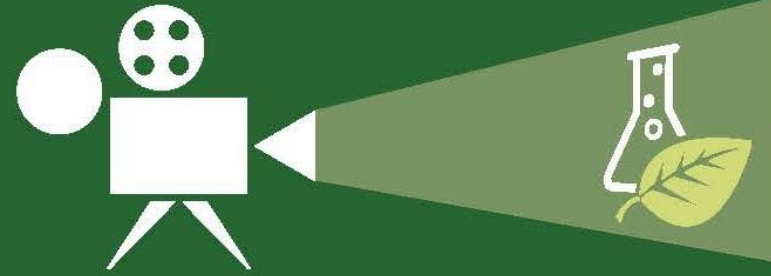




United States Department of Agriculture

Rocky Mountain Research Station
Science You Can Use
Webinars



SPRING 2022 SCHEDULE

*Welcome to the
Science You Can Use
Spring 2022 Webinar Series*

*Presented by:
Rocky Mountain Research Station*

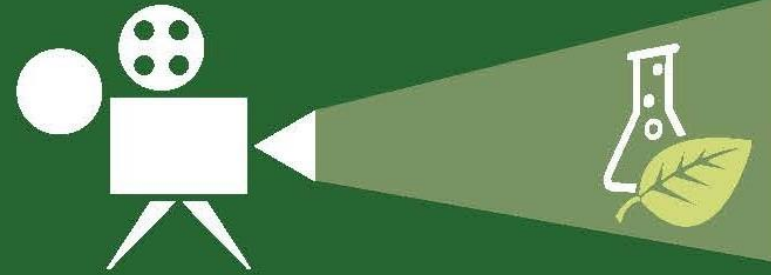
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United States Department of Agriculture

Rocky Mountain Research Station Science You Can Use *Webinars*



SPRING 2022 SCHEDULE

Today's Presentation

The OBIWAN App: Estimating Property-Level Carbon Storage Using NASA's GEDI Lidar

Sean Healey
sean.healey@usda.gov

Zhiqiang Yang
zhiqiang.yang@usda.gov

Forest Inventory and Monitoring

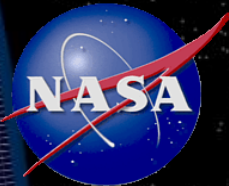
Facilitator: David Wright

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A large satellite with multiple solar panel arrays is shown in orbit against a black background with stars. The satellite has a central white body with various instruments and a large array of solar panels extending outwards.

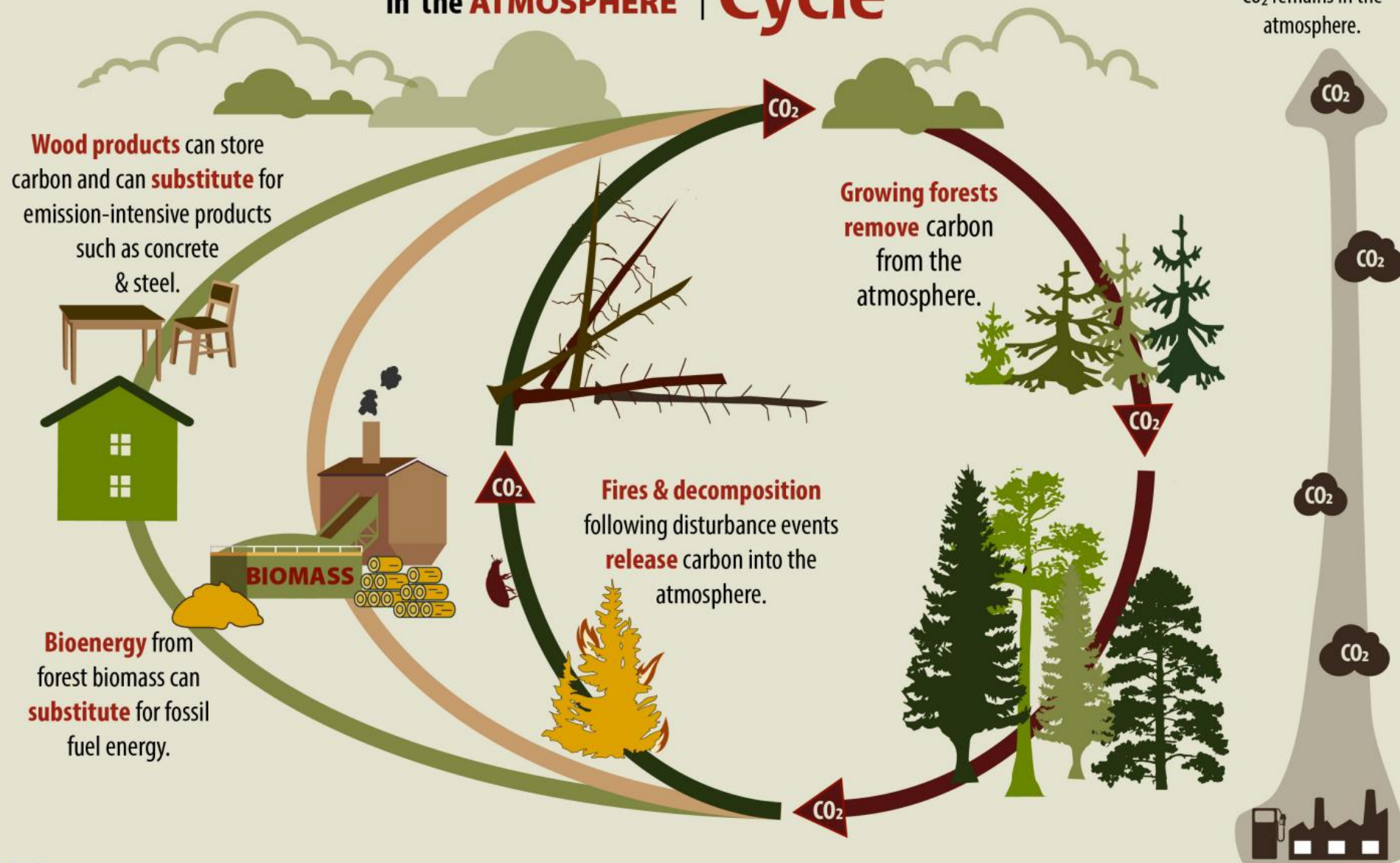
OBIWAN: Estimating Property-Level Carbon Storage Using NASA's GEDI Lidar



Sean Healey, Zhiqiang Yang
USFS Rocky Mountain Research Station

The closed loop of FOREST CARBON in the ATMOSPHERE

Carbon Cycle



Why care about carbon storage at the level of a property?

- Carbon offset markets
- REDD+ accounting
- 2012 Planning Rule requirements for National Forest System

