Global Ecosystem Dynamics Investigation

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GEDI Science Team

Outline

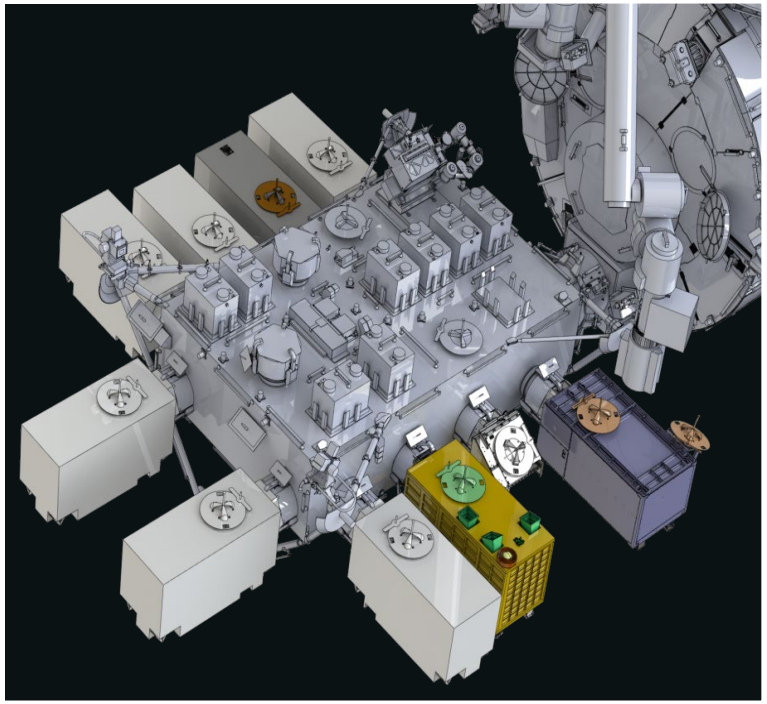
- Science Goals and Objectives
- Mission and Instrument Details
- Science Approach and Data Products
- Example Data

Important Facts About GEDI

- Operational as of 25 March 2019 on the ISS
- Nominal on-orbit mission length of two years (April 2021)
- First data delivered to DAAC 25 September 2019
- Uses a lidar instrument optimized for vegetation measurements
- 3 lasers with full waveform measurements in the NIR
- 8 tracks of data with 25 m footprints, ~500 m between tracks
- GEDI is a sampling mission but produces gridded data products as well
- 10 billion canopy structure measurements
- GEDI is a science investigation with specific goals

GEDI: NASA Earth Ventures Instrument (EVI)

High Resolution Laser Ranging of the Earth's Forests and Topography

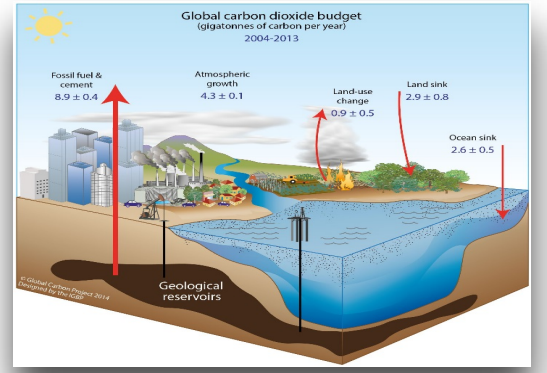


- Selected in 2014 for $94 M
  - Mission is led by University of Maryland
- Multi-beam waveform lidar instrument
  - NASA Goddard Spaceflight Center (GSFC)
- Deployed on International Space Station
  - Launch on SpaceX-16 in December 2018
  - Fully commissioned on 1 April 2019
- Nominal 2 year mission length
  - Potential for longer on-orbit deployment

GEDI is deployed on the JEM-EF

Science Questions and Objectives

GEDI Goal: Advance our ability to characterize the effects of changing climate and land use on ecosystem structure and dynamics



Carbon Cycle

Biodiversity

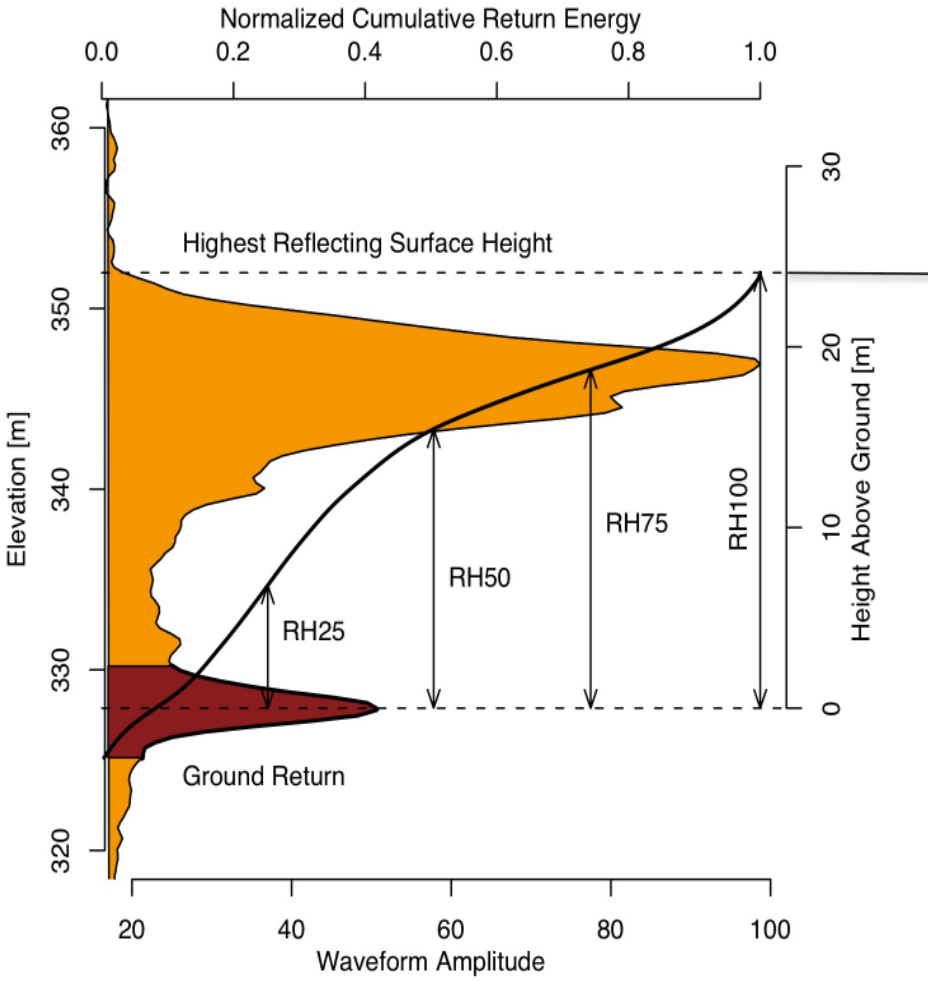
Question	Quantify
What is the carbon balance of the Earth's forests?	Forest Biomass; Disturbance and Recovery
How will the land surface mitigate atmospheric CO2 in the future?	Carbon Sequestration Potential
How does forest structure affect habitat quality and biodiversity?	Vertical Forest Structure and its Relationship to Biodiversity

