National Lab Day   Lectures

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Remote Sensing Capabilities and Needs at LANL:Synergy with Montana

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Remote Sensing Capabilities and Needs at LANL: Synergy with Montana

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DOE Lab Day, Butte, Montana
October 8, 2019 dubey@lanl.gov
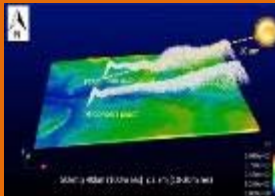
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Our capabilities define science, technology and engineering areas in which we must lead to meet our enduring & evolving nuclear stockpile, global and energy security missions

MATERIALS FOR THE FUTURE

Defects and Interfaces

Extreme Environments

Emergent Phenomena

RS Hardware

SCIENCE OF SIGNATURES

Discover Signatures

Revolutionize Measurements

Forward Deployment

RS Data Mining

INTEGRATING INFORMATION, SCIENCE, AND TECHNOLOGY FOR PREDICTION

Complex Networks

Computational Co-Design

Data Science at Scale

NUCLEAR AND PARTICLE FUTURES

High Energy Density Physics & Fluid Dynamics

Nuclear & Particle Physics, Astrophysics & Cosmology

Applied Nuclear Science & Eng.

Accelerator S&T

RS Knowledge

COMPLEX NATURAL & ENGINEERED SYSTEMS

Understand and Control Systems

- **Weapon Effects**
- **Treaty Verification**
- **Energy Security**

Los Alamos
NATIONAL LABORATORY
EST.1943

# Programs & Needs: Students & Postdocs are our pipeline

- Climate Observations for Predictions (BER, ARM/NGEE-Arctic)
- Energy Security: Resiliency in Complex Systems (FE)
- Treaty Verification and Surveillance (NNSA, DoD)
- Satellite, Ground and Airborne Observations (NASA, NNSA, DOE)
- Big Data & ML: Predict Earthquakes & Detect Leaks (BES/ARPA-E)
- End to End: RS Design, Development, Deployment to Discovery
- *450 postdoc, 1880 students in FY19: Pipeline for the future (61%)*
- *National Security Education Center*
  - *https://www.lanl.gov/projects/national-security-education-center/centers-institutes.php*

Energy NOx-CO$_2$ Emissions Verification: Four Corners

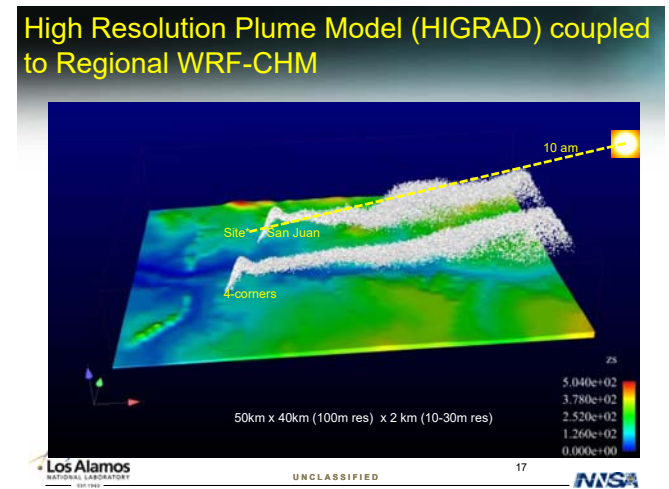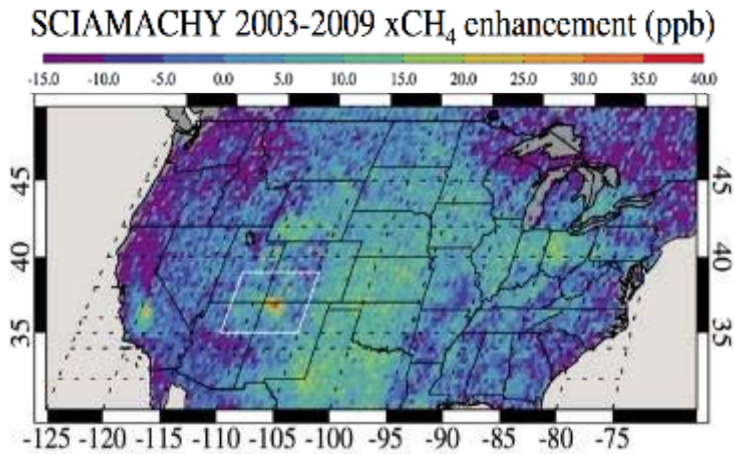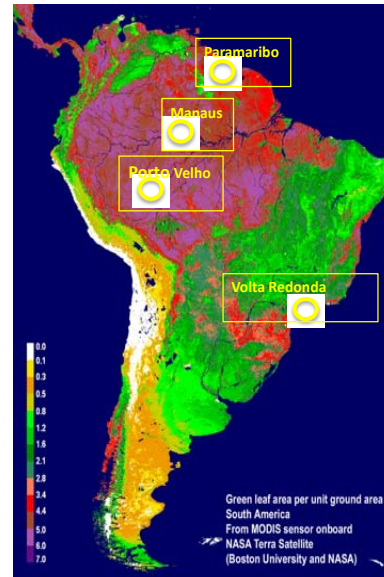### NO$_2$ OMI (NASA)
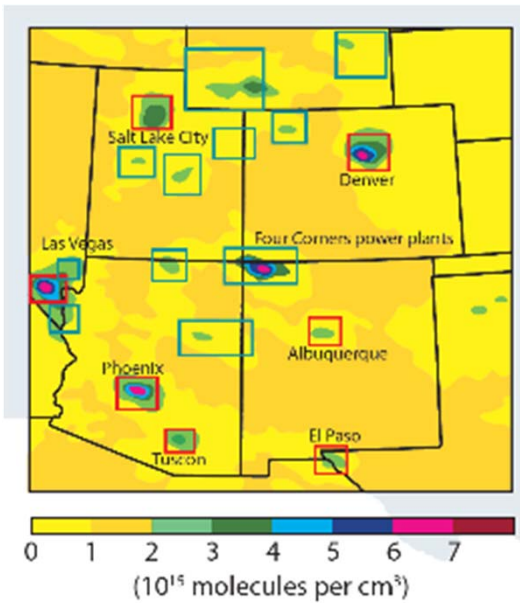
LANL Solar FTS

