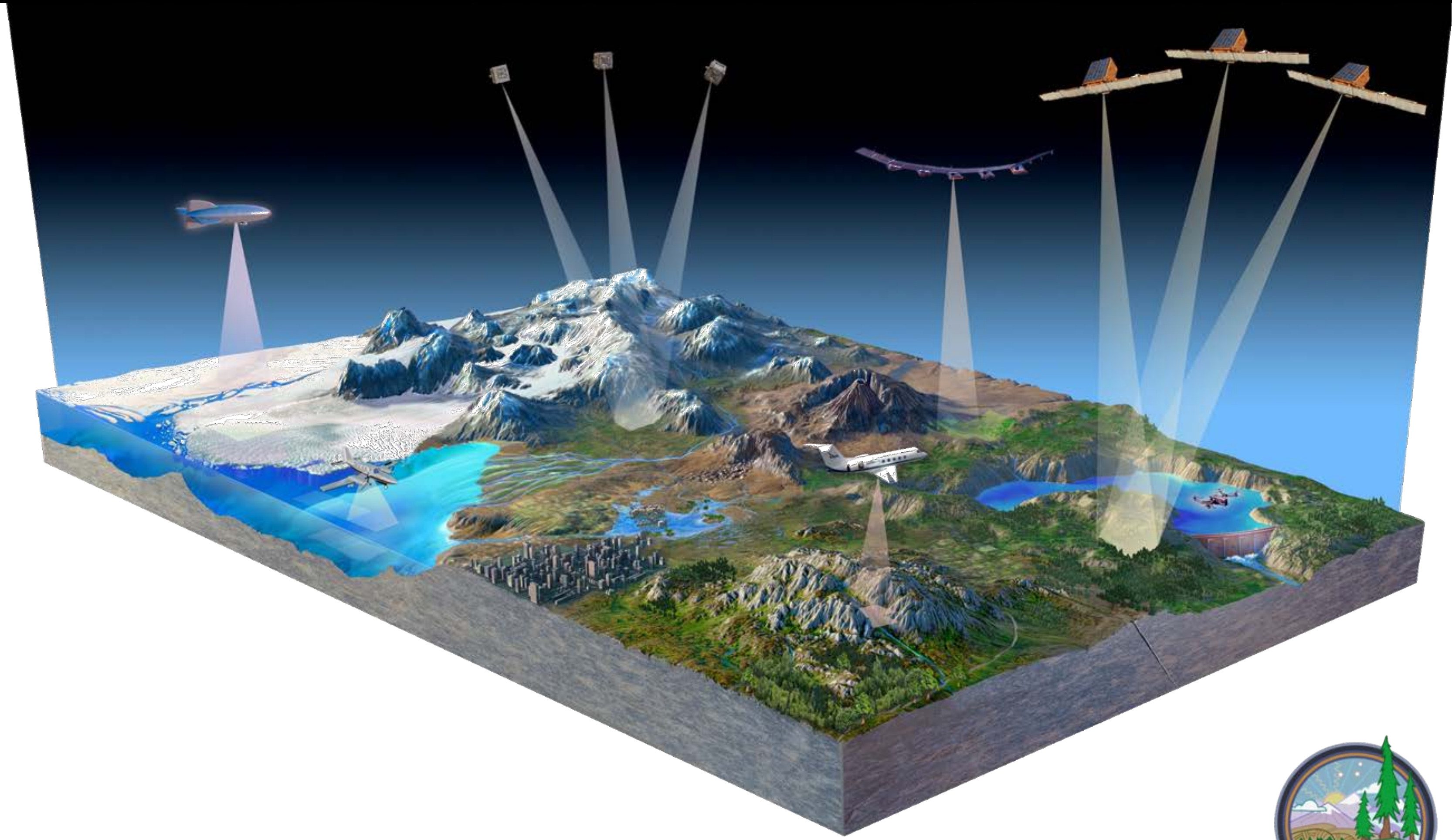
STV Panel Discussion: Separating Vegetation from Ground

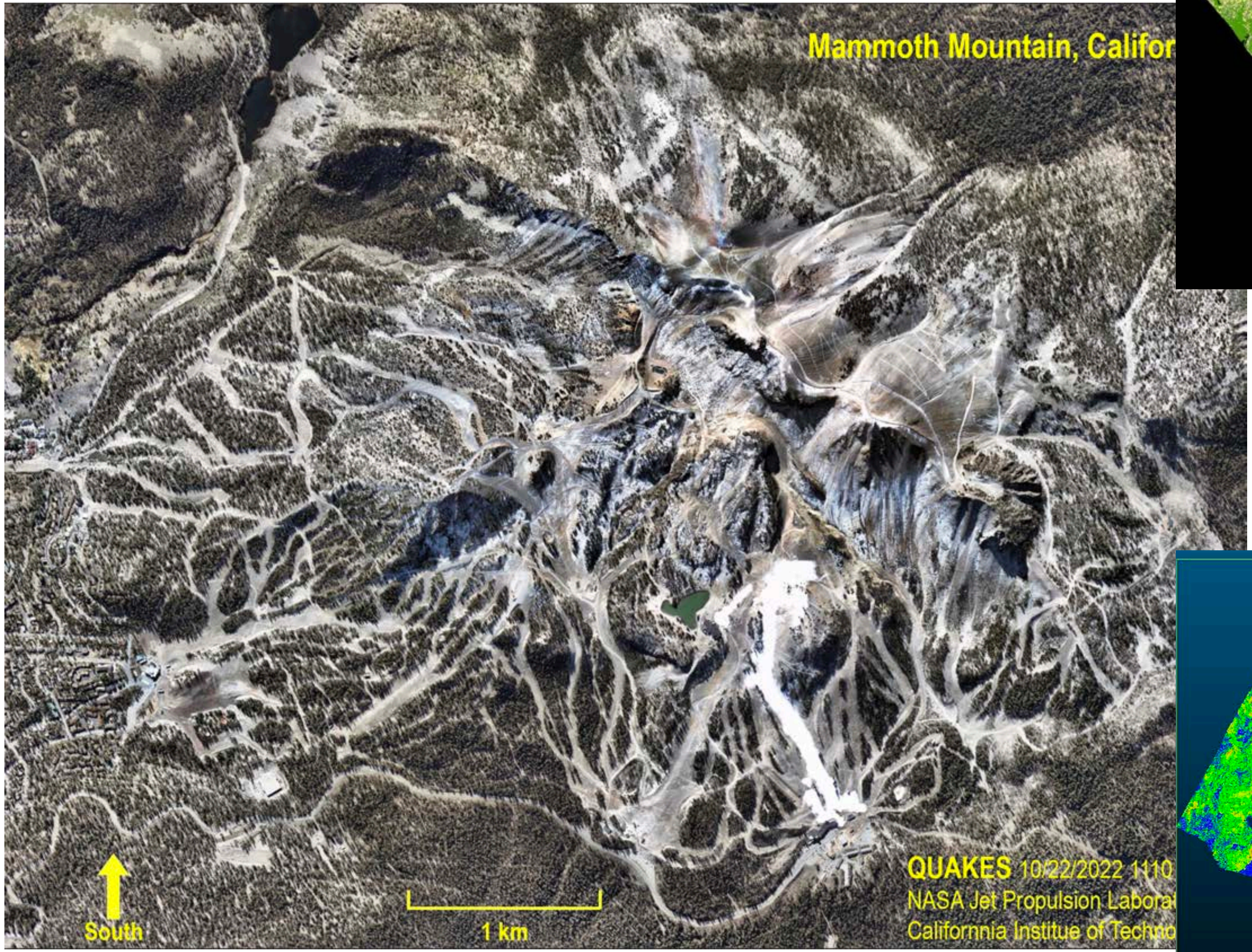
Panel Member	Application Expertise
Keith Krause	LIDAR
Sassan Saatchi	SAR
David Shean	Stereo Imaging
Lori Magruder	LIDAR
Robert Treuhaft	SAR