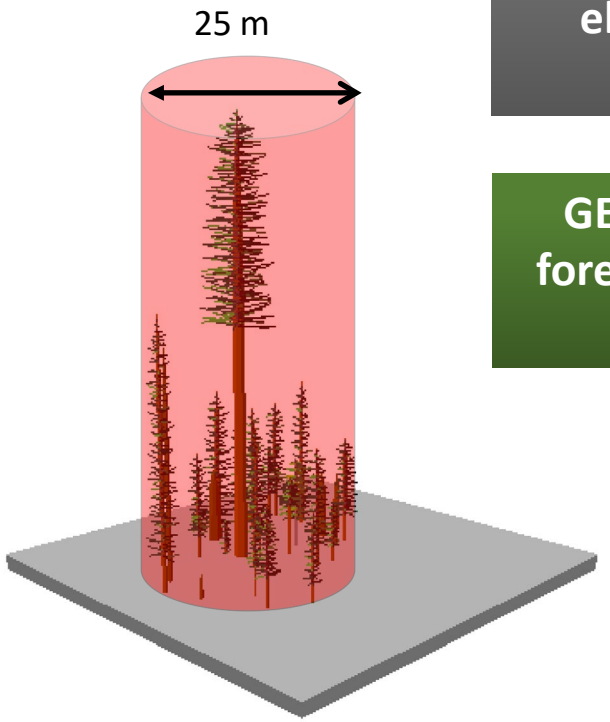
Science Applications

Geodetic-class laser ranging measurements have far reaching applications

Forest height and vertical structure; habitat quality & biodiversity; Forest carbon sinks & source areas; loss of carbon from extreme events such as fires and hurricanes; parameterization of ecosystem models	Forest Management & Carbon Cycling
Canopy 3D structure that influences snowmelt, evapotranspiration, canopy interception of precipitation. Glacier surface elevation change; lake & river stage; snowpack elevation; coastal tides.	Water Resources
Improved canopy aerodynamic profiles to parameterize weather prediction models. Canopy and biomass products that initialize and constrain climate models; impacts of land use change on climate	Weather Prediction
Accurate bare earth and under canopy topographic elevations for improved digital elevation models from radar. Calibration of satellite based observations of surface deformation and earthquakes	Topography & Surface Deformation

GEDI Lidar Measurements

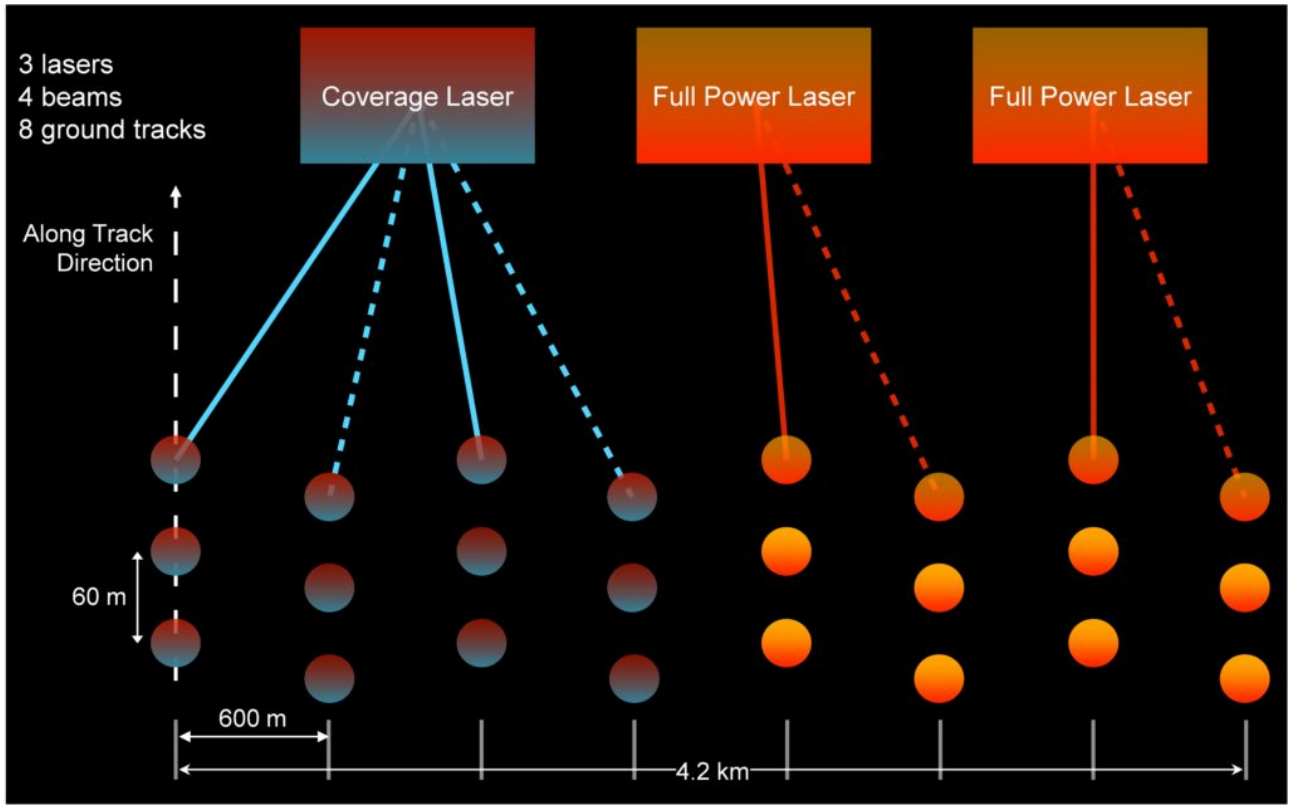




GEDI's sole observable is the lidar waveform which provides ground elevation, canopy height, cover and various profiles and metrics.

