





# UAVSAR Overview

DFRC Gulfstream-III



- UAVSAR was developed under NASA ESTO funding to support repeat-pass radar interferometry and was designed to also serve as a radar technology test bed for future spaceborne imaging radar missions
- Instrument in the non-pressurized pod is compact, modular, and adaptable to support multiple airborne platforms and frequency upgrades



*Electronics bay common to all frequencies*



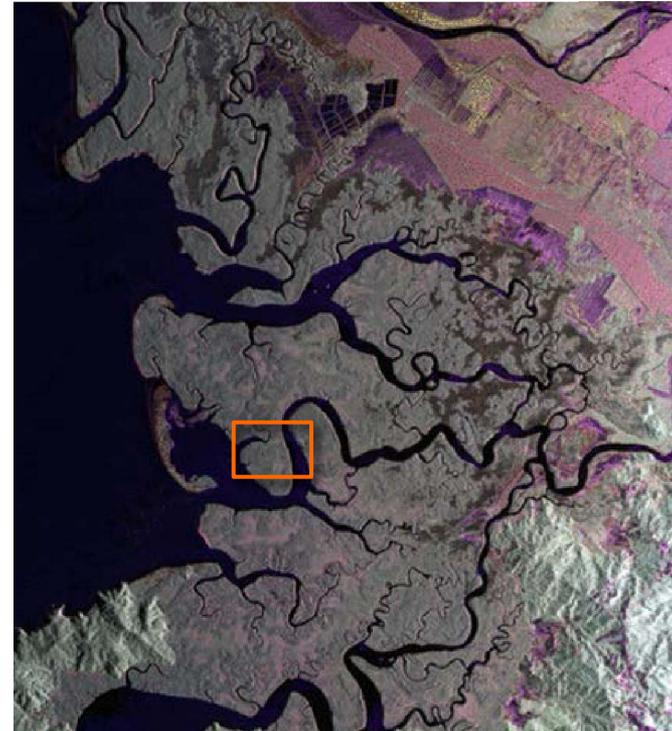
## Current Capabilities:

- **L-band repeat-pass polarimetric interferometry to study earth science (earthquakes, volcanoes, vegetation, hydrology, ice, etc. and emergency response potential.)**
- P-band polarimetry for subsurface soil moisture and forest biomass measurements
- Ka-band single pass interferometry for polar ice study



Jet Propulsion Laboratory  
California Institute of Technology

## Overview



***Sierpe Mangrove, Costa Rica. Ground photo (left) and UAVSAR image (right)***



***502 at San Jose Airport during 2010 deployment to Costa Rica***



# 2013 Deployment

- March 4<sup>th</sup> through April 3<sup>rd</sup>
- North America:
  - Arizona and Gulf Coast
  - 12 Hours
  - 2 sorties
- Central and South America:
  - 112 hours
  - 20 sorties
- 12 Science investigators

