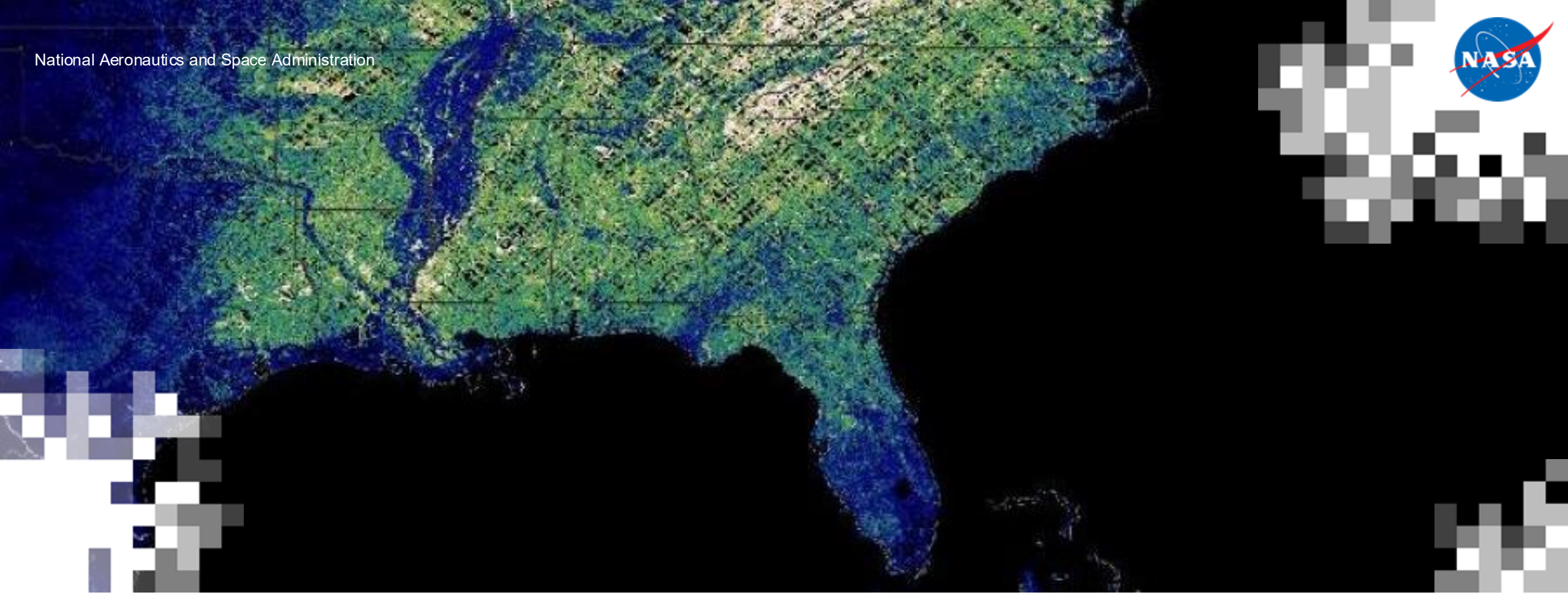


Estimating Biomass and Change with GEDI and the OBIWAN API

Session 2: Estimating Biomass Change with GEDI and the OBIWAN API

Sean Healey, Ph.D., U.S. Forest Service (USFS)/U.S. Department of Agriculture (USDA)
Erika Podest, Ph.D., Jet Propulsion Laboratory/Caltech

May 28, 2026

Training Outline

Session 1

Estimating Biomass using GEDI

May 21, 2026

11 AM - 12 PM EDT

Session 2

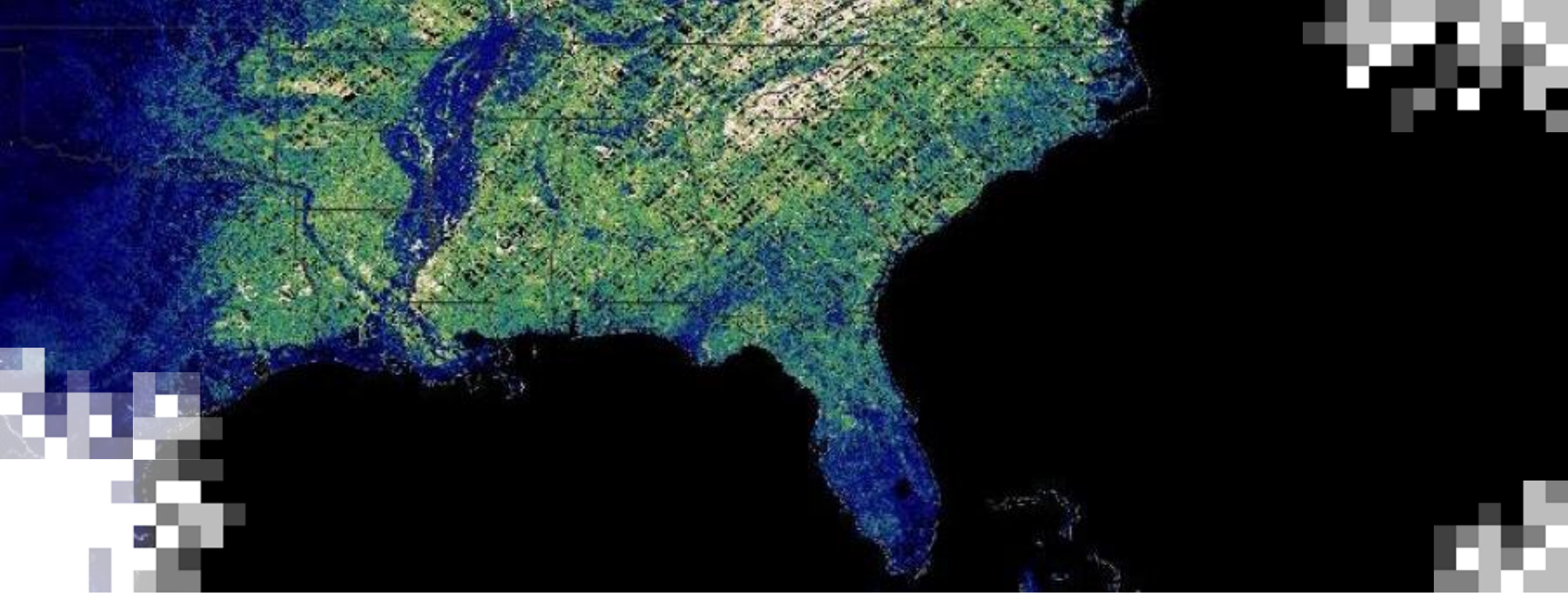
Estimating Biomass Change with GEDI and the OBIWAN API

May 28, 2026

11 AM - 12 PM EDT

Homework opens on May 28 – Due June 18 – Posted on the training Webpage

A certificate of completion will be awarded to participants who attend all live sessions and complete the homework assignment by the due date.



