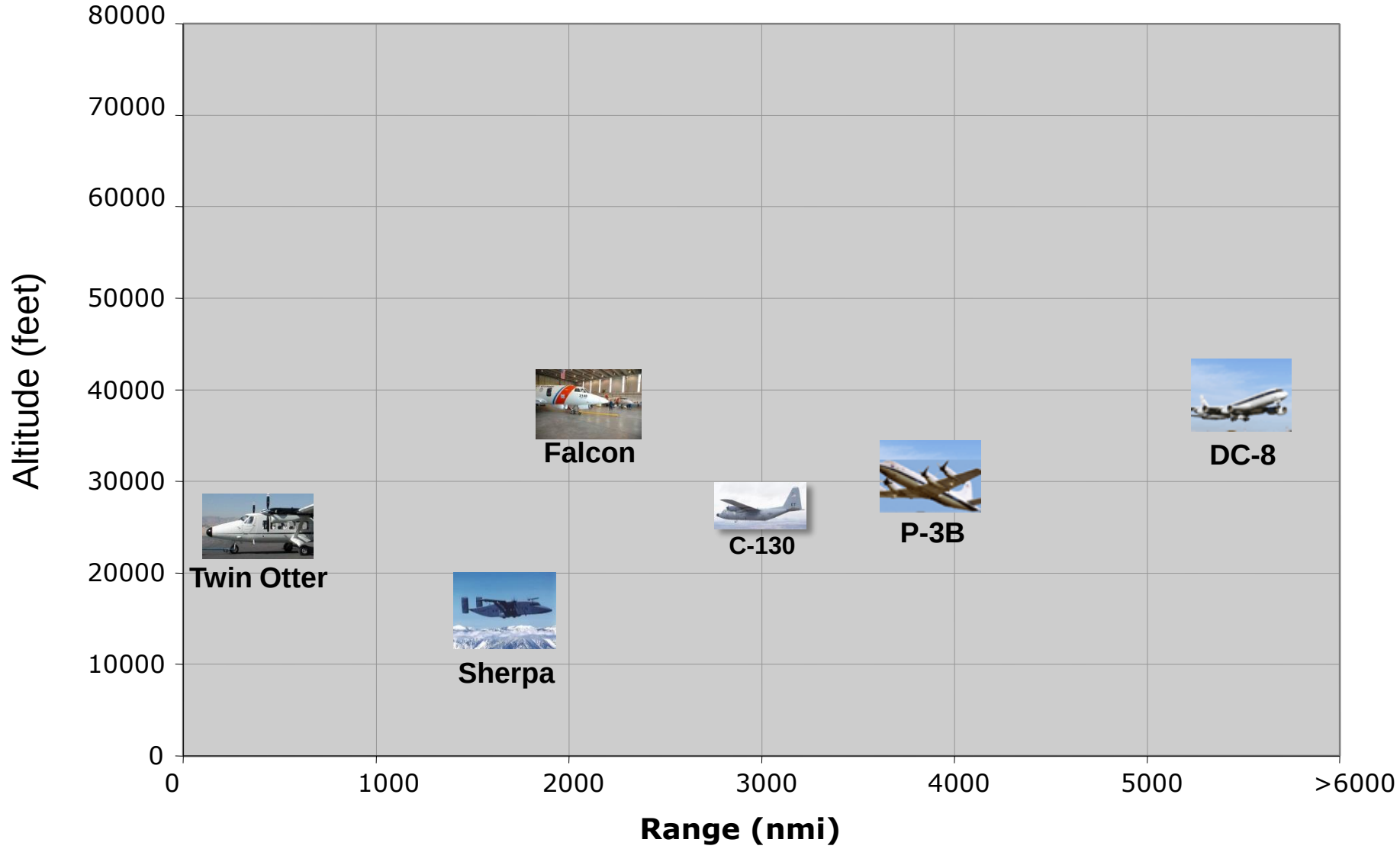
Red indicates ASP funded

NASA Airborne Science Aircraft



NASA Manned Airborne Science Aircraft

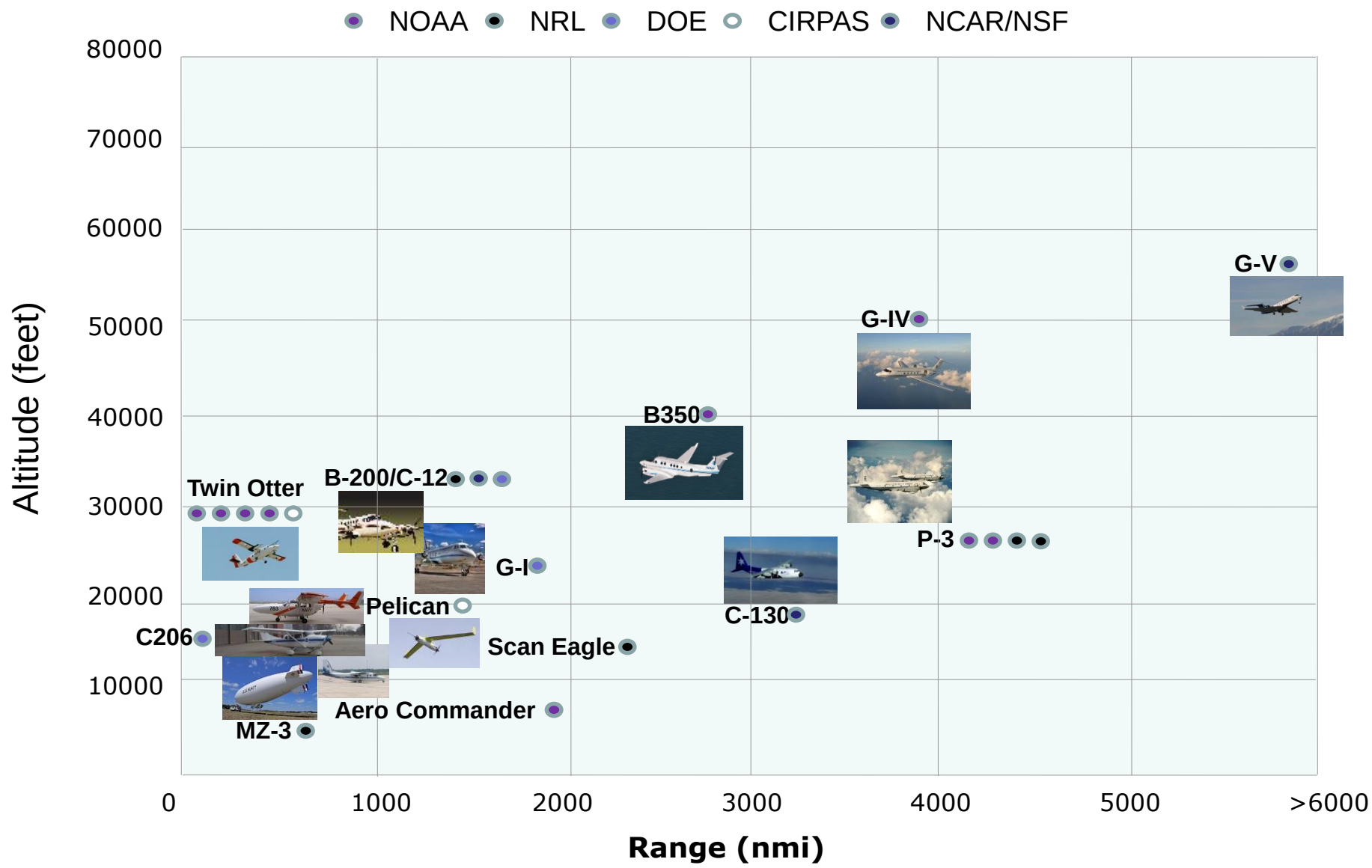
(with nadir ports & room to work for 4 + people)



