



# Interagency Coordinating Committee for Airborne Geosciences Research and Applications (ICCAGRA)



**NRL/VXS-1**





# ICCAGRA Membership



- ONR/NRL/VXS-1/CIRPAS
- NASA
- NASA/NSERC
- NSF/NCAR
- NOAA (AOC & UAS)
- DOE
- USGS
- UAS working group includes:
  - USDA – US Forest Service
  - DHS – FEMA may be doing some geosciences...need to inquire
  - DOI – The dept. of interior runs USGS and does some other UAS based science



# Establishment of NRL



**THOMAS A. EDISON**

**“GOVERNMENT SHOULD MAINTAIN A GREAT RESEARCH LABORATORY TO DEVELOP GUNS, NEW EXPLOSIVES AND ALL THE TECHNIQUE OF MILITARY AND NAVAL PROGRESSION WITHOUT ANY VAST EXPENSE.”**

**THOMAS A. EDISON,  
THE NEW YORK TIMES MAGAZINE  
SUNDAY, MAY 30, 1915**

## A WORLD-CLASS LABORATORY

- **Idea followed the sinking of the Lusitania in 1915**
- **Secretary Josephus Daniels Established Naval Consulting Board with Edison Chair, meeting October 7, 1915**
- **August 29, 1916 Congress appropriates funds to establish the Lab**
- **Delayed by WW-I, Assistant Secretary of the Navy, Theodore Roosevelt, Jr. Commissions the Lab at Bellevue site on July 2, 1923**

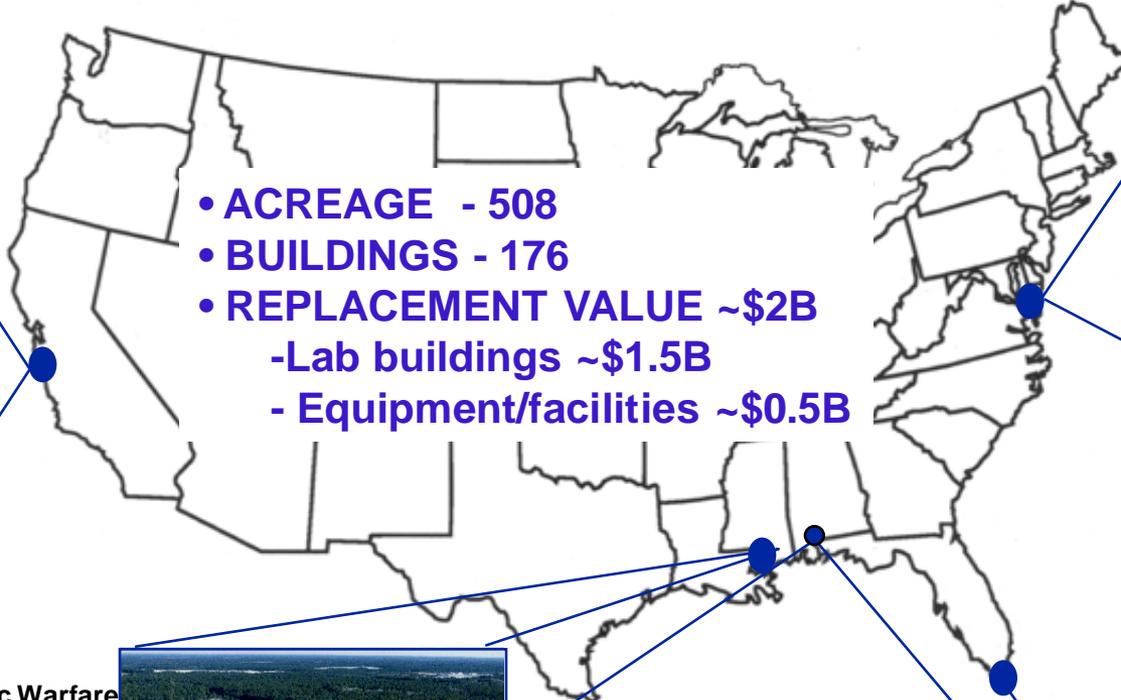
*Navy and Marine Corps Corporate Laboratory*



# Naval Research Laboratory



**MONTEREY, CA**

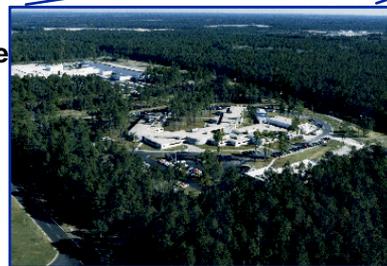


**PATUXENT RIVER  
VXS-1 Squadron**



**NRL D.C.**

**Chesapeake Bay Div  
Tilghman Is.  
Midway Res Ctr  
Blossom Point  
Pomonkey**



**BAY ST. LOUIS, MS  
John C. Stennis Space Center**



**MOBILE, AL  
Ex-USS Shadwell**

**NAF,  
KEY WEST  
Marine  
Corrosion  
Facility**

## Mission Focus Areas:

- Sensors, Electronics and Electronic Warfare
- Materials/Processes
- Battlespace Environments
- Undersea Warfare
- Information Systems Technology
- Space Platforms
- Technology Transfer