Session 2: Estimating Biomass Change with GEDI and the OBIWAN API

OBI-WAN
Forest Carbon Reporting

Session 2 – Guest Instructor

Sean Healey

Research Ecologist
USFS/USDA

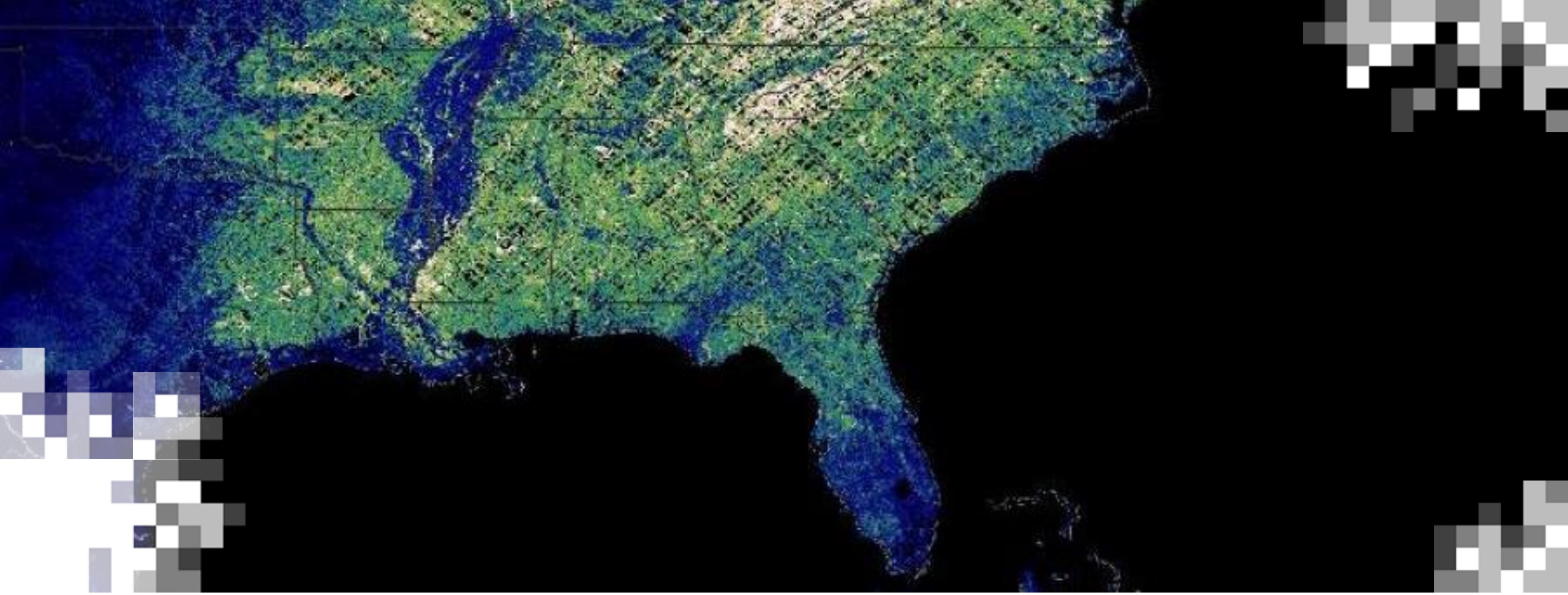
Session 2 Learning Objectives

By the end of this session, participants will be able to:

- Identify key concepts in carbon monitoring, including system requirements, decision-making needs, and the concept of additionality.
- Recognize how OBIWAN estimates biomass change, including its use of GEDI, Landsat time series, and underlying data infrastructure.
- Evaluate uncertainty and validation, using Forest Service inventory data to assess the accuracy and precision of OBIWAN change estimates.
- Access the open-source OBIWAN API to generate estimates of biomass change in areas of interest.
- Apply OBIWAN tools and APIs to visualize biomass change and compare carbon gains against different climate scenarios.

How to Ask Questions

- Please write your questions in the 'Q&A' window, which you can find in the bottom right under the three '…'. We will address them at the end of this session.
- Feel free to enter your questions during the presentation. We will try to answer all of the questions during the Q&A session at the end of this webinar.
- The remaining questions will be answered in the Q&A document, which will be posted to the training website in approximately one week.



Meeting Practical Forest Carbon Assessment Needs with OBIWAN

Sean P. Healey and Zhiqiang Yang
USDA Forest Service Forest Inventory and Analysis Program

OBI-WAN
Forest Carbon Reporting

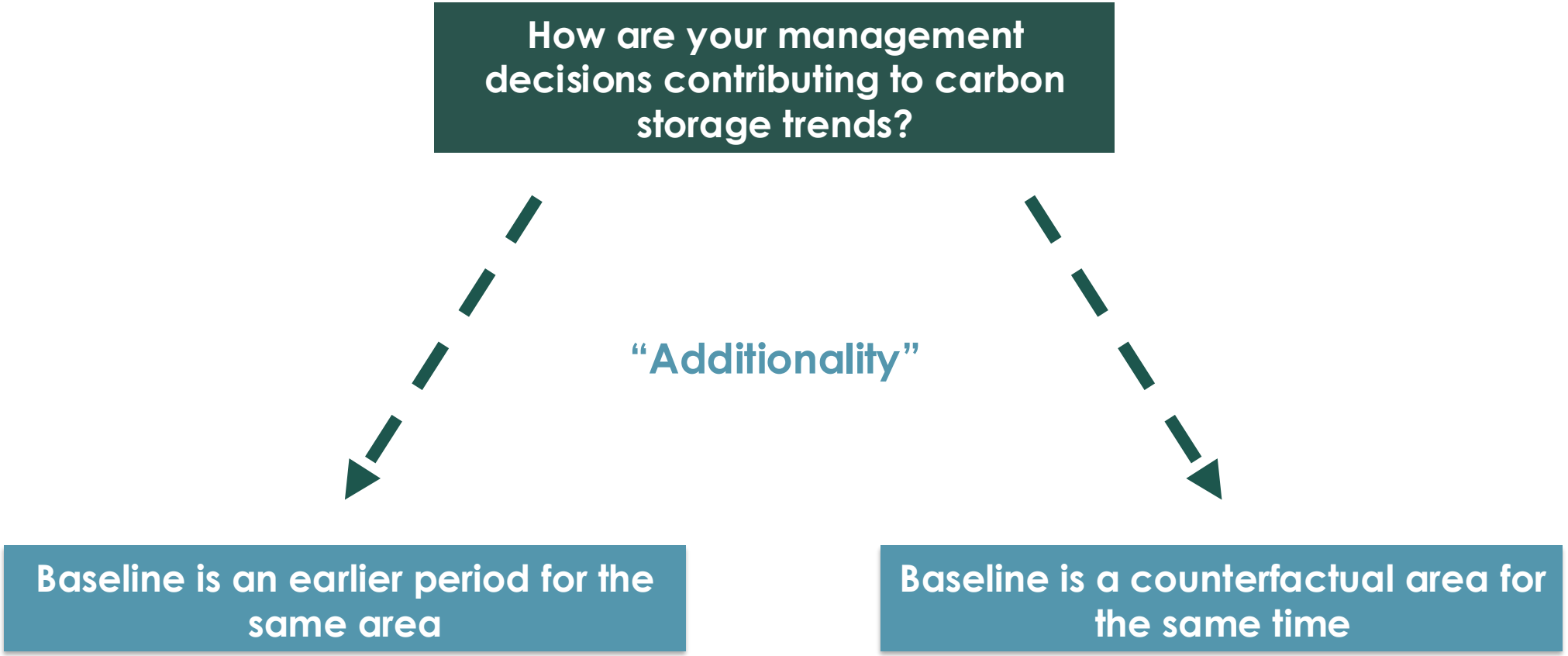
What information is needed to verify market- or treaty-based mitigation commitments?