Other Factors for Science Platforms

- Speed
- Payload volume and capacity
- Power
- Perspectives/viewpoints
- Communications/network
- Operations cost/constraints
- Basing/airspace

ICCAGRA Science Research Aircraft (excluding NASA)



Payload Perspectives

TC4 WB-57 Payload
July 2007

Left Wing Pod
Water Vapor
MTP , CSI/CDP

Cockpit
ACAM (forward)

Nose
P/T
MMS
FCAS, NMASS

Forward Transition
Ozone

Pallets
P1: ICOS
P2: HOXITOPE
P3: *2 ch NO/NOy*, SP2, *UAS Ozone*
P4: WAS, *Harvard C02*

Left Wing Hatches
JLH
Frostpoint

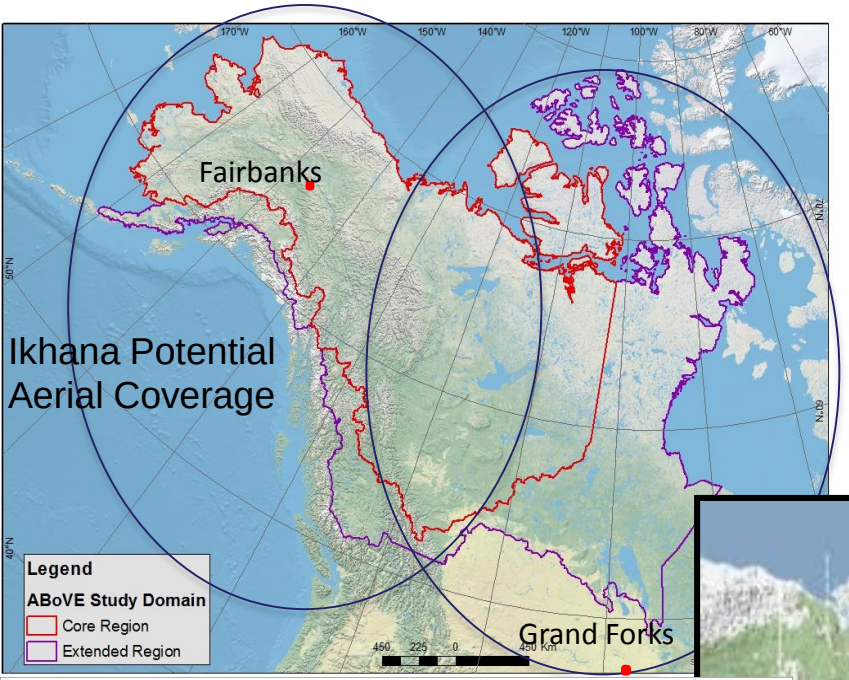
Upper Equip Bay
CAFS

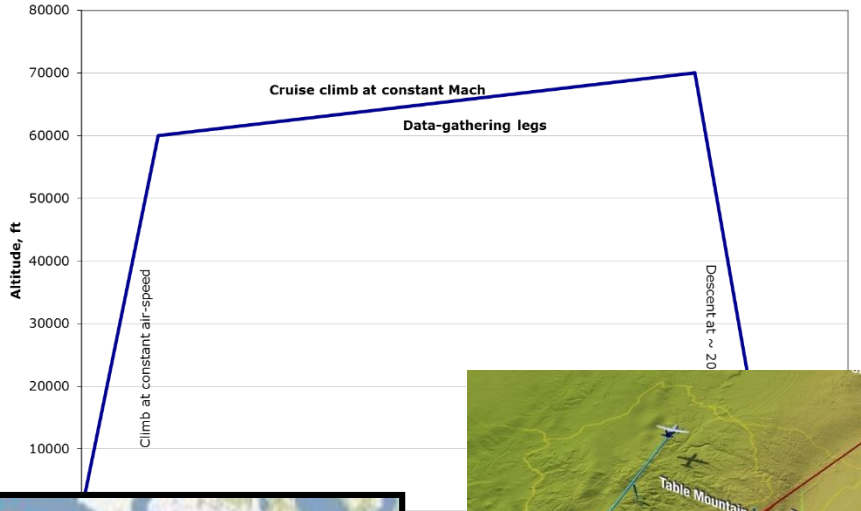