# Scientific Development Squadron ONE (VXS-1)



- Provides airborne research capability to NRL
- Sensor and system test bed, airborne surrogate
- Worldwide deployable
- **5** Aircraft (and over 200 UASs)
  - **2** Research Modified NP-3D
  - **1** AEW Rotodome NP-3D
  - **2** Research Modified RC-12
- **12** Officers, **76** Enlisted, **4** Civilians





# Airborne Science Program

## Observing Platforms for Earth System Science Investigations



WB-57



Global Hawk



ER-2



G III



Learjet



DC-8



Ikhana



P-3



S-3B



B-200



Twin Otter



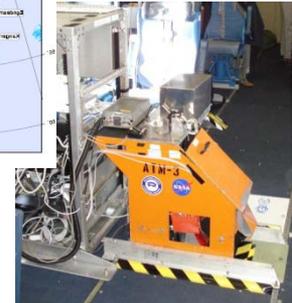
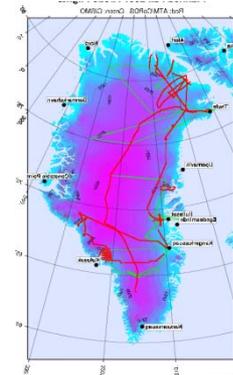
SIERRA



# Program Objectives

## Satellite Calibration and Validation

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

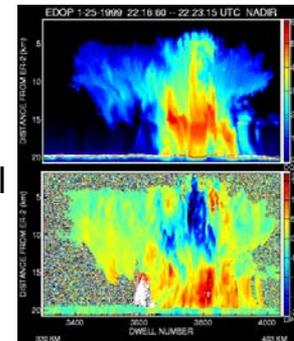


## New Sensor Development

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

## 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.



## Development of Next-Generation Scientists and Engineers

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





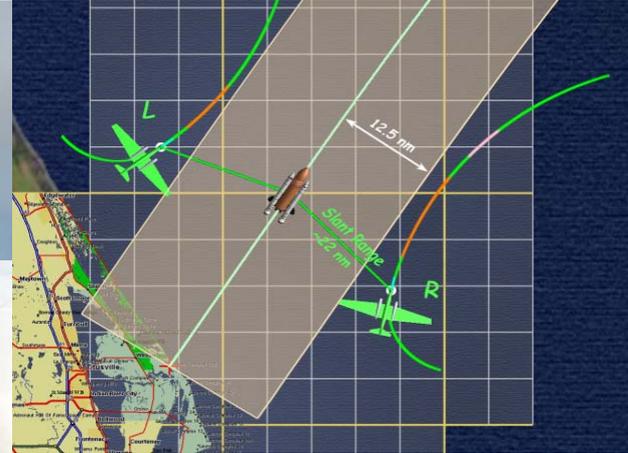
# Unique NASA-only Heavy Lift High Altitude Fleet (50k+ feet)



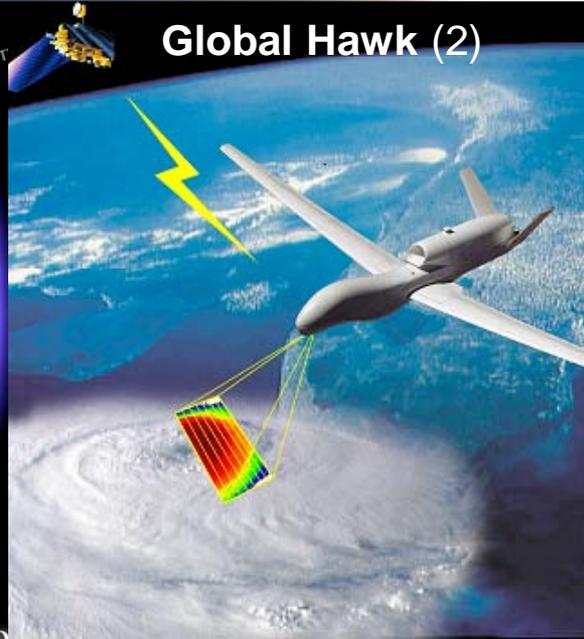
ER-2 (2)



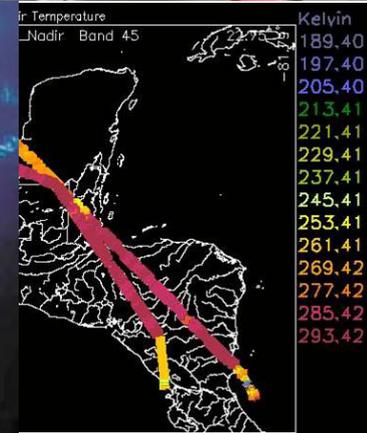
WB-57F (2)



Global Hawk (2)