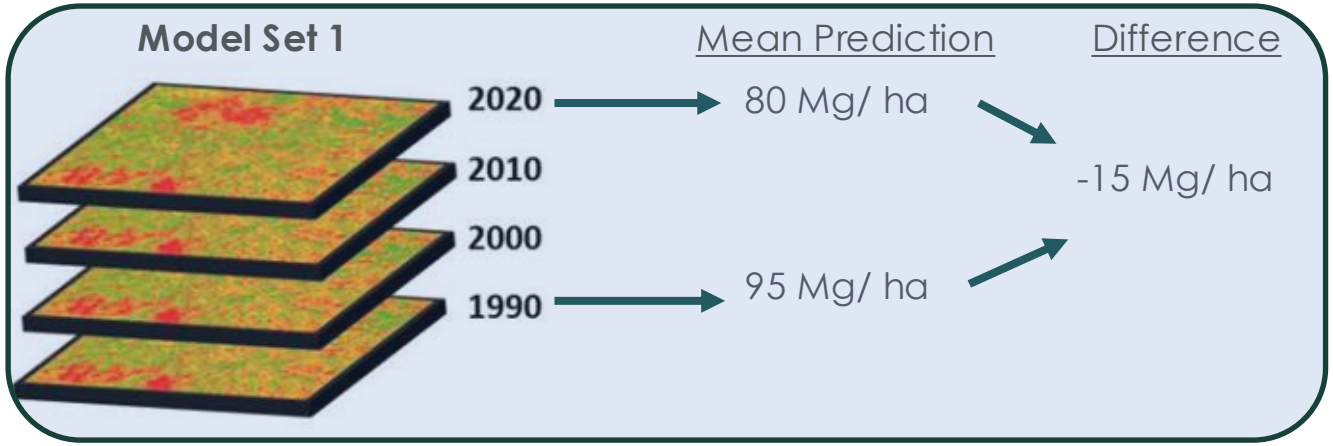
How are your management decisions contributing to carbon storage trends?

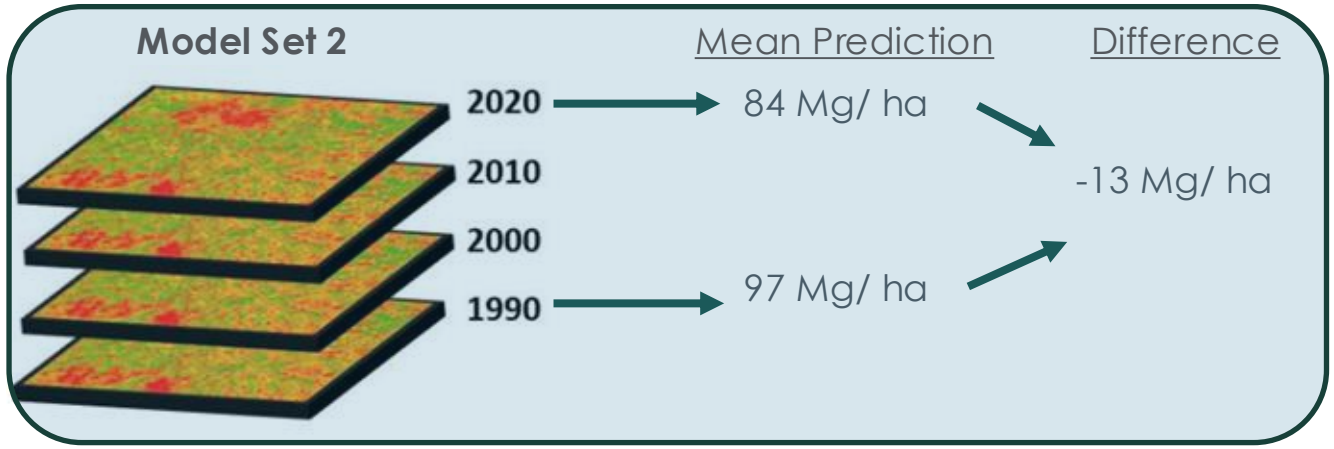
How much carbon is your forest adding (i.e., removing from the atmosphere)?

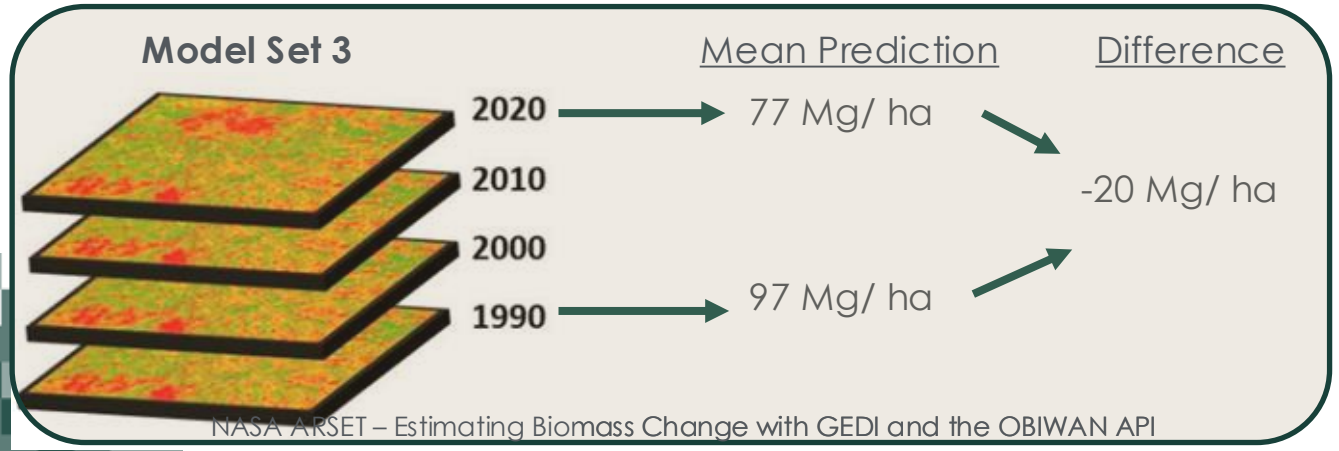
How much carbon is stored in your forests now?

What information is needed to verify market- or treaty-based mitigation commitments?