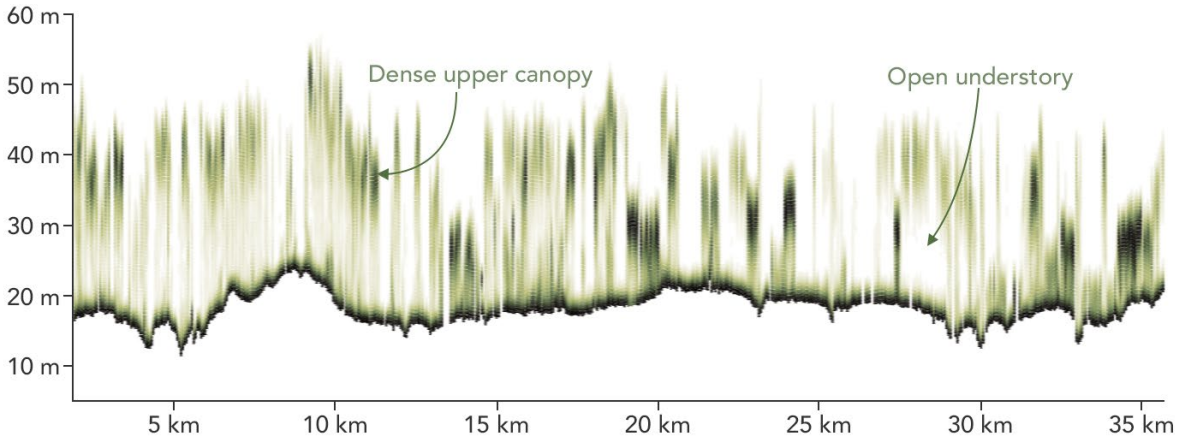
GEDI makes 10 billion observations of forest and land surface structure over its nominal two-year mission

GEDI Observations



GEDI uses 3 lasers to produce 8 transects of lidar waveforms.

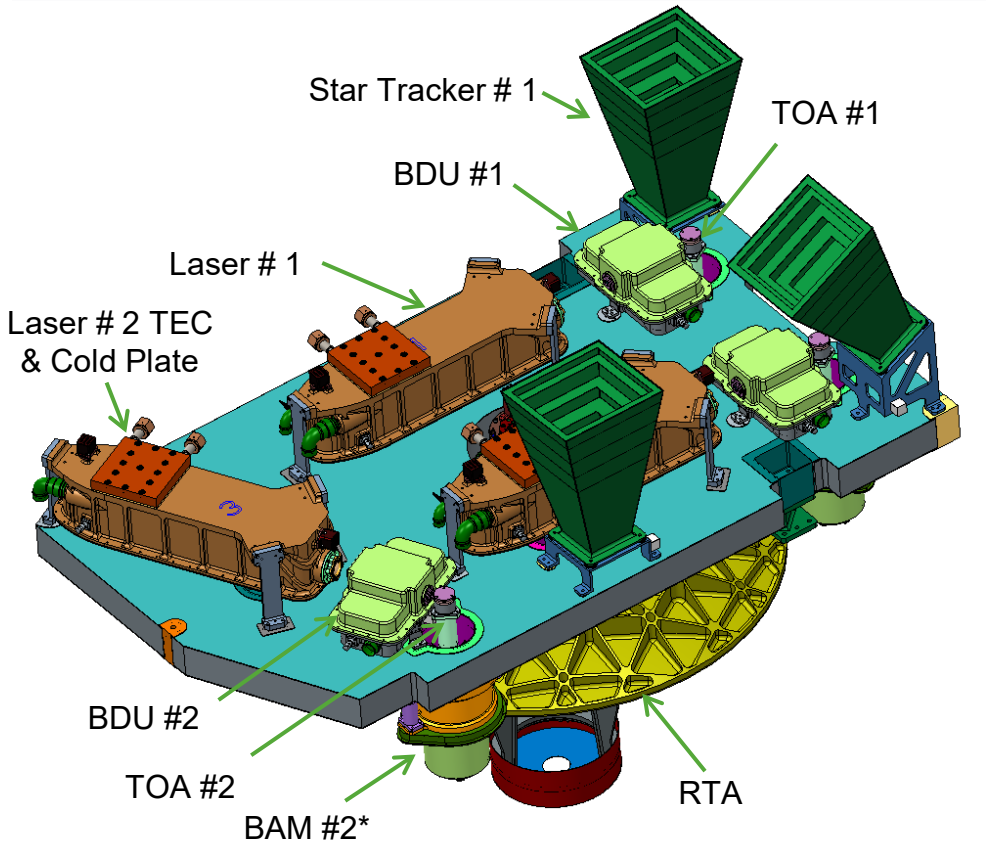
Each footprint provides the complete vertical structure of the canopy.