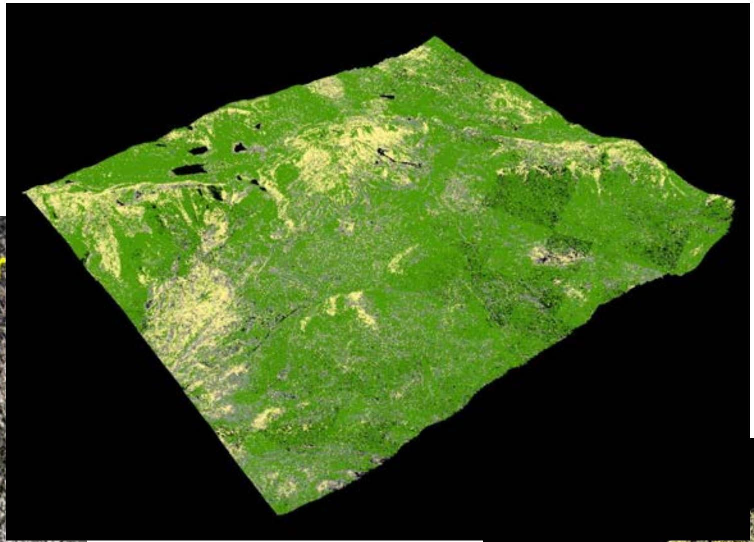


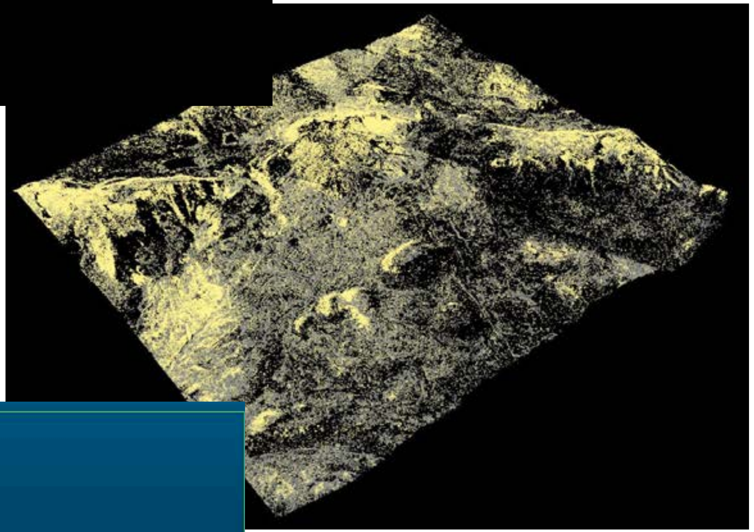
Last updated 11/13/2023

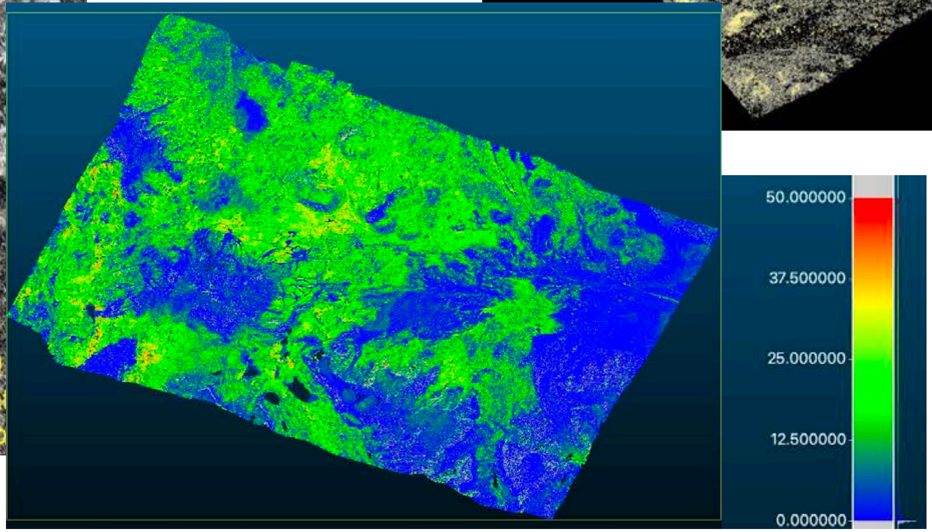
STV

Stereo Imaging Example

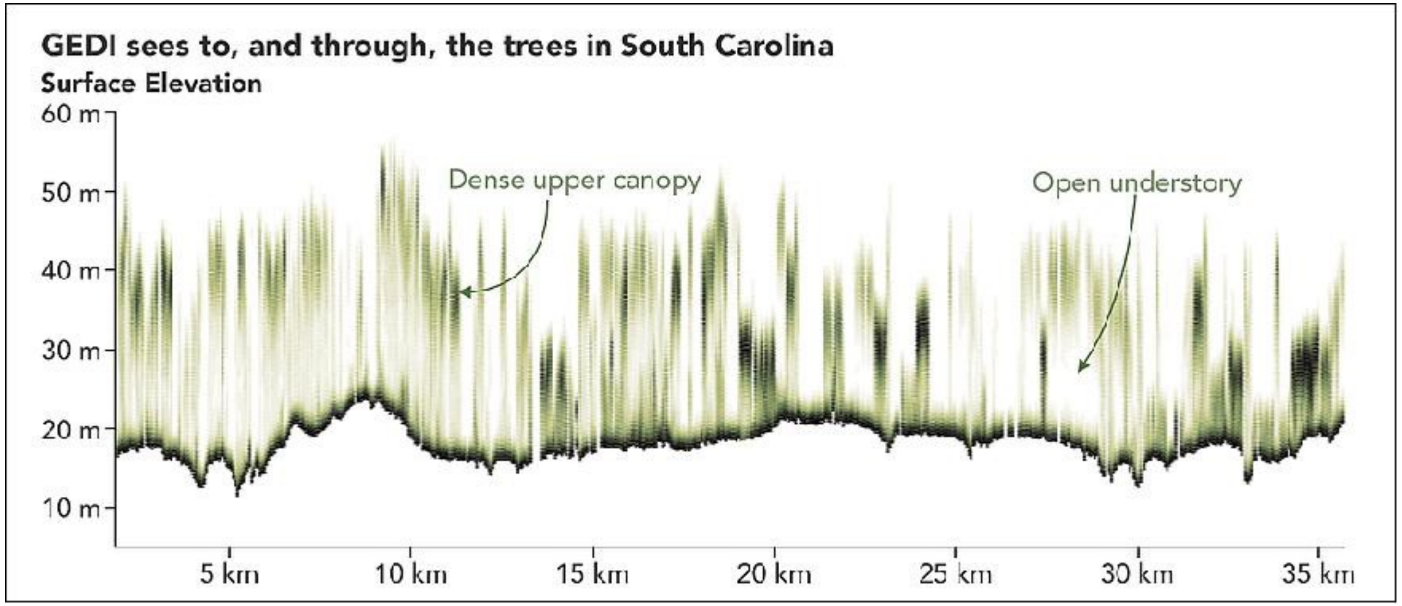




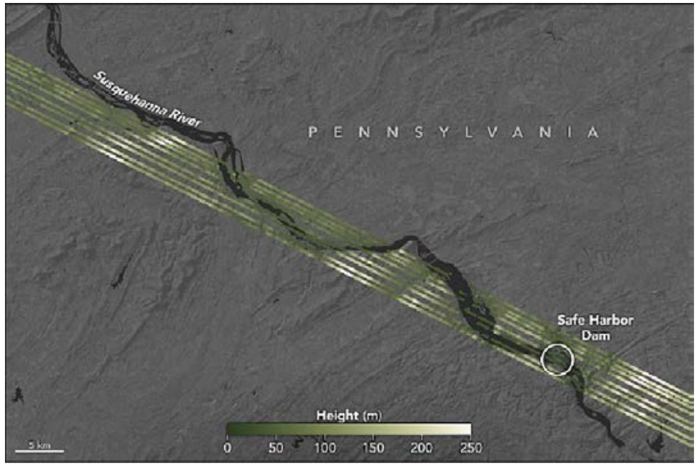




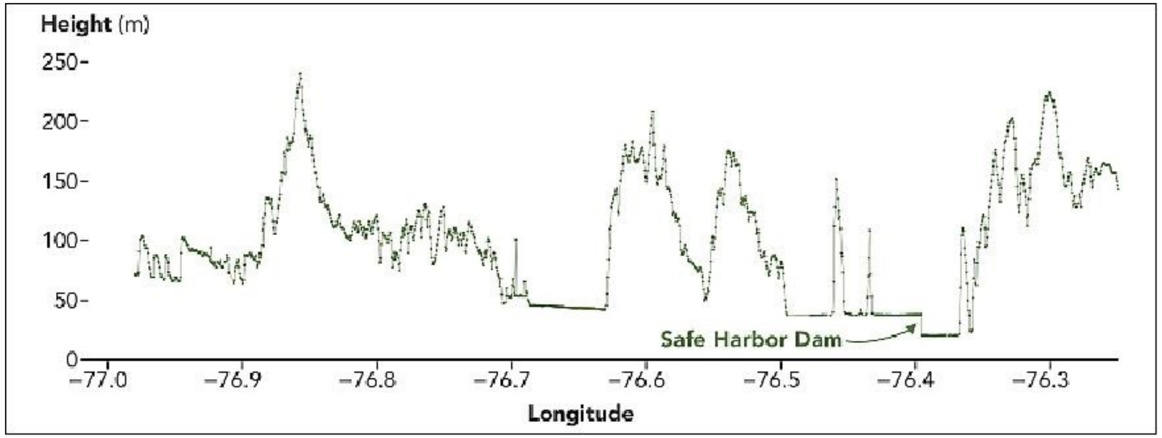
LIDAR Example



Left: When scientists process GEDI's data, the resulting measurements reveal the vertical structure of the forest. This GEDI image is of a South Carolina woodland where darker green shows where the leaves