NASA A-Train

LANL Plume Model

High Resolution Plume Model (HIGRAD) coupled to Regional WRF-CHM

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CH$_4$ hot spot in 4Corners, CO$_2$ uptake by Amazon & CH$_4$ from CA Dairies

SCIAMACHY 2003-2009 xCH$_4$ enhancement (ppb)

Top-down emissions x3 EPA inventory

Green leaf area per unit ground area
South America
From MODIS sensor onboard
NASA Terra Satellite
(Boston University and NASA)

Central Valley Study Area

- Emissions from Four Corners of **~0.59 Tg CH$_4$/yr** have persisted 2003-2009, 2012 and verified by ground based observations.
- The study pioneers the use of space-based observations to identify and quantify localized regions of anomalous CH$_4$ emissions.
- **LANL's portable solar FTS, UAV, Cubesat & Machine Learning expertise extends verification applications**
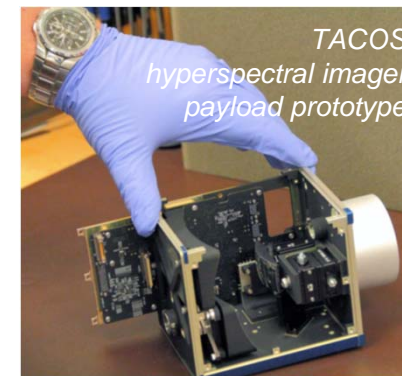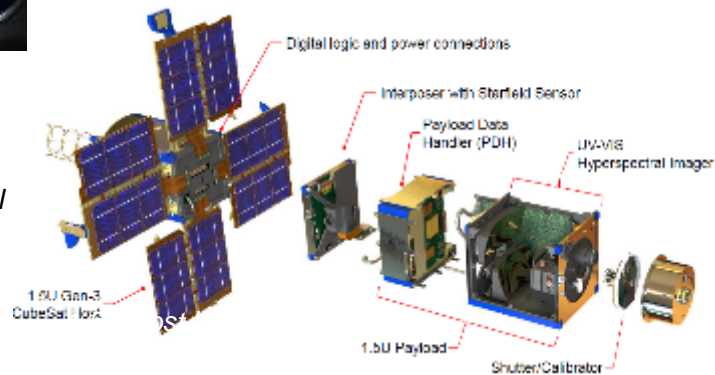
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Agile Space: SmallSat Program at LANL

- *19 launches since 2010 – 7 launches planned for 2020*
- CubeSats based on a 1.5U host bus developed at LANL: includes a Command & Data Handler, 2 software defined radios, Attitude Determination & Control System & a power system
- Designs embrace modularity, on-orbit reconfigurability, and on-orbit processing
- Capability to host a 1.5U payload via an interface board → 3U CubeSat
- Various missions underway to measure RF and hyperspectral signatures
- Upcoming missions are trending to larger 6U and 12U sizes
- Multi-disciplinary team of scientists, hardware/software engineers, and technicians

TACOS / NACHOS Project: 3U hyperspectral imager for mapping of volcanic trace gases (SO_2, NO_2) in the 300-500 nm spectral range

Digital logic and power connections

Interposer with Starfield Sensor

Payload Data Handler (PDH)

UV-VIS Hyperspectral Imager

1.5U Gen-3 CubeSat Host

1.5U Payload

Shutter/Calibrator

TACOS hyperspectral imager payload prototype

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Landscape change detection and characterization using Unmanned Aerial Systems (UAS)

Arctic Application: Hyper-resolution (500 points per square meter) Lidar altimetry is used to understand the interactions between multi-scale topography, ecosystem structure, hydrology and permafrost degradation in the hilly shrub-tundra watersheds of the Seward Peninsula, Alaska.

Flight Plan

Teller site

3 km^2
34 flights
8-days
80 control pts
Post leaf-out

Lidar point cloud

Photogrammetry Lidar (intensity)