NASA Airborne Science Program Update

Platform Upgrades
Recent Science Missions

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ICCAGRA Meeting November 9, 2009

Presentation Outline

- Platform upgrades
  - Onboard data networks
  - Cockpit tablet computers for pilot awareness
  - IRIDIUM and INMARSAT satcom systems
  - Ground stations for remote/short deployments
- Recent Airborne Science Missions
  - NASA Student Airborne Research Program (SARP)
  - NASA IceBridge Antarctica mission

Rationale for platform upgrades underway

A major goal of the Airborne Science Program is to provide a seamless environment to science investigators to maximize the science return from missions. Moving towards this goal will require the following:

Standardization across the program

- Instrument information requirements
- Aircraft data systems
- Data feed formats
- Real time data displays (Current activities for the DC-8, P-3B, and GHOC)
- Facility instrumentation

Provide situational awareness to science investigators on board and on the ground

- Google Earth like displays of aircraft position and satellite/instrument data
- Xchat availability for science team communications from anywhere in the world
  - This requires reliable communications between aircraft and ground bases
    - Multi-link IRIDIUM has provided limited communications in the recent past
    - INMARSAT BGAN now appears to be a higher bandwidth option

Onboard data display systems

Onboard high speed network data display functionality has been implemented on the NASA DC-8. The system is based on the following:

- Onboard GB fiber optic network with access points around the aircraft
- Network time and data servers for applications and data archive
- Xchat application for science team communications
- A comprehensive Web Application for display of data
- High resolution LCD touch screen displays for data selection
- Digital video cameras, forward and nadir pointing

A nearly identical system has been assembled for the P-3B which be permanently installed in January 2010

The Web Application used on the DC-8 and P3-B is also being modified for data display in the Global Hawk Operations Center

New yoke mounted tablet computers have been integrated on the DC-8 for pilot awareness and readout of ILS navigation for precision flying of flight lines

IRIDIUM SatCom systems

Two 4 channel multilink IRIDIUM satcom systems were successfully deployed on the DC-8 and P-3B during the second half of the ARCTAS mission. These systems are functional from pole to pole around the globe.

The systems provide near continuous 9.6 KB bandwidth for the following services:

- Xchat service for intra-aircraft, inter-aircraft, and aircraft-ground communications
- Reliable upload/download of satellite/instrument data
- Multilink systems are being upgraded to 6 channel systems

INMARSAT BGAN SatCom systems

Chelton SwiftBroadband INMARSAT systems are now available with BGAN service allowing for bandwidths up to 432KB. Current INMARSAT coverage is global to ~72 degrees north and south limiting polar communications.

Dual channel SwiftBroadband systems were installed on the DC-8 in September and will be installed on P-3B in January 2010. These systems will be compatible with the INMARSAT system on other ASP platforms including the B-200 and WB-57s.

Phoenix Avionics LLC installs the systems to FAA standards, provide all drawings and documentation, testing, and training staff in operation.

Ground stations for remote/short deployments

- New portable ground stations have been assembled in rack mount containers that could be shipped as aircraft cargo. These systems include the following components:
  - INMATSAT BGAN receiver for communications with the aircraft or internet access
  - Data and application servers with Web display application
  - Network switches for a ground based science investigator network
  - Wireless access points for internet access for investigators while the aircraft is on the ground
  - Large format displays for investigators on the ground

Recent NASA Airborne Science Missions

NASA Student Airborne Research Program (SARP)

DC-8 platform
July 13-August 12
UC Irvine-Palmdale, CA

NASA IceBridge Antarctic mission

DC-8 platform
October 11-November 24
Punta Arenas, Chile-Antarctica

NASA Student Airborne Research Program (SARP)

SARP's Objectives

- **Inspire students to pursue STEM disciplines.**
- **Develop next generation of Earth System Scientists —with fresh research ideas.**
- **Demonstrate integration of science, engineering, and operations in major missions.**
- **Expose students to NASA programs.**

NASA Student Airborne Research Program (SARP)

29 Students from 26 Institutions

- University of Puerto Rico
- Montclair State U
- Rutgers University
- University of Michigan
- Howard University
- Coastal Carolina U
- University of Florida
- Loyola Marymount
- Slippery Rock University
- Carleton College
- U of Alaska Anchorage
- Randolph College
- University of Iowa
- Montana State University
- UC Irvine
- Wellesley College
- Georgia Tech University
- Michigan Tech University
- South Dakota School of Mines and Technology
- University of North Dakota
- Brown University
- Texas A&M University
- Arizona State University
- University of Maryland
- UC Santa Cruz

NASA Student Airborne Research Program (SARP)

Complete Airborne Science Experience

- **Classroom—lectures for context**

  (See http://www.nserc.und.edu/learning/SARPmm.html)
- **Hangar—flight planning**
- **Aircraft—data acquisition**
- **Field—ground truth validation**
- **Laboratory—data analysis & interpretation**
- **Classroom—Student presentations**

NASA Student Airborne Research Program (SARP)

3 SARP Research Topics

- **Evapotranspiration in Almond Orchard and Cotton Field, CA Central Valley**
- **Air Quality, CA Central Valley**
- **Algal Bloom, Monterey Bay, CA**