Aft Transition
PANTHER
CAFS

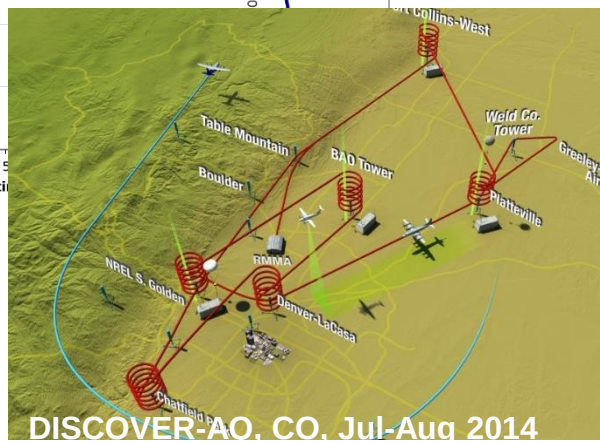
Right Wing Hatches
2DS
CPI
CEM

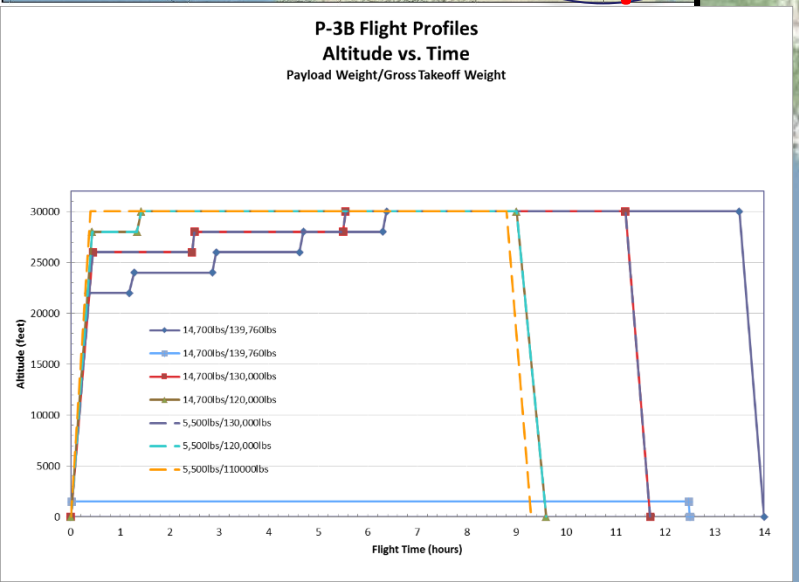
Right Wing Pod
Argus, CLH, CPI Data

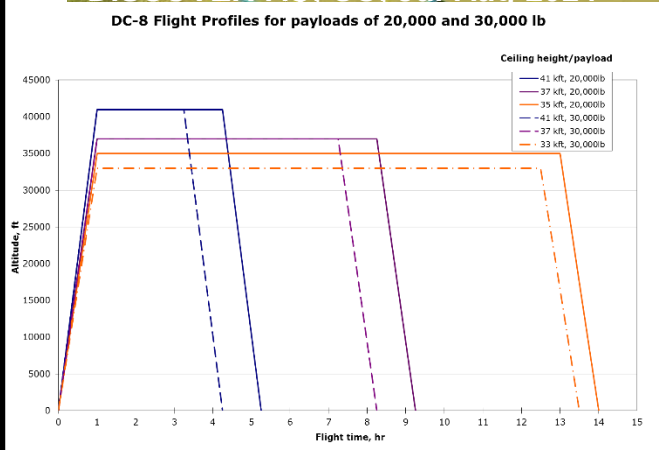
Ranges and Profiles





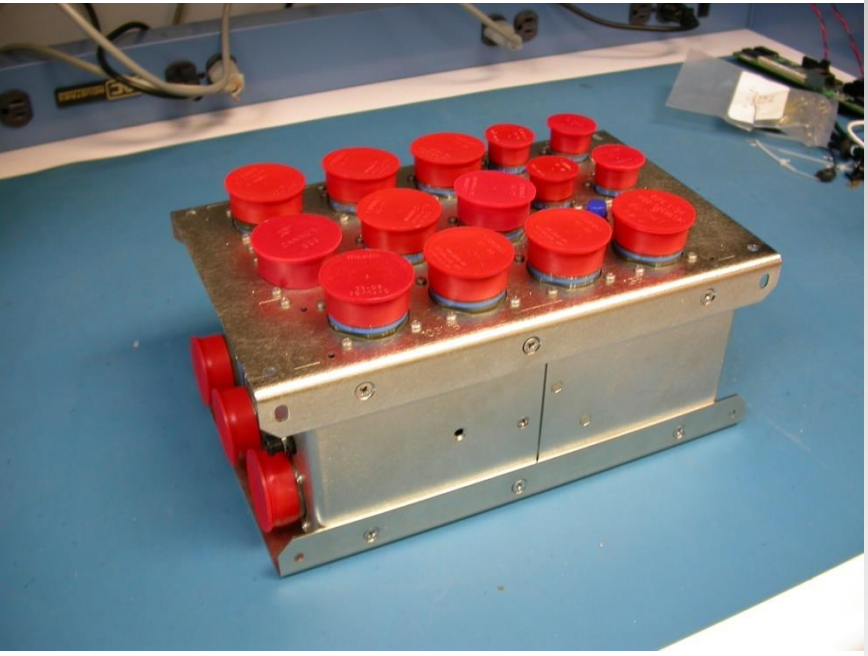


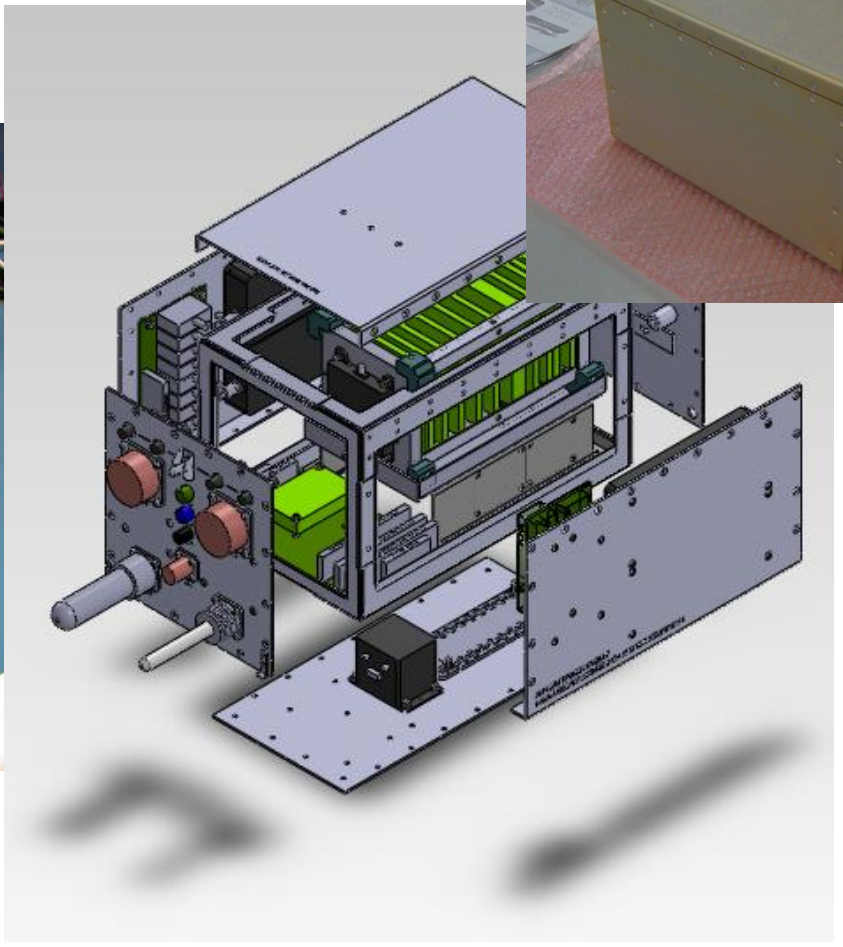




ASP Cross Cutting Infrastructure

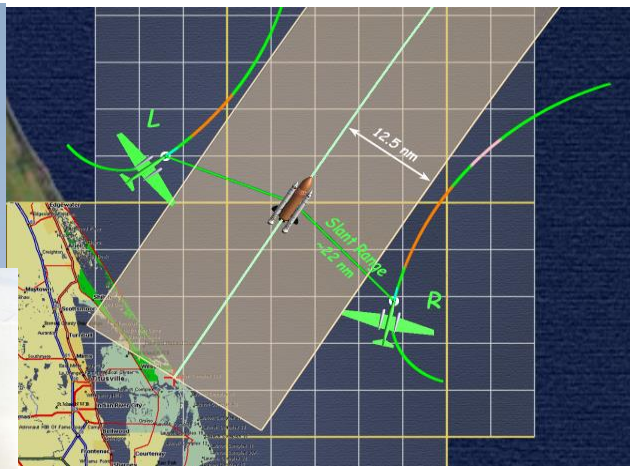
NASA Airborne Science Data and Telemetry System (NASDAT) - airborne network server and low bandwidth Iridium gateway which captures navigational data as well as allows scientists to talk to their instruments