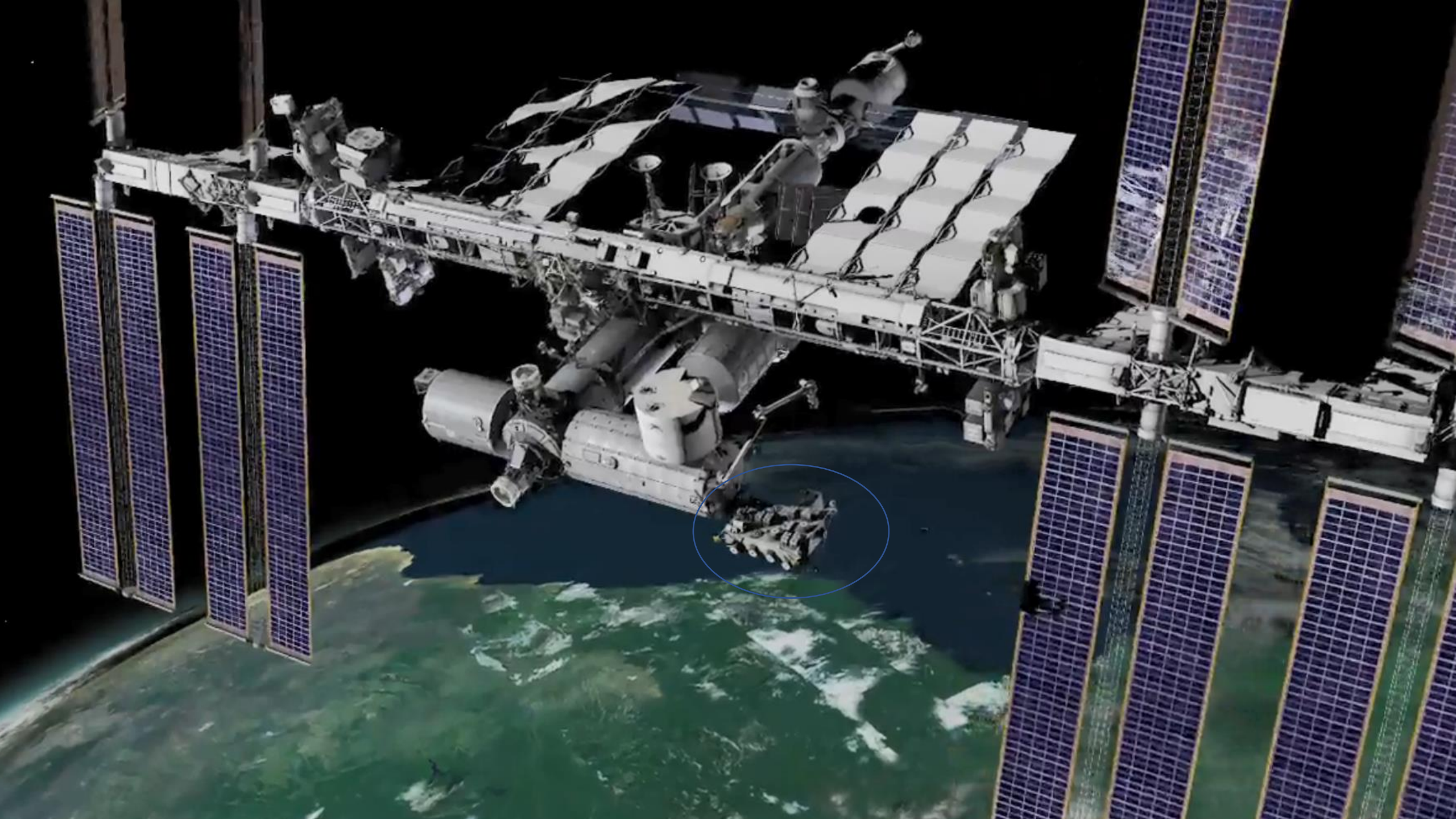


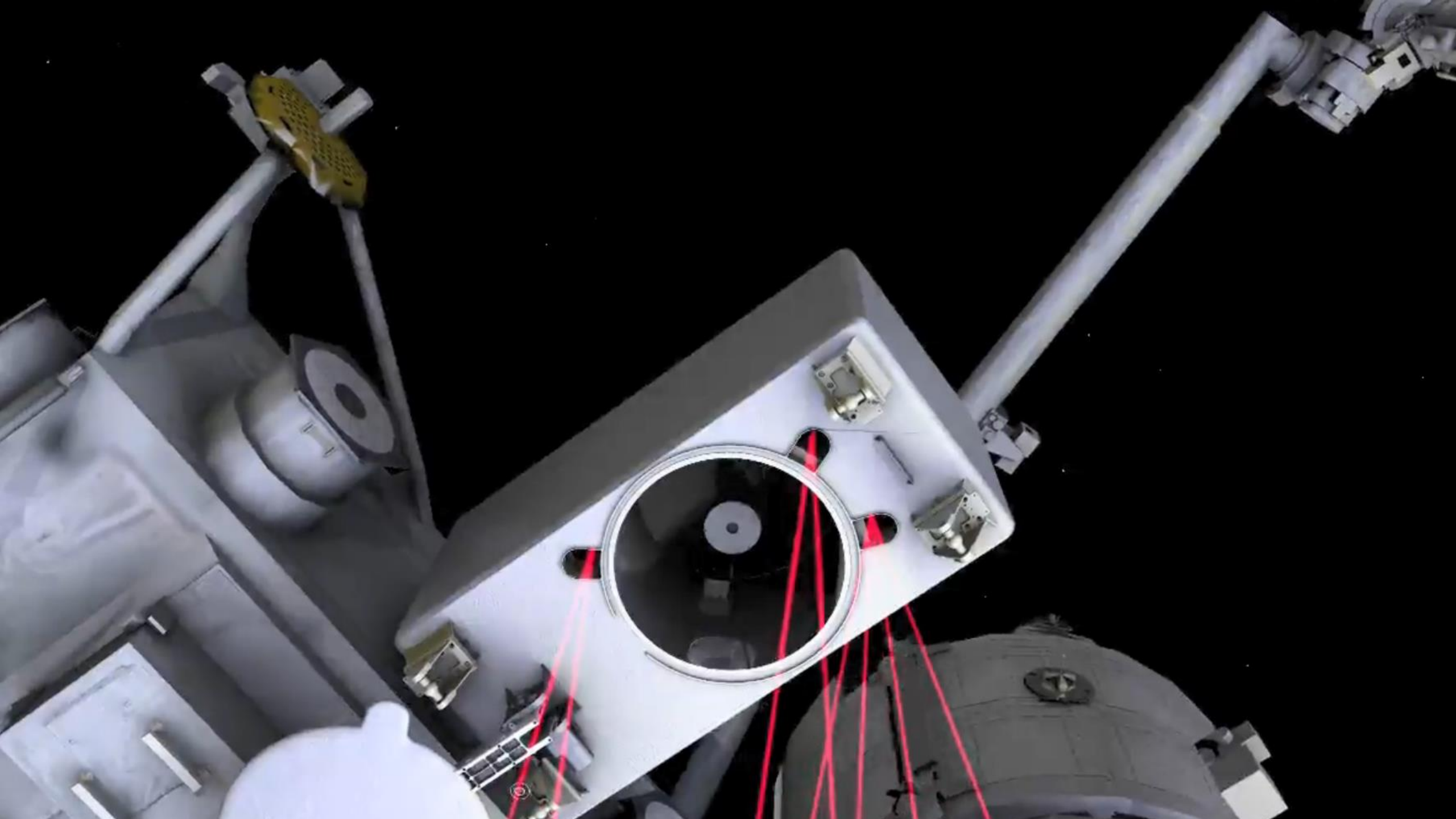
The Global Ecosystem Dynamics Investigation (GEDI)

- Launched in December, 2018
- Operational in April, 2019
- Mounted on the ISS
- NASA Earth Venture Class Mission led by the University of Maryland (PI: Dubayah)

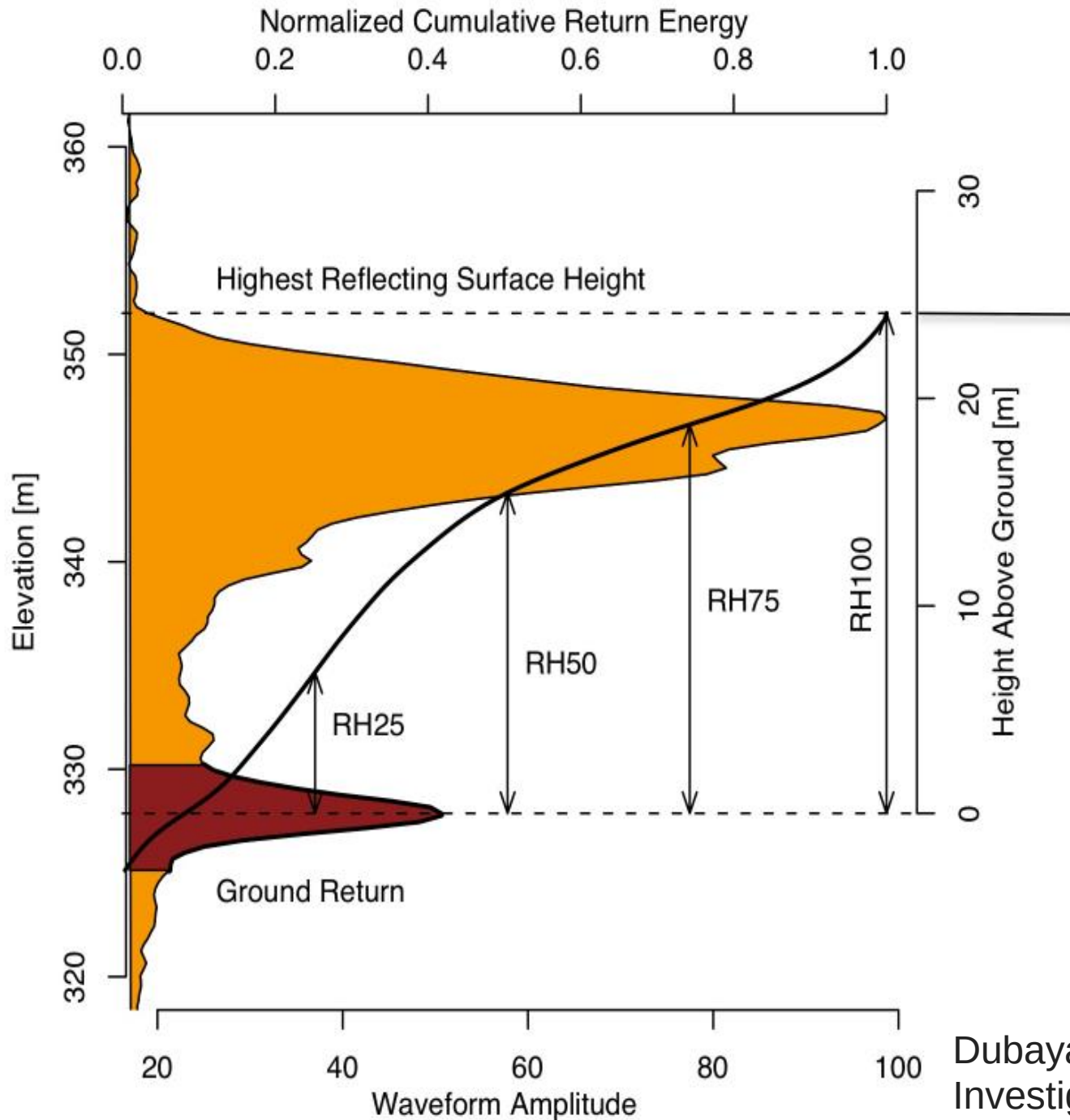
- Nominal 2-year mission life
- Orbit covers 51.6°N to 51.6°S
- 3 lasers providing ~20m waveform lidar returns