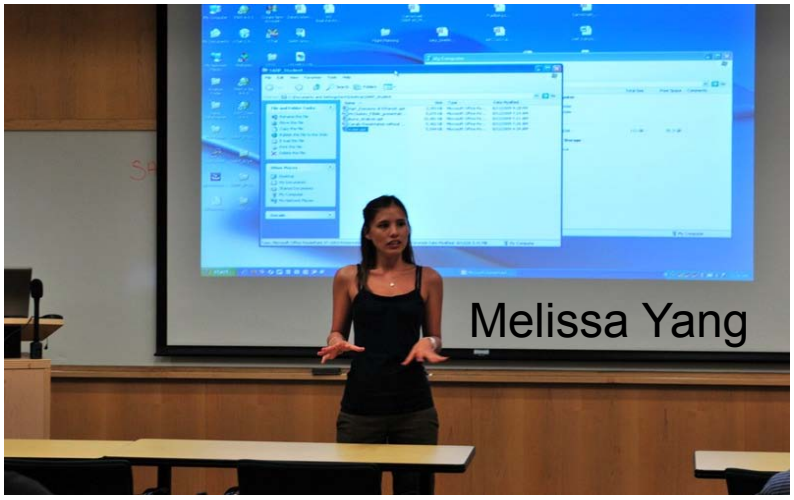
NASA Student Airborne Research Program (SARP)

Faculty Lecturers

- **UC Irvine:** Don Blake, Sherwood Rowland (chemistry)
- **Monterey Bay Aquarium Research Institute:** John Ryan (oceanography)
- **UC Davis:** Susan Ustin (agriculture)
- **Florida State U:** Henry Fuelberg (meteorology)
- **U Iowa:** Greg Carmichael (modeling)
- **NASA:** Jeff Myers, Andy Roberts, Jack Kaye, Brenda Mulac, Marilyn Vasques, Ken Jucks, Jim Crawford

NASA Student Airborne Research Program (SARP)

Mentors

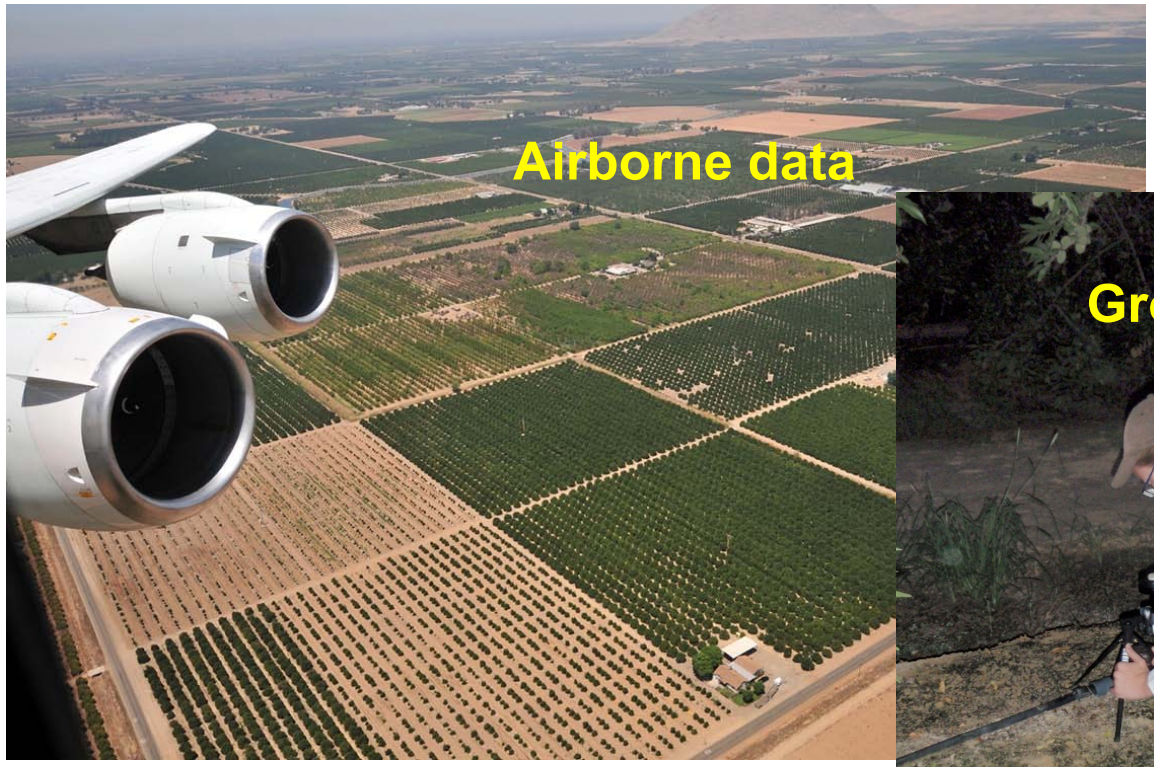


Crucial Strengths of SARP

- Fully committed to students
- Extremely knowledgeable
- Constantly accessible
- Guidance

NASA Student Airborne Research Program (SARP)