and branches are denser, while the lighter areas show where the canopy is less dense (image credit: Joshua Stevens / NASA Earth Observatory, Bryan Blair / NASA Goddard Space Flight Center, Michelle Hofton and Ralph Dubayah / University of Maryland)



(image credit: NASA Earth Observatory, images by Joshua Stevens, using GEDI data courtesy of Michelle Hofton/University of Maryland. Story by Jessica Merzdorf, NASA GSFC, with Mike Carlowicz) [12)]

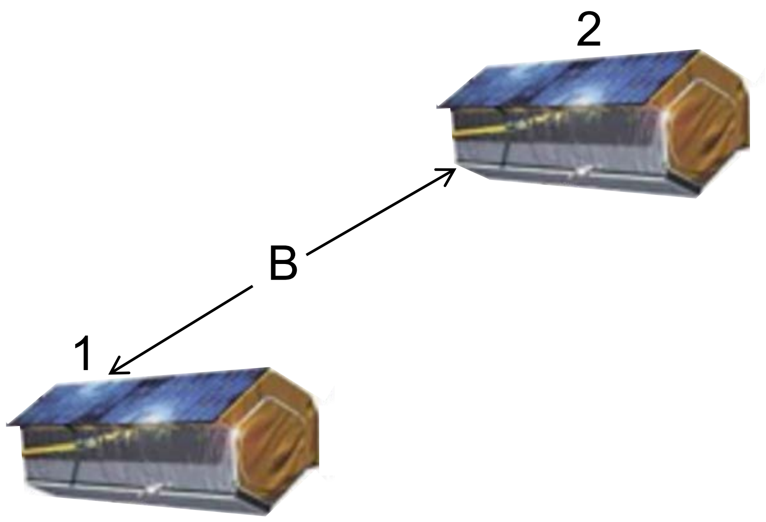


(image credit: NASA Earth Observatory)