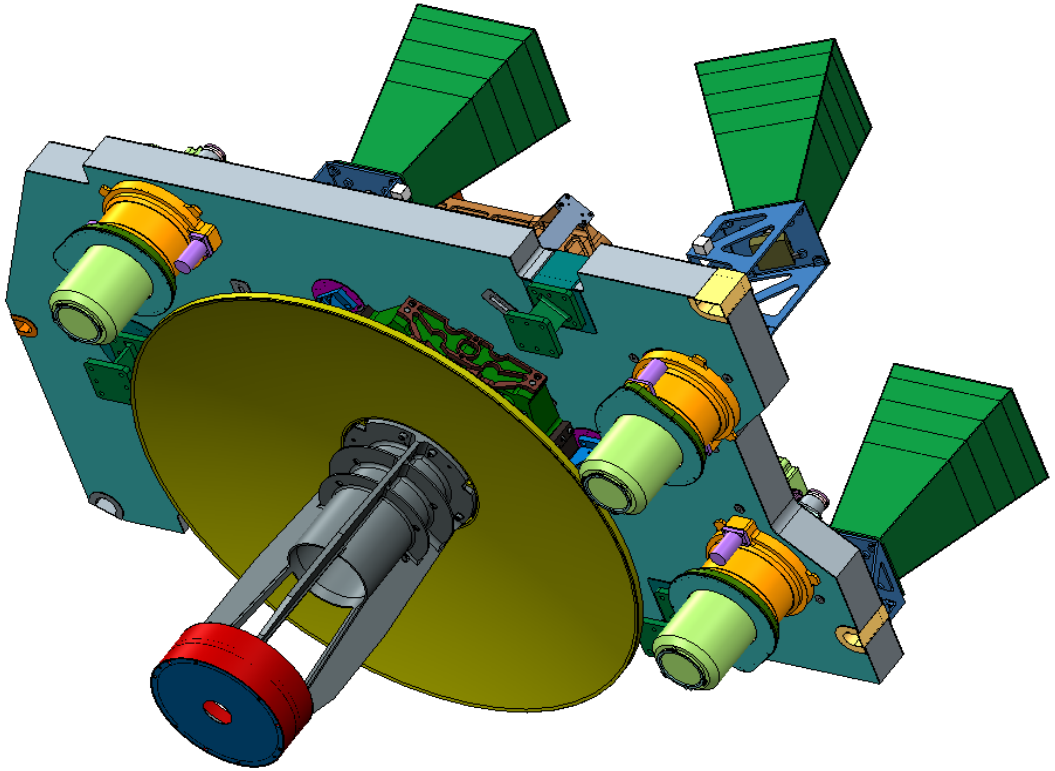


GEDI Observations

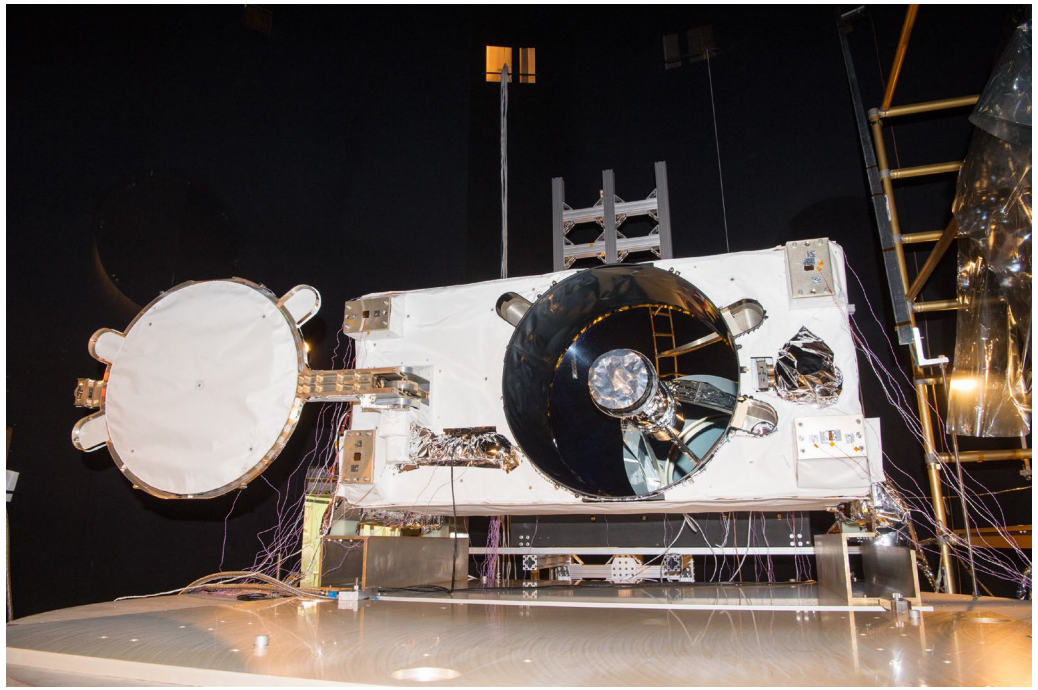
Conceptual
Image Lab
NASA/GSFC

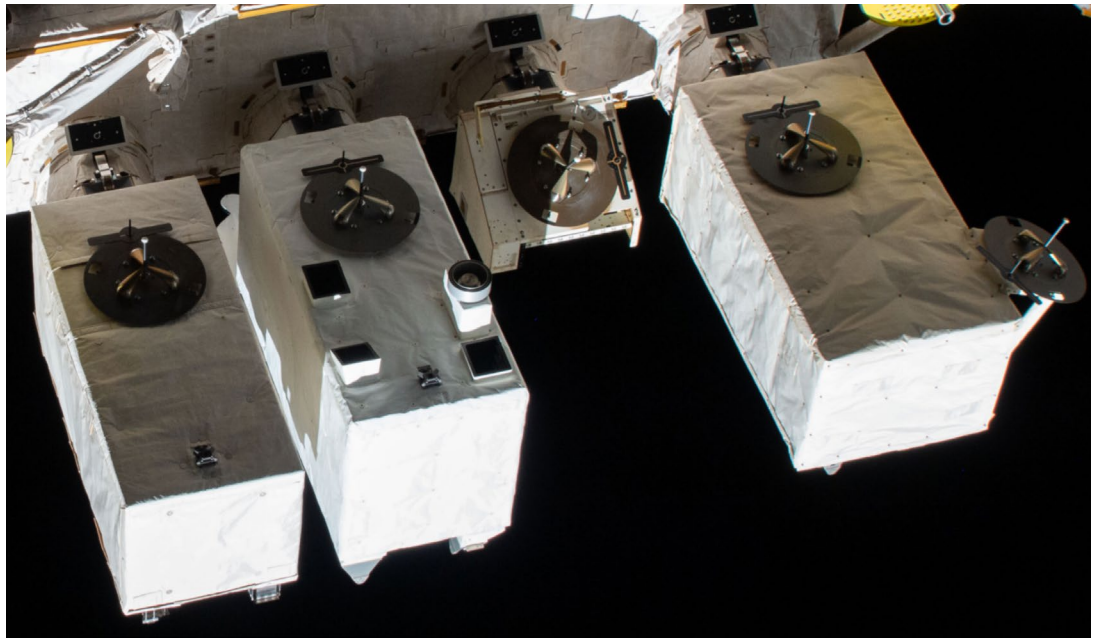