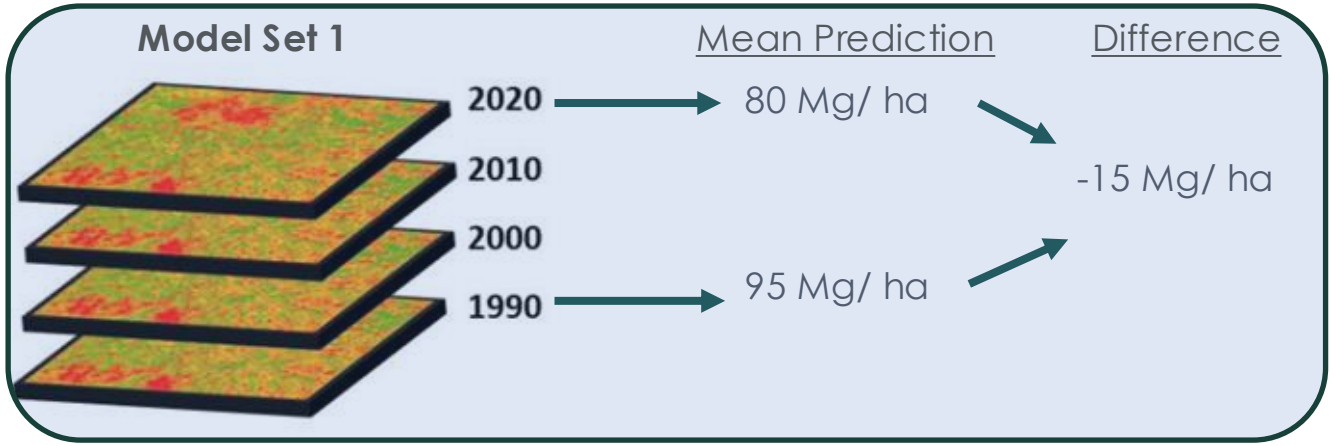


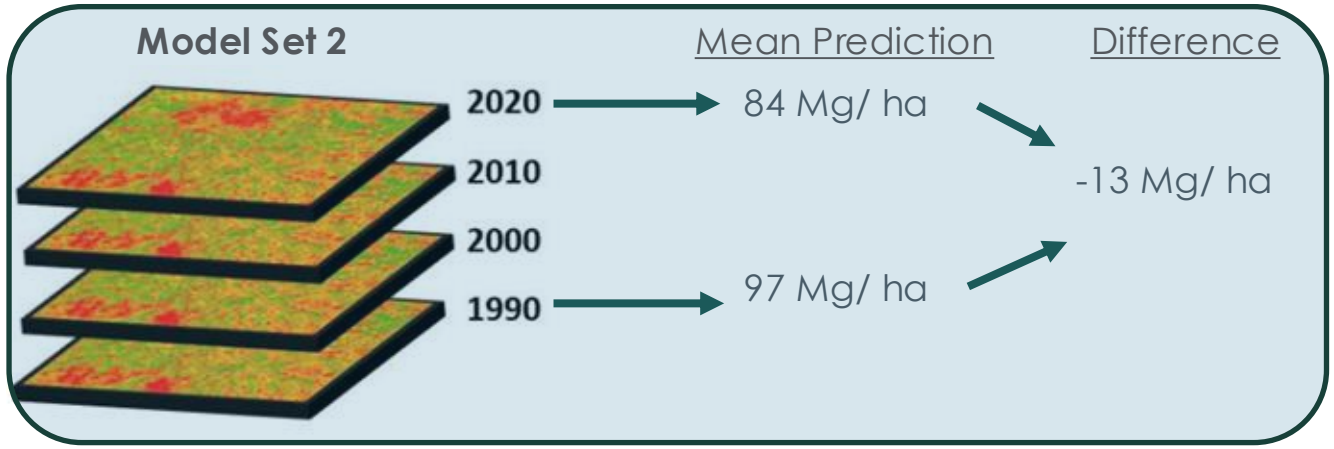


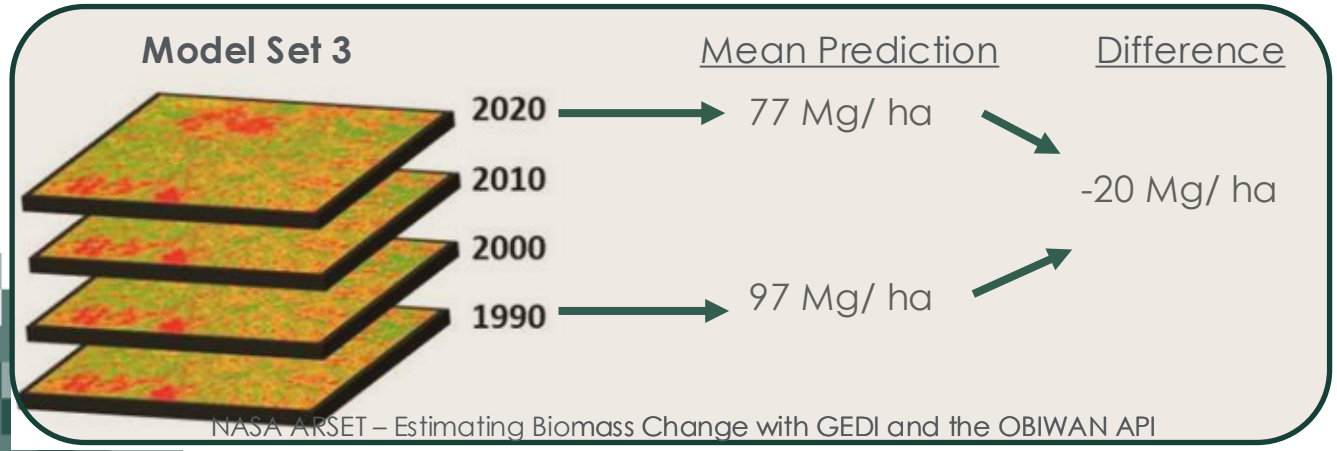




Recall:
OBIWAN uses hierarchical bootstrapping to get **a distribution** of predicted changes.







Consider that distribution of interest could be:

- An estimate for a single point in time
- The difference for the same place between two points in time
- The difference in the rate of gain between two periods

Baseline is an earlier period for the same area

- The difference in the rate of gain between two places

Baseline is a counterfactual area for the same time

Calibration is important

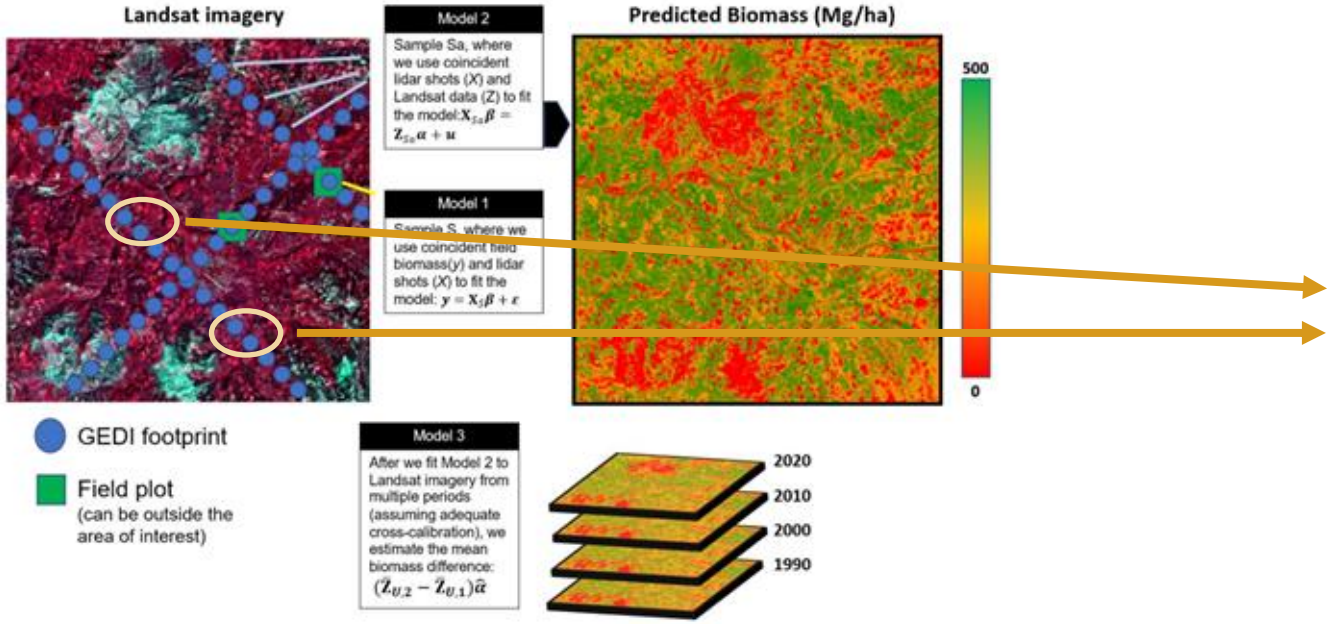
- Optical imagery from sensors like Landsat do not 'see' through the canopy and are likely to:
  - Underpredict high biomass while overpredicting low biomass for a single point in time.
  - Underpredict changes between high- and low-biomass conditions.

- **Calibration** is a simple correction based on independent data and applied to the predictions to **minimize bias**.

- Calibration can also be used to ensure **alignment** of OBIWAN predictions with local inventory measurements.