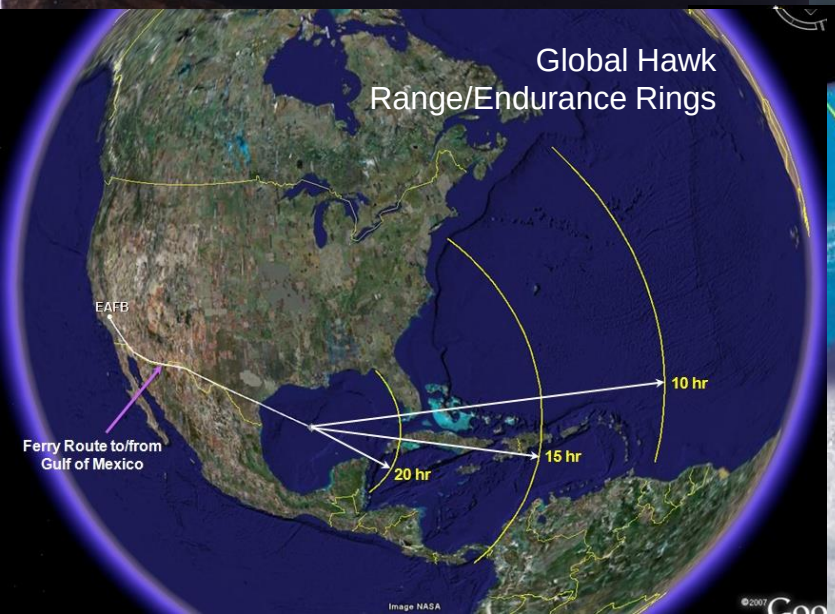


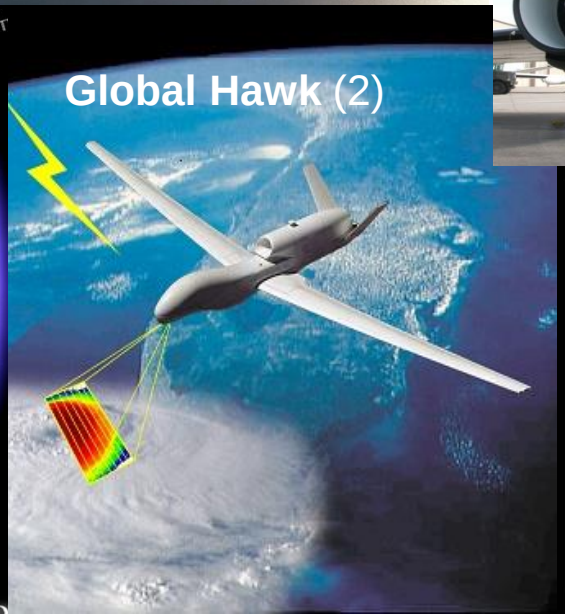


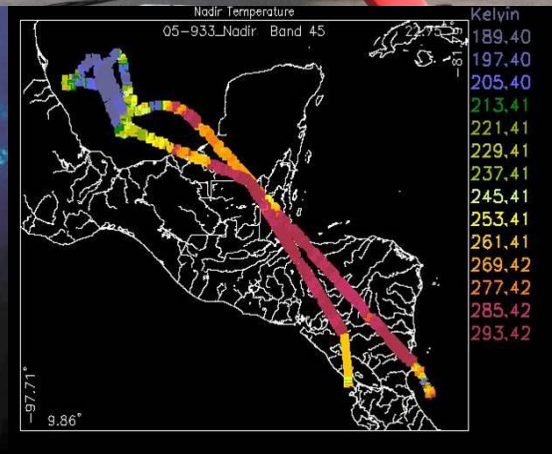
Experimenter Interface Panel – science instrument to aircraft interface

Unique NASA-only Heavy Lift High Altitude Fleet (50k+ feet)







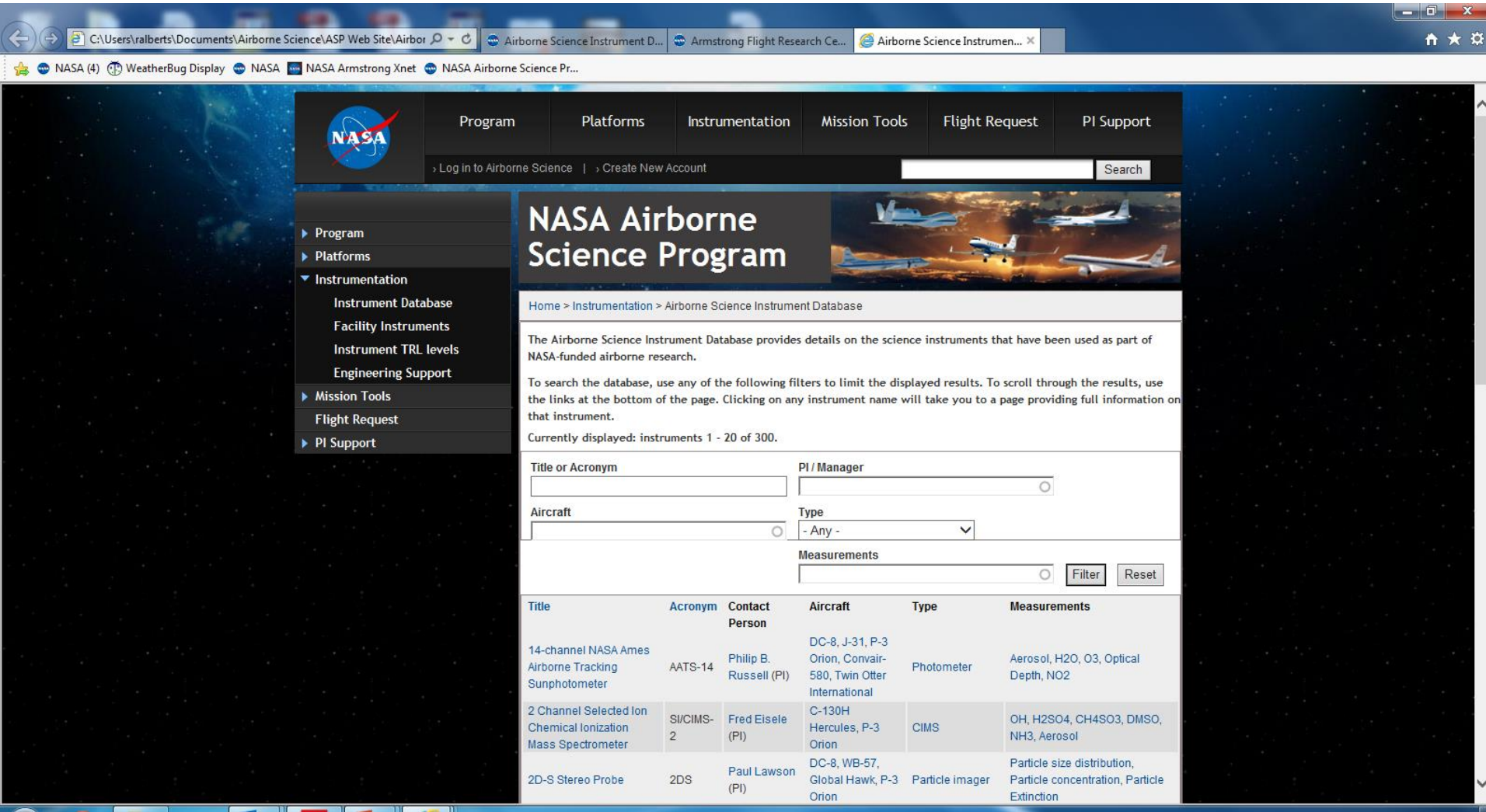


Unique NASA-only Reconfigurable Large Flying Laboratories

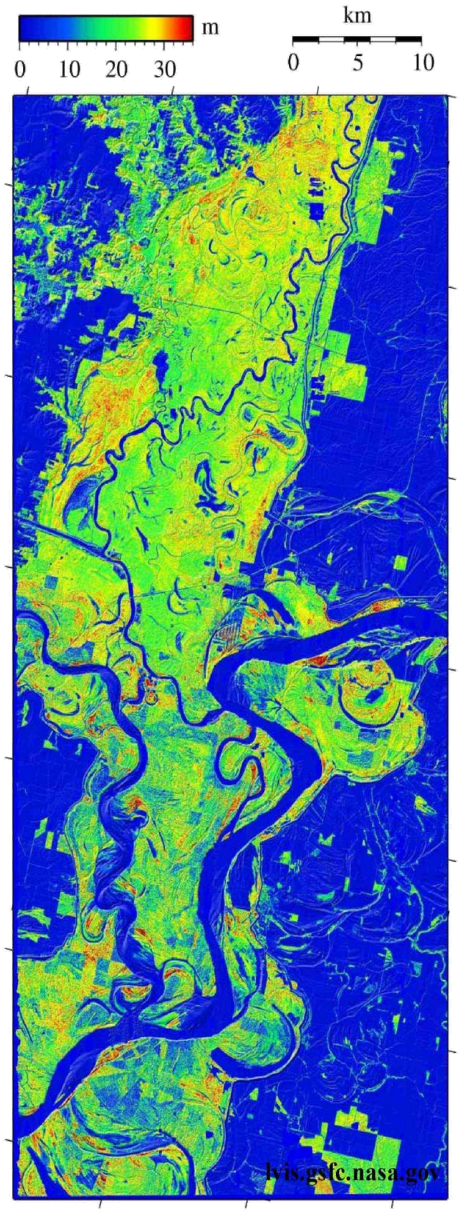
- Internal Comm and Data Networks
- Onboard satcom sensor web networks
- Dropsonde Ejectors
- Specialized Racks for quick payload reconfiguration
- Nadir and Zenith ports with sensor attachment provision
- Wing hard points for sensor mounting
- Specialized ports for probe mounts with CFD Analysis
- Common Aircraft State data to Sensor broadcast