GEDI Lidar Instrument





GEDI Instrument



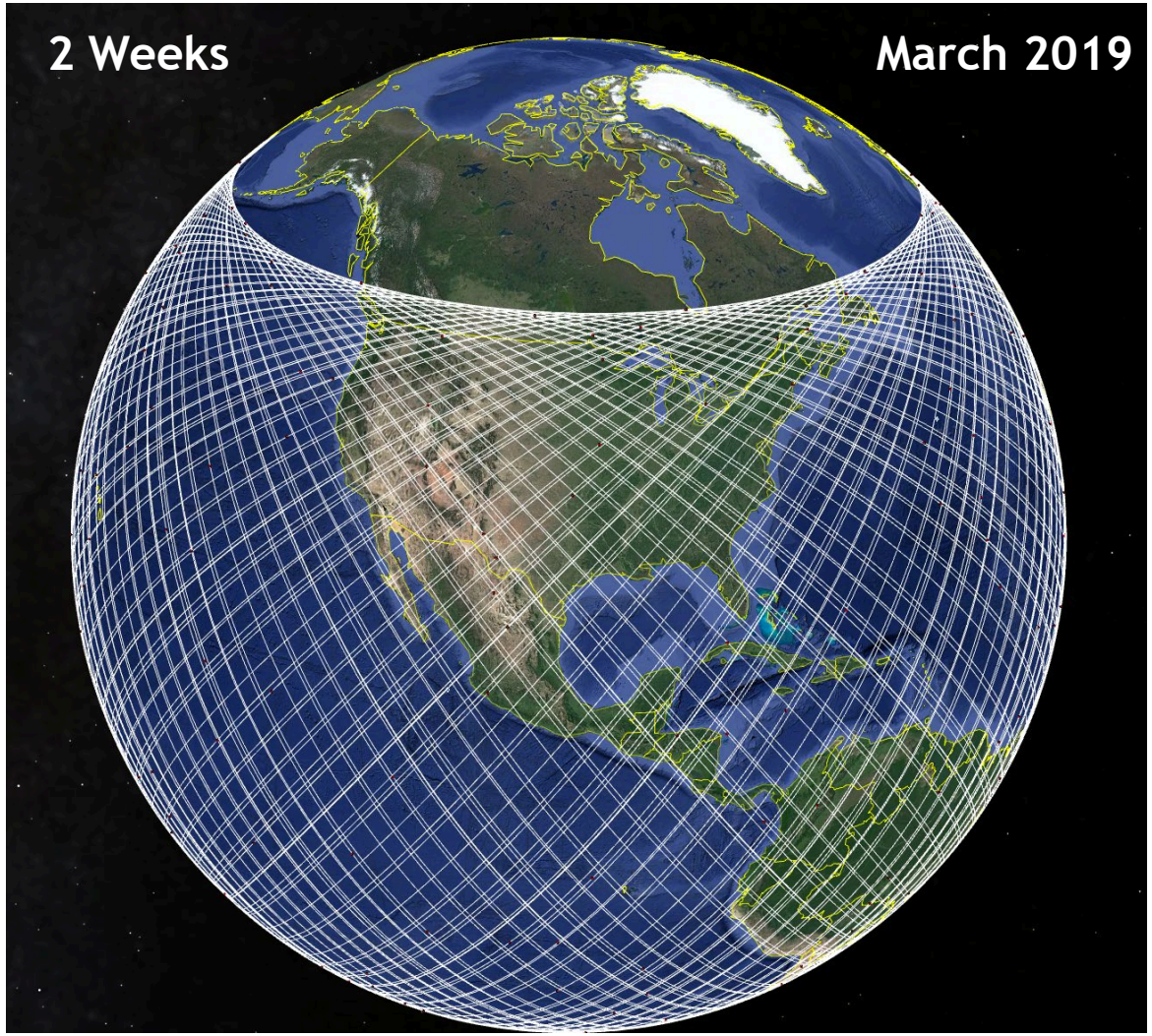


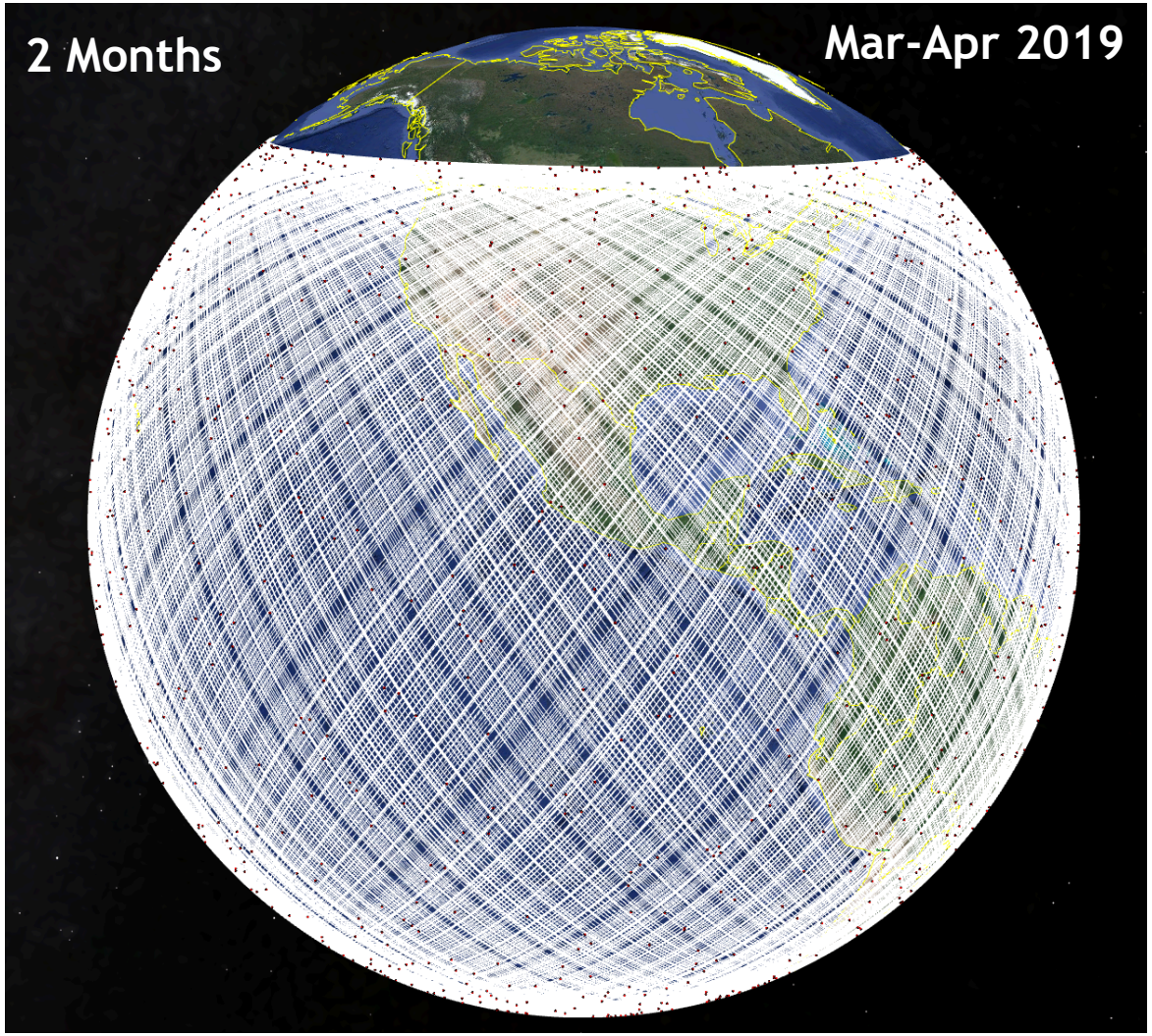
Current Mission Status and Data Products