Calibration Option 1

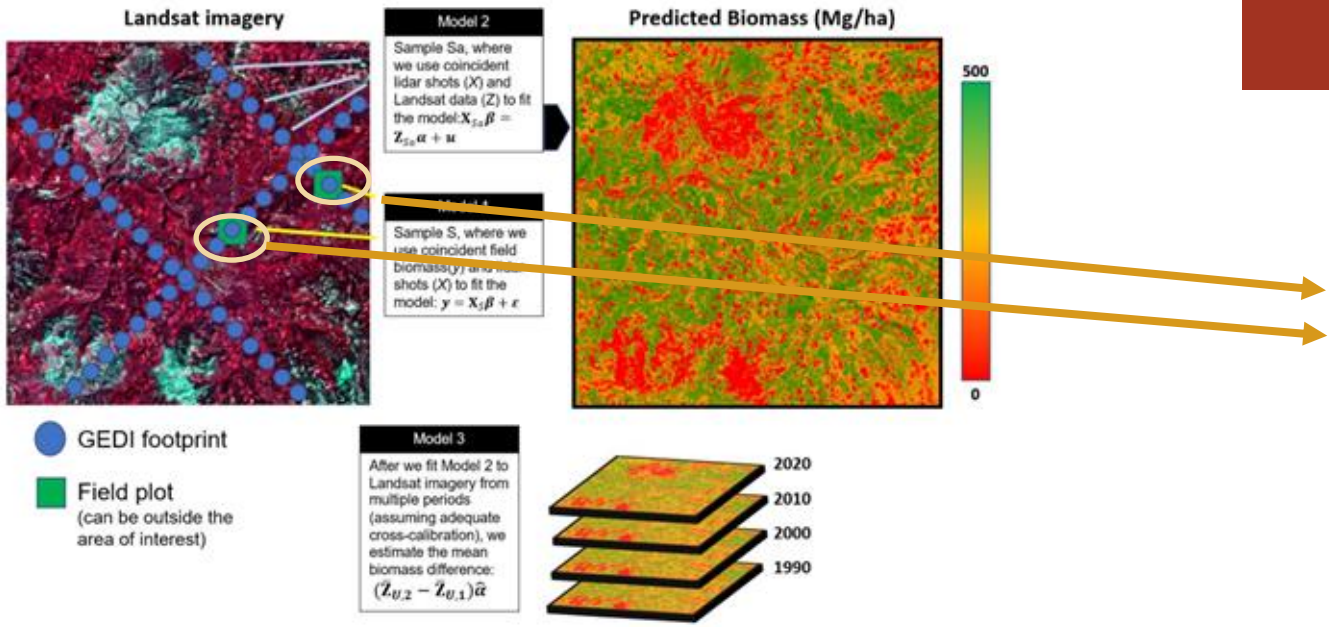
Available Globally



Develop calibration of Landsat single point-in-time predictions with **independent** GEDI L4A biomass values.

Generally, high predictions get higher and low predictions get lower.

Calibration Option 2



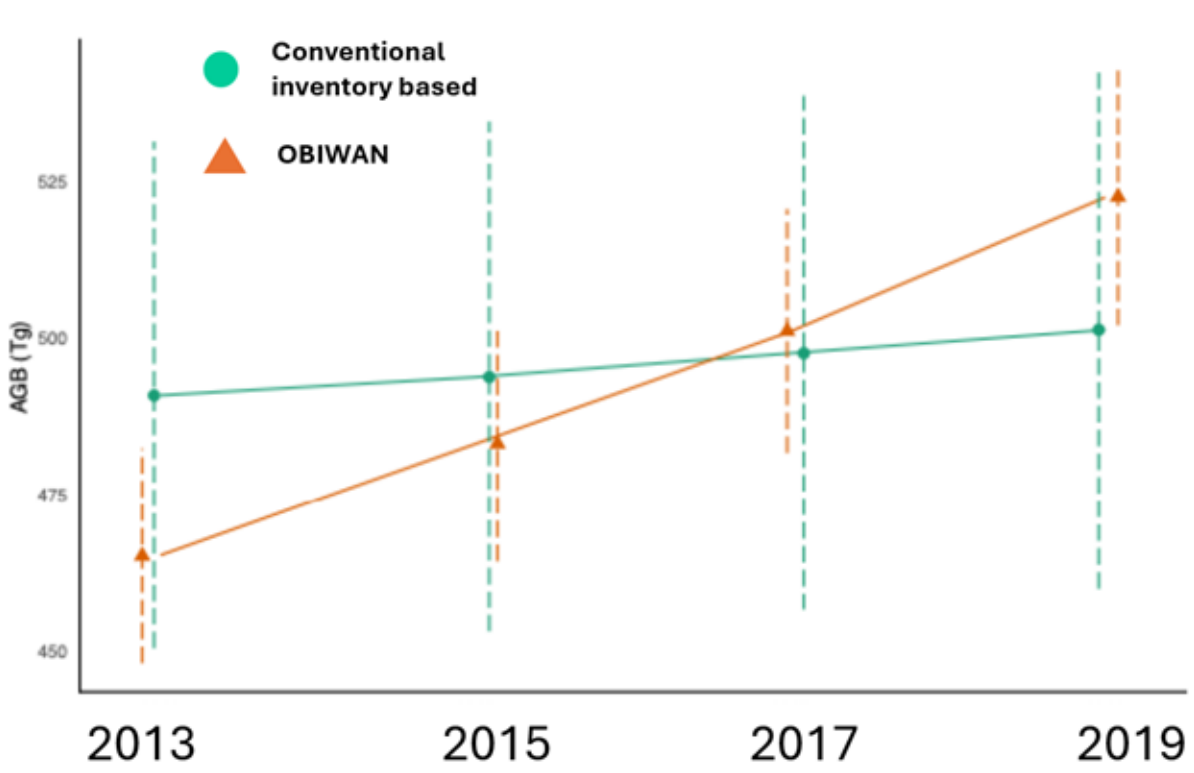
Available in the U.S. with Repeated Plot Measurements from FIA

Develop calibration of Landsat **change** predictions with biomass changes actually measured on long-term plots.