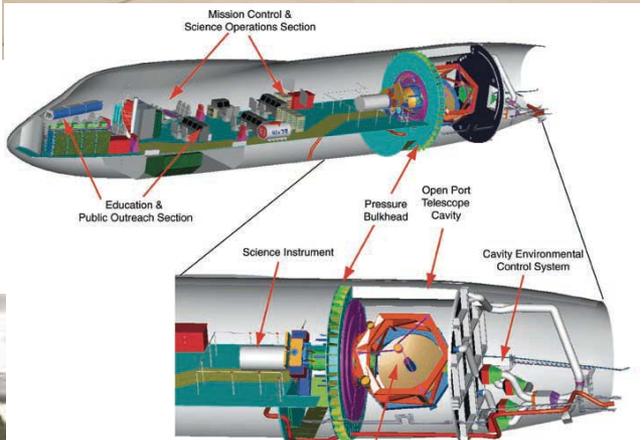


Global Hawk Range/Endurance Rings





# Unique NASA-only Reconfigurable Large Flying Laboratories





# New Technologies



## Platforms:

**Global Hawk UAS:** Long-range, high altitude heavy-lift aircraft with 30+ hour endurance



**Ikhana UAS:** Medium altitude Predator-B with 24 hour endurance



**SIERRA UAS:** Low altitude, easily deployable, with 100 Lb. payload

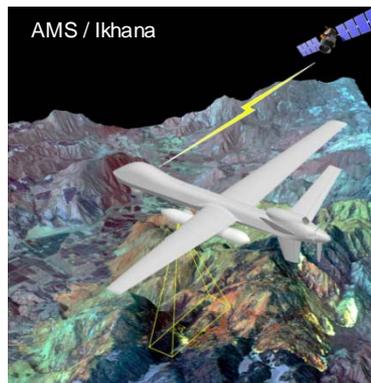


## Sensor Systems:

**G-III/UAV-SAR:** L- and Ka-Band Interferometric polarimetric Synthetic Aperture Radar



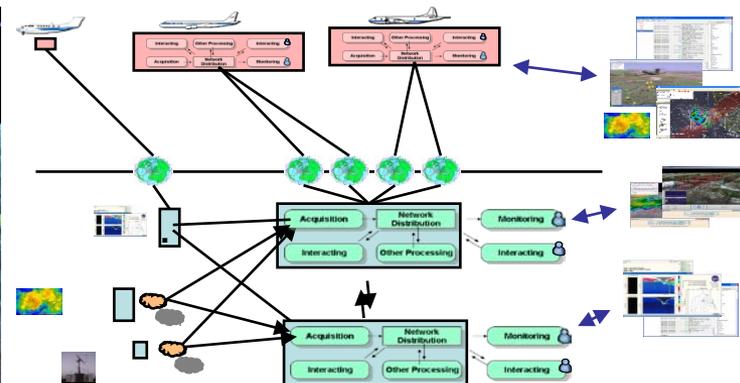
**UAS AMS:** IR sensor for fires & hurricanes, generates and transmits image products autonomously



## Real-Time Data Systems:

New science data web portal will allow P.I.s to monitor missions and interact with sensors in real-time via sat-com links and the Internet.

Airborne Science Sensor Web





# Airborne Science Program Catalog Platforms (2009)



NASA LaRC B200  
(HSRL, LVIS, MFSL)



NASA GRC Lear-25  
(ACCLAIM, SIMPL)



Commercial Twin Otter  
(AVIRIS, PALS)

U.S.D.o.E. B200  
(MASTER)



NOAA/NASA. Aerosonde  
(Hurricane Boundary Layer)





[WWW.NSERC.UND.EDU](http://WWW.NSERC.UND.EDU)



**University of North Dakota**  
and the  
**National Aeronautics and Space Administration**



# The National Suborbital Education and Research Center at the University of North Dakota was created in 2005 with a 5 year Cooperative Agreement with NASA

**NSERC major responsibilities include:**

- **Science Mission Operations for NASA DC-8 research missions**
- **Education and Outreach activities for the Airborne Science Program**



**DC-8 instrument  
Payload**



# Science Mission Operations Activities

- **Interface with science investigators**
  - **Collection of requirements from investigators**
  - **Assist in communications between scientists and operations staff**
- **Payload Integration Engineering**
  - **Design of aircraft interfaces for instruments**
  - **Structural and load analysis of probes and installations**
- **Mission director duties on aircraft**



# Science Mission Operations Activities (con't)

- Data distribution and display networking
  - GB fiber network on the aircraft for data distribution
  - Display hardware for investigators
  - Data distribution of aircraft and facility instrument data
  - Digital video distribution
  - Archiving of aircraft parameter and video data
- Communications
  - Multi link IRIDIUM satcom for global data links
  - INMARSAT BGAN satcom for high speed data links
  - XCHAT for communications with other aircraft and ground staff
- Facility Instrumentation including T, P, and RH



# Education and Outreach Activities

Informational booths at national and international conferences

Maintain a web page on NASA DC-8 scientific missions and educational activities

Maintain a database of scientific publications utilizing NASA Airborne Science assets