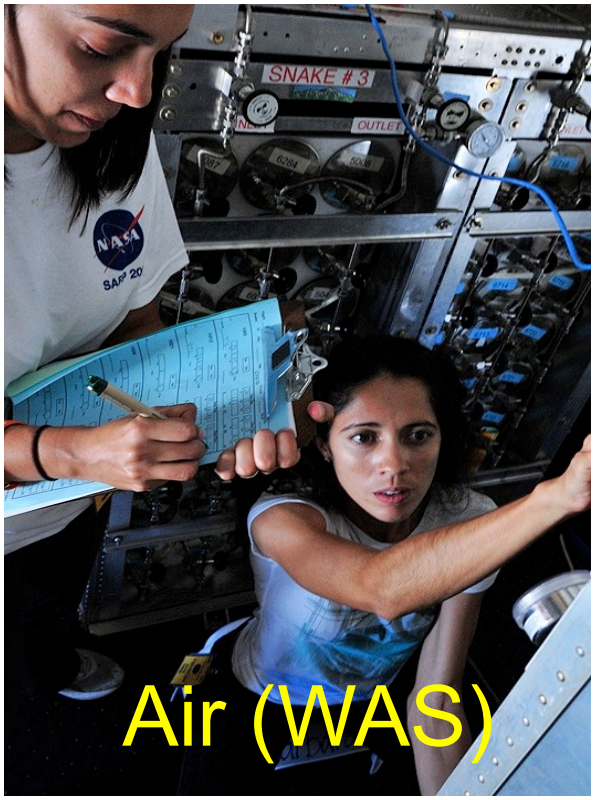
Almond Orchard Research

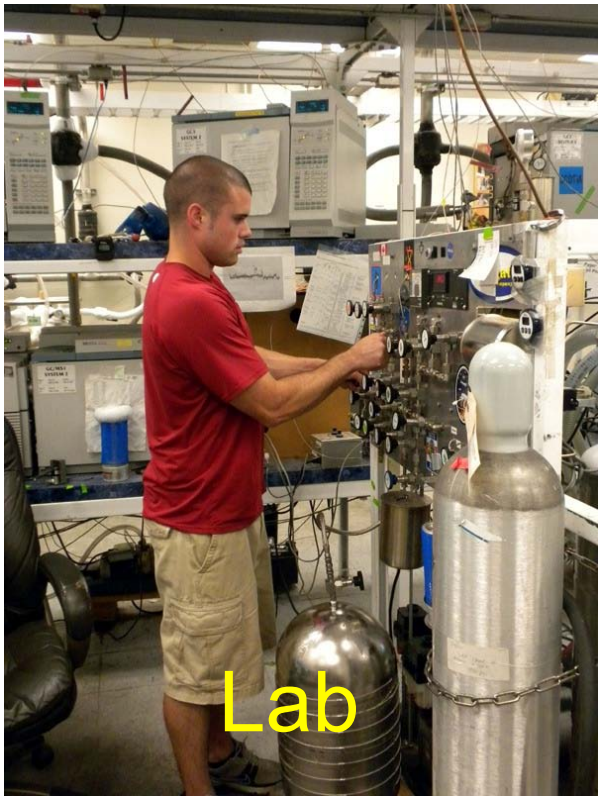


Integration of Data

NASA Student Airborne Research Program (SARP)

Air Sampling and Analysis





NASA Student Airborne Research Program (SARP)

Final research results were presented by all of the students the last 2 days of the program

The presentations are available online at http://www.nserc.und.edu/learning/SARPmm.html

A summary of SARP and presentations by 3 SARP students will presented at the NASA booth at the Fall AGU meeting in San Francisco

IceBridge Antarctica Mission

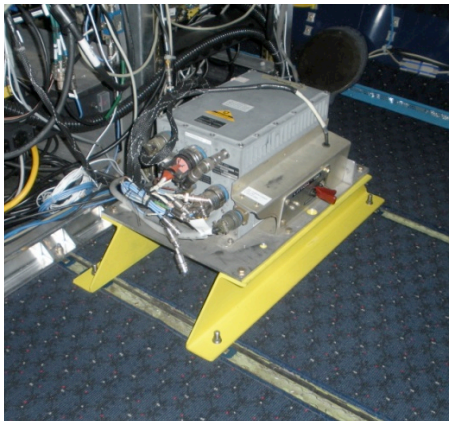
Airborne instruments available for IceBridge missions

- **ATM-Airborne Topographic Mapper**
  Measures topography to an accuracy of ten to twenty centimeters
- **Snow Radar**
  Measures snow thickness over sea and land ice formations
- **Ku-Band Radar**
  Measures altitude, surface backscatter, and depth profile to ~5m depth in snow, firn, and ice
- **MCoRDS-Multichannel Coherent Radar Depth Sounder**
  Measures radar reflectivity vs. depth to determine ice thickness, internal layer maps, and bed maps
- **PARIS-Pathfinder Airborne Radar Ice Sounder**
  Measures ice thickness over the ocean and land formations
- **LVIS-Laser Vegetation Imaging Sensor**
  Scanning laser altimeter for topography
  and vegetation coverage data
- **Gravimeter**
  Precisely measures variations in gravity magnitudes
- **DMS-Digital Mapping System**
  Provides High Resolution Geo-Rectified Nadir Imagery