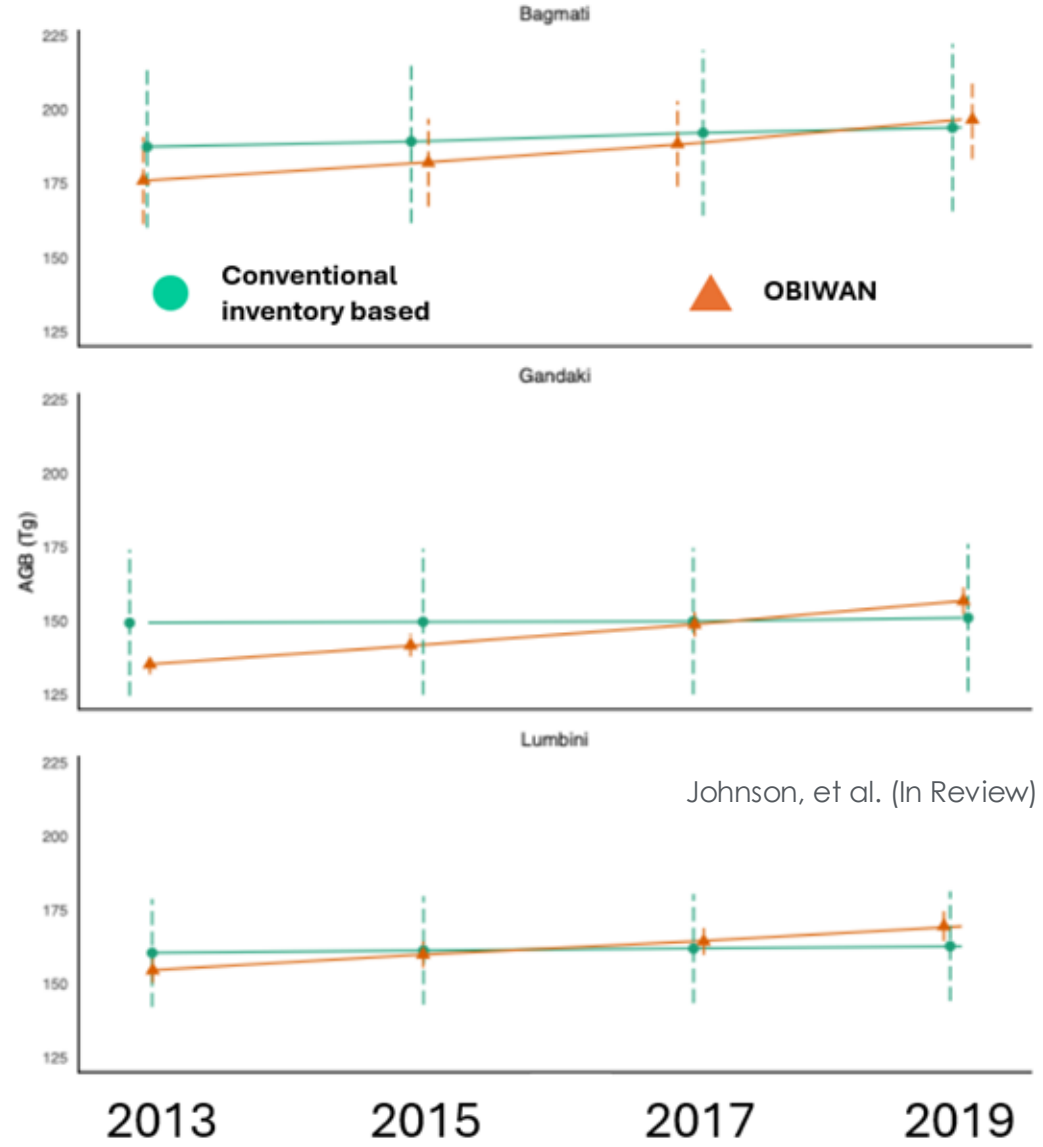
Both predicted losses and gains tend to go up.

Consistency Assessment using National Forest Inventory: Nepal

National-Scale Biomass Estimate



Province-Scale Biomass Estimates

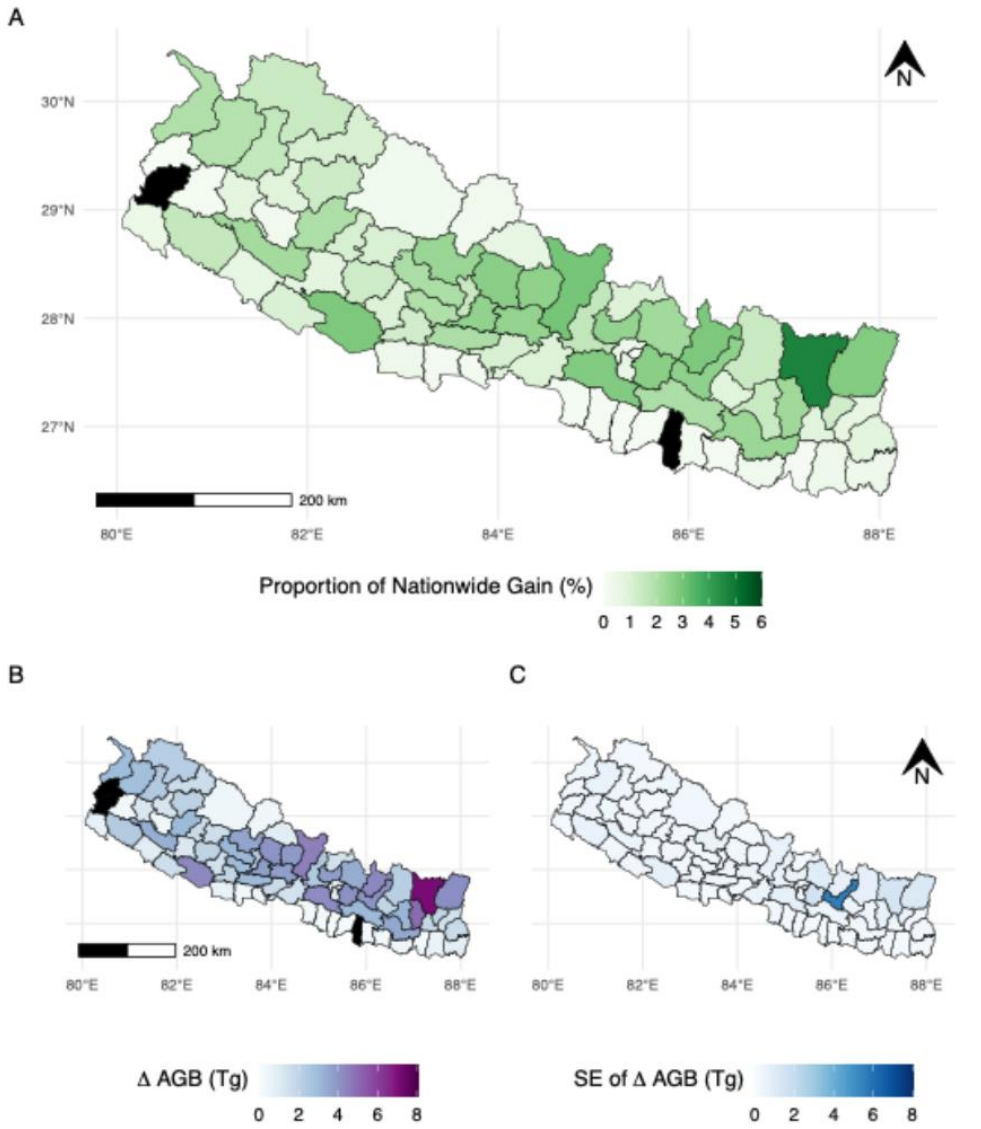


Johnson, et al. (In Review)

Conducted in collaboration with Nepal's national forest inventory, maintained by the Forest Research and Training Centre with support from NASA's SERVIR program.

OBIWAN Application: Attributing National Contributions to Local Districts

- Since OBIWAN shows good agreement with Nepal's inventory at the national level, it may be of use in the process of systematically decomposing the country's reported mitigation contributions to the district level.