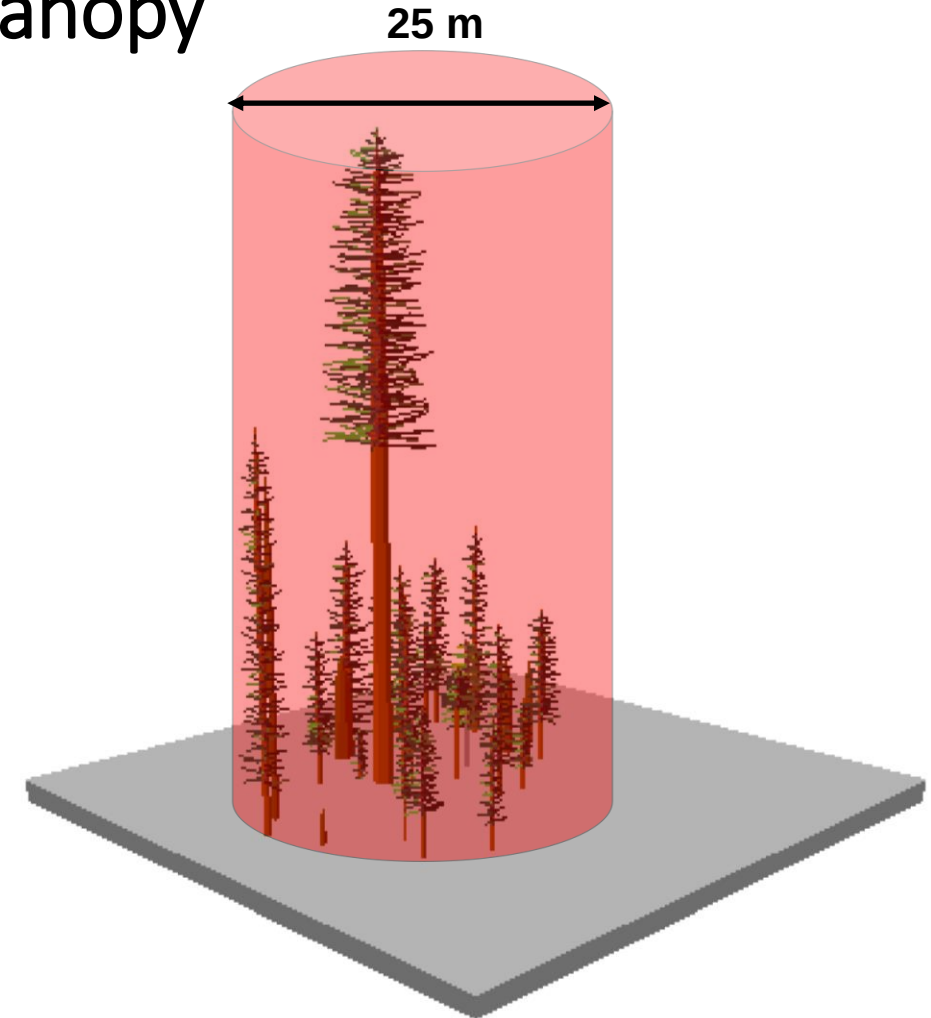






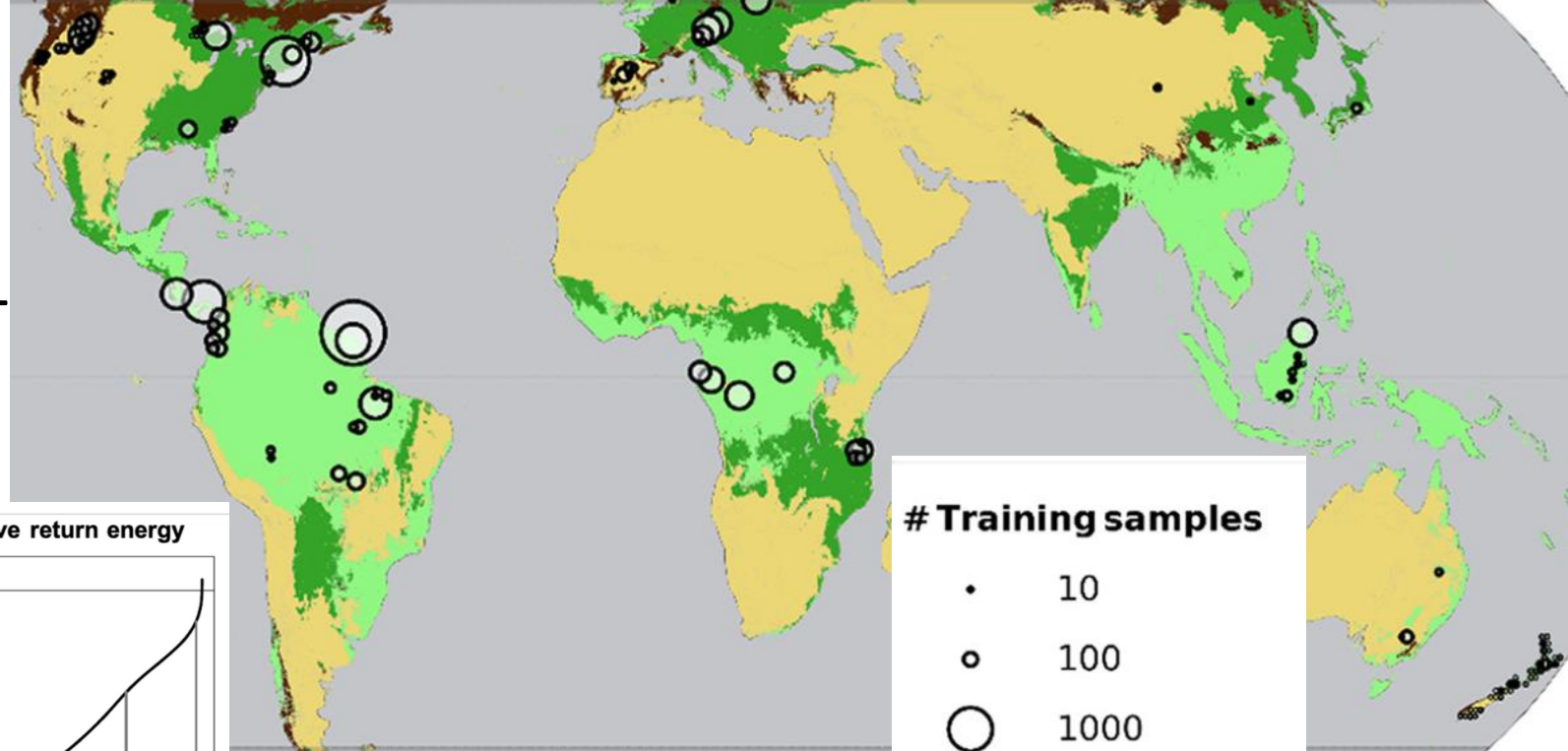
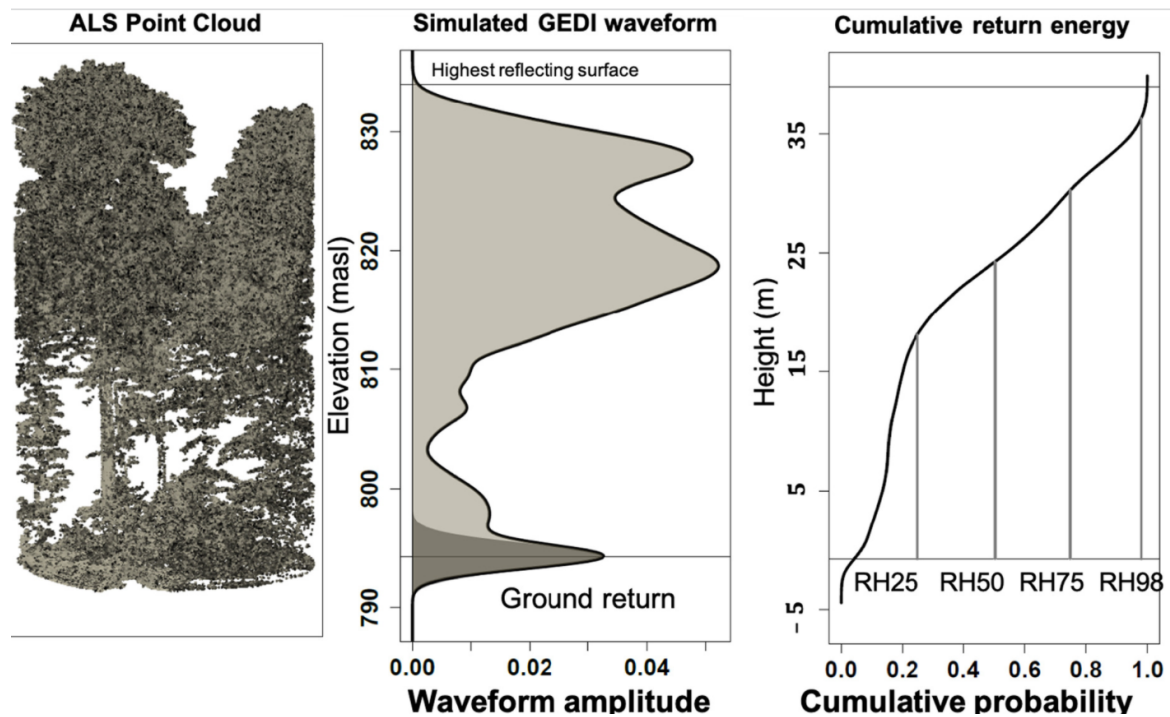


GEDI collects waveforms related to the vertical profile of the canopy

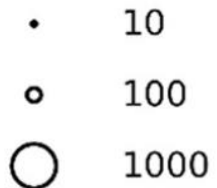


Dubayah et al. 2020. The Global Ecosystem Dynamics Investigation. *Science of Remote Sensing* 1 (2020): 100002.

GEDI's L4a Footprint Biomass Products predicts AGBD from co- located lidar/field data