- Currently in Phase E
- GEDI is operational and collecting data as planned along Reference Ground Tracks (RGTs)
  - Each week science planning team chooses an RGT for each orbit (by pointing across track)
- First data delivery to DAACs by 25 September 2019
- LVIS (airborne GEDI simulator) cal/val campaign scheduled for this summer

Product	Description
Level 1	Geolocated Waveforms
Level 2	Canopy Height/Profile Metrics • RH metrics • Canopy top height • Ground elevation • Canopy cover and cover profile • LAI and LAI profile
Level 3	Gridded Footprint Metrics
Level 4	Biomass
Level 4	Demonstrative Products • Ecosystem model outputs • Enhanced height/biomass using fusion with Tandem X & Landsat • Habitat model outputs

GEDI Orbital Coverage

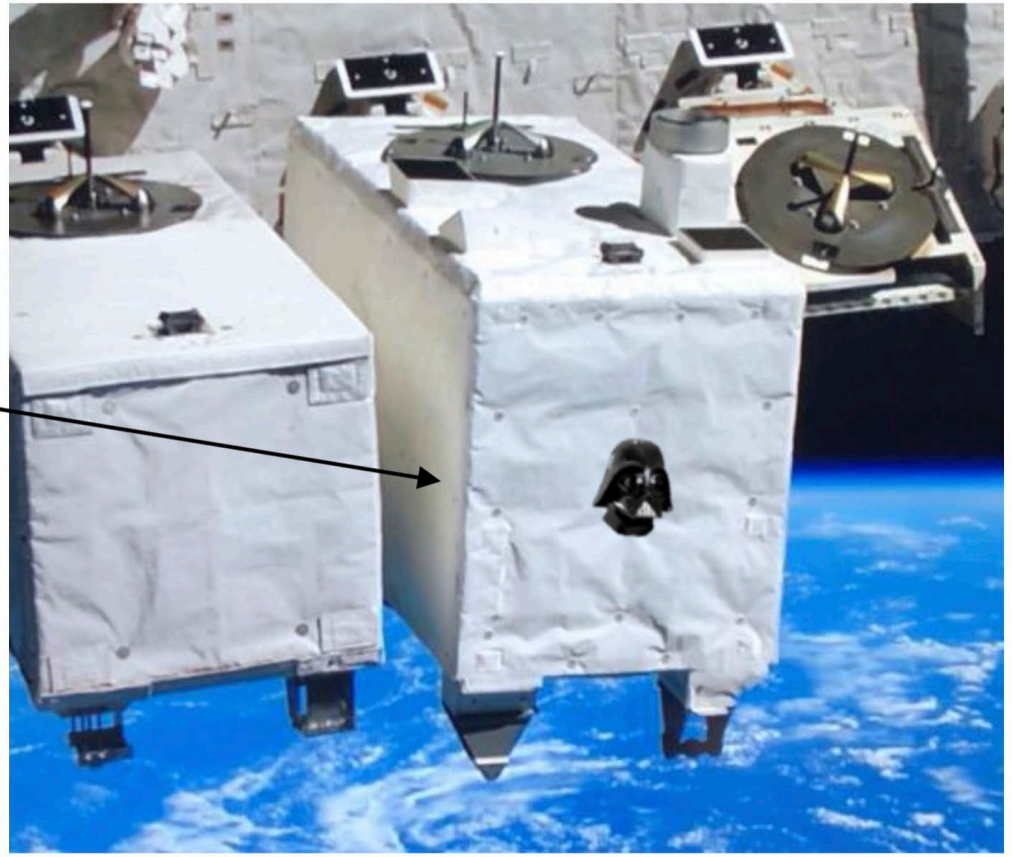




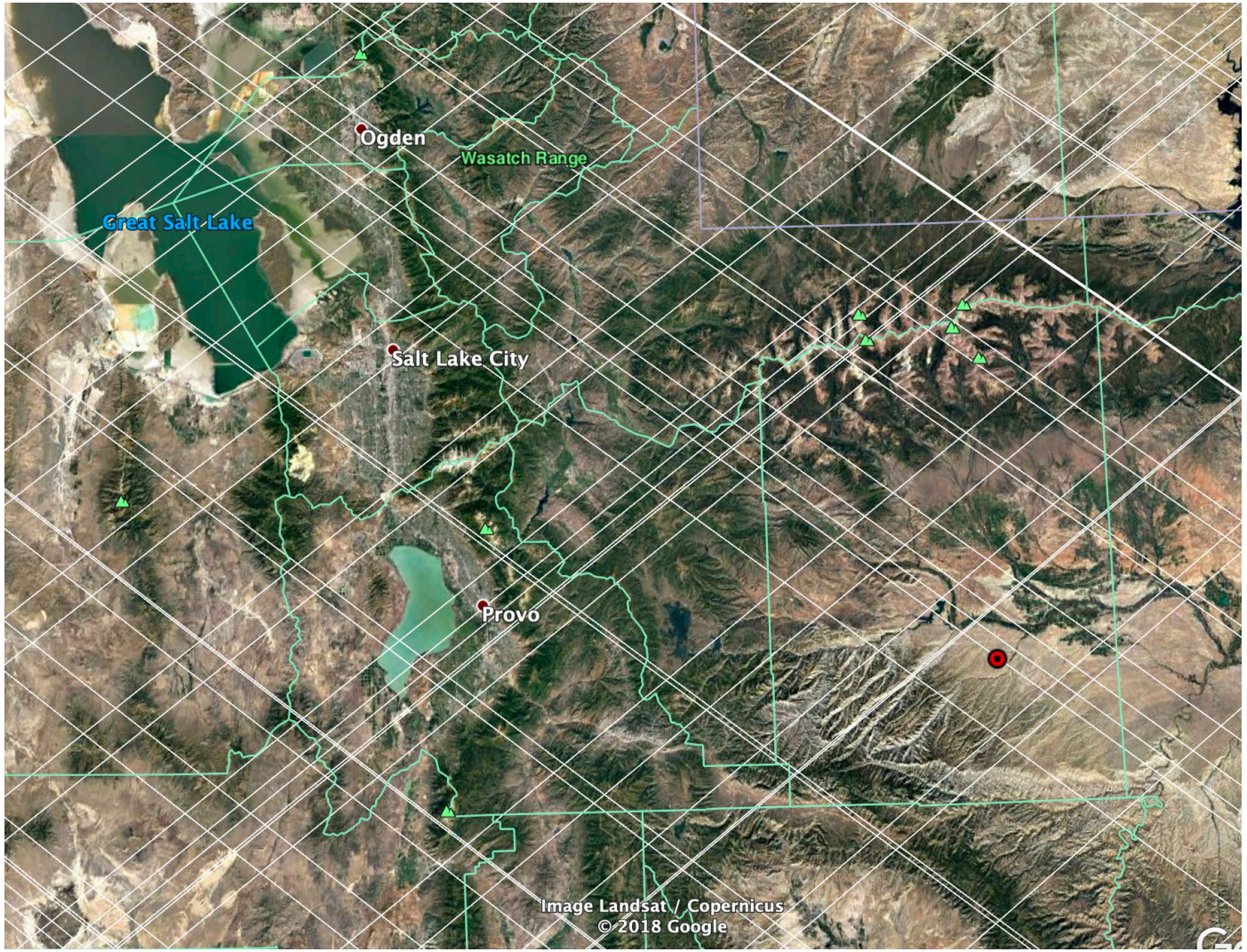
GEDI Pointing

GEDI rotated at maximum +/-5.6 degrees

- Each week GEDI Science Team picks most appropriate set of ground tracks available through pointing.
- Target specific locations currently to < 35 m



Detail Orbital Coverage: Utah (April 2019)



Each line is one ascending or descending orbital path

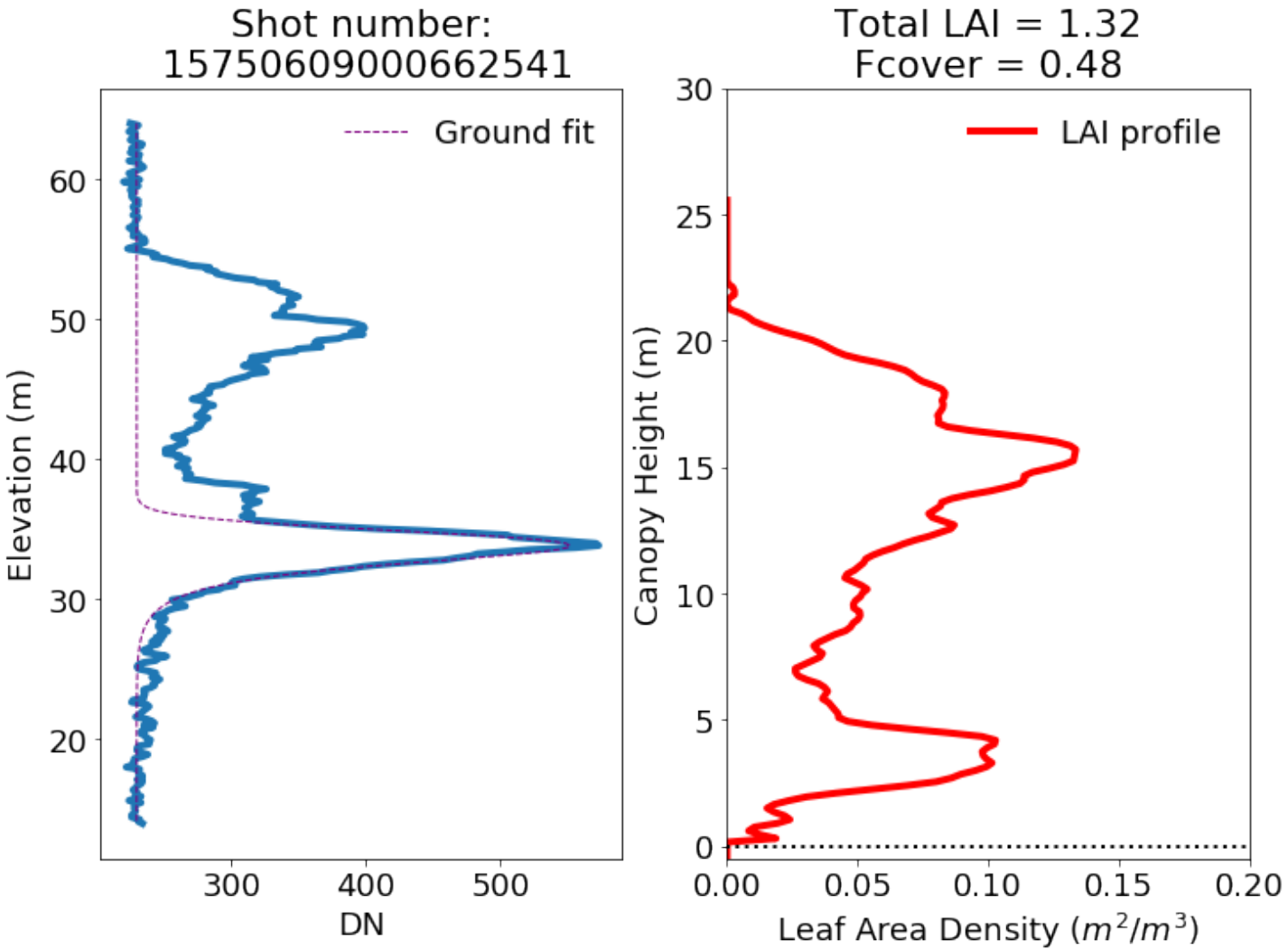
8 laser tracks are centered on each orbital line (these are not shown)