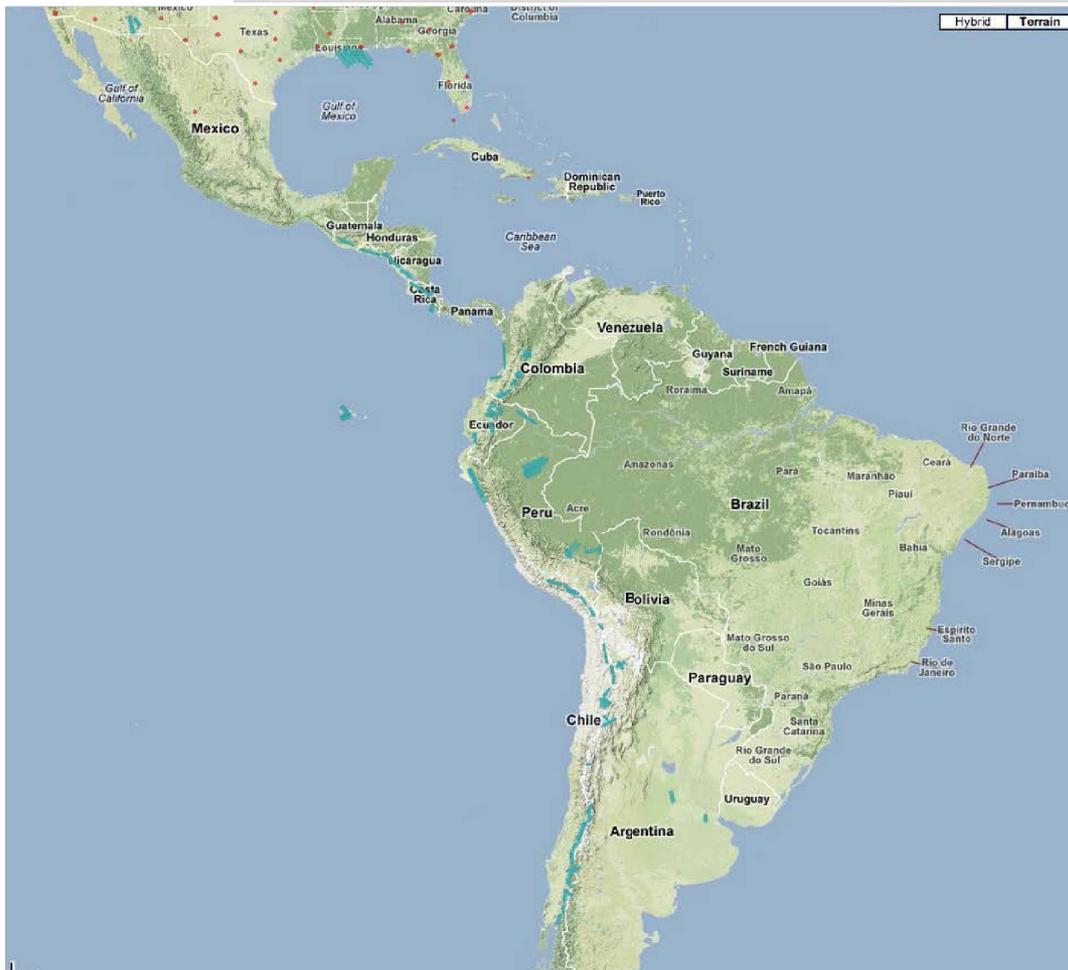




# Data Acquisition Strategy

Land-Cover / Land-Use Change

Earth Science Data Records



Applied Sciences

Solid Earth  
(volcanoes)

Solid Earth  
(subsidence)

Terrestrial Ecology

Hydrology

Cryosphere

Space Archaeology

Biodiversity



# UAVSAR Science Products

## PoISAR

- L-band enables data simulation and calibration for SMAP and PALSAR products
- High resolution (5 m)
- Fully polarimetric:
  - HH, HV, VV
- Change detection
- Land cover/ land use classification
- Vegetation structure
- Archaeological features

## Repeat Pass Interferometry

- L band enables improved correlation and phase estimation
- Complementary to spaceborne data:
  - Flexible viewing geometry
  - Shorter revisit period



# Solid Earth (Volcanoes)

- Paul Lundgren, JPL
- Sites: Guatemala, Nicaragua, Costa Rica, Colombia, Ecuador, Peru, Bolivia, Chile, and Argentina (border with Chile)
- UAVSAR science products: Lines are intended to be repeated in 2014 to generate interferometric pairs
- UAVSAR provides flexible viewing geometry that complements satellite observations and enable estimation of volcano surface deformation
- Results are expected to improve models of crustal deformation for hazard mitigation



***Lascar volcano, Chile (bottom) and swath for planned UAVSAR acquisition (top)***



# Solid Earth (Subsidence)

- Brian Conway, Arizona Department of Water Resources
- Site: Cochise County, Arizona
- Science products: L-band interferograms from UAVSAR repeat-pass interferometry provide higher coherence in comparison with satellite C-band data over the target site
- Goal: To improve the monitoring of land subsidence and uplift in Arizona



***Warning sign and earth fissure in Cochise county  
(pictures by Brian Conway)***



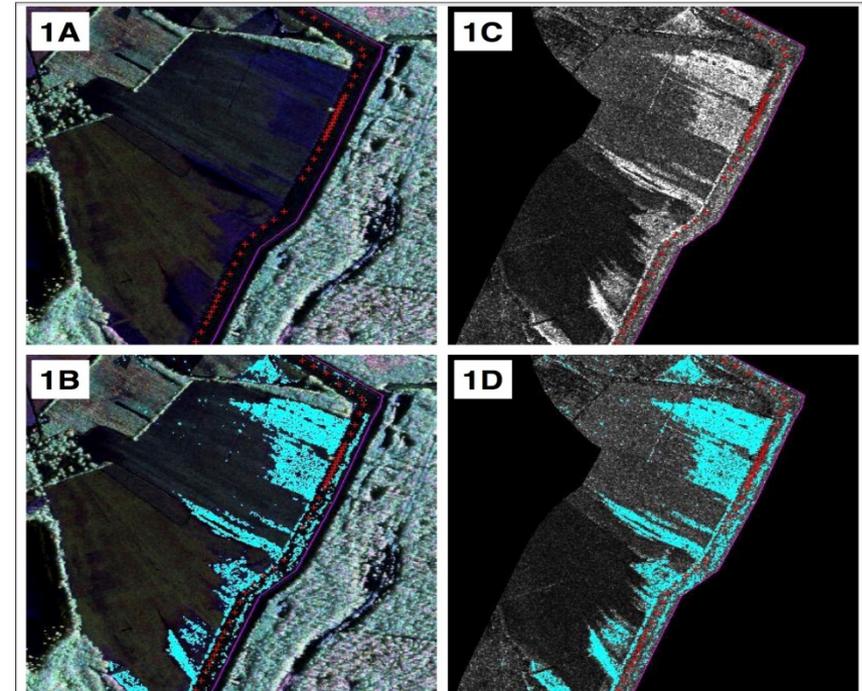
## Solid Earth (Subsidence)