Airborne Sensors

Compellation of previously integrated sensors:
https://airbornescience.nasa.gov/instrument/all



LVIS Airborne, Swath-mapping Lidar Facility



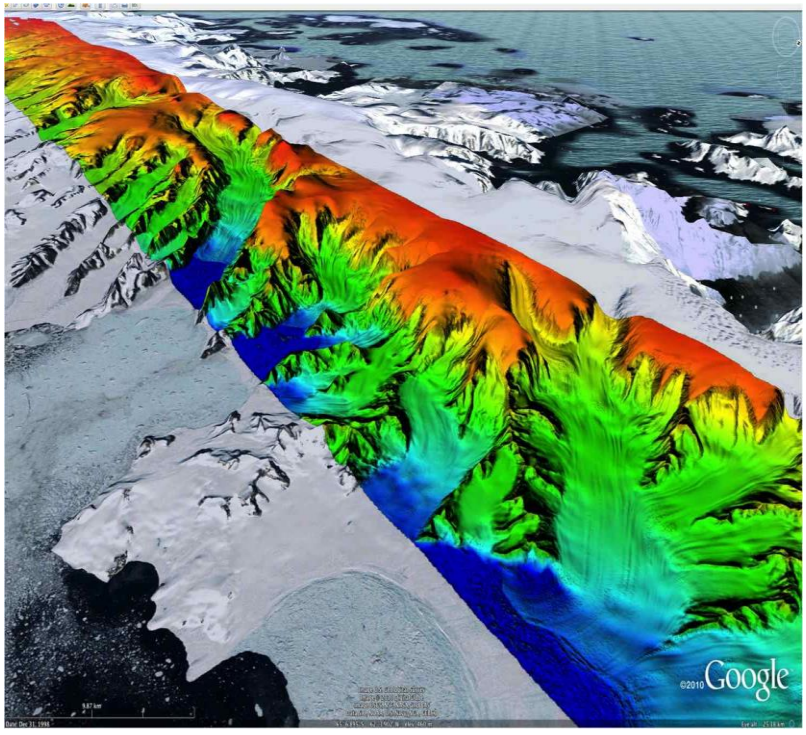
Wide-swath, Full-waveform, High-accuracy Laser Altimeter for large area mapping

- Mature instrument & measurement concept
- Serves multiple science measurement goals

(Terrestrial Eco, Cryo, Carbon Cycle, Biodiversity, Natural Hazards,..)

- Capable of mapping 100,000's of sq. km
- Proven capability
- 10 cm vertical and 1 m horizontal accuracy
- Multi-aircraft support
- Initial Operations begin in mid/late-2016

LVIS maps Vegetation Height (Left) and Ice Surface Topography over the Antarctic Peninsula (below)

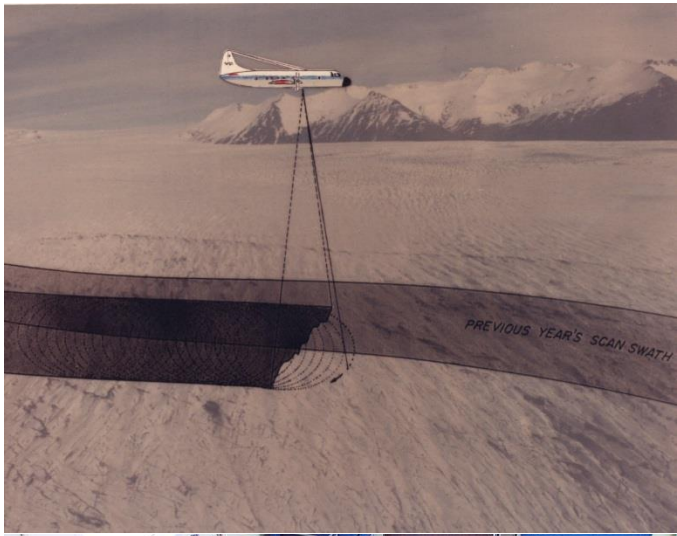


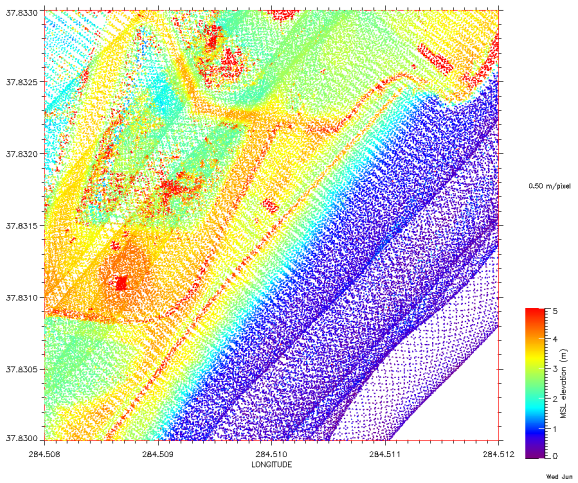
http://lvis.gsfc.nasa.gov/
Contact: Bryan Blair, (301) 614-6741
Code 694, Laser Remote Sensing Laboratory
NASA/GSFC

Airborne Topographic Mapper

- Laser
  - 5000 pulses per second, 2-nanosecond wide pulse
  - Rotating scan mirror sweeps beam around a cone @20Hz
  - Gives range to ground ~5cm acccuracy
- GPS
  - Ground-based receiver gives reference
  - Airborne receiver
  - Dual-frequency carrier-phase solution gives ~5cm accuracy
- Inertial navigation system (INS)
  - Aircraft attitude (pitch, roll, heading) to ~.04 degrees
- Post-flight processing produces (x,y,z) coordinates of individual ground measurements