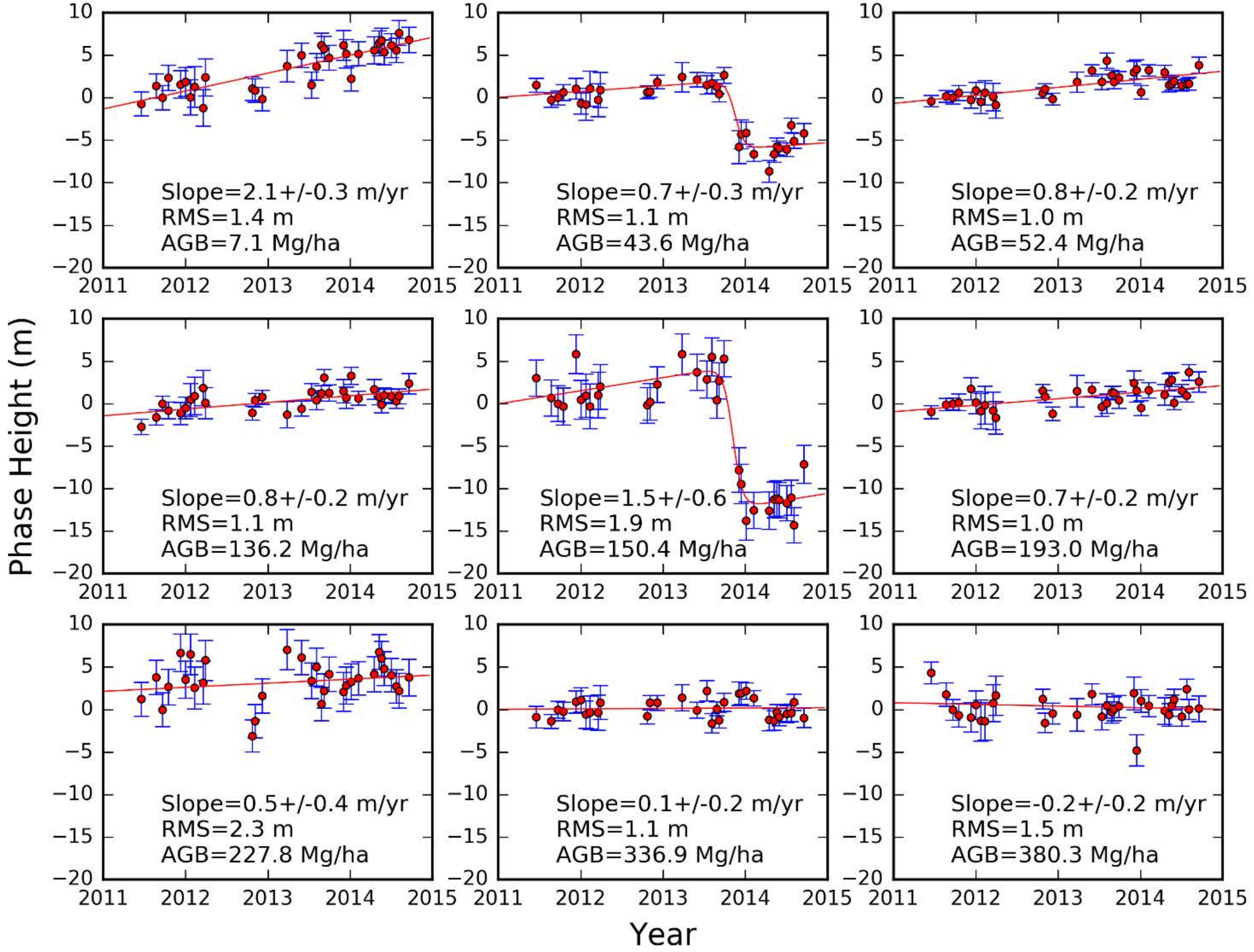
Data examples

https://directory.eoportal.org/web/eoportal/satellite-missions/content/-/article/iss-gedi

Interferometric Synthetic Aperture Radar



Results: Monitoring Forest Structure Dynamics with Interferometric SAR –TanDEM-X (X-Band)



Overview

TABLE 5-1. Key advantages and disadvantages for lidar, radar and stereo technologies.

Sensor	Key Advantages	Key Disadvantages
Lidar	• High vertical accuracy • Detection of ground through vegetation • Vegetation structure • Day and night operation	• Coverage • Cloud cover • High power • Limited detection of ground through very dense vegetation
Radar	• Coverage • Day and night operation • Operates through clouds	• Complex to infer vegetation structure and underlying topography • Changing snow, firn and ice dielectric properties makes height measurements very challenging • High power
Stereophotogrammetry	• High spatial resolution • Low power • High maturity • High reliability	• Day only operation • Cloud cover • Limited detection of ground through dense vegetation

Discussion Topics

Technology Strengths and Weakness

Spatial Resolution and sampling
Height Resolution and sampling
Success of penetrating Vegetation (Trees)
Cross-Track Field of View
Observational Conditions (Clouds / Haze / Night)
Automatability of achieve separation
Power vs Range

Compatibility with Other Science Themes

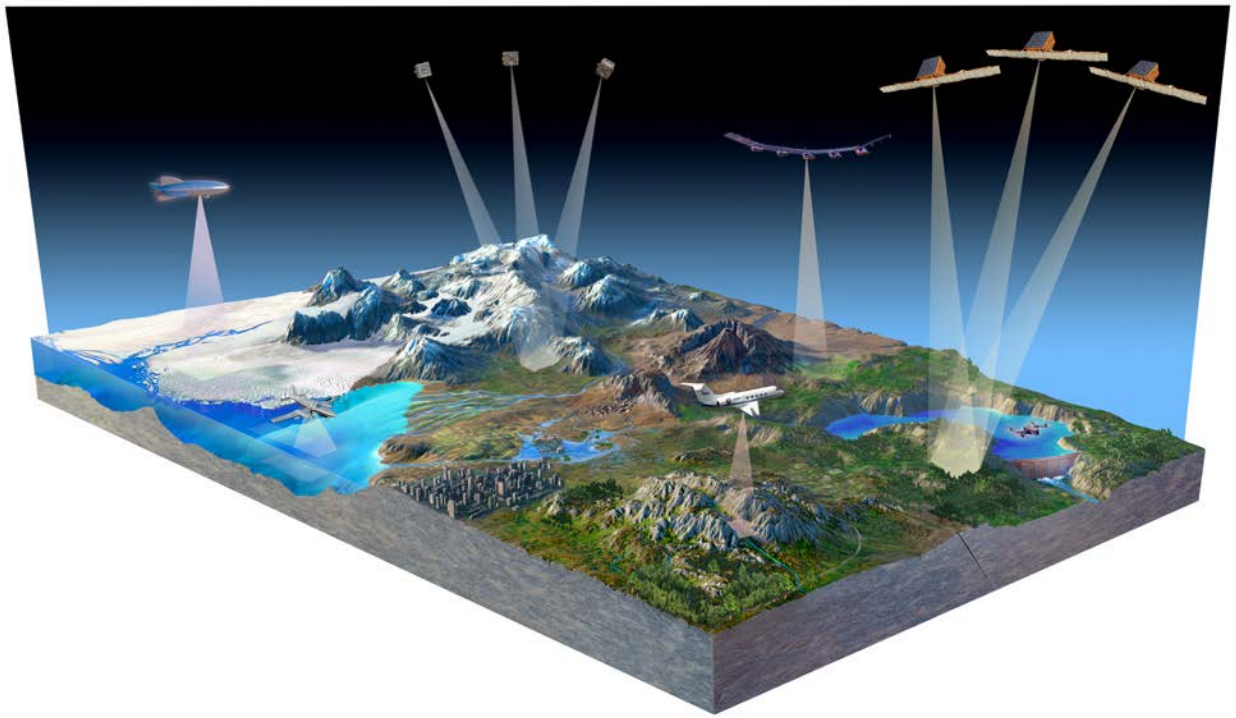
LIDAR: Bathymetric favors 532nm vs Vegetation favors 1064nm