Training samples



Plant functional type



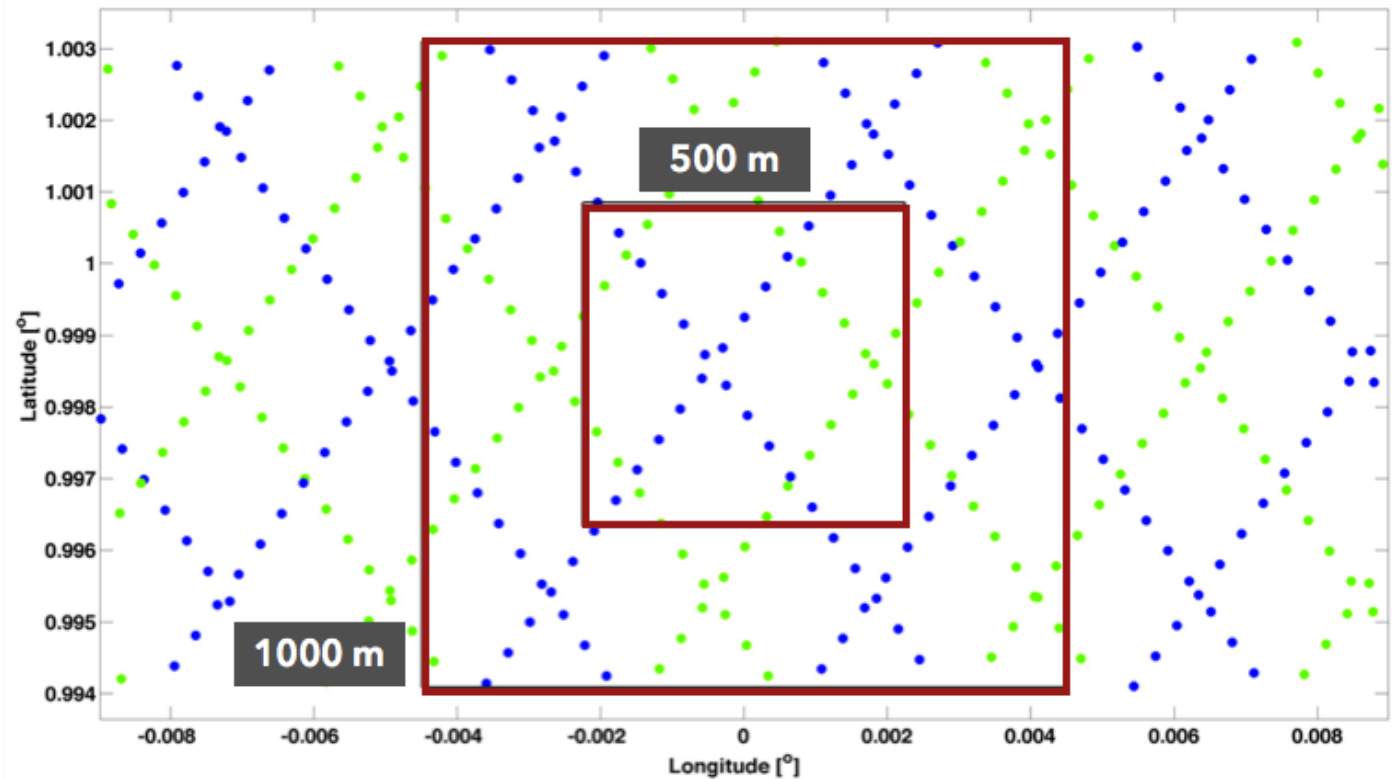
Duncanson et multi alii, 2022. Aboveground biomass density models for NASA's Global Ecosystem Dynamics Investigation (GEDI) lidar mission. Remote Sensing of Environment 270: 112845

Statistical estimates of mean biomass for 1-km grid cells

Baseline Requirement:

Biomass estimates in at least 80% of the **1 km cells** will be estimated with a **standard error** of less than 20% (or 20 Mg/ha if estimate is less than 100 Mg/ha).

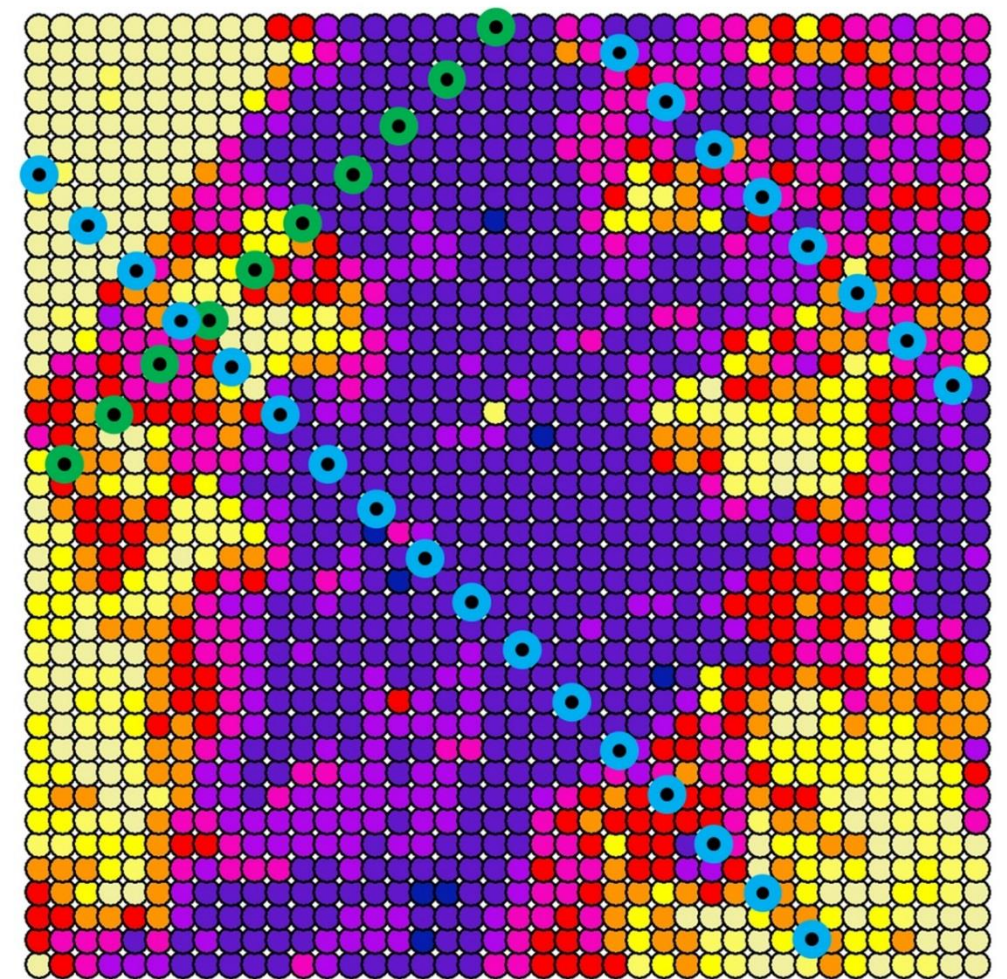
GEDI gives us a sample, so we use sampling theory to estimate mean biomass and uncertainty



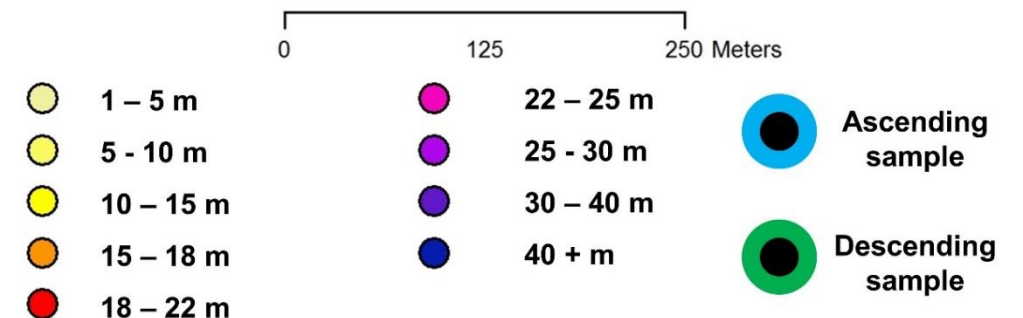
Main estimation strategy: **hybrid**
model-based inference

Sampling uncertainty: based upon
properties of the sample

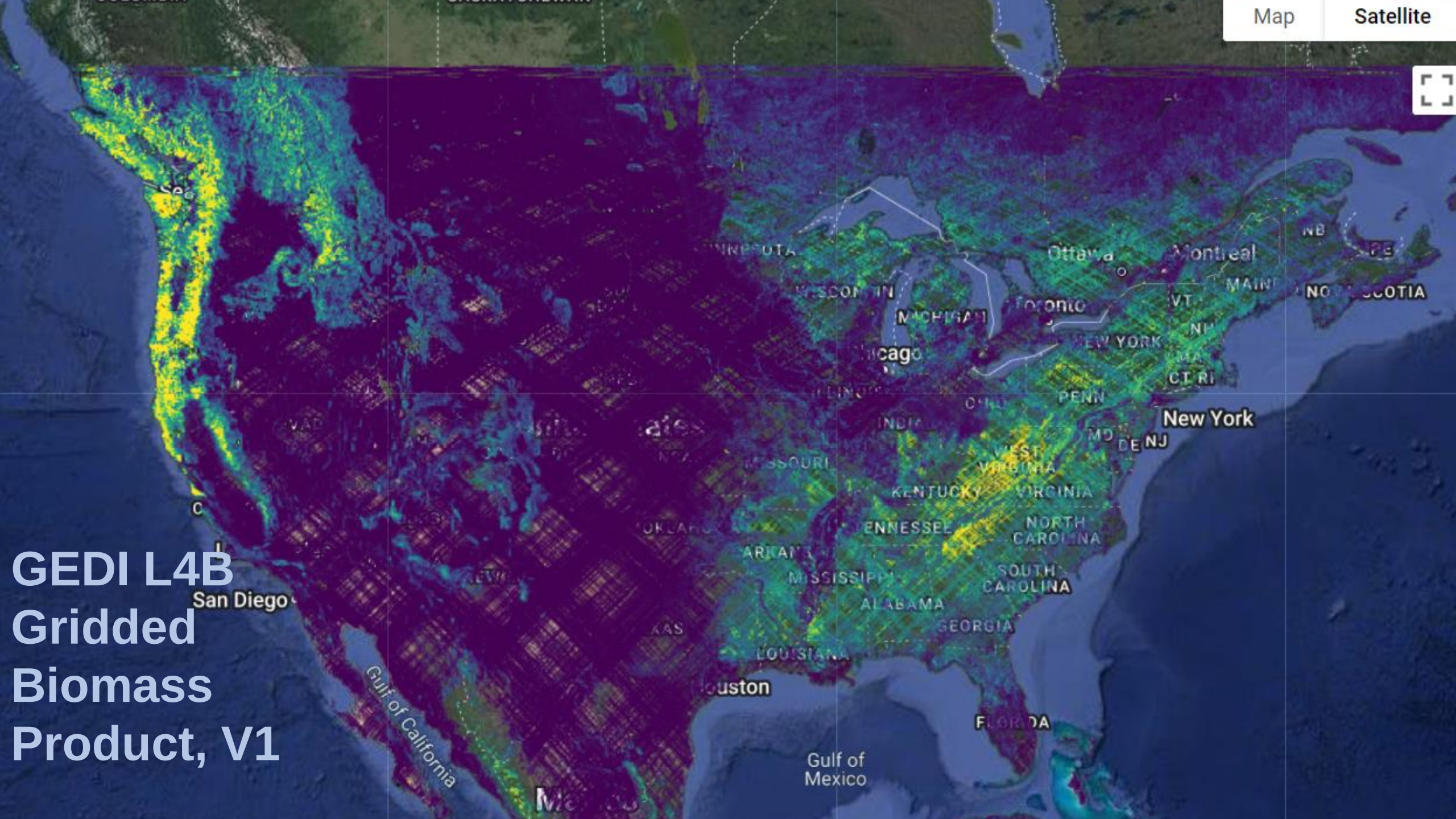
Model uncertainty: based upon
parameter uncertainty in the model
that produces biomass predictions



Patterson, Healey, Ståhl, Saarela, Holm, Andersen, Dubayah, Duncanson, Hancock, Armston and Kellner (2019) "Statistical properties of hybrid estimators proposed for GEDI—NASA's global ecosystem dynamics investigation." *Environmental Research Letters* 14, no. 6: 065007.