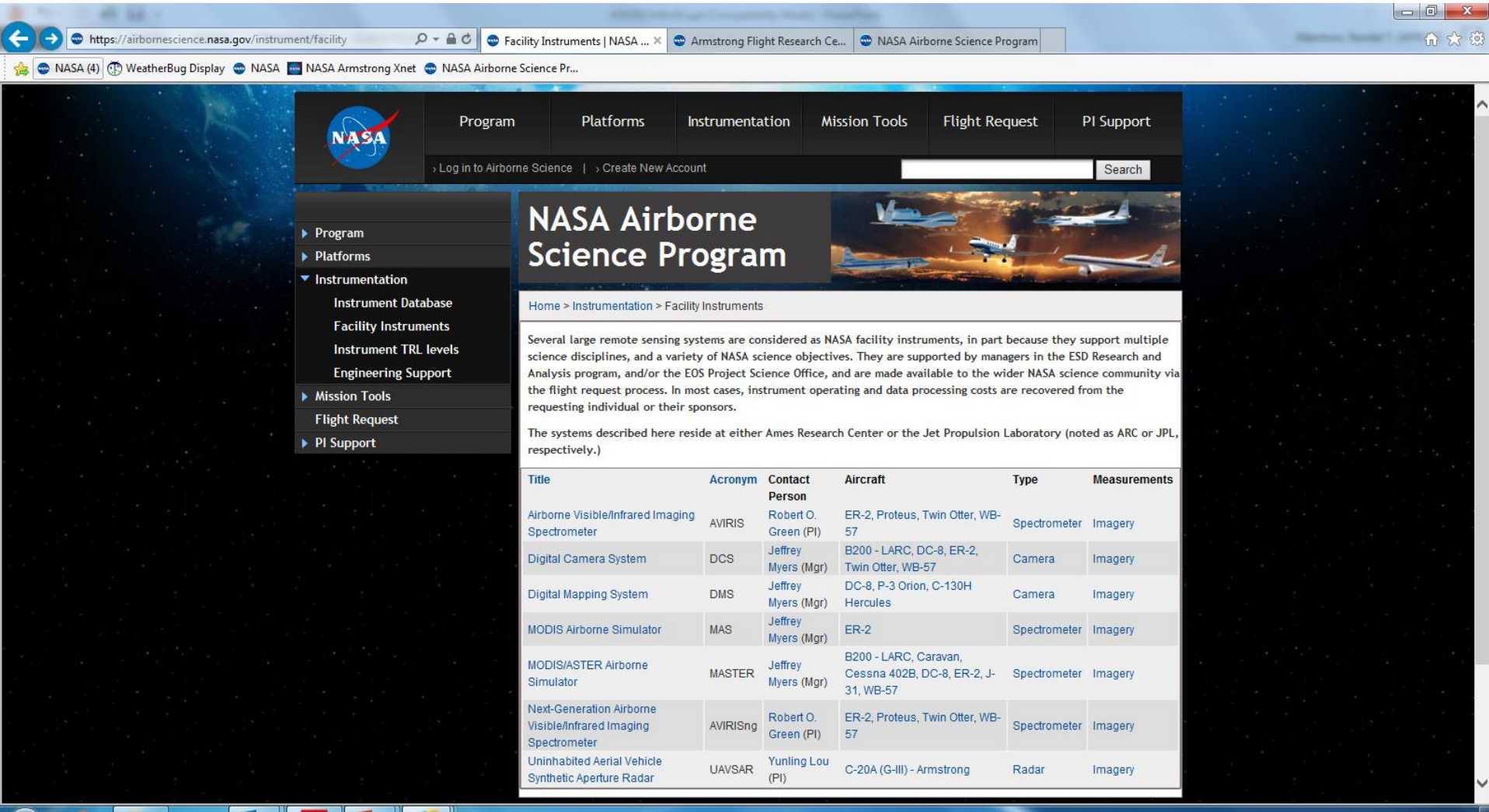
  ~15cm elevation accuracy, ~50cm horizontal





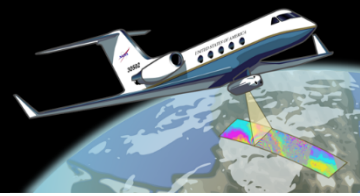
Airborne Facility Sensors

https://airbornescience.nasa.gov/instrument/facility



UAVSAR Products in the 2015 May CA Capstone/So Cal NLE/Argent Sentry Exercises

JPL, CA Earthquake Clearinghouse



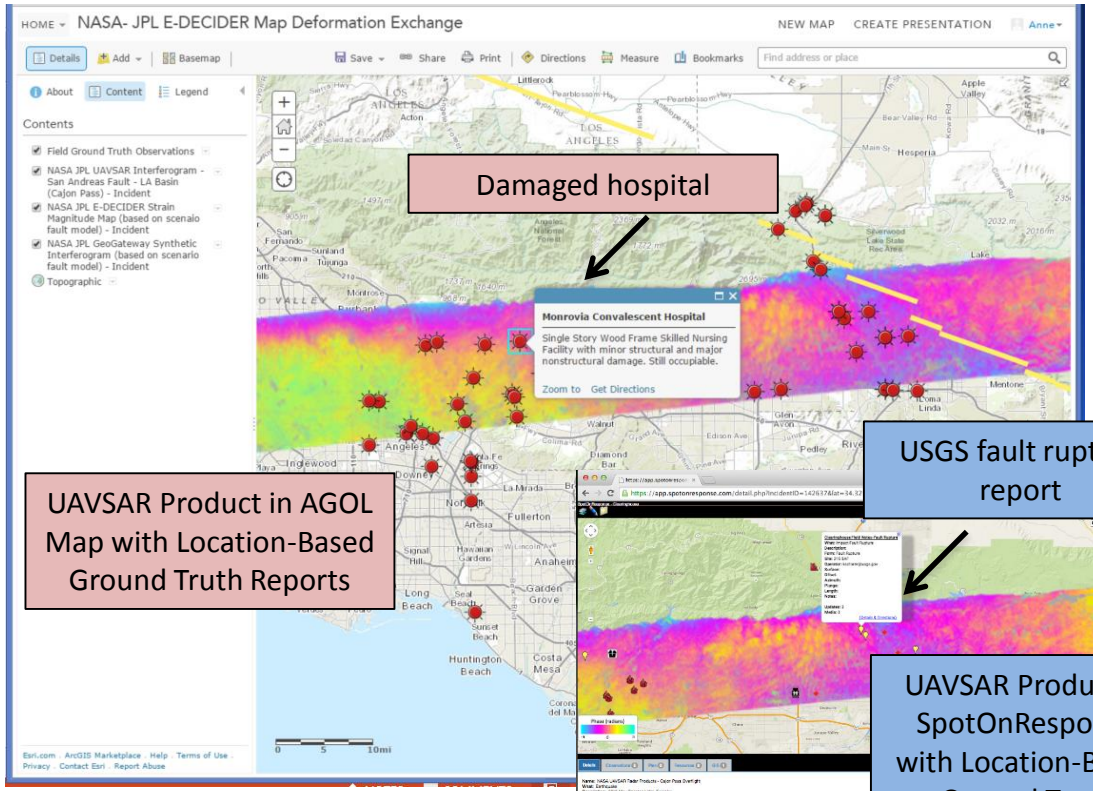
UAVSAR scene acquired across Cajon Pass, northern Los Angeles Basin on May 10; processed and posted to NASA XchangeCore on May 14

The May 2015 CA Capstone/So Cal NLE/Ardent Sentry Exercises were a combined 5-day response scenario based on a catastrophic M 7.8 event on the San Andreas fault that occurred May 10-15, 2015.

UAVSAR imagery were collected and posted for distribution to Clearinghouse participants as part of field validation efforts as well as integration into combined map data products.

Successful demonstration of data layers with ground truthing and import into GIS layers for integrated data products.

Products Generated → **Authoritative data securely shared** (XchangeCore) → **Users query products (Spot On Response, etc)** → **Pass on to End-Users (local, state, federal)**