Organize opportunities for student participation in Airborne Science

A major activity in 2009 will be the **Student Airborne Research Program**



# NASA Student Airborne Research Program (SARP)

- A 6 week program for 30 undergraduate and early graduate students
- Lectures on airborne research topics from experts in the field
- Hands on experience with aircraft instrumentation and data collection on the NASA DC-8
- Data analysis and presentation of scientific results



DC-8 taking off with Diamond Head in background





# NOAA Aircraft Operations Center

MacDill AFB, FL





G-IVSP



Twin Otter



AC695 Jet Prop  
Commander



AC500 Shrike Commander



WP-3D Orion



Citation II



King Air 350ER



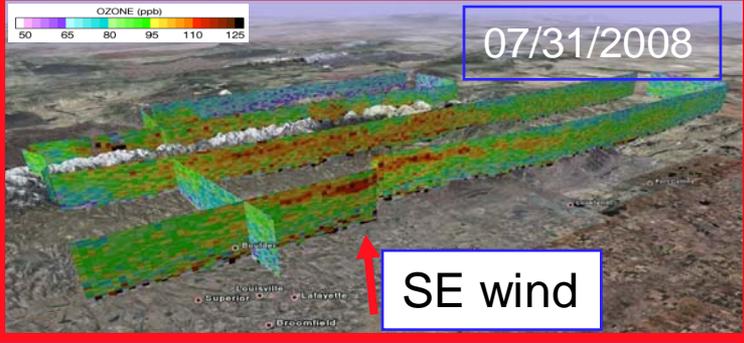
P-3C Orion



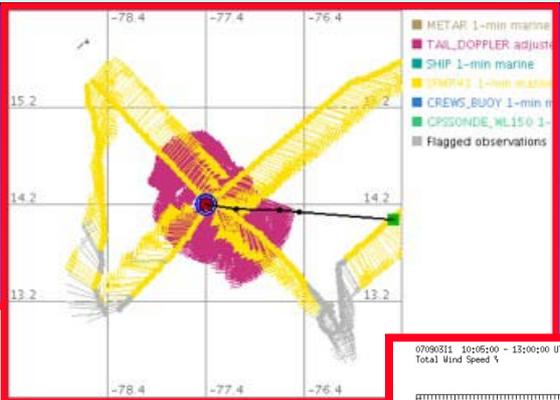
Lake Sea Wolf

**AIRCRAFT OPERATIONS  
CENTER AIRCRAFT 2009**

# A Few Examples of NOAA Remote Sensing

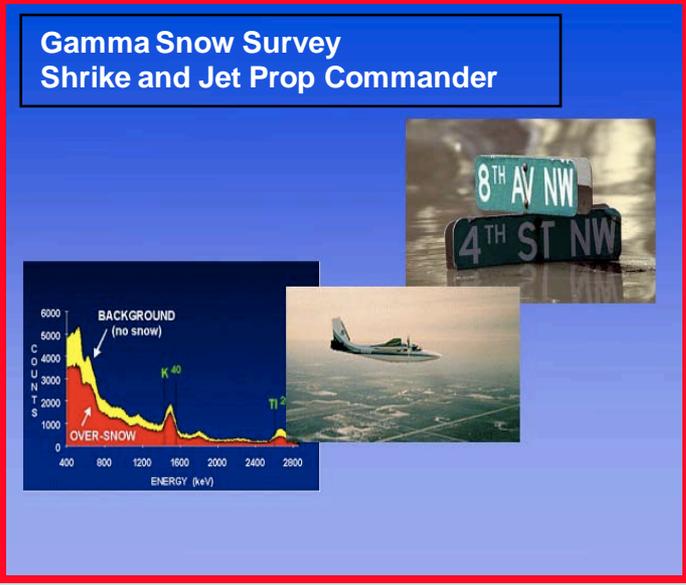
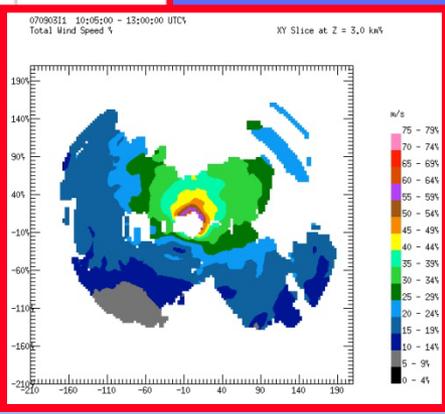
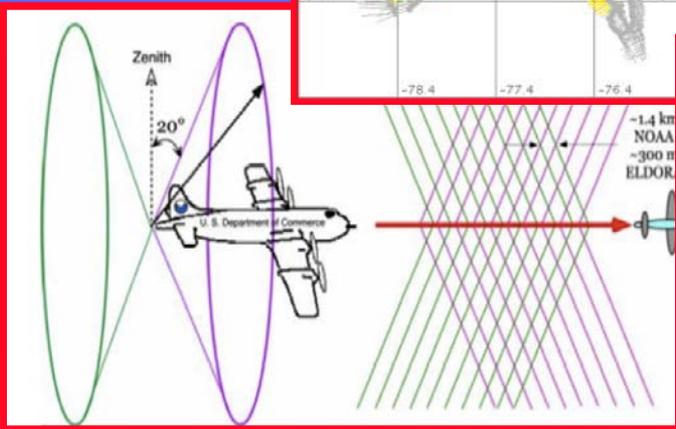


NOAA  
WP-3D  
Tail Doppler  
Radar



Horizontal  
Wind Fields

Transport of ozone from the Denver metro area into and over the mountains west of Denver. Data were taken with the TOPAZ ozone LIDAR deployed on a NOAA Twin Otter in summer 2008.