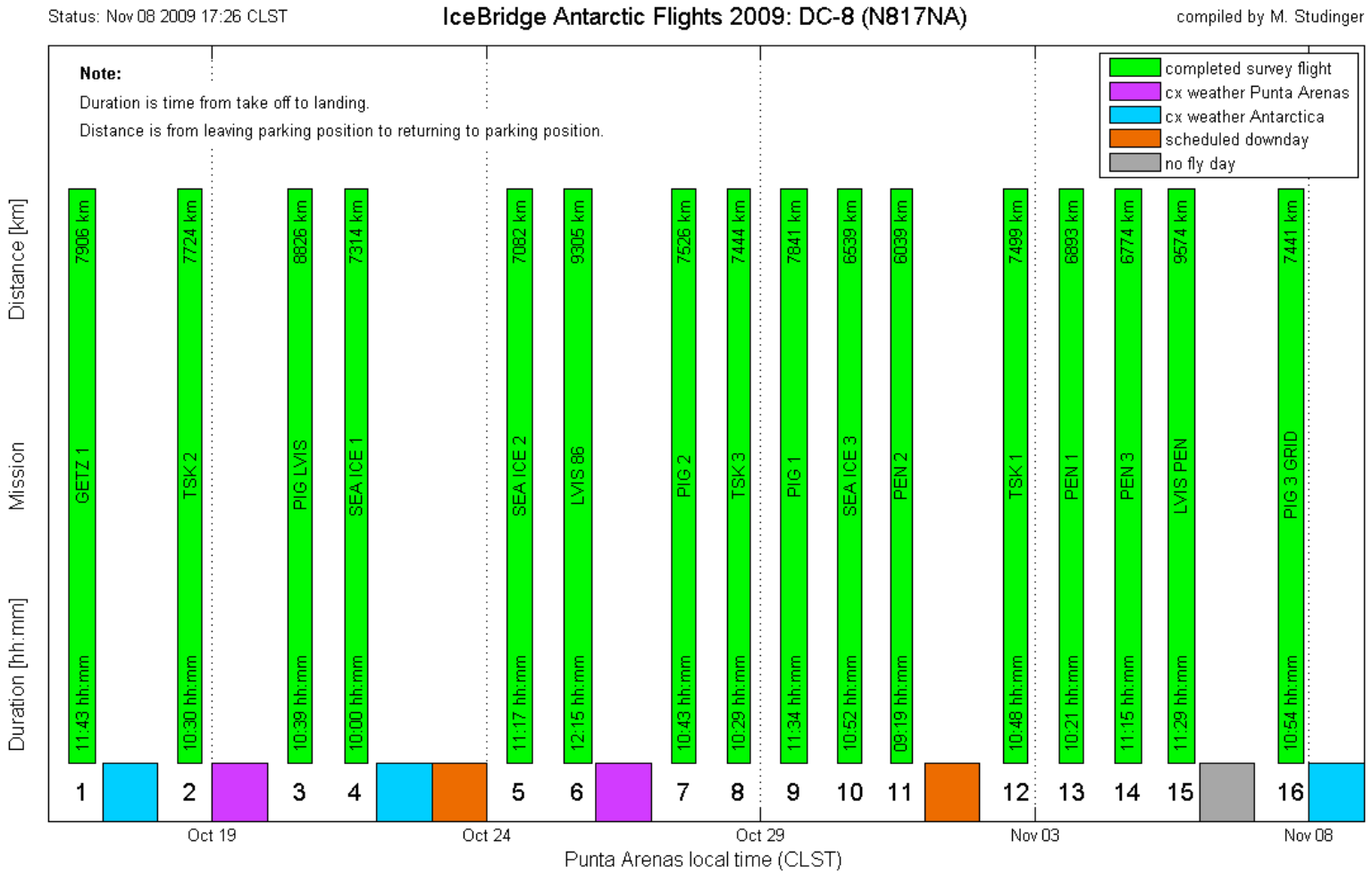
ATM: Airborne Topographic Mapper

Scanning LIDAR measures Surface Topography

- Operates at 400 and 800 meters above ground level, and measures topography to an accuracy of ten to twenty centimeters by incorporating measurements from GPS (global positioning system) receivers and inertial navigation system (INS) attitude sensors. Major research has been in Greenland measuring ice sheet thickness changes.