- Ronald Blom, JPL
- Sites: Gulf Coast, including New Orleans and the Mississippi Delta
- Science products: UAVSAR repeat-pass interferometric data will be collected over areas with the highest subsidence rates. High temporal and spatial resolution will complement data from spaceborne sensors such as ALOS/PALSAR
- While GPS stations are placed at single points, InSAR provides geodetic data over large spatial scales to improve understanding of the geophysical processes underlying subsidence events
- C-band InSAR shows high temporal decorrelation over the study site. UAVSAR L-band data are believed to increase our ability to measure the interferometric phase and estimate ground motion
- Goal: To understand the causes of subsidence of the Gulf Coast and predict future subsidence rates to inform decisions about how to manage the protection of infrastructure



# Applied Sciences

- Cathleen Jones, JPL
- Sites: Louisiana and Mississippi
- UAVSAR science products: high-resolution, fully polarimetric PolSAR images are filtered to derive band ratio VV/HH and other polarimetric products
- The resulting maps will be used to delineate locations with increased soil moisture along levees, which are potentially impacted by seepage and/or sandboils



**Images 1A-1D:** Areas of increased soil moisture on the protected side of the levee due to the expulsion of water via local levee relief wells.

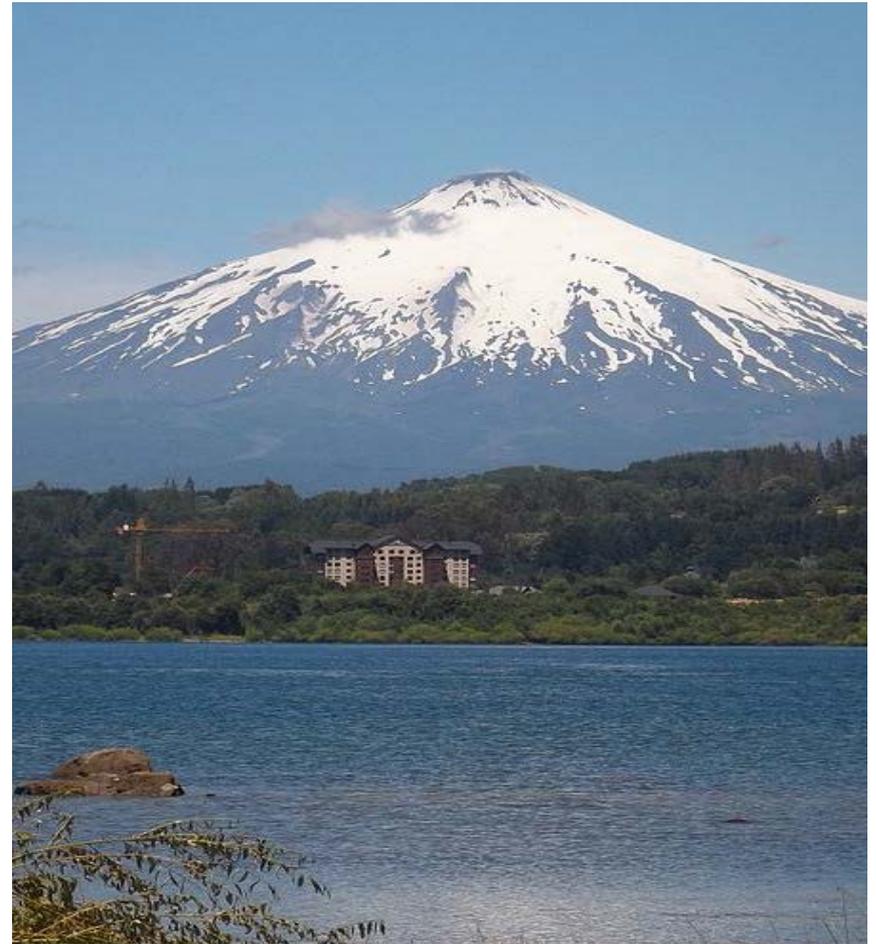
— Levee Centerline    ● Increased Soil Moisture    + Levee Relief Wells