## QuickScat/WindSat Surface Wind Validation

***Status of Airborne Facilities  
At the National Science Foundation (NSF)***



# NSF has two Separate Programs that own Federal Aircraft

- The **G-V** and **C-130** aircraft operated and maintained by the National Center for Atmospheric Research (NCAR), a NSF FFRDC, for the Division of Atmospheric Sciences
  - These aircraft operate as Public Use in the United States, and now internationally as State aircraft (although this is becoming more problematic); the G-V can operate under civil rules as it is certified
- **LC-130** aircraft maintained and operated by the NY ANG 109<sup>th</sup> Airlift Wing for the Office of Polar Programs (Antarctica and Greenland). As military operated aircraft they are not managed per 41CFR 102-33
- The NSF also supports, through a Cooperative Agreement, a modified **King Air** maintained and operated by the University of Wyoming. The King Air is a Wyoming state owned aircraft.
- UASs
  - UASs will play an increasing role in NSF's research programs, but NSF will leverage off its partner agencies (NASA, DOE, NOAA) to maximize effectiveness
  - NSF has used UASs to acquire critical research data (e.g., Alaska, Maldives, Galapagos) and NSF will continue to expand their use



# NSF LC-130 ski plane



A Navy C-130 is undergoing tests of the NP2000 propeller system (8 bladed). If sufficient increased thrust is realized then the objective is to remove JATO assist from LC-130s. The annual cost savings would be significant, ~\$7M.



GV has completed several major science missions, **T-REX**, Terrain Induced Rotor Experiment, **PACDEX** (Pacific Dust) mission, **GISMOS** (GPS Multistatic and Occultation Instrument for Atmospheric, Oceanographic and Land Remote Sensing), **START-08** (Strat-Trop Analyses of Regional Transport) and just completed the first of several **HIPPO** (HIAPER Pole to Pole) missions. Shortly will be an atmospheric electrification mission, **SPRITE SPECTRA**, and **ADELE**, a study to examine electron runaway breakdown in thunderstorms. In addition scheduled are numerous FAA certification flights for the large underwing pods.



C-130 successfully completed several major campaigns over the last 18 months.

These include:

**PASE** – The Pacific Atmosphere Sulfur Experiment, Christmas Island

**ICE-L** – flown out of RMMA

**VOCALS** – VAMOS Ocean-Cloud-Atmosphere-Land Study, Arica, Chile (multi-agency and multi-national (DOE G-1; UK Bae146; DLR Falcon, NOAA Ron Brown))

C-130 will undergo major inspection this spring

After the inspection possible avionics modernization to meet anticipated NexGen requirements and then upload to next major campaign, **PLOWS**, Profiling of Winter Storms.



University of Wyoming King Air  
State Owned – NSF Funded



A-10: probable replacement for the no longer in service T-28 Storm Penetration Aircraft  
Evaluation done by Zviko, Inc.  
A/C to be bailed from USAF to NPS/CIRPAS



NRL P-3 and ELDORA radar  
P-3 replaced NSF Electra after it reached its useful service life  
P-3/ELDORA most recently participated in T-PARC





## 5 Disciplines... 1 Mission

Biology  
Geography  
Geology  
Geospatial  
Hydrology

# Mission

- The USGS is a world leader in the natural sciences through our scientific excellence and responsiveness to society's needs.
- The USGS serves the Nation by providing reliable scientific information to:
  - Describe and understand the Earth
  - Minimize loss of life and property from natural disasters
  - Manage water, biological, energy, and mineral resources
  - Enhance and protect our quality of life