ATM installed on the DC-8 for IceBridge



16 flights in 22 days totaling 191 flight hours

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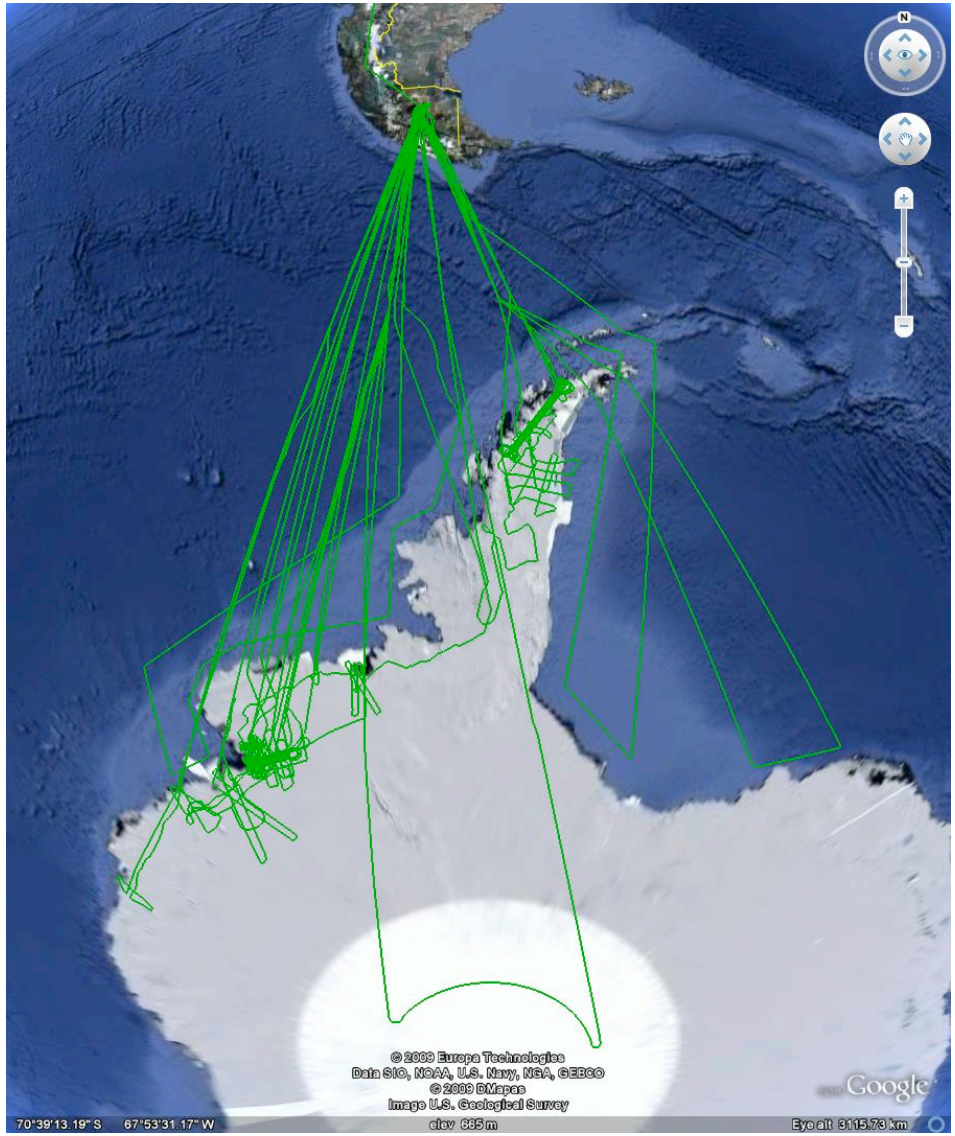
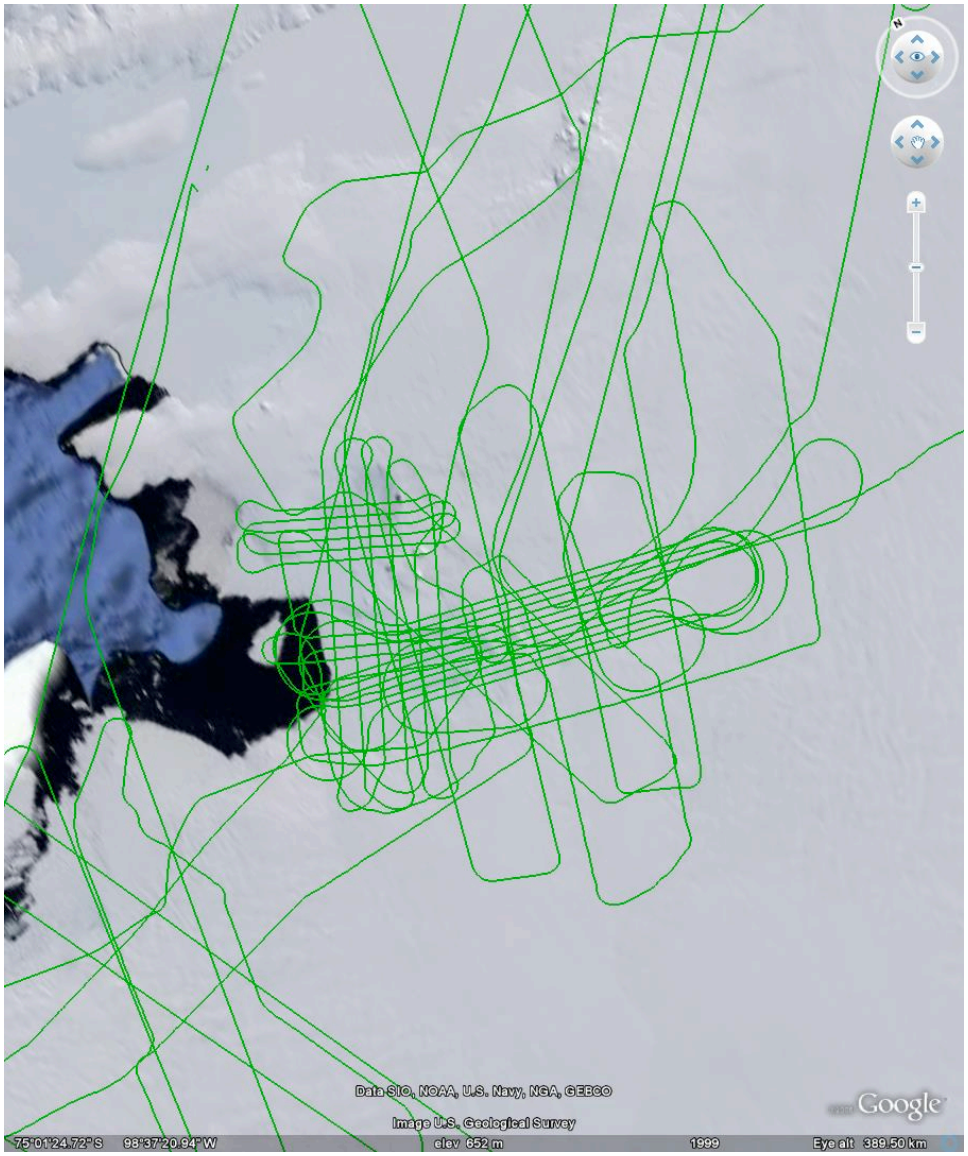
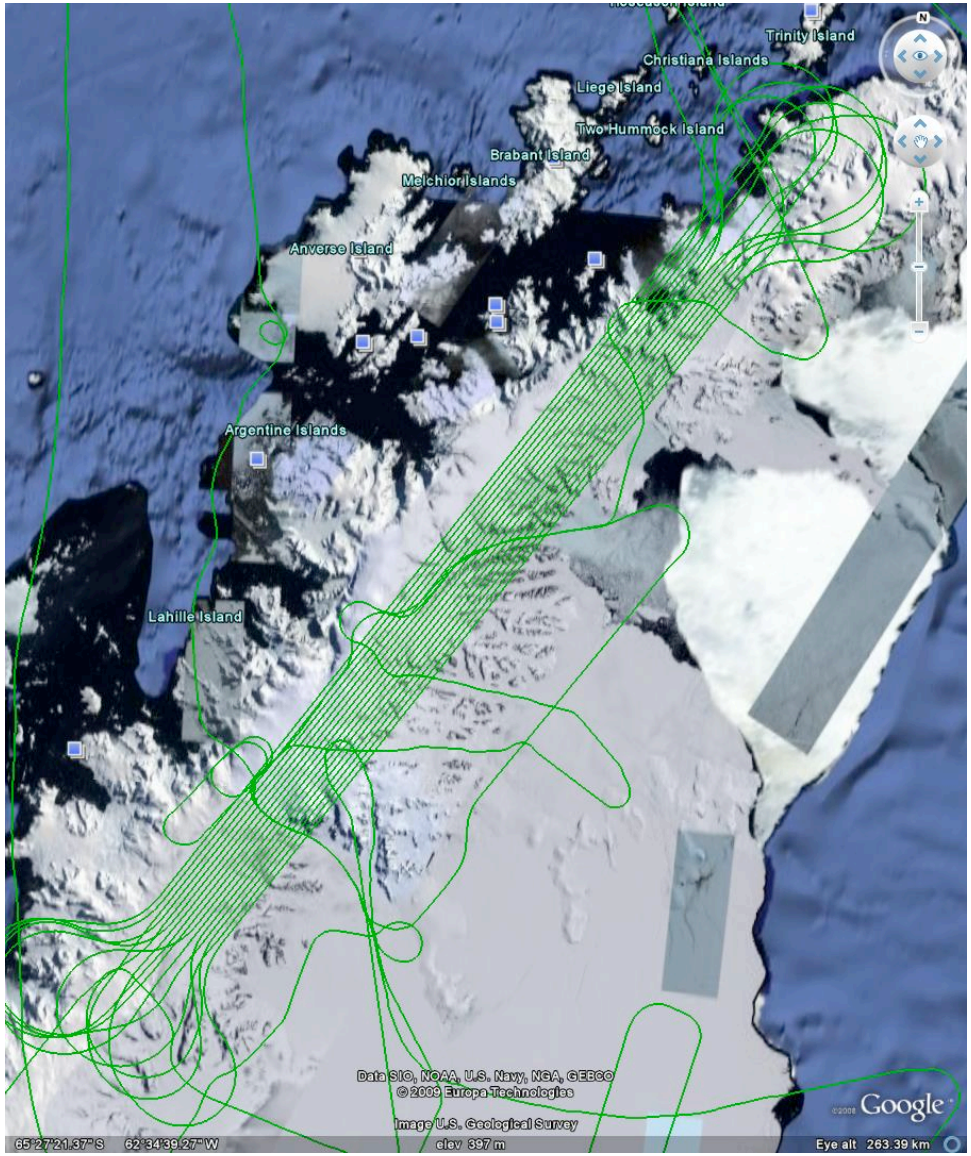
Completed Flight Tracks