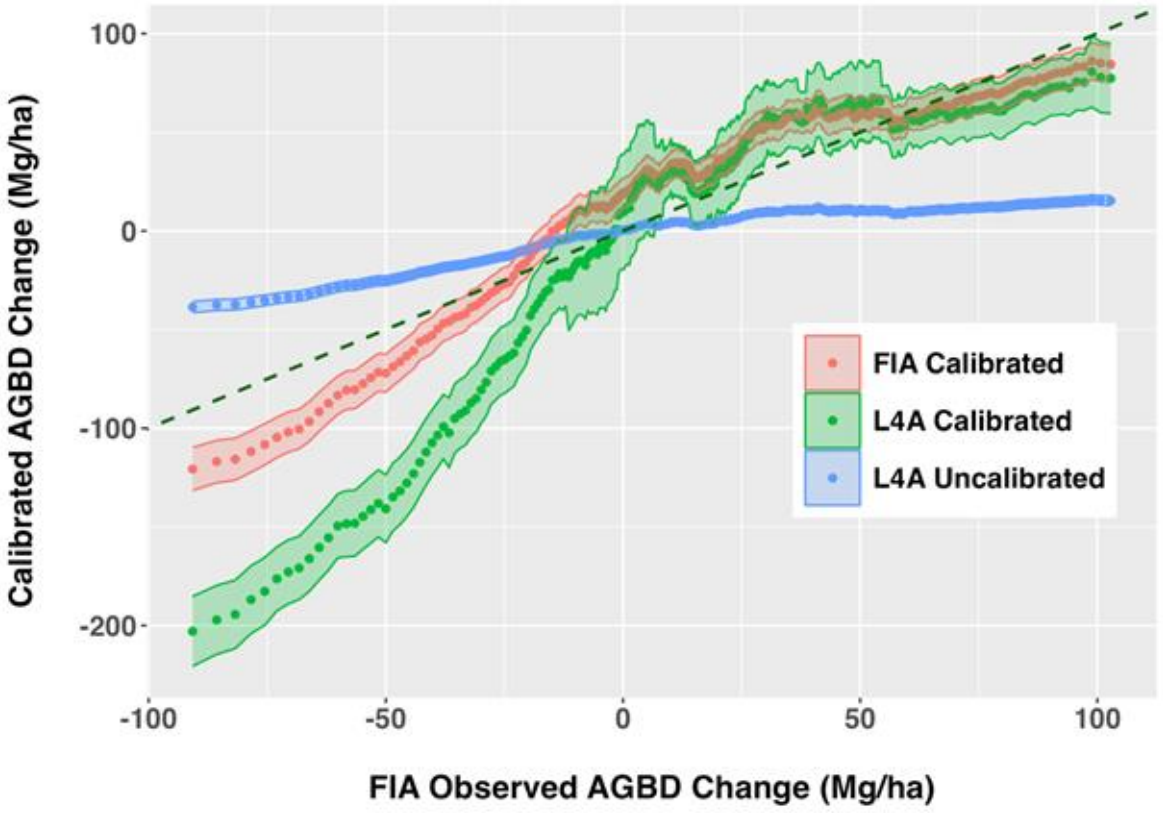


Johnson et al. (In Review)

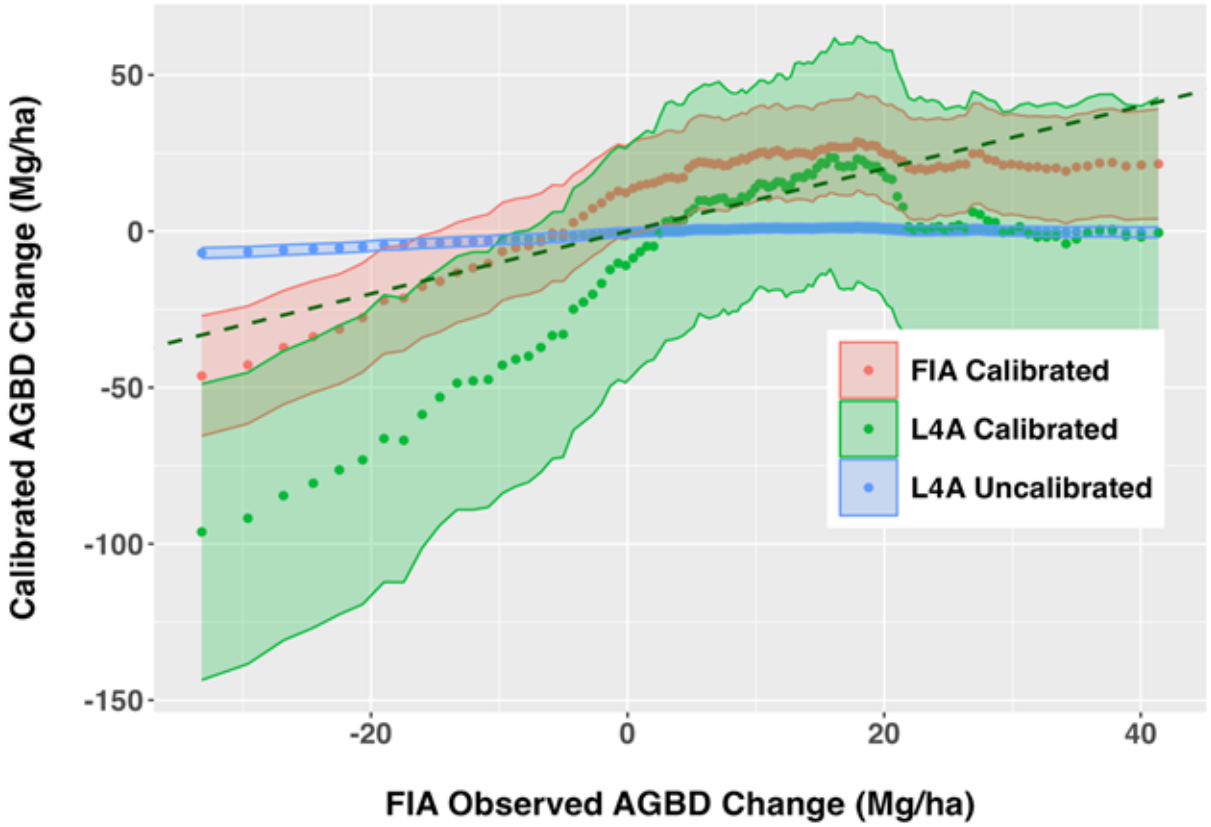
Consistency of Biomass Change Estimates with FIA

US Only
Globally Available
No Calibration

Alabama



Maine



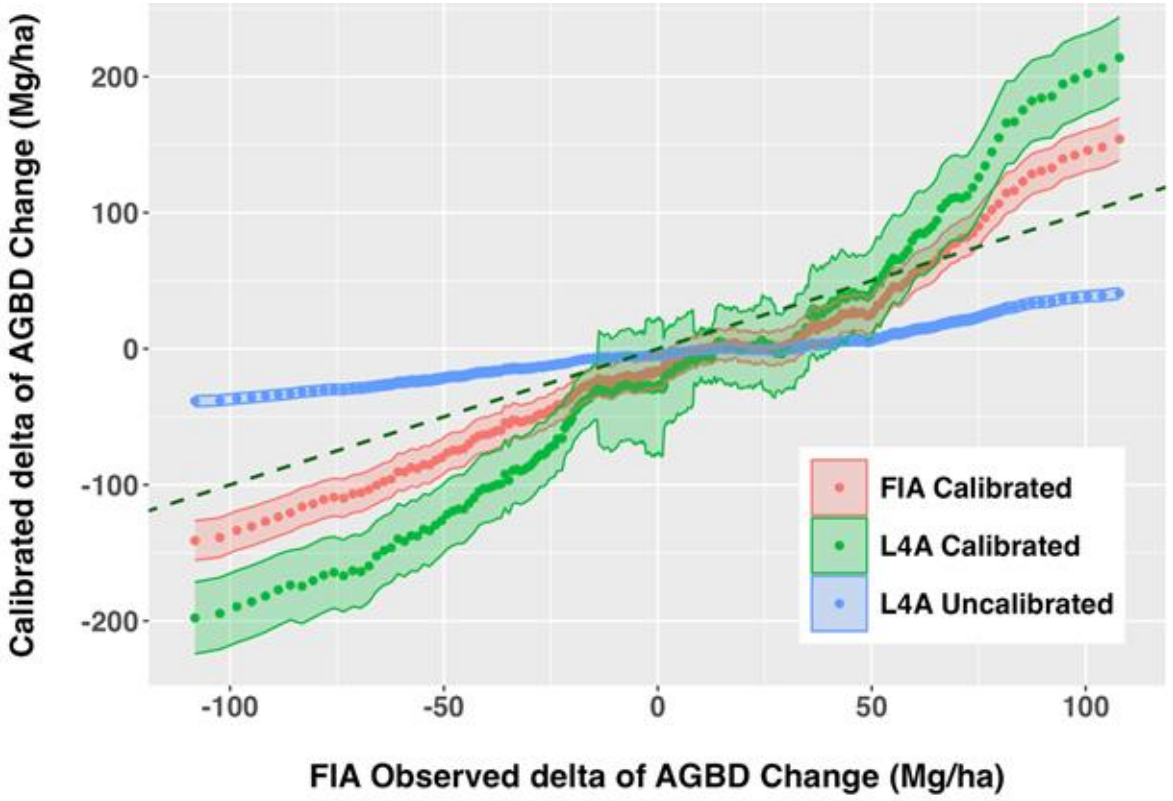
Change: Biomass difference between 2 points in time for groups of 500 FIA plots