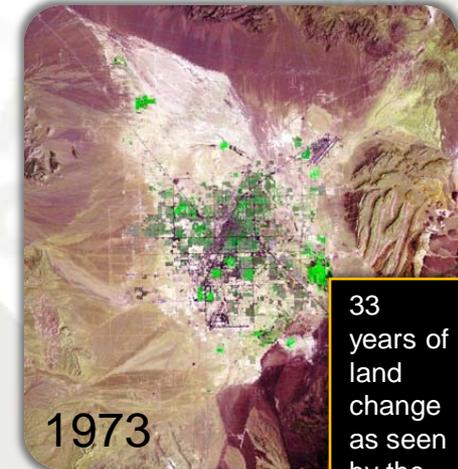


# Strategic Science Vision

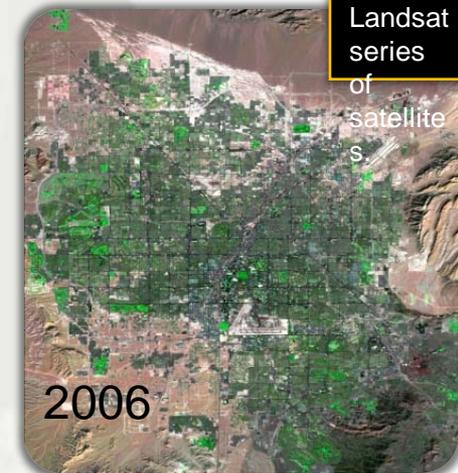


*Las Vegas, Nevada*

- **Understanding Ecosystems and Predicting Ecosystem Change**
  - Ensuring the Nation's Economic and Environmental Future
- **Role of the Environment and Wildlife in Human Health**
  - A Warning System for Environment Risk to Public Health in America
- **A Water Census of the United States**
  - Quantifying, Forecasting, and Securing Freshwater for America's Future
- **A National Hazards, Risk, and Resilience Assessment Program**
  - Ensuring the Long-Term Health and Wealth of the Nation
- **Climate Variability and Change**
  - Clarifying the Record and Assessing the Consequences
- **Energy and Minerals for America's Future**
  - Providing a Scientific Foundation for Decision Makers



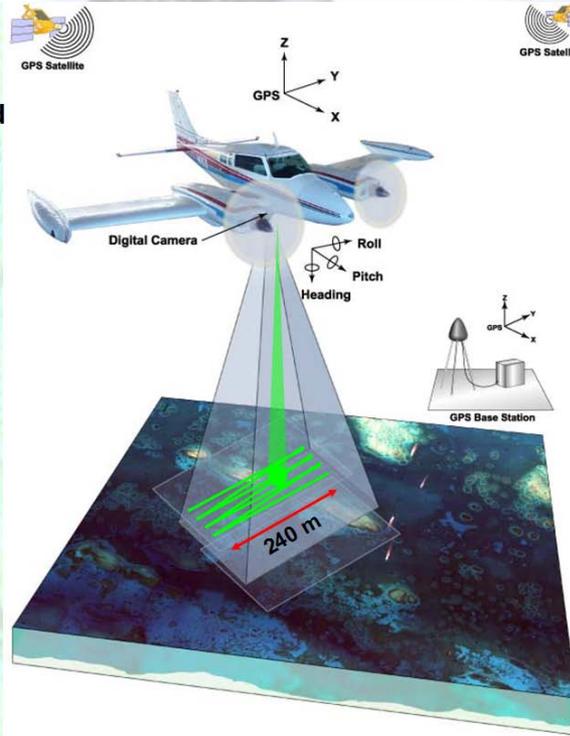
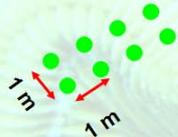
33 years of land change as seen by the Landsat series of satellites



# USGS Aerial Remote Sensing Data & Imagery

## NASA Experimental Advanced Airborne Lidar (EAARL)

- Green laser**  
(532 nm)
- Low power**  
(70  $\mu$ J/pulse)
- High pulse rate**  
(3000+ Hz)
- Small footprint**  
(15 cm)
- Raster scanning**  
(25 rasters/sec)
- 1 x 1 m sample Spacing (2 passes)**



A screenshot of the USGS LIDAR Information Coordination and Knowledge (CLICK) website. The header includes the USGS logo and the text 'Welcome to the USGS Center for LIDAR Information Coordination and Knowledge'. Below the header, there are several sections: 'Discrete return point clouds', 'Bare Earth', and 'USGS-NASA-NOES EAARL Data'. Each section has a small thumbnail image and a brief description. At the bottom, there is a 'Upcoming Events / Recent Links' section with links to various resources.