Science Applications and Modeling

Multimodality and Data Fusion
Dense Imaging anchored by Sparse LIDAR / InSAR

National Aeronautics and Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

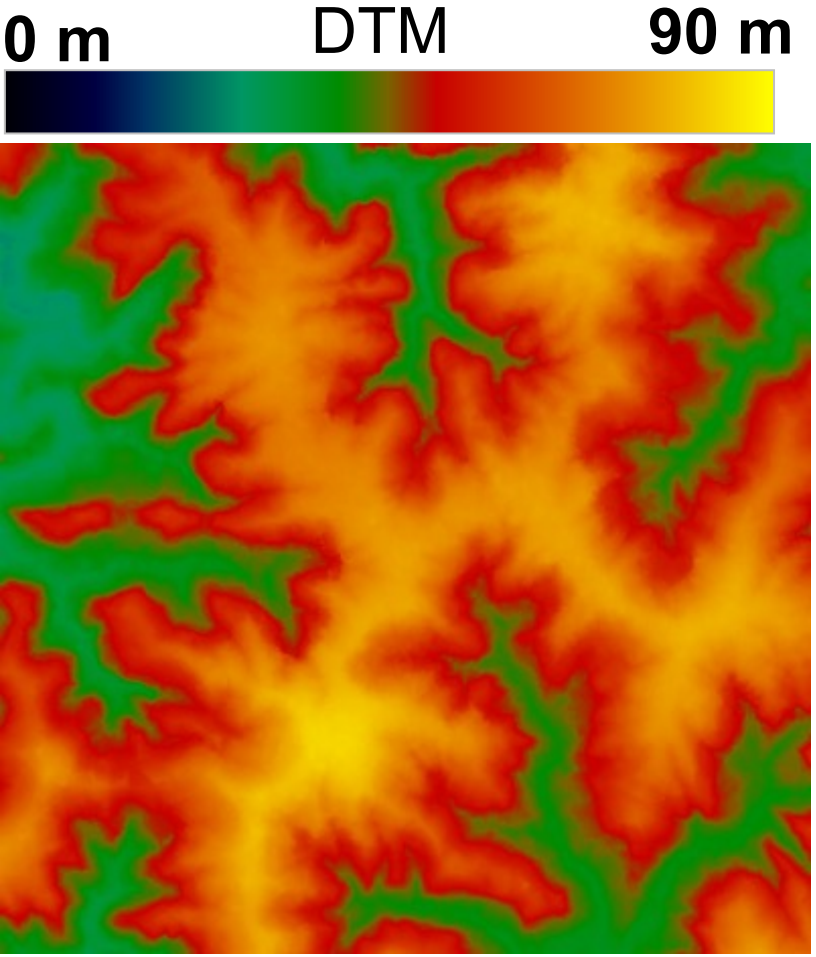


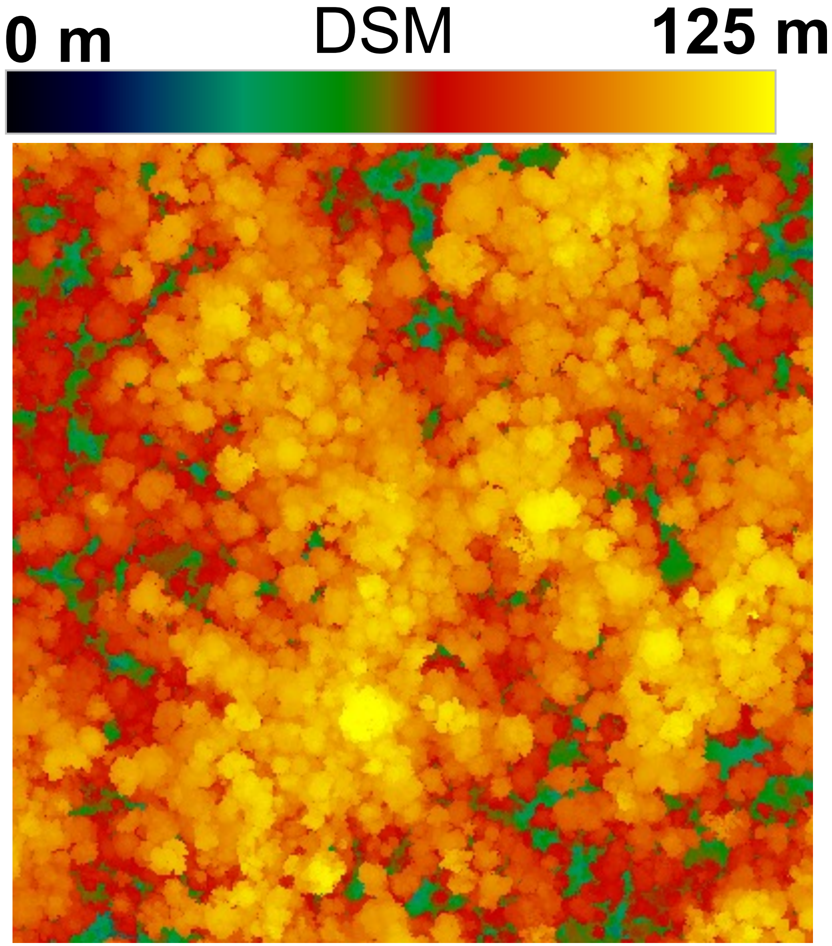
Slides for panel discussion

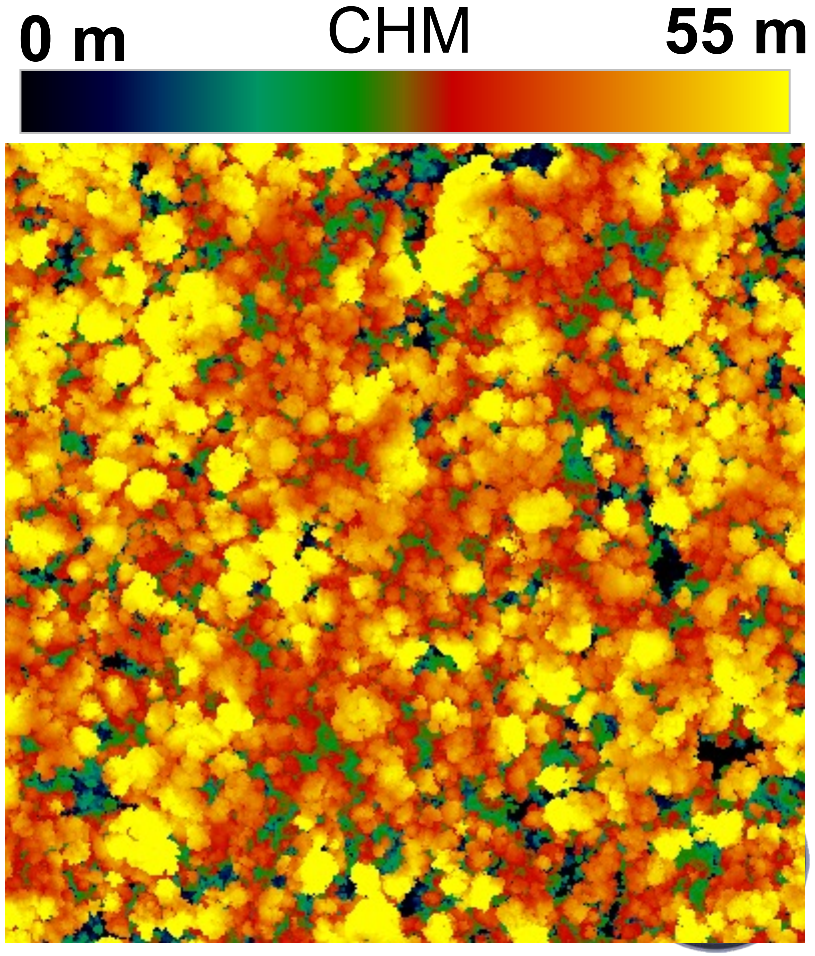
Sassan Saatchi

Separating Vegetation from Ground

Surface topography and vegetation structure are poorly correlated and must be treated as two independent biophysical variables to be retrieved