GED L4B Gridded Biomass Product, V1





OBI-WAN

Online Biomass Inference using
Waveforms And iNventory

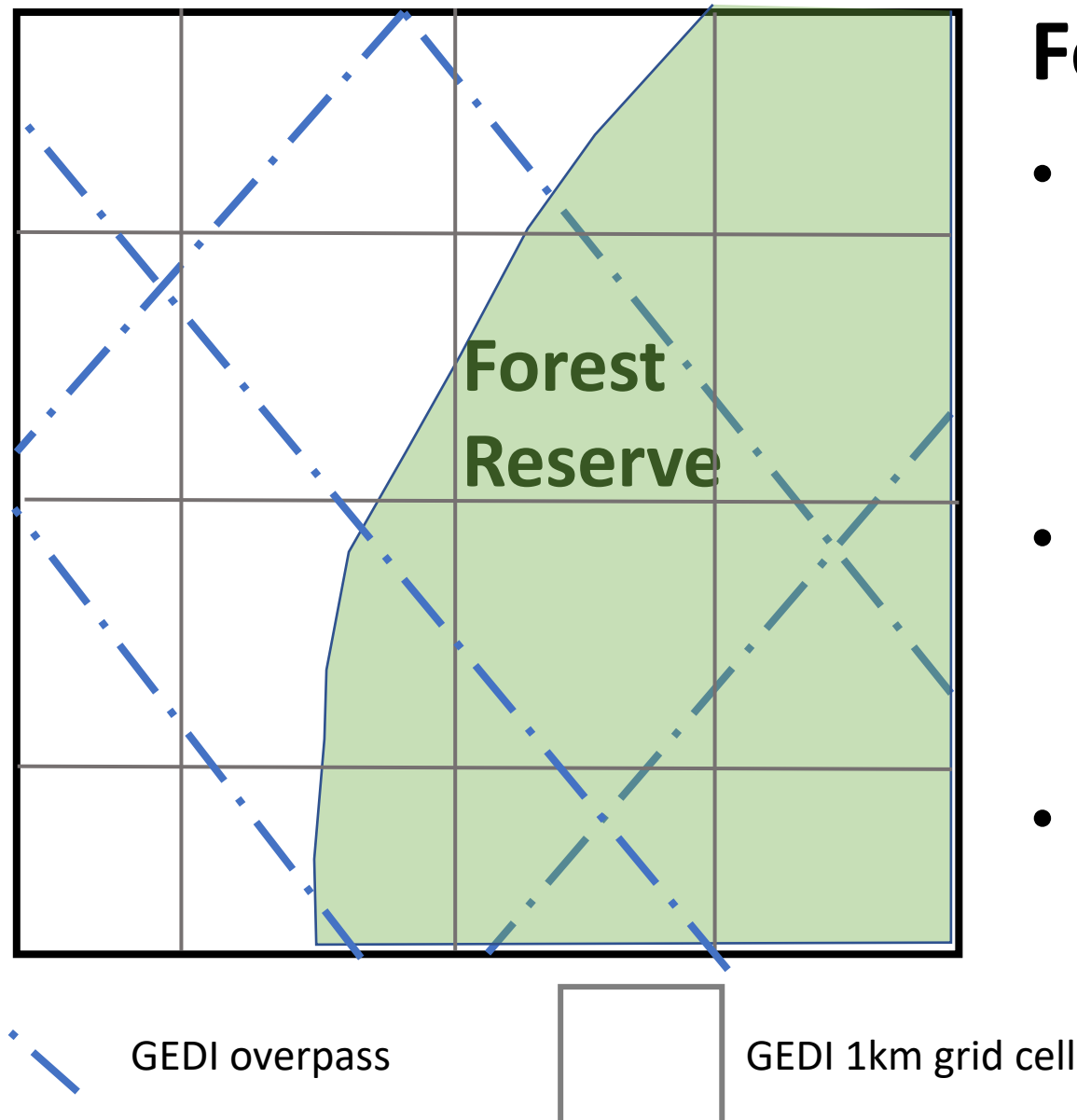
How it works...

OBI-WAN
Forest Carbon Reporting

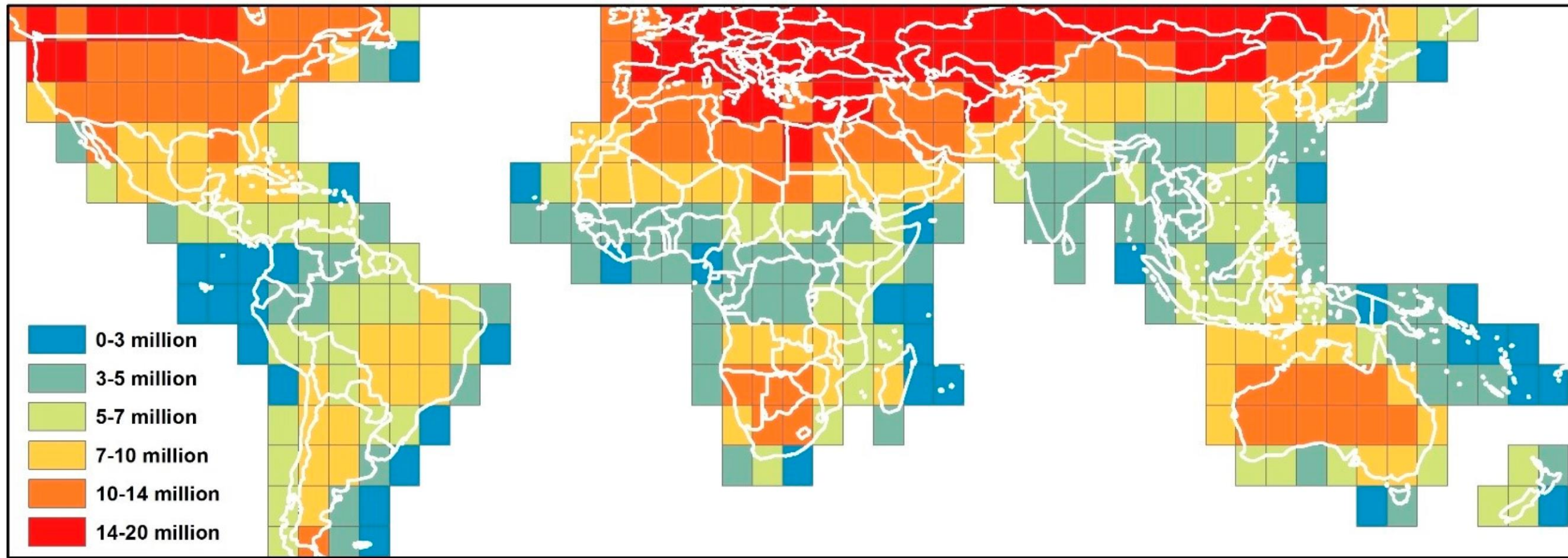


OBIWAN – New Source of Forest Emission Factors

- Adapts models and statistical estimators used to create standard GEDI average biomass estimates to address user-specified areas
- Returns standardized carbon report, documenting sample properties and uncertainties
- Currently limited to areas up to 10,000 hectares (25,000 acres)



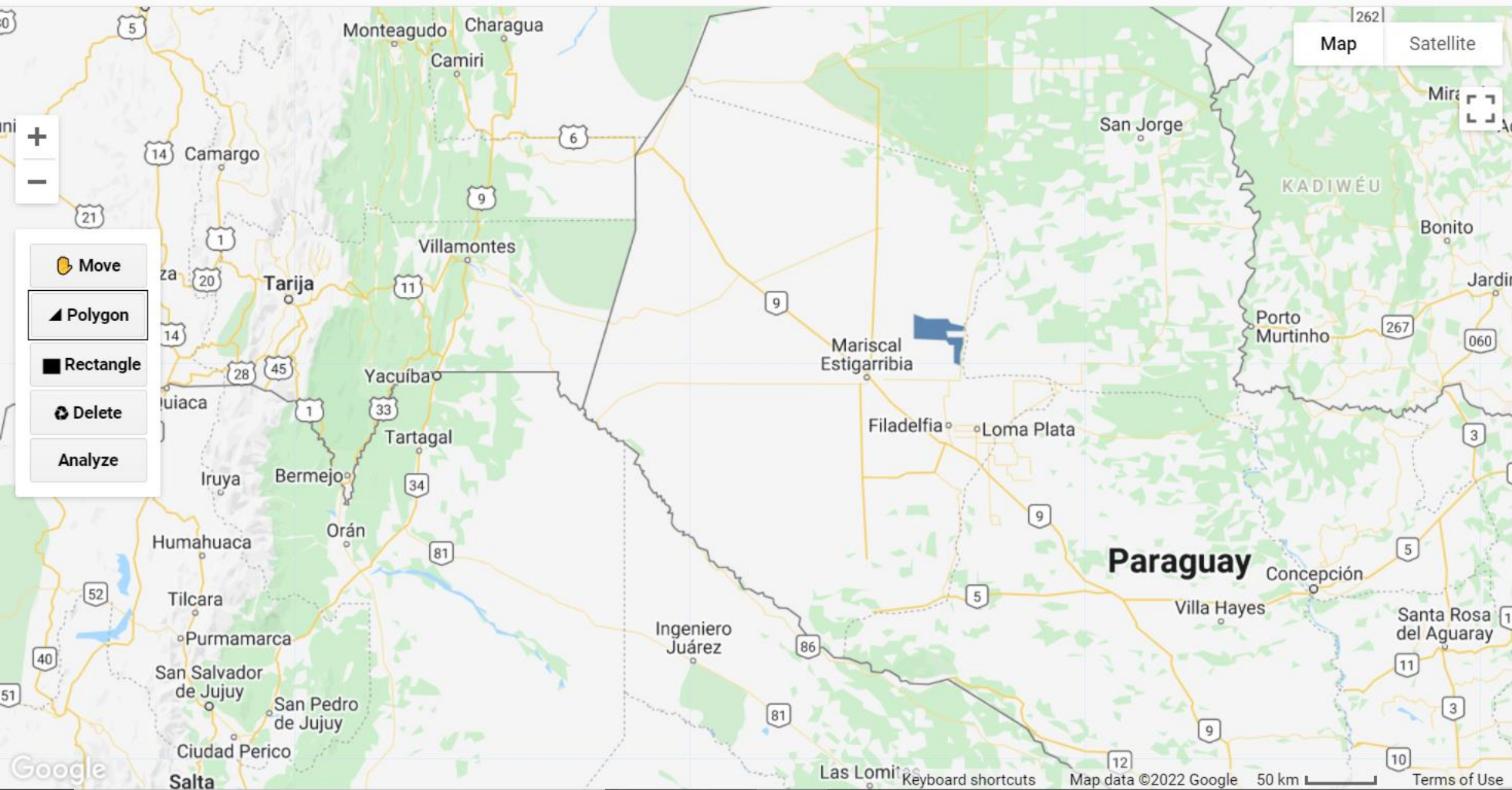
Google now maintains a rasterized version of the GEDI waveform data on Earth Engine (officially released yesterday!!)