<http://lidar.cr.usgs.gov/index.php>

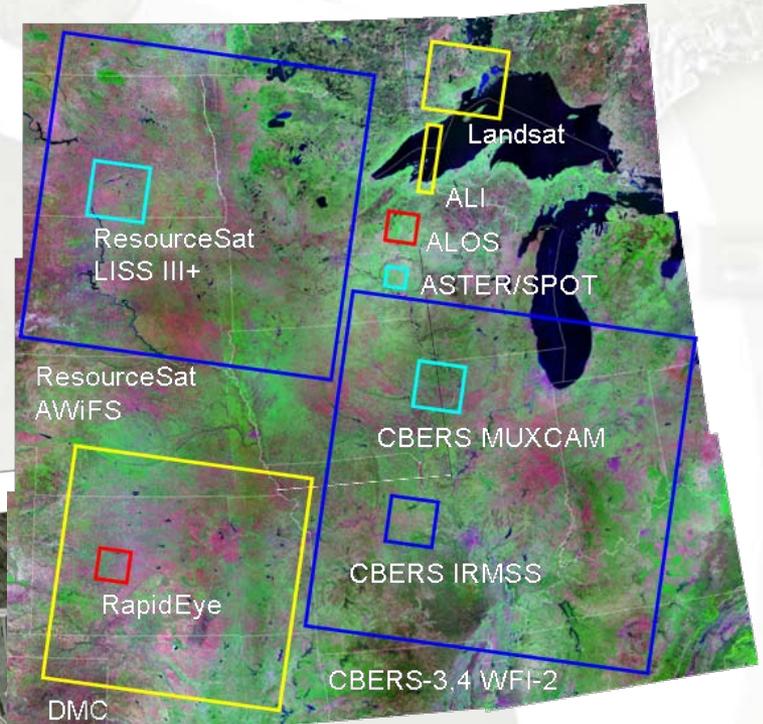


# Land Remote Sensing Program

## Multi-mission Operations

### Program Objectives:

- Acquire, archive, and process land-image data from multiple satellite and airborne platforms to meet DOI/USGS requirements
- Distribute standard GIS-ready products from multiple satellite or airborne sources to users over the Internet at no charge, with the fewest possible restrictions.



# Land Remote Sensing Program Multi-mission Operations

## Current Status

- Summary list of Multi-Mission Data Sets at EROS

**NASA Funded Data Sets**

**NGP Funded Data Sets**

**LRS Funded Data Sets**

USGS Satellite Film and Digital Data Sets	
<b>Film Data Sets</b>	<b>Digital Data Sets</b>
Skylab	Landsat Processed Data Collection
Gemini	TM Scrounge
Large Format Camera	NASA (V0) Landsat Processed Data Collection
Declassification I (CORONA, ARGON, LANYARD)	Landsat Orthorectified Scenes and Mosaics
Declassification II (KH-7, KH-9)	North American Landscape Characterization (NALC)
Landsat MSS, TM, and RBV Film	Global Land Cover Test Sites (GLCTS)
<b>Digital Data Sets</b>	Shuttle Imaging Radar-C (SIR-C)
EO-1	Global Land Cover Characterization (GLCC)
SPOT	Multi-Resolution Land Characterization (MRLC)
Shuttle Radar Topography Mission (SRTM)	AVHRR Greenness maps (7/14 day)
AVHRR	ALOS Pulsar
Landsat 1-5,7	WorldView
<b>NASA LPDAAC Digital Data</b>	QuickBird
MODIS	AWIFS
ASTER	SPOT / Eagle Vision
USGS Aerial Film and Digital Data Sets	
<b>Department of Interior (DOI) Film</b>	<b>NASA Film</b>
USGS Aerial Mapping Photography	Ames Research Center
National Aerial Photography Program (NAPP)	Johnson Space Center
National High-Altitude Photography (NHAP)	Wallops Island
High Resolution Ortho Imagery (Urban Areas)	Stennis
Bureau of Land Management	Kennedy Space Center
Bureau of Reclamation	Marshall Space Flight Center
National Park Service	Environmental Research Institute of Michigan
South Dakota State University	<b>Digital Aerial Data Sets</b>
InterMountain Survey	NASA Daedalus Scanner
McDonnell Douglas	Airborne Ocean Color Imager Aerial Scanner
Corp of Engineers (COE)	Side Look Airborne Radar (SLAR)
<b>Department of Defense (DOD) Film</b>	National Uranium Resource Evaluation (NURE/LIL)
Army Map Service	NPS Geophysical Research Program
U.S. Air Force	Advanced Solid-State Array Sensor (ASAS)
U.S. Navy	MODIS/ASTER Airborne Simulator (MASTER)
Scientific Committee on Antarctic Research (SCAR)	LIDAR
USGS Carto/Topo Digital Data Sets	
Digital Orthophoto Quad (DOQ)	Digital Elevation Model (DEM)
Digital Raster Graphic (DRG)	Digital Line Graph (DLG)
High ResOrtho Digital Imagery	National Atlas

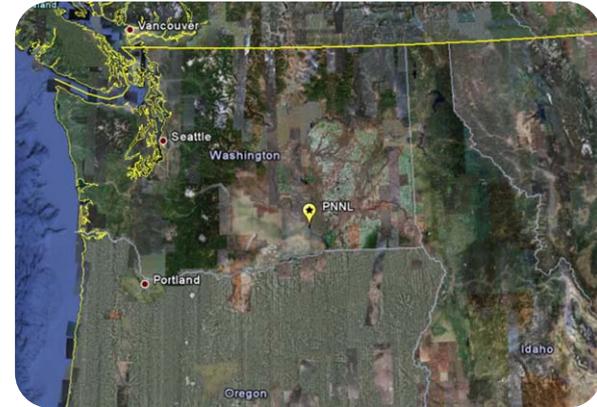


# The United States Department Of Energy Atmospheric Radiation Measurement Aerial Facility

Jason Tomlinson, John Hubbe, and Beat Schmid  
Pacific Northwest National Laboratory