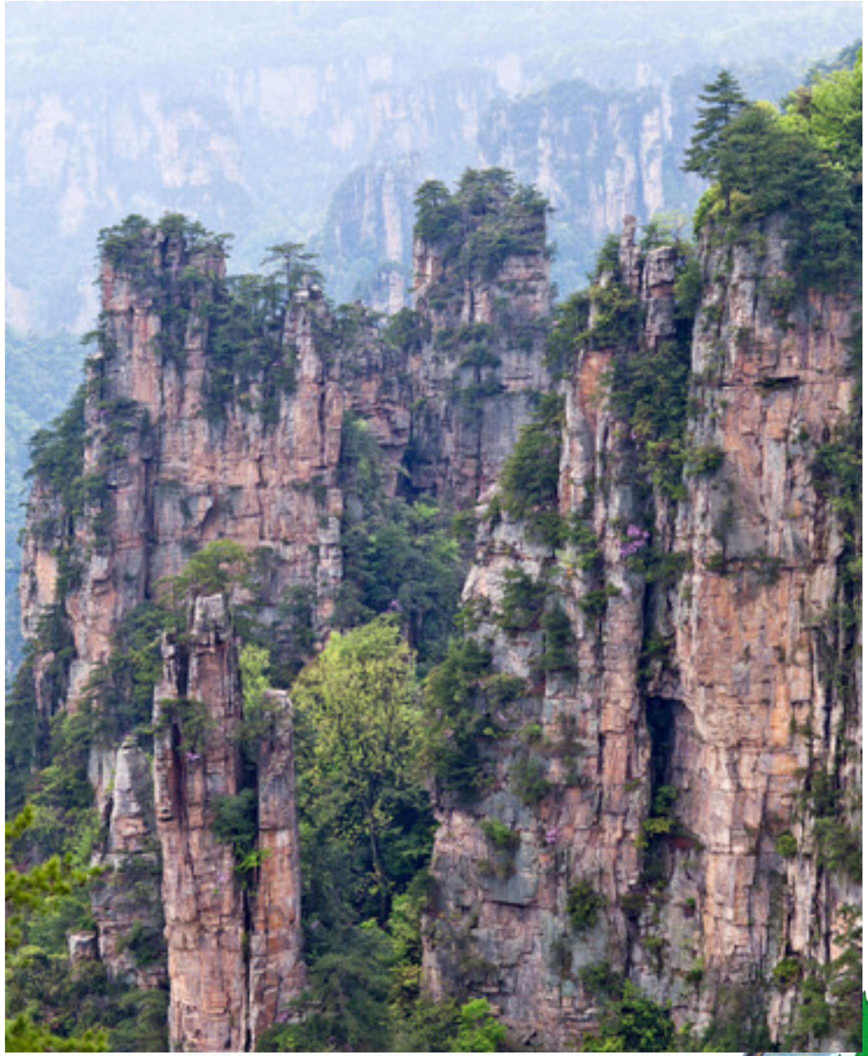


Separating Vegetation from Ground

Can measurements from existing InSAR image technology and lidar point samples solve the problem of separating vegetation from ground globally?

How can data fusion and AI help overcome the complexity of retrieval STV variables from multi-sensor and platform measurements?

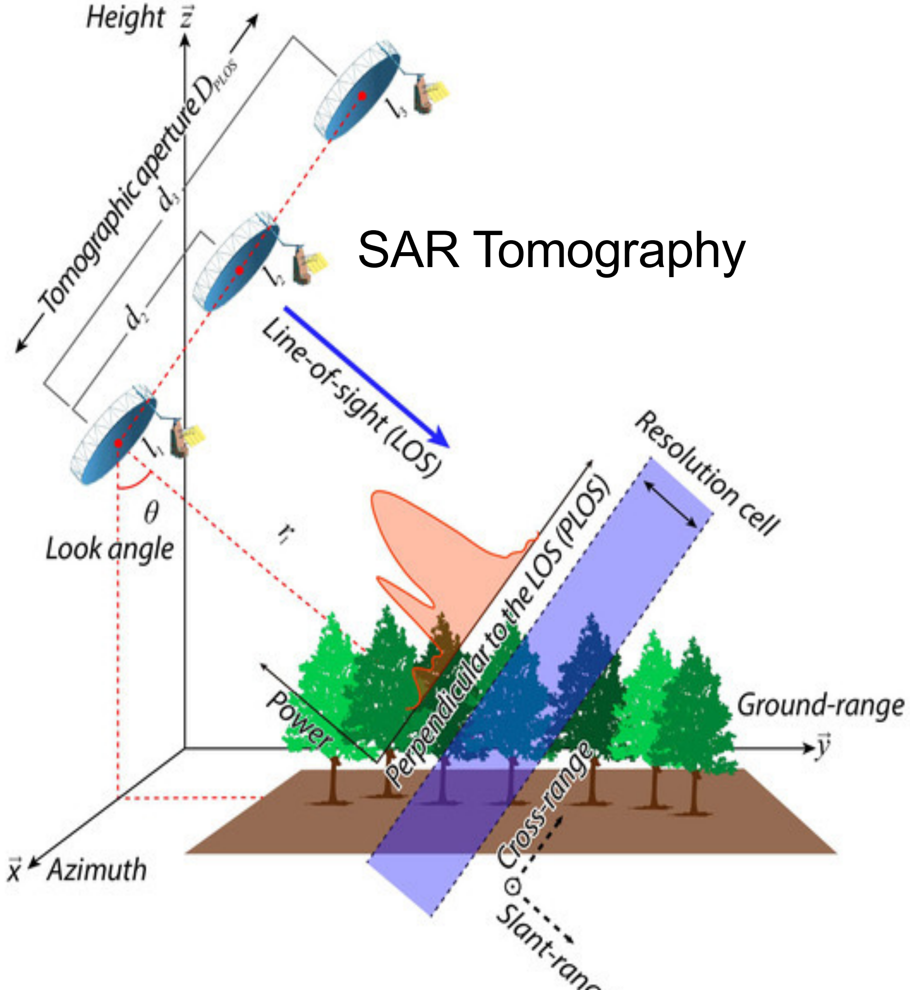
To what extent solutions to mapping the one-time state of the system can be combined with solutions address system dynamics/change?