Healey et al., 2020 *Remote Sensing* 12(17), 2840; <https://doi.org/10.3390/rs12172840>

Earth Engine Apps

Search places





Obi-Wan

Forest Carbon Reporting

Online Biomass Inference using Waveforms and iNventory with GEDI

For more information [LARSE](#)

Layers **RH98**

☒ Opacity 0

Model Selection **L4A**

🔍 Search places



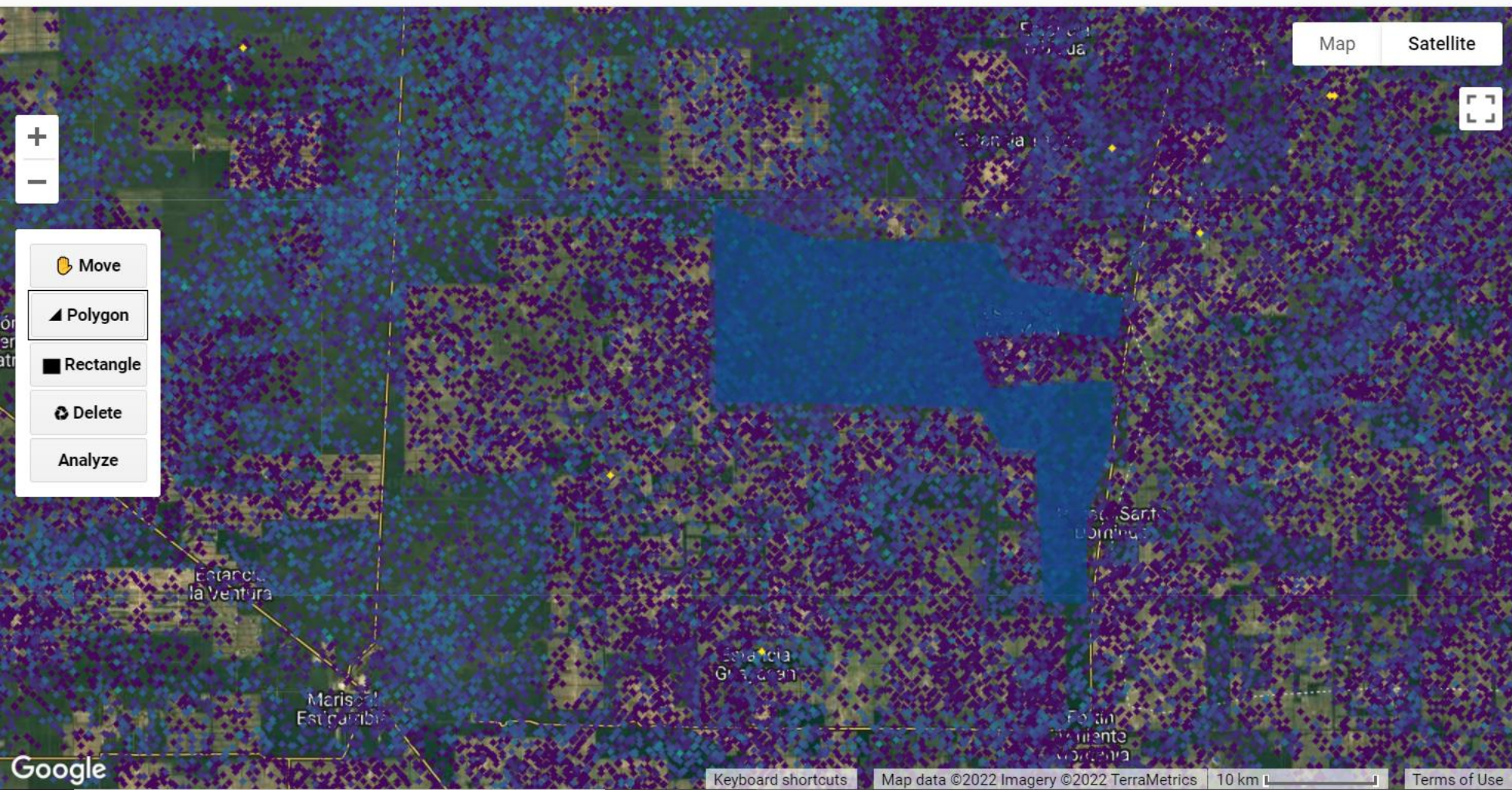
For more information [LARSEN](#)

☒ Opacity

Model Selection

Earth Engine Apps

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Forest Carbon Reporting

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For more information [LARSE](#)

Layers **RH98**

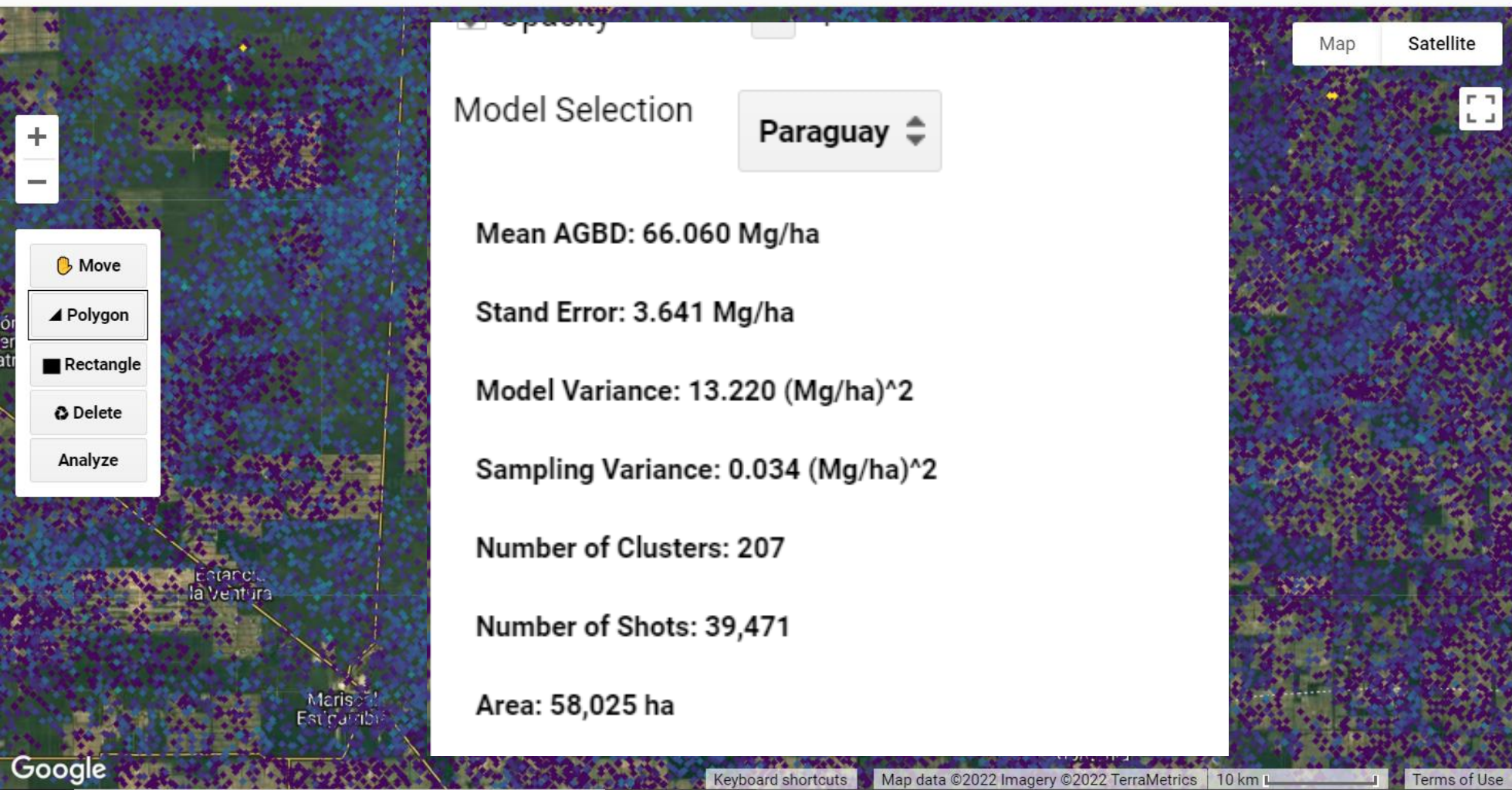


☒ Opacity 1

Model Selection **L4A**

Earth Engine Apps

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Obi-Wan
Forest Carbon Reporting