Note not-regular repeat pattern. GEDI pointing can fill in large gaps

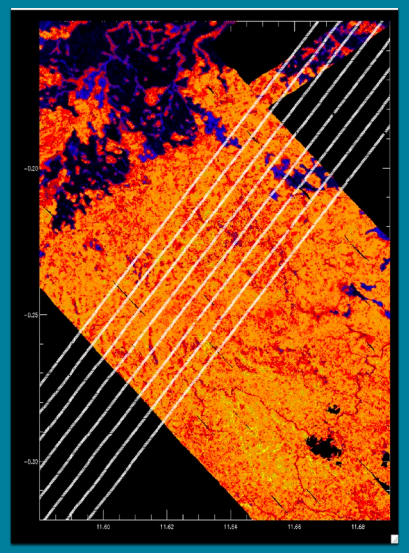
Final coverage will have ~ 20x frequency of orbital lines shown (and each line has 8 tracks)

Provide ample data for county-based FIA-type assessments, and for fusion and fine spatial resolution.

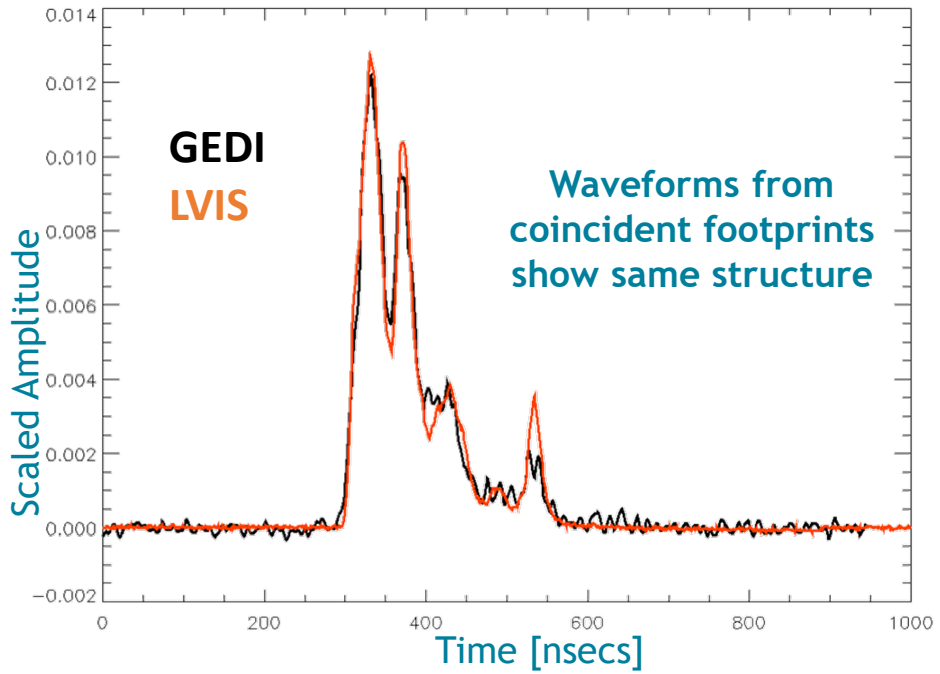
Example Footprint Data

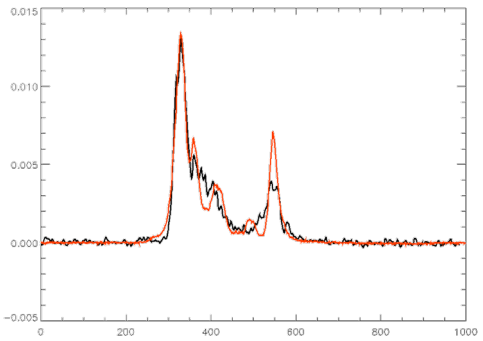


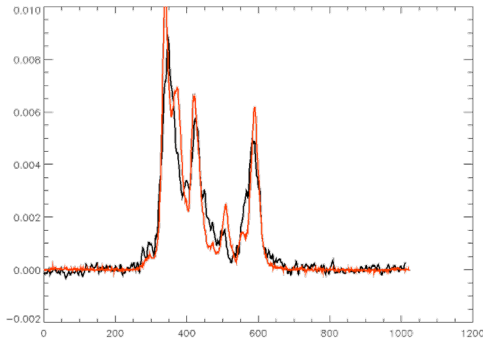
Early Validation of GEDI Waveforms in Gabon

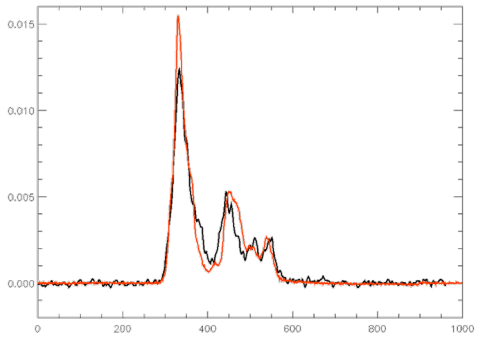


8 GEDI tracks crossing LVIS data image in Gabon









- GEDI waveforms capture complex vertical forest structure in closed canopies and show excellent agreement with LVIS, confirming expected instrument performance
- LVIS airborne lidar data acquired during the AfriSAR campaign are used to validate GEDI
- Gabon has some of of the most difficult forests to measure because of high canopy cover and complexity
- GEDI will conduct many such analyses over different biomes to validate sensor performance and science data products

Summary

- GEDI measurements of ecosystem structure are unique from a space-based platform
  - Provide long-needed observations on canopy height and canopy vertical structure
  - Contemporaneous IceSAT-2 observations provide remarkable opportunity

- GEDI data should provide valuable data for a variety of USFS applications
  - Direct linkage to county-scale biomass estimates from FIA for both calibration and validation
  - Important initialization data for widespread use of prognostic ecosystem and carbon flux models
  - Conservation/biodiversity studies
  - Parameterization of fire models

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