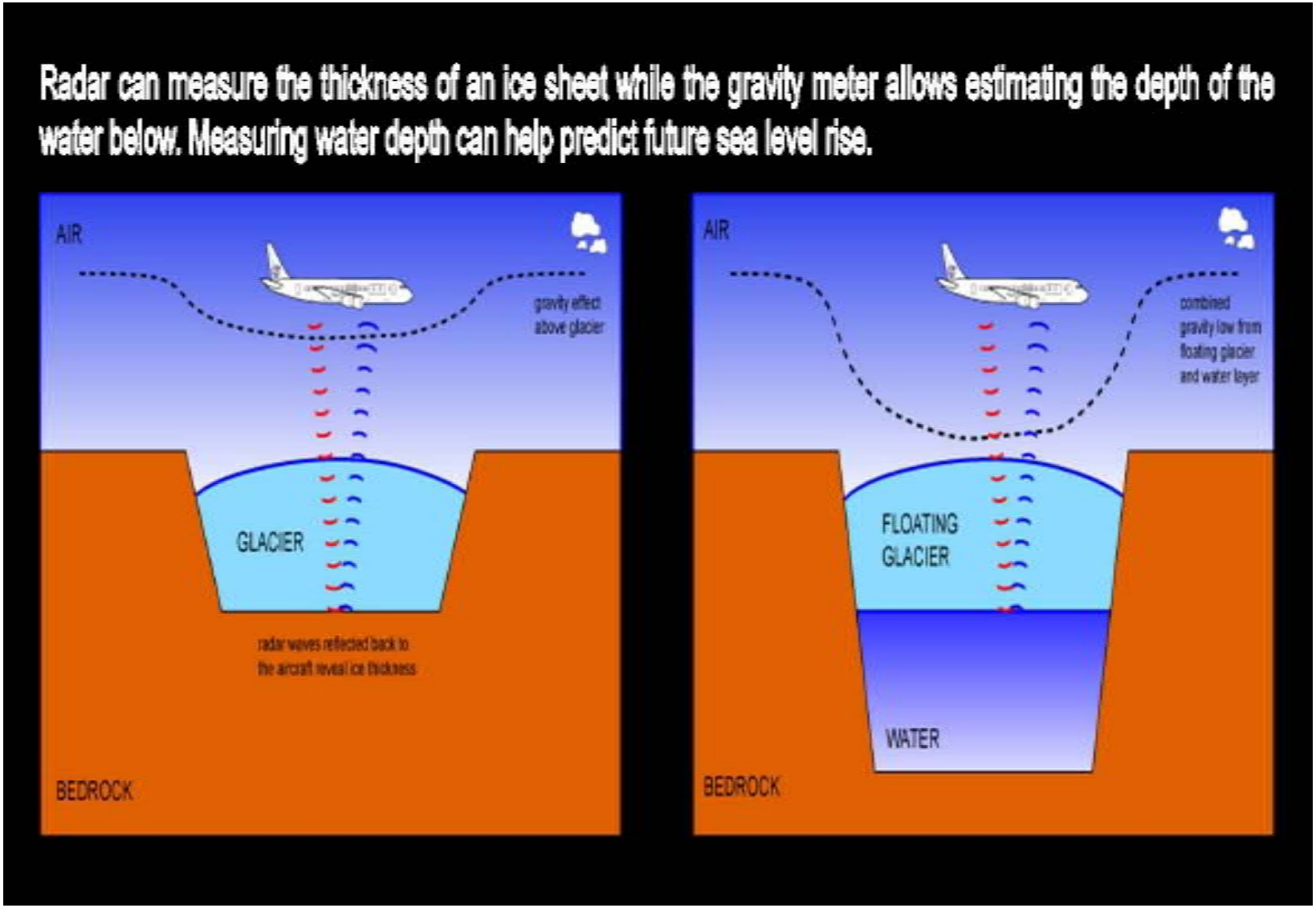
Pine Island Glacier Coverage



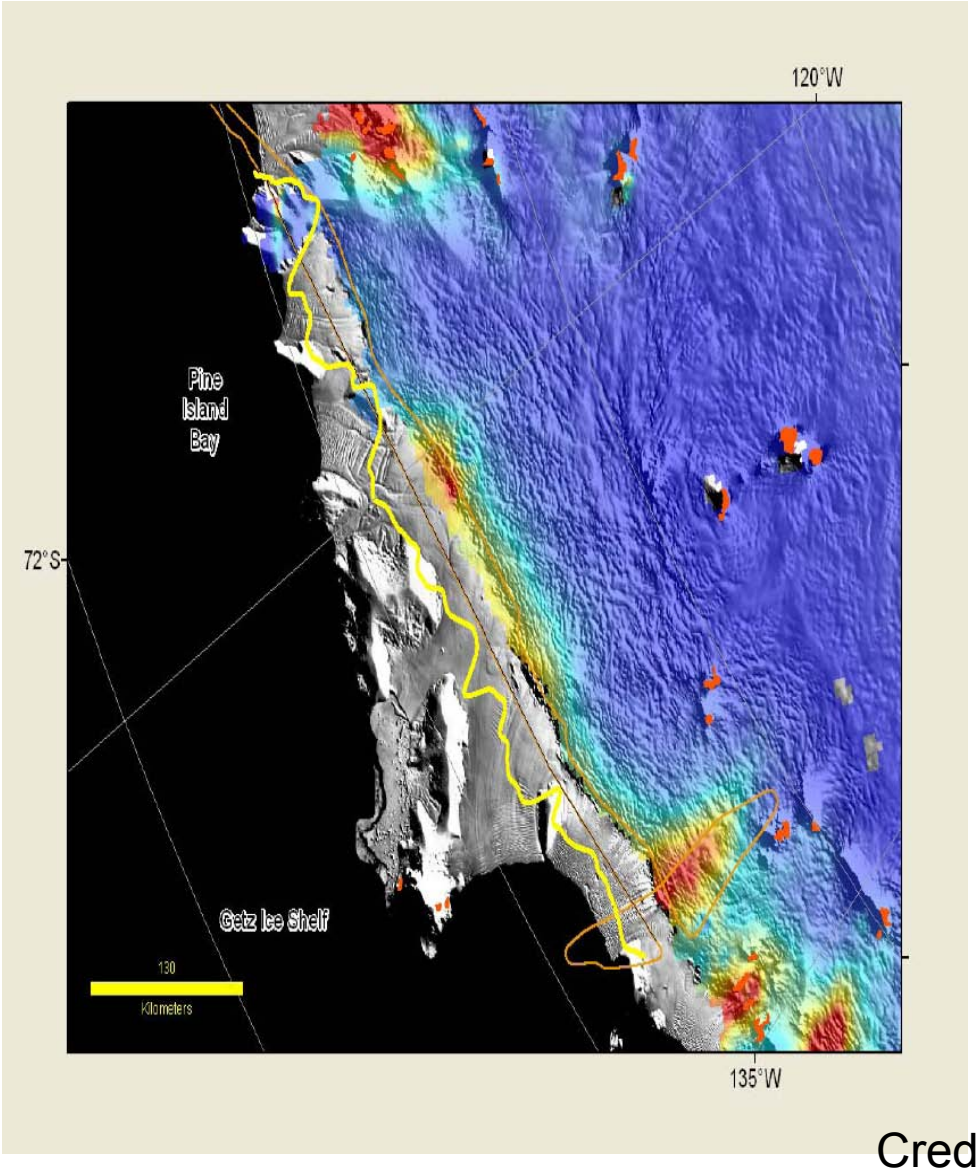
Antarctic Peninsula Coverage



Columbia University Gravimeter
Michael Studinger and LDEO Staff

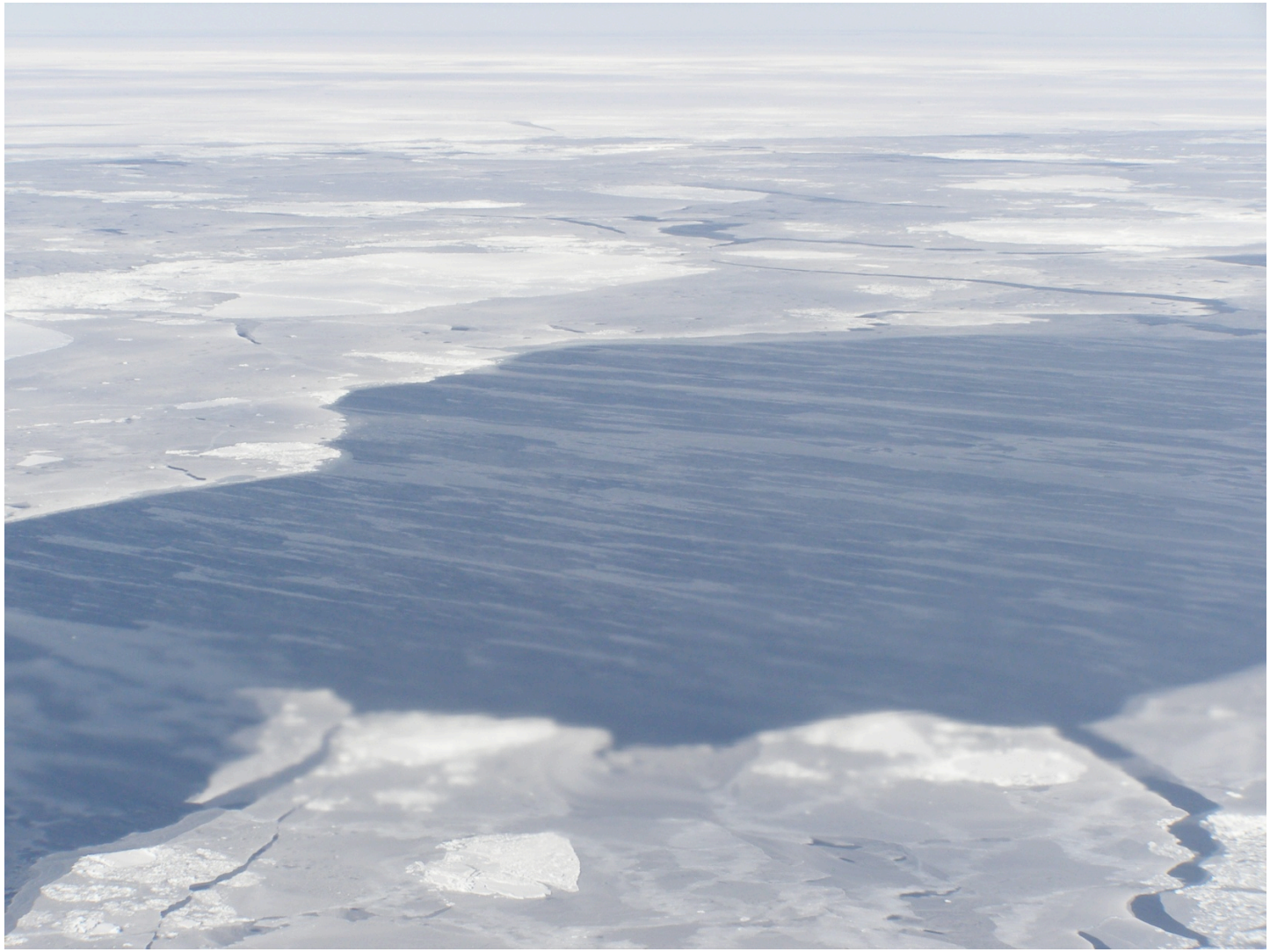


Gravimeter Preliminary Results



Credit: Michael Studinger

Sea Ice in Weddell Sea



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Crevasses on Pine Island Glacier

Overflight of Palmer Station, Antarctica


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