Online Biomass Inference using Waveforms and iNventory with GEDI

For more information [LARSE](#)

Layers: RH98

Opacity: 1

Model Selection: Paraguay

Mean AGBD: 66.060 Mg/ha

Stand Error: 3.641 Mg/ha

Model Variance: 13.220 (Mg/ha)²

Sampling Variance: 0.034 (Mg/ha)²

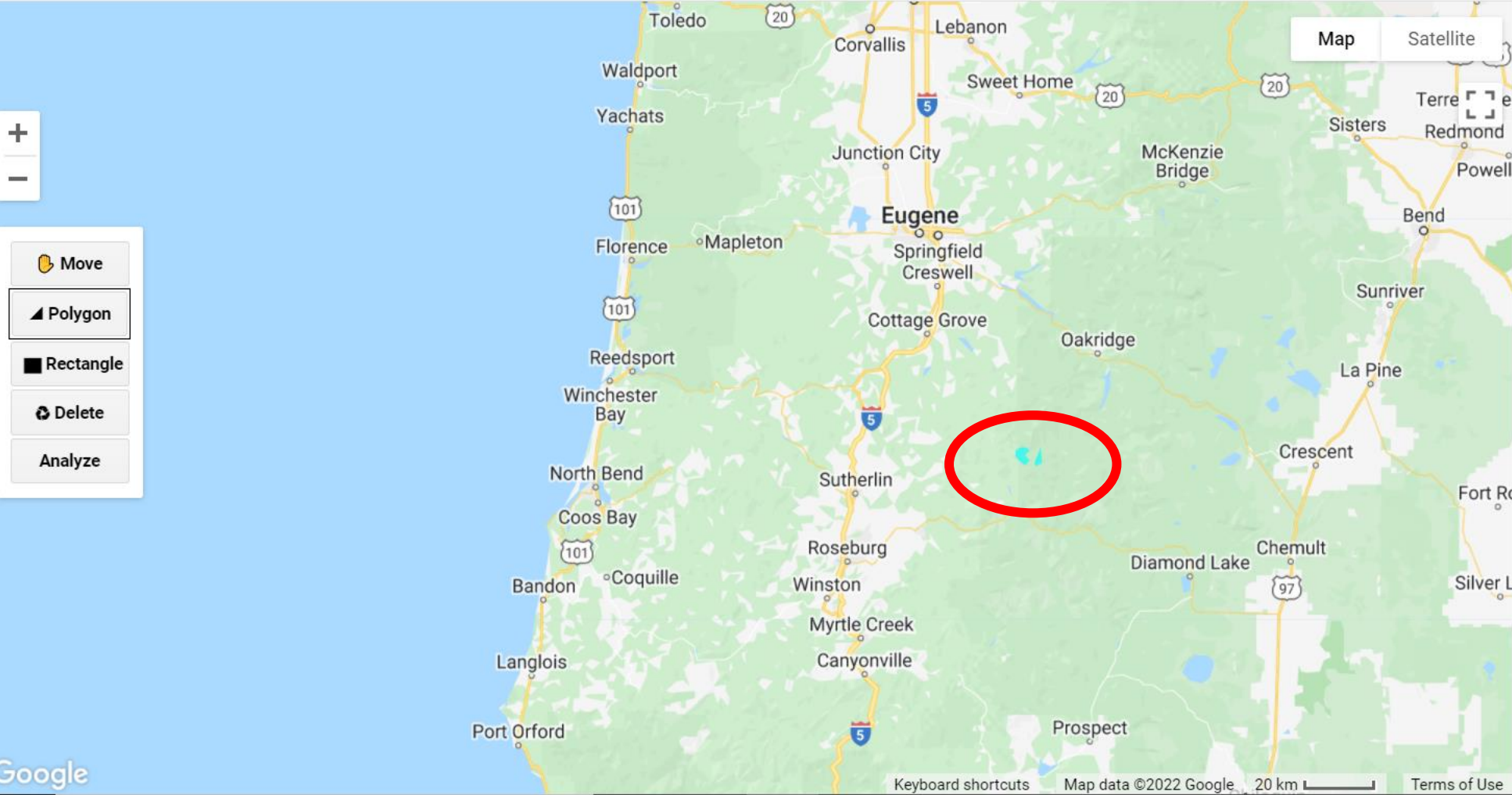
Number of Clusters: 207

Number of Shots: 39,471

Area: 58,025 ha

Earth Engine Apps

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OBi-WAN Forest Carbon Reporting

Online Biomass Inference using Waveforms and iNventory with GEDI

For more information [LARSE](#)

Layers **RH98**



☒ Opacity 0

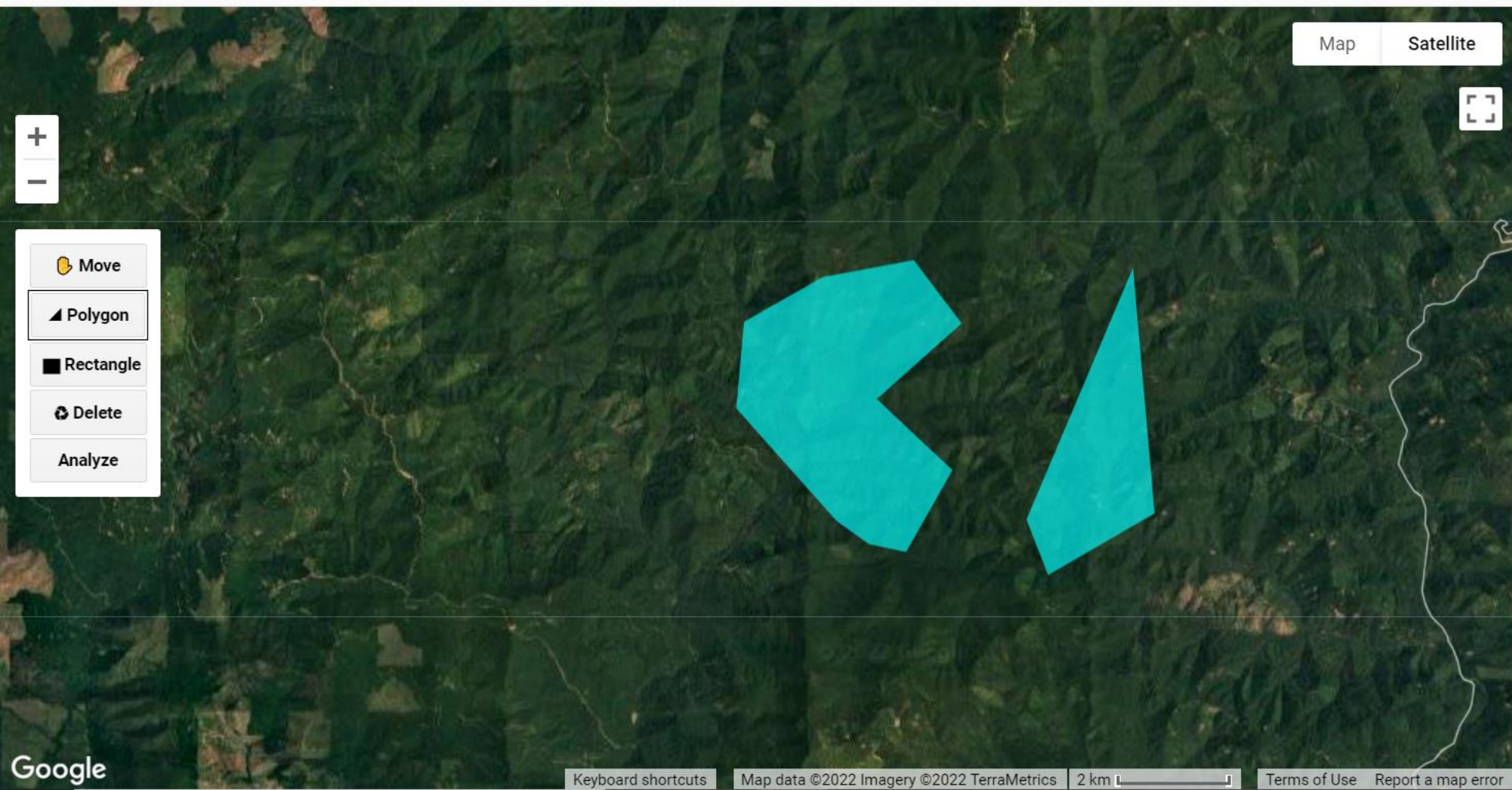
Model Selection **L4A**

Mean AGBD: 417.477 Mg/ha
Stand Error: 51.102 Mg/ha
Model Variance: 2,444.811 (Mg/ha)²
Sampling Variance: 166.604 (Mg/ha)²
Number of Clusters: 36
Number of Shots: 1,562
Area: 1,936 ha

Earth Engine Apps

Q

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OBI-WAN

Forest Carbon Reporting

Online Biomass Inference using Waveforms and iNventory with GEDI

For more information [LARSE](#)