***Madson et al., AGU 2012 Fall Meeting***



- Gerald Bawden, USGS
- Sites: Andean glaciers along the Chilean-Argentinean border: Tapado, San Francisco, Universidad, Villarrica.
- UAVSAR science products: Lines will be acquired with a 48-hour interval to generate interferometric pairs and estimate glacier motion
- UAVSAR interferograms will be combined with ground measurements and lidar data to resolve glacier motion during the summer months in Chile
- Collaborative project with Chilean government to understand glacier processes in the context of climate change and anthropogenic factors

## Cryosphere



***Villarrica Glacier, Chile***



# Land Use-Land Cover

- Marc Simard (JPL)
- Mangroves along the coast of Honduras, Costa Rica, Colombia, and Ecuador
- UAVSAR science products: high-resolution, fully polarimetric PolSAR images will be used to map mangrove extent
- Repeat-pass interferometric products will be used to estimate canopy height and model aboveground carbon stocks
- Results will be integrated with socio-economic data to model the drivers of mangrove degradation



*Ground crew surveying a mangrove patch in Costa Rica*



# Earth Science Data Records

- Bruce Chapman, JPL
- Kyle McDonald, CUNY/JPL
- Erika Podest, JPL
- Sites:
  - Pacaya-Samiria wetlands in the Peruvian Amazon
  - Napo River, Peru/Ecuador
- UAVSAR science products: high-resolution, fully polarimetric PolSAR images will be used to delineate wetlands
- Maps of flooded areas aid in hydrological modeling and vegetation mapping, as some forest types are associated with flooded zones
- Results will aid in validating and interpreting inundation maps derived from spaceborne sensors ALOS/PALSAR and AMRS-E under the NASA MEaSURES task



***Palm swamp in Pacaya-Samiria National Park,  
Peru  
(photo by Erika Podest)***



# Space Archaeology

- William Saturno, Boston University
- Douglas Comer, Cultural Site Research and Management
- CO-Is: Bruce Chapman and Ronald Blom, JPL
- UAVSAR science products: high-resolution, fully polarimetric PolSAR images will be used to identify and map archaeological features associated with the Moche culture
- Site: Peruvian coastal desert valleys
- Improved inventory of cultural sites will enable researchers to identify associations with ecological features and understand ancient environmental adaptations.



*Temple of the Sun near Trujillo, Peru*



# Hydrology

- Thomas Jackson, USDA
- Sites: SMAP validation sites in Argentina: Cordoba, Pampas Humidas, and Chaco Forest
- Science products: high-resolution PolSAR data will be used to develop soil moisture retrieval algorithms
- UAVSAR data will serve to simulate SMAP L-band observations, and support the generation of soil moisture algorithms



# Terrestrial Ecology

- Sassan Saatchi, JPL
- Tropical forest in Manu National Park, Peru
- UAVSAR science products: high-resolution, fully polarimetric PolSAR images will be used to map forest structural types across an altitudinal gradient
- PolSAR images will be integrated with field studies and lidar data to estimate carbon stocks over the study area
- Results will improve our understanding of the main determinants of variation of forest structure, biomass, and composition along altitudinal gradients



# Biodiversity

- Kyle McDonald, CUNY/JPL
- Madre de Dios region in Southern Peru.
- UAVSAR science products: high-resolution, fully polarimetric PolSAR images will be used to map forest structural types across a geomorphological gradient in the Peruvian Amazon
- Forest structural studies will be integrated with field data to improve our understanding of Amazon biogeography
- This project is collaborative study supported by the NASA/NSF Dimensions of Biodiversity program



# Summary

- A broad range of science disciplines is using SAR data
- Most dedicated flights are for solid earth studies, with additional disciplines taking advantage of transit flights
- A single study site can be used by more than one PI, for example volcanic sites that also have glaciers
- Studies using UAVSAR data help US researchers establish and broaden their network of collaborations in Latin America



Jet Propulsion Laboratory  
California Institute of Technology

# Thank You



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## UAVSAR

Uninhabited Aerial Vehicle Synthetic Aperture Radar

Science & Applications Technology Education

Tools

The deadline to register for the UAVSAR workshop (March 25-27, 2013) has been extended to March 6, 2013!

Calendar (2013)

This Week

Sun 2/17 Mon 2/18 Tue 2/19 Wed 2/20 Thu 2/21 Fri 2/22 Sat 2/23

NASA Dryden G3

NASA Johnson G3

Global Hawk

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What is UAVSAR? Search for Data Create a Flight Plan

Last Flight Flown: PLAN\_13019 (Feb 11, 2013)  
P-band Location: California

Last Image Released: Salton\_08520 (08/04/12)  
L-band Acquired May 1, 2012  
Salton Trough, Mexico

NASA Airborne Radar Studies Icelandic Ice Caps

UAVSAR heads back to Iceland to study the glacial velocity of ice caps.

Read More

Please visit: <http://uavsar.jpl.nasa.gov>