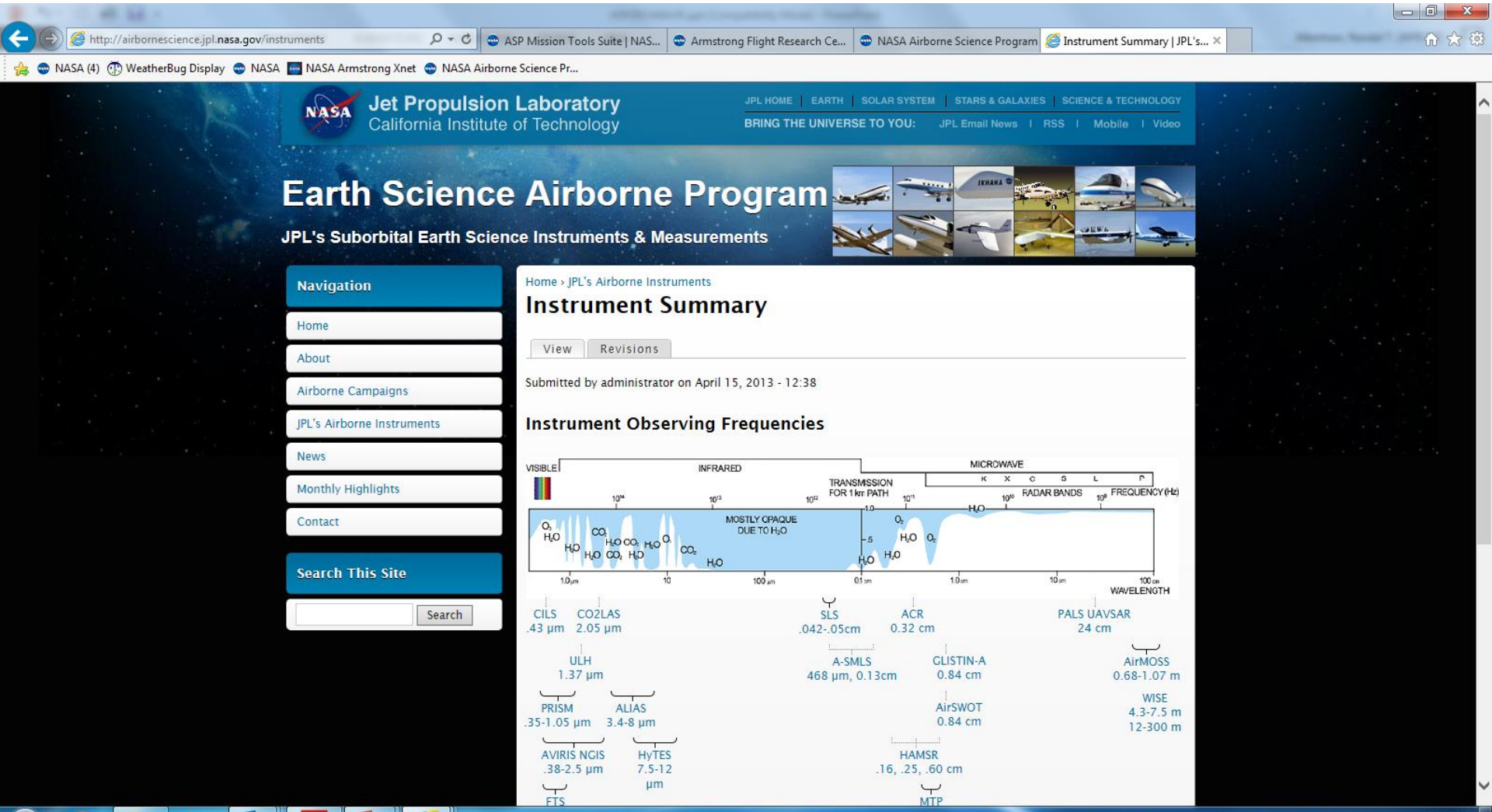


Clearinghouse After Action Debrief: https://www.youtube.com/watch?v=aLPW-85b2M8

Clearinghouse Capstone Website: http://www.californiaeqclearinghouse.org/exercises/2015-national-level-exercise/

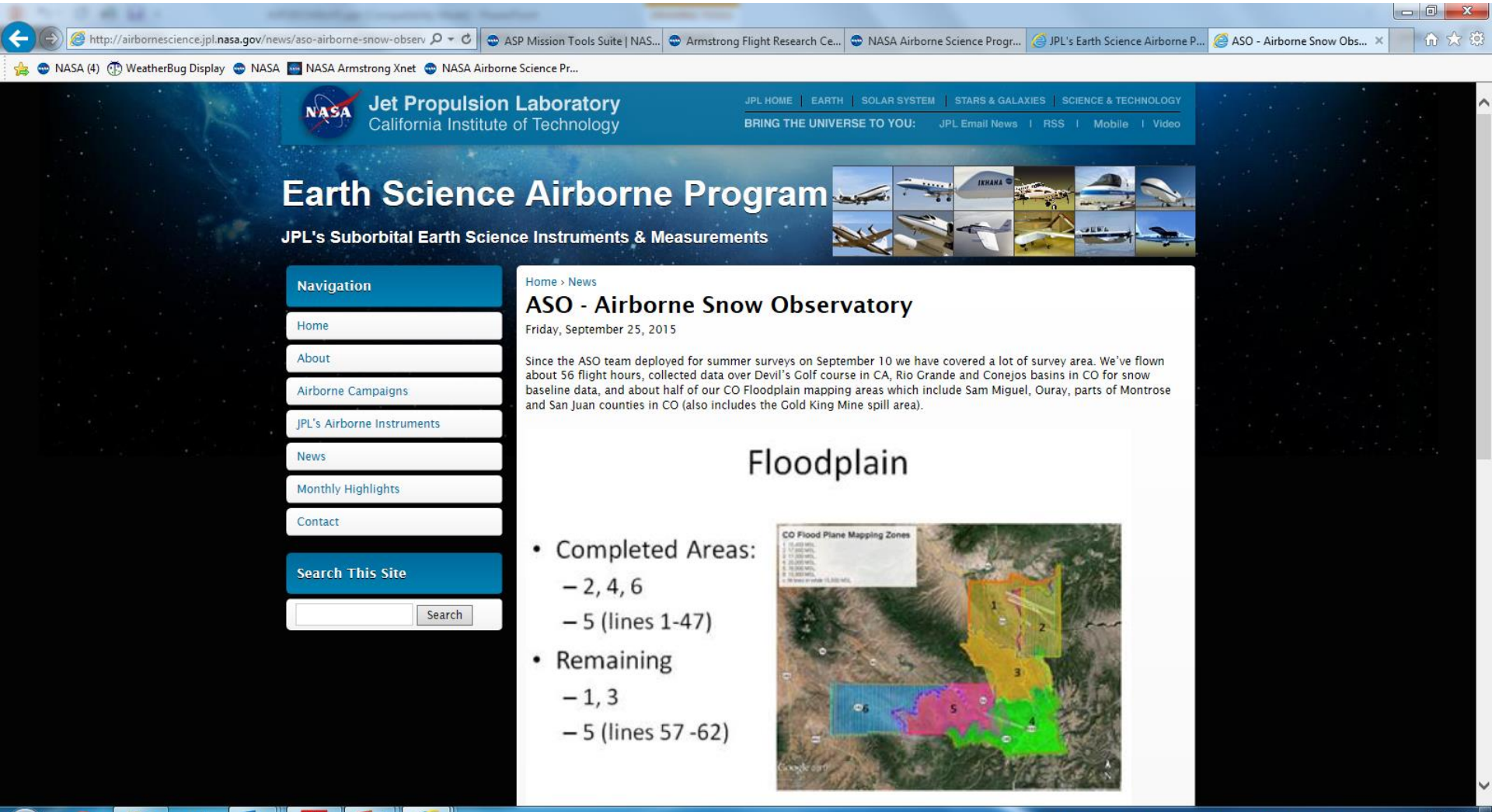
JPL Airborne Sensors

http://airbornescience.jpl.nasa.gov/instruments



JPL Airborne Snow Observatory

Megan Richardson, JPL, (818) 354-8407,
megan.richarson@jpl.nasa.gov



How to Access

- Solicited and Unsolicited Proposals
  - Research Opportunities in Space and Earth Science (ROSES)
  - Technology infusion
  - Satellite support
- Science Operations Flight Request System (SOFRS): https://airbornescience.nasa.gov/sofrs/
  - Details of what, where, when, how much, payload, sponsor/funding source, etc.
  - Means to acquire cost estimates, mission planning
  - Report progress and access status
- Process:
  - Investigators fill out flight requests for each research activity
  - ASP analyzes for implementation (cost, schedule resources)
  - HQ's program scientists analyze for science merit and alignment
  - Many times to minimize our flight costs for data collection we are able to incorporate multiple flight requests into one mission.

SOFRS
New Flight Request
Flight Requests
User Control Panel
How To Submit a Flight Request

Program
Platforms
Instrumentation
Mission Tools
Flight Request

ESPO Archive
Browse Archive
Upload Files
Help

NAS Airborne Science Program

Home > Science Operations Flight Request System (SOFRS)

Science Operations Flight Request System (SOFRS)

Accessing NASA Airborne Science Platforms and Instruments

The Airborne Science Program (ASP) maintains aircraft and sensor assets to support the Science Mission Directorate (SMD). The Science Operations Flight Request System (SOFRS) manages and tracks the allocation of the ASP aircraft and facility sensors. The aircraft (platform) as well as facility sensor (instrumentation) information is accessible through the Airborne Science Program website.