Layers

RH98

☒ Opacity

0

Model Selection

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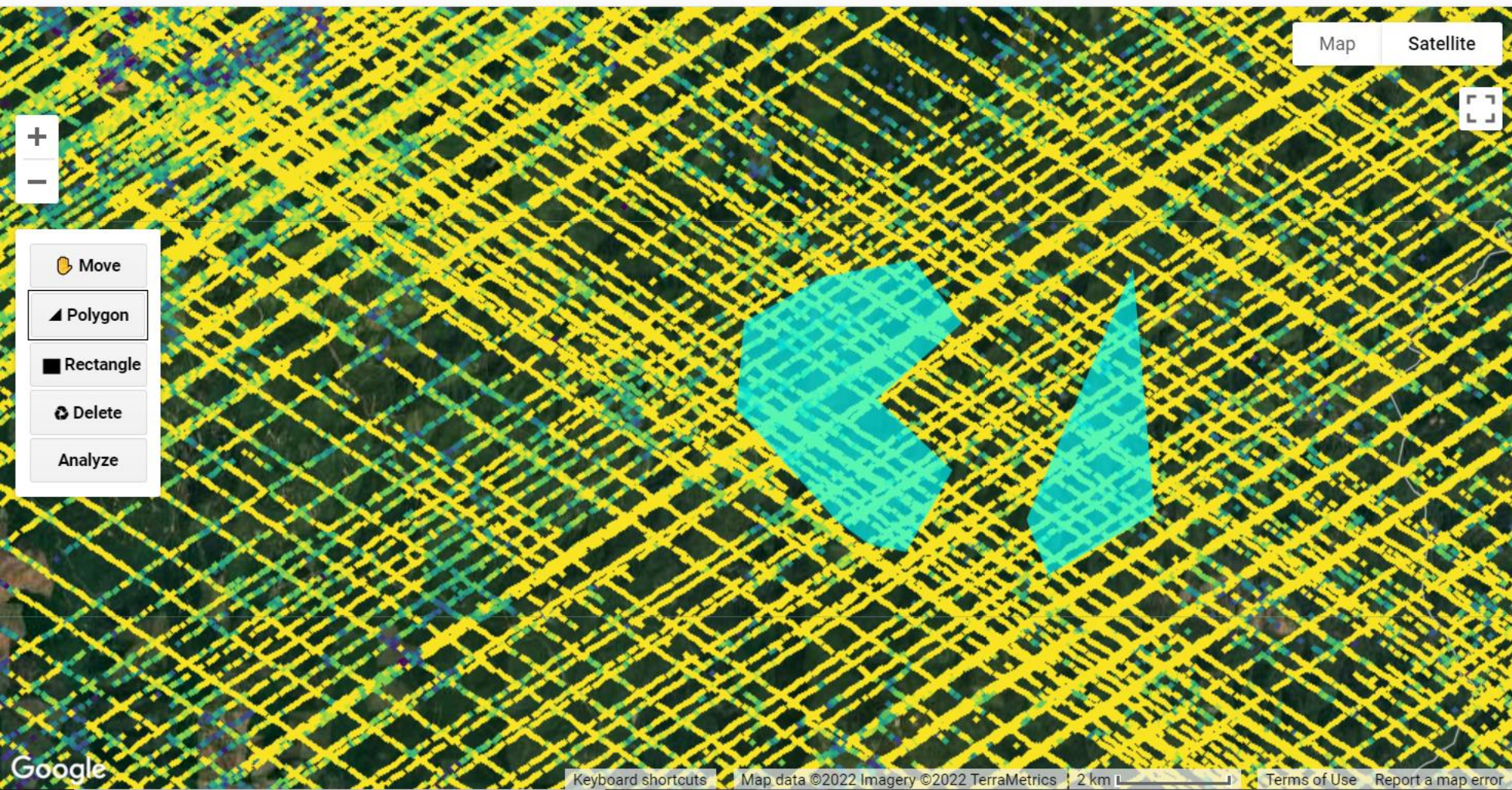
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Earth Engine Apps

Search places



Obi-Wan Forest Carbon Reporting

Online Biomass Inference using Waveforms and iNventory with GEDI

For more information [LARSE](#)

Layers **RH98**



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- Number of Clusters: 36
- Number of Shots: 1,562
- Area: 1,936 ha

Why you can't just add up pixels from your favorite biomass map

- The pixel-level predictions have errors that are correlated: small differences in model parameters can affect many pixels in the same way. If the predictions aren't independent, you can't simply sum their uncertainties
- GEDI's approach uses an analytical approach to appropriately account for dependencies as we estimate biomass and uncertainty for a large area

Where GEDI's statistics can go wrong

- GEDI uses the largest global calibration dataset ever assembled, but many areas are not well represented. If GEDI's global biomass models don't fit in an area, the estimates and their variances can be wrong by an unknown amount.

Why you can't just add up pixels from your favorite biomass map

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**For verification purposes, it may be worthwhile
to build local models**

If you match your field plots to nearby on-orbit GEDI data (or to simulated GEDI data from airborne lidar), you can make and use your own footprint-level biomass model.

Search for ...

Q

3+

YANG 

Customized Model

Import

Export

Save

Delete

Biomass Transformation: None ▾

Model Parameter

Parameters	Intercept		RH98
Transformation		transformation None ✓ SQRT LOG	SQRT ▾
Values	-120.777	5.3077	6.808

Variance Covariance Matrix

Variables	Intercept	RH50	RH98
Intercept	4.1962	-0.3047	-0.0976
RH50	0.3047	0.0564	-0.0253
RH98	0.0976	-0.0253	0.0329



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☒ sean.p.healey01@gmail.com

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Online Biomass Inference using Waveforms and iNventory

Forest Carbon Reporting

Date: 2022/03/08

ASSESSMENT SUMMARY

Date of latest GEDI measurement in the area:	2020-04-19
GEDI data version:	2.0
Hybrid model-based estimate of mean biomass (Mg/ha):	69.753
Hybrid model-based estimate of standard error (Mg/ha):	4.135
Hybrid model-based model variance ((Mg/ha)^2):	14.133
Hybrid model-based sampling variance ((Mg/ha)^2):	2.964
Number of GEDI clusters in area of interest:	20
Number of GEDI shots in area of interest:	758
Area analyzed (ha):	3036

KEY CONTEXT



Type here to search



32°F



9:18 PM
3/8/2022



GEDI 1km Grid - Apr to Dec 2019 (MW019-MW054)



GEDI 1km Grid - Jan to Sep 2020 (MW055-MW090)



Ecological Society of Ame

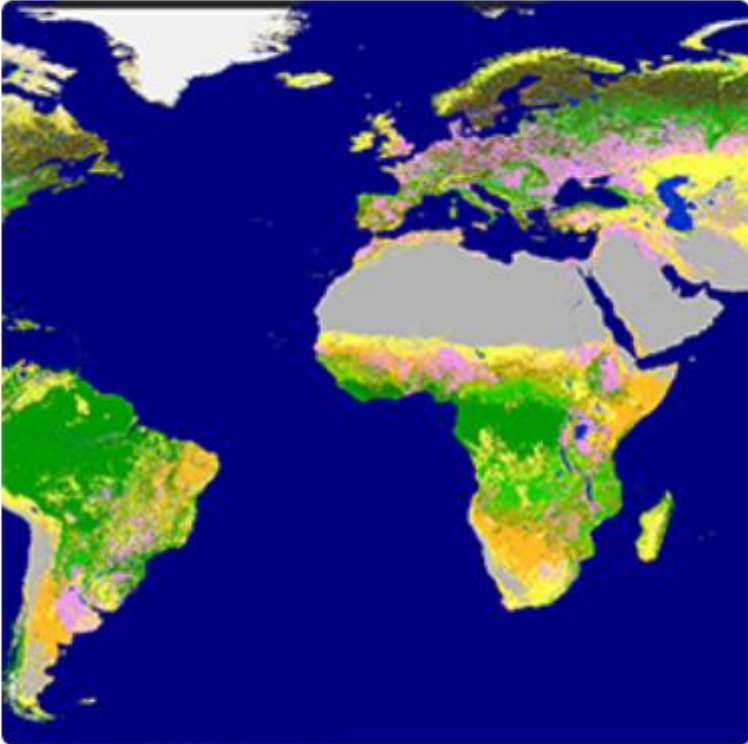
We currently limit queries to 10,000 hectares

Different places have different sample probabilities, which we are still working on accommodating

- Orbital resonance
- Variable cloud cover
- Latitude

You can mask out non-forest from your query using one of many land cover maps on Earth Engine

Copernicus Global Land Cover,
Collection 3



National Land Cover Dataset
Landscape Change Monitoring System
Copernicus 100-m
MODIS MCD-12
Global Forest Cover Change 30-m
Hansen Global Forest Change

Where are we?

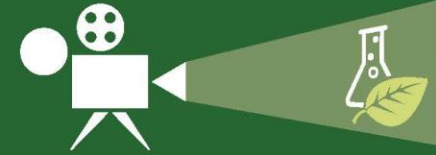
- OBIWAN is expected to support carbon storage verification for offset markets, voluntary contributions, sustainability assessments, REDD+
- Turning OBIWAN on will require reprocessing of GEDI data on Google Earth Engine (fixing shot id field) ~ several weeks
- OBIWAN may look different if it gets a new host
- OBIWAN inherits GEDI's focus on formal inference, allowing straightforward confidence intervals

More to come!
Continue to join us
for more Science
You Can Use
Webinars this spring!



United States Department of Agriculture

Rocky Mountain Research Station Science You Can Use Webinars



SPRING 2022 SCHEDULE

Save These Dates!

We hope you can join us for land management focused webinars.
The sessions will be half presentation, half discussion and Q&A.

Connection Information: <https://usfs.zoomgov.com/j/16104530612>

Meeting ID: 161 0453 0612 Password: USFS1905!

 FEBRUARY 16 10–11 AM MST Exploring the Interagency Fuel Treatment Decision Support System (IFTDSS) <i>Caroline Noble, Bre Schueller, and Kim Ernstrom (WFMRA)</i>	 FEBRUARY 23 10–11 AM MST The Aviation Use Summary (AUS): analytics to inform decisions and manage risk <i>Crystal Stonesifer</i>	 MARCH 2 10–11 AM MST A Modern Approach to Quantifying Ungulate Carrying Capacity <i>Matt Reeves</i>
 MARCH 9 10–11 AM MST The OBIWAN App: Estimating Property-Level Carbon Storage Using NASA's GEDI Lidar <i>Sean Healey and Zhiqiang Yang</i>	 MARCH 30 10–11 AM MST Recent megafires provide a tipping point for desertification of conifer ecosystems <i>Dr. Dan Neary</i>	 APRIL 6 10–11 AM MST Accounting for the benefits of public lands <i>Travis Warziniack</i>
 APRIL 13 10–11 AM MST Effects of forest management and climate scenarios on biodiversity in the Sierra Nevada Mountains <i>Kathy Zeller</i>	All presenters are RMRS scientists unless otherwise noted. Click the scientist's name for more information about their work. Continuing credits for SAF and The Wildlife Society will be available. Click here for past webinar recordings. Spring 2022 presentations will also be posted once the event is over.	



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