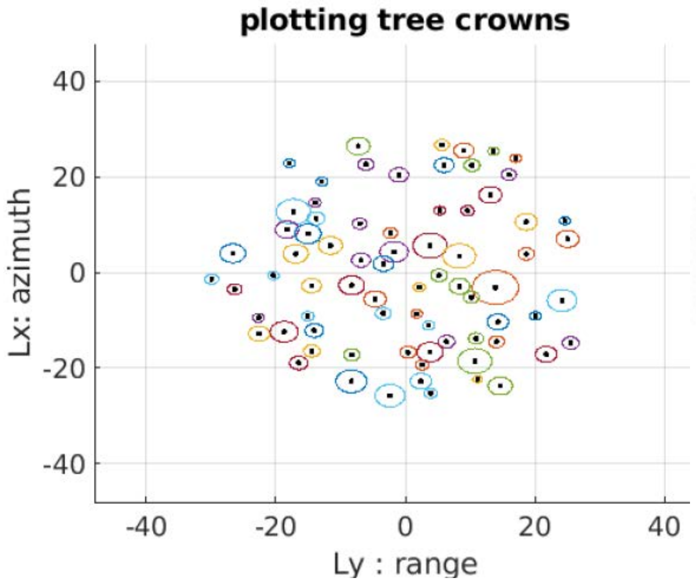
Zhangjiajie National Forest Park, China

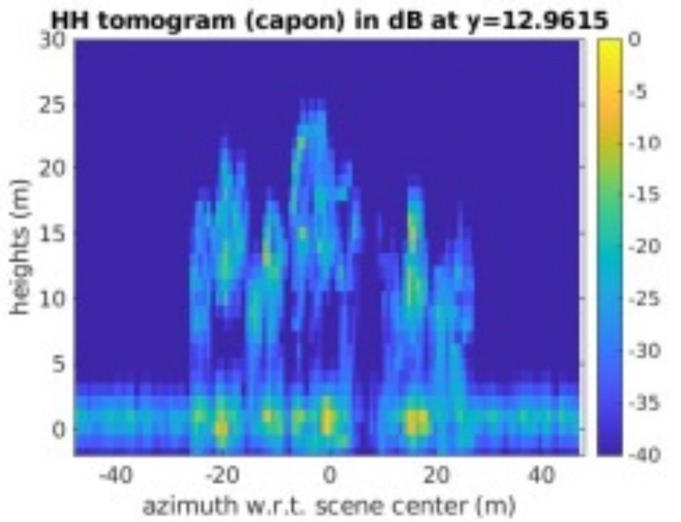
Separating Vegetation from Ground

- L-band and P-band TomoSAR both show strong return from ground depending on vegetation density
- Lidar & TomoSAR data fusion present a reliableSTV solution depending on architecture