Requests for scheduling these assets shall be submitted through S . This system was designed to allow researchers to have access to unique NASA aircraft, as well as some comm ircraft with which NASA has made contracting arrangements.

The only way to schedule the use of NASA SMD plat nd instrument assets is to submit a Flight Request through SOFRS.

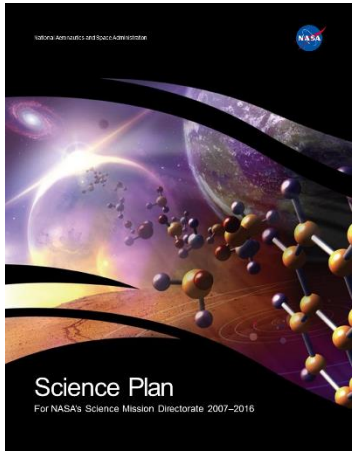
Step by step instructions for submitting a Flight Request are at this link:
HOW TO SUBMIT A FLIGHT REQUEST

User Fees

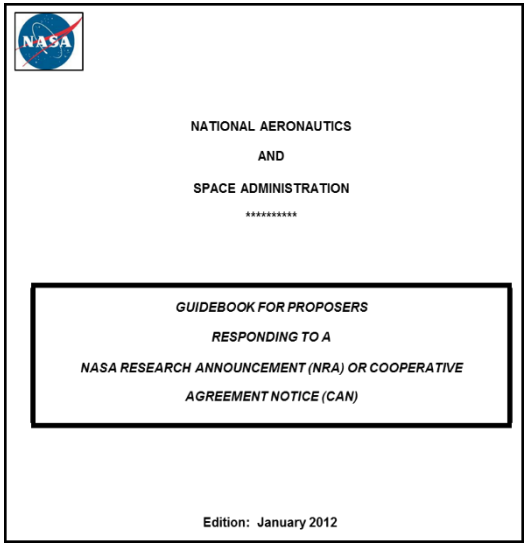
The assets of the program are available on a fee-for-service basis, although, because the SMD maintains a base capability, only the marginal cost of the actual missions are borne by experiments given NASA HQ science concurrence. User fees are based on the flight hour cost (e.g. pilots, in-flight engineer, fuel, etc..), mission-specific costs (engineering and deployment costs) and any ancillary support costs (satellite communication requirements, facility instrument data and operations costs).

Proposals

- Relates to NASA need
  - Need to respond to NASA science plan
    - **How is the global earth system changing?**
      - **What are the sources of change in the Earth system and their magnitudes and trends?**
    - **How will the Earth system change in the future?**
      - **How can Earth system science improve mitigation of and adaptation to global change?**
  - **http://science.nasa.gov/media/medialibrary/2010/03/31/Science_Plan_07.pdf**

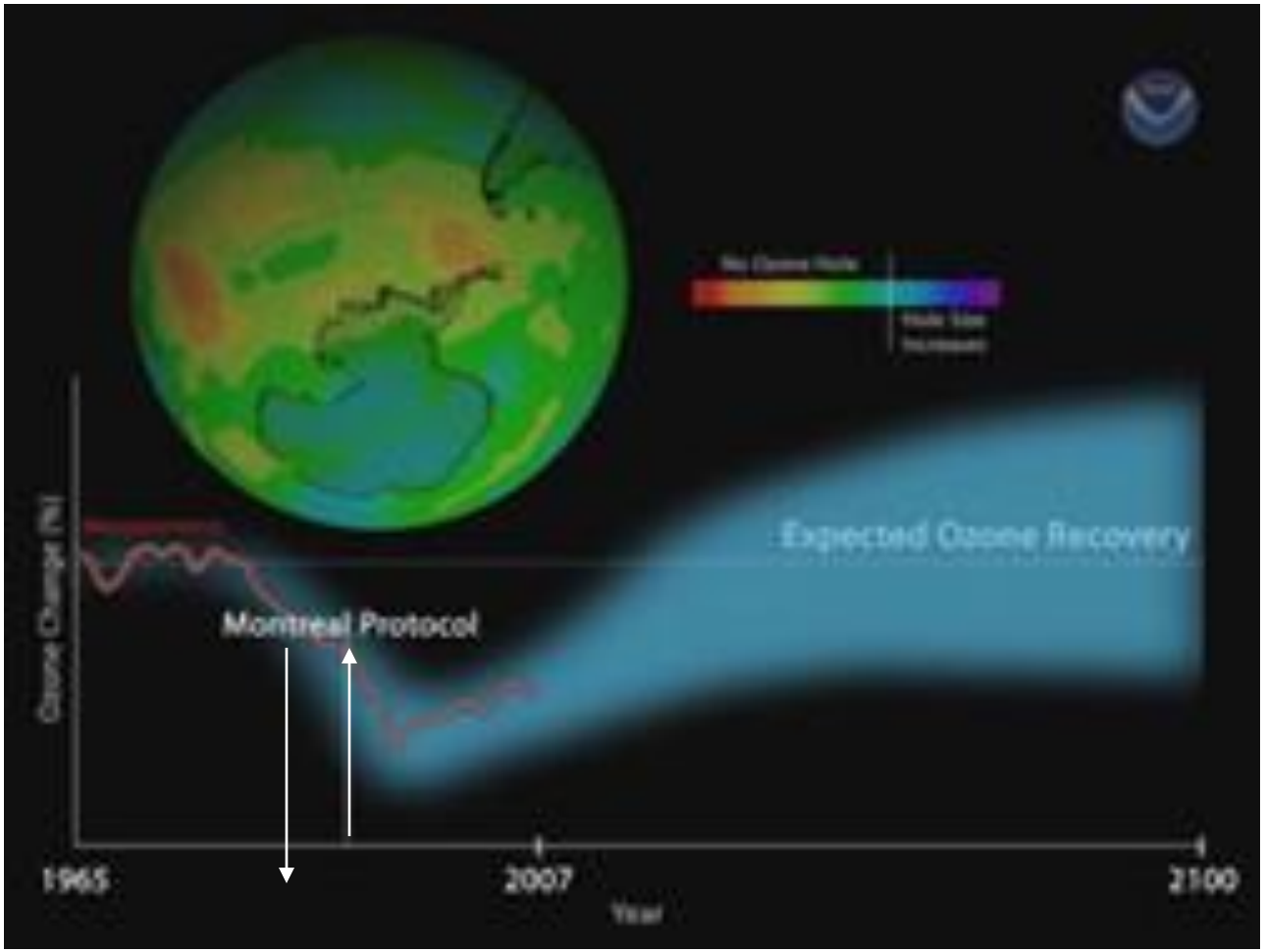


- Scientific merit
  - Adequately addresses measurement approach
- Implementability
  - Can be done within available resources/schedule
  - Doesn't require "Unobtainium"



- NRA/Cooperative Agreement Notice Proposers' Guidebook
  - http://www.hq.nasa.gov/office/procurement/nraguidebook/proposer2015.pdf

How Can Airborne Data and Policymakers Benefit Society



How policy has protected our planet

Using Airborne Science facilities scientists collect the data that led to the determination that CFC's are the main contributor to ozone hole formation

Summary

- ASP Objectives
  - Satellite Cal/Val
  - New Sensor and Algorithm development
  - Process Studies
  - Next Generation of Scientist and Engineers
- Science Aircraft
  - Modified and capable
- ASP Provides the infrastructure and personnel to conduct these investigations in accordance with NASA, national and international policies and regulations
- Numerous sensors have been integrated
- Support National Science Objectives to provide the policymakers with the information to benefit society