# DOE ARM Aerial Facility

Based at the Pacific Northwest National Laboratory in Richland, Washington



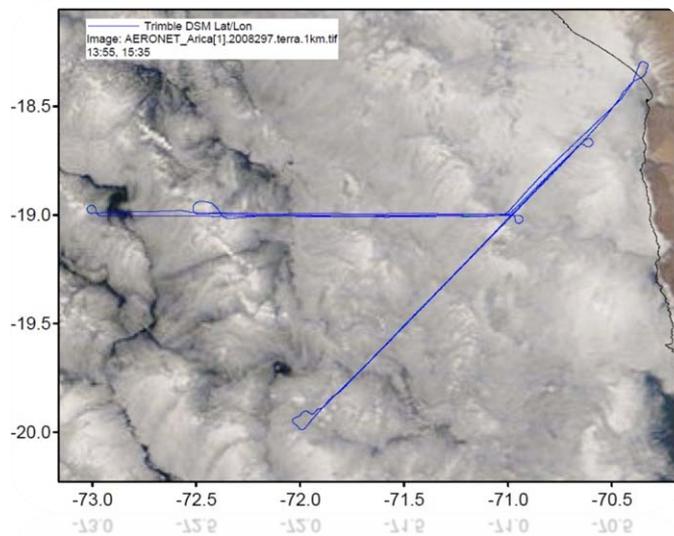
- ▶ Operates and maintains the G1 aircraft
- ▶ Will normally conduct 2 missions per year
  - One will be using the G1
  - The other will use an aircraft that is called for in the awarded proposal
    - Preferred aircraft is the G1 however recently we have used the NRC-Convair and the CIRPAS Twin Otter

# G1 Aircraft



- ▶ Typically operates with an aerosol and trace gas package
- ▶ Currently 2 fixed mounts on the front of the aircraft. 1 Pylon under each wing is being added
  - Currently holds 2 probes
  - In Fy10 a total of 8 cloud probes
- ▶ A cloud radar will be at the end of 2010
- ▶ Range up to 1,500 nautical miles (2,800 km)
- ▶ Max altitude approaching 25,000 ft (7.5 km)

# Recent and Future G1 Field Campaigns

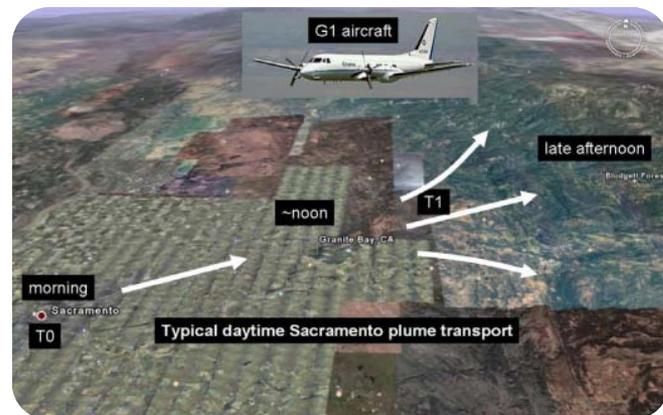


## The Variability of the American Monsoon Systems (VAMOS) Ocean Cloud Atmosphere Land Study (VOCALS) 2008

- ▶ October 14<sup>th</sup> – November 13<sup>th</sup>, 2008
- ▶ Measurements of stratocumulus clouds, aerosols, and trace gases to the west of Arica, Chile
- ▶ Collaboration with the NSF C-130, Met Office BAE-146 and Dornier, and CIRPAS Twin Otter

## Carbonaceous Aerosols and Radiative Effects Study (CARES)

- ▶ June 2010
- ▶ Airborne and surface based measurements of the evolution of the Sacramento, California plume
- ▶ May coordinate some flights with the NOAA WP-3D (CalNex)



# Recent and Future Field Campaigns

- ▶ Recently funded campaigns have had an emphasis on routine flying, i.e. 5 – 6 months in one area



## Routine AAF Clouds with Low Optical Water Depths (CLOWD) Optical Radiative Observations (RACORO)

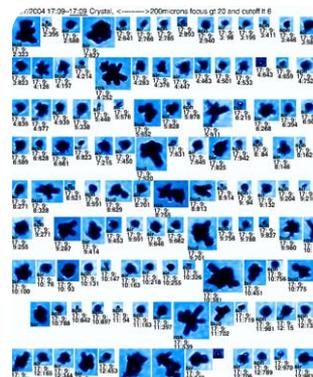
- ▶ January 22<sup>nd</sup> to June 30<sup>th</sup>, 2009
- ▶ Measurements of boundary layer clouds, aerosols, and radiation near the DOE Southern Great Plains National User Facility in Northern Oklahoma

<http://acrf-campaign.arm.gov/racoro/>

## Small Particles in Cirrus (SpartICus)

- ▶ Tentatively October 15<sup>th</sup>, 2009 to April 15<sup>th</sup>, 2010
- ▶ Measurement of the microphysical properties of cirrus clouds over DOE Southern Great Plains National User Facility in Northern Oklahoma

<http://acrf-campaign.arm.gov/sparticus/>



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