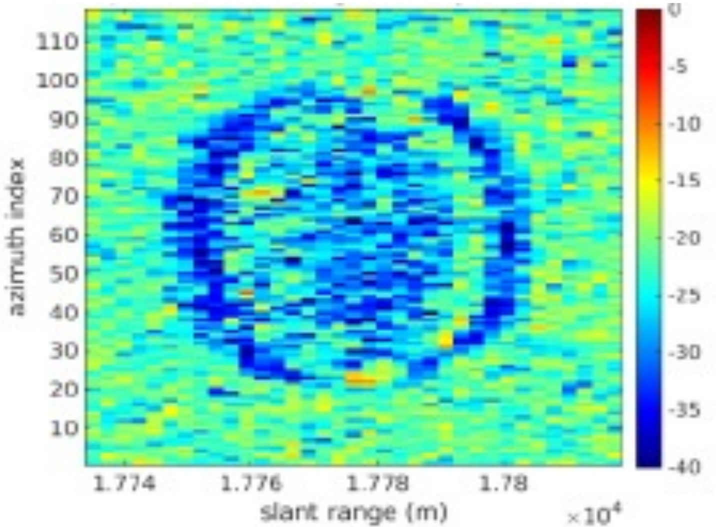
SAR Tomography



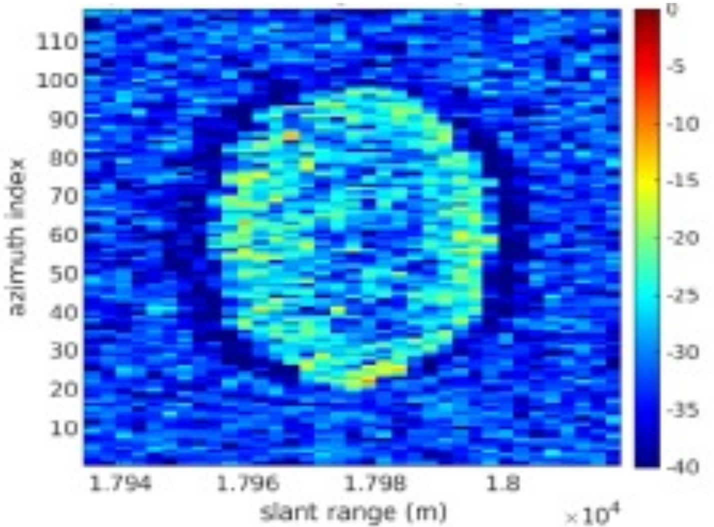


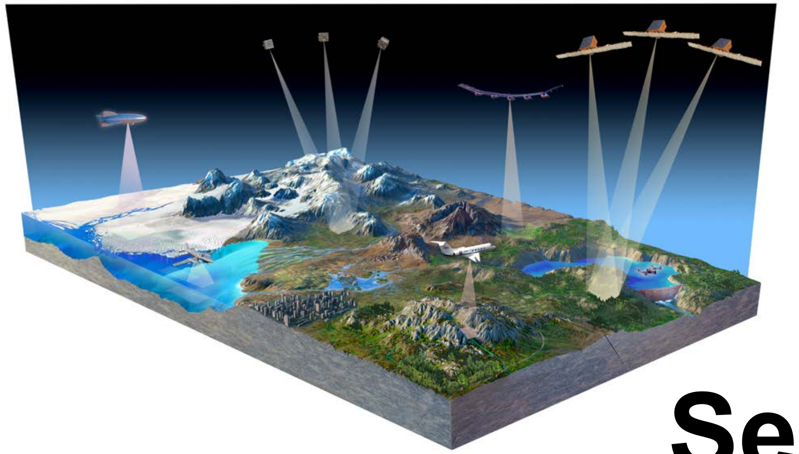
Strength of ground return

L-band



P-band



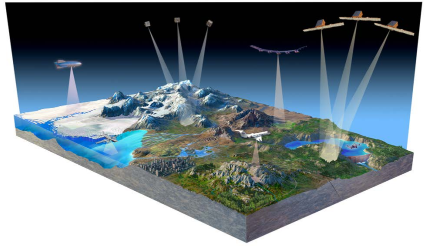


Separating Vegetation From Ground

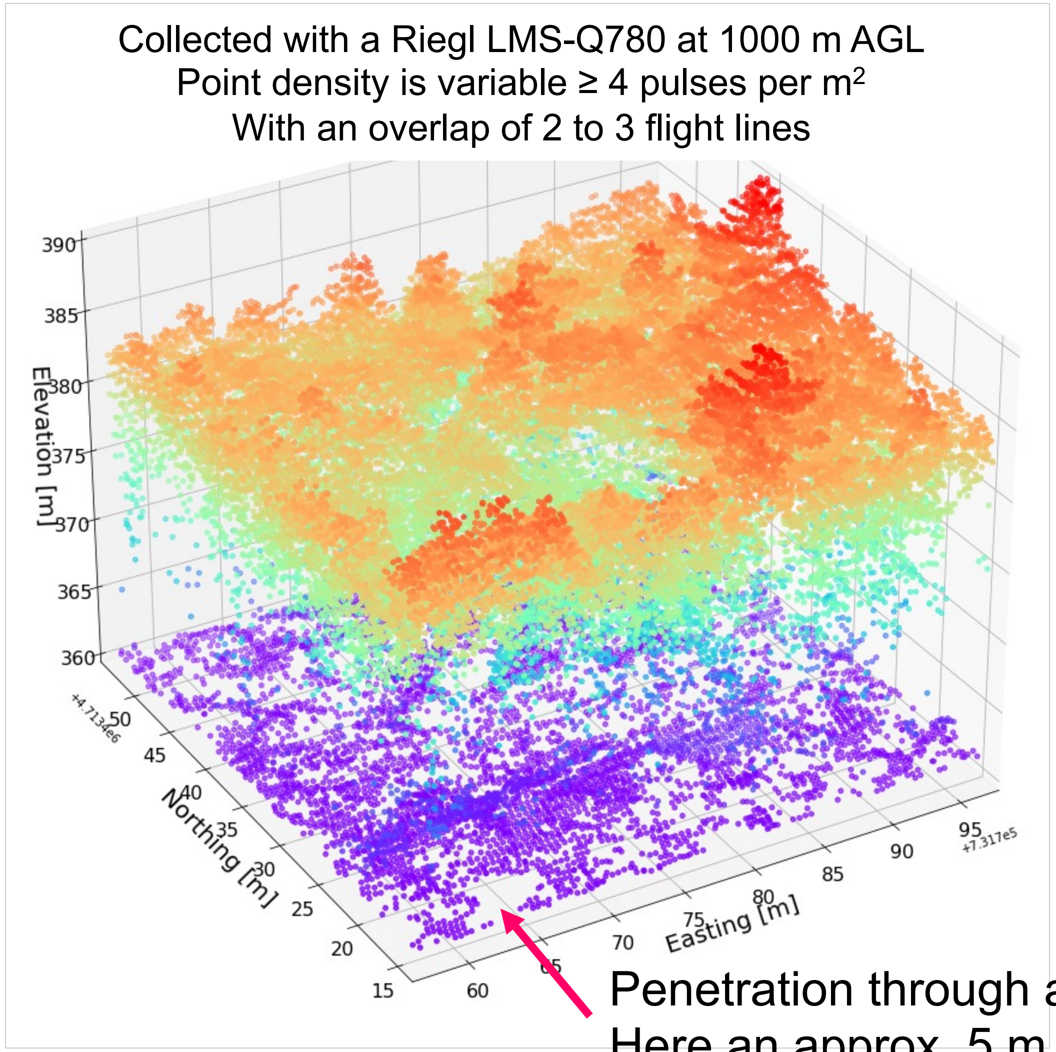
Challenges Using Lidar

Keith Krause

Separating Vegetation From Ground With Lidar



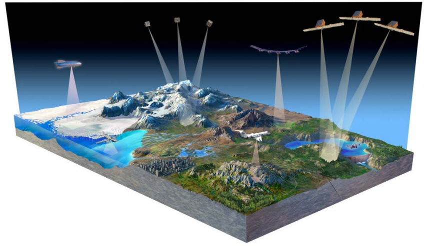
NEON AOP 2022 Discrete Return Point Cloud

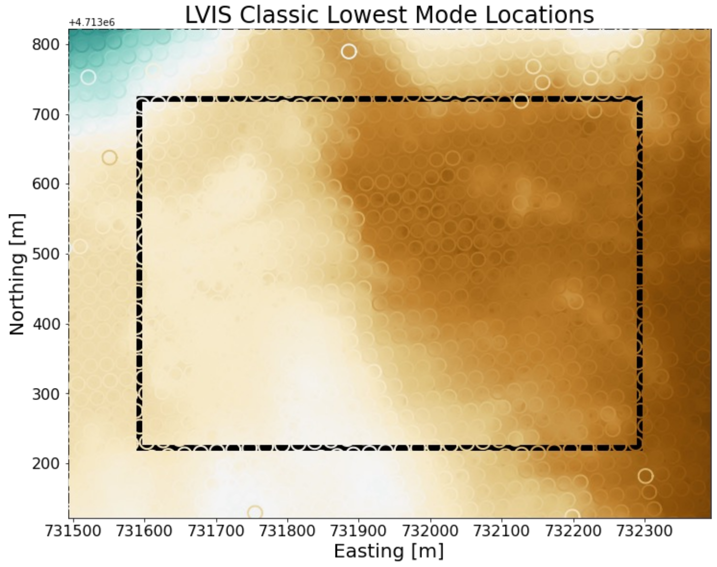


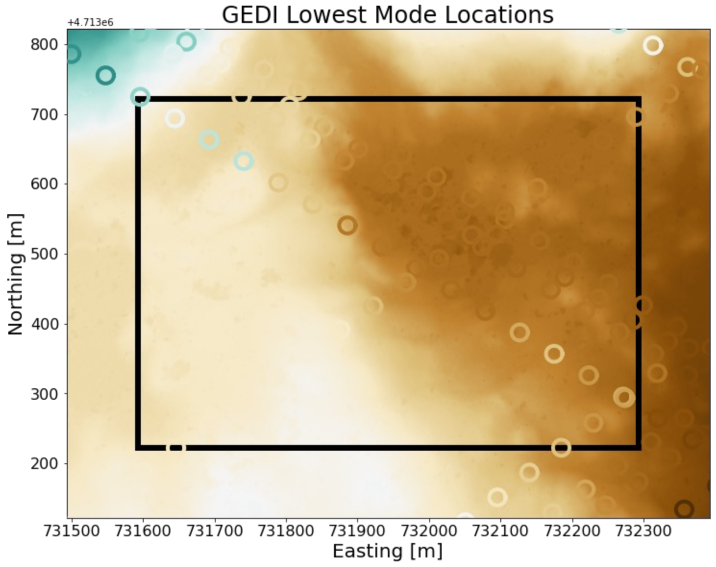
- In order to generate accurate high spatial resolution terrain models beneath vegetation, improvements may be needed:
  - Instrument and collection specifications
  - Algorithms for ground detection
  - Interpolation of terrain models

Penetration through a thick canopy to the ground is an issue.
Here an approx. 5 m x 5m gap exists without any ground returns.

Visual Comparisons of Ground Products From Existing Lidar Instruments: Harvard Forest, MA







- LVIS: L2, lowest detected mode
- GEDI: L2A, power and coverage beams, lowest mode
- ICESat-2: ATL08, strong beams, best fit terrain
- GEDI and ICESat-2 have both leaf-on and leaf-off tracks
- Quality flags have NOT been used to filter bad points
- The background is the 2022 NEON AOP DTM