Healey et al. (In Prep)

Consistency of Estimated Change in Storage Rates with FIA

US Only
Globally Available
No Calibration

Alabama



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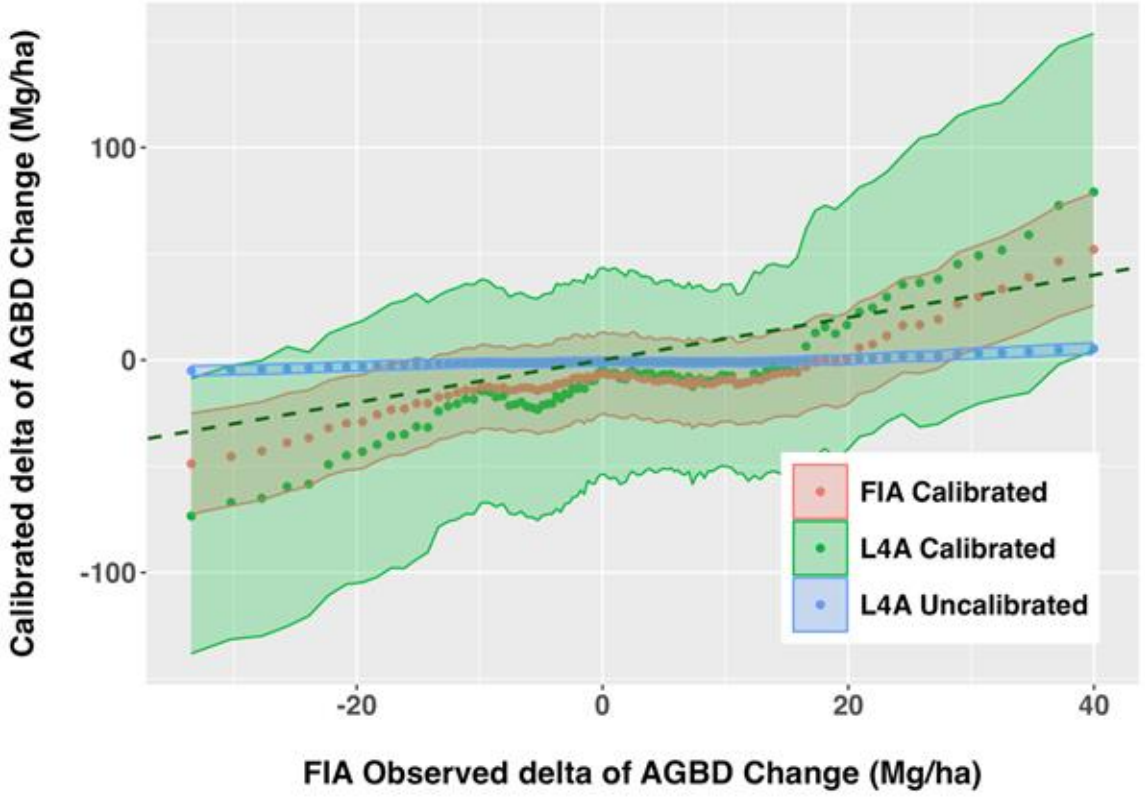
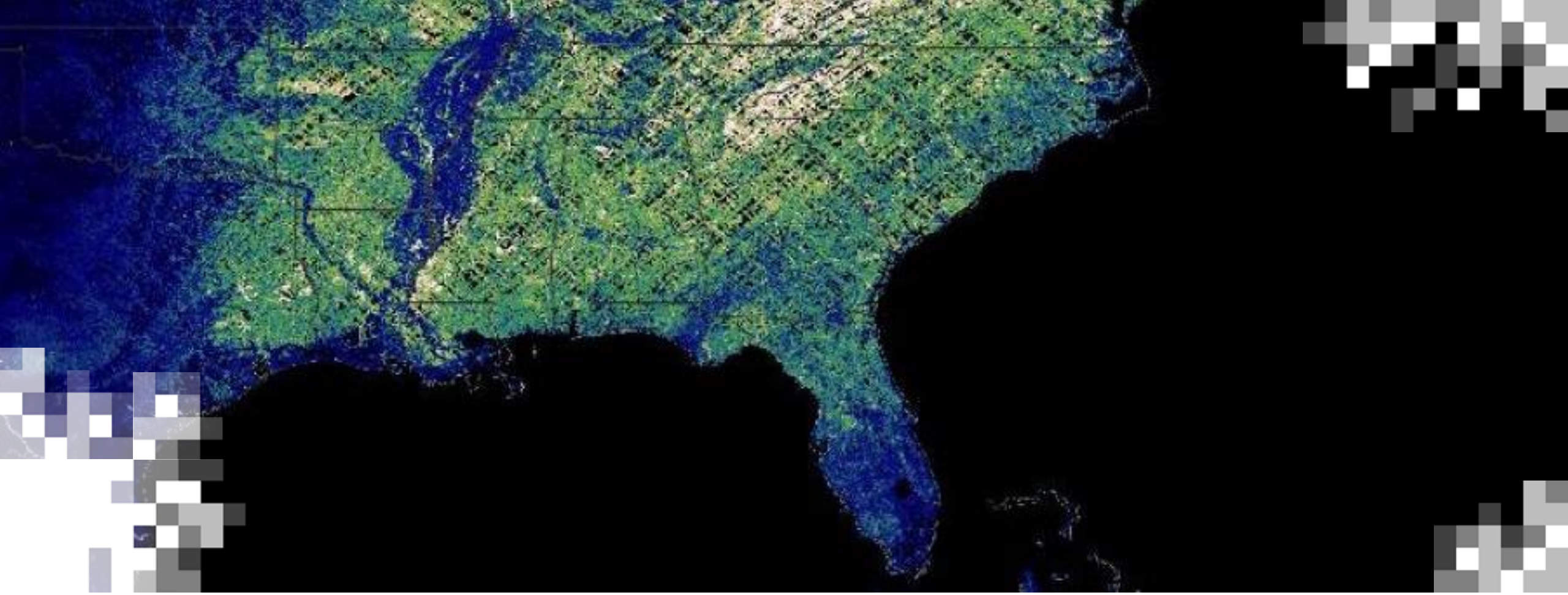


Additionality: Change in gain from one period to the next in groups of 500 plots

Healey et al. (In Prep)



The OBIWAN API

OBI-WAN
Forest Carbon Reporting

How the OBIWAN API Works

- Our project is pre-computing bootstrapped biomass maps around the world (starting in the U.S.).
- The OBIWAN API exposes those assets to the public.
- The API has many functions for estimating biomass, biomass change, and additionality for places of interest.
- Developers can stand up client-specific services that implement any:
  - Period of Interest (Post-2000 in 2-year intervals)
  - Visualization
  - Authentication
  - Additionality Baseline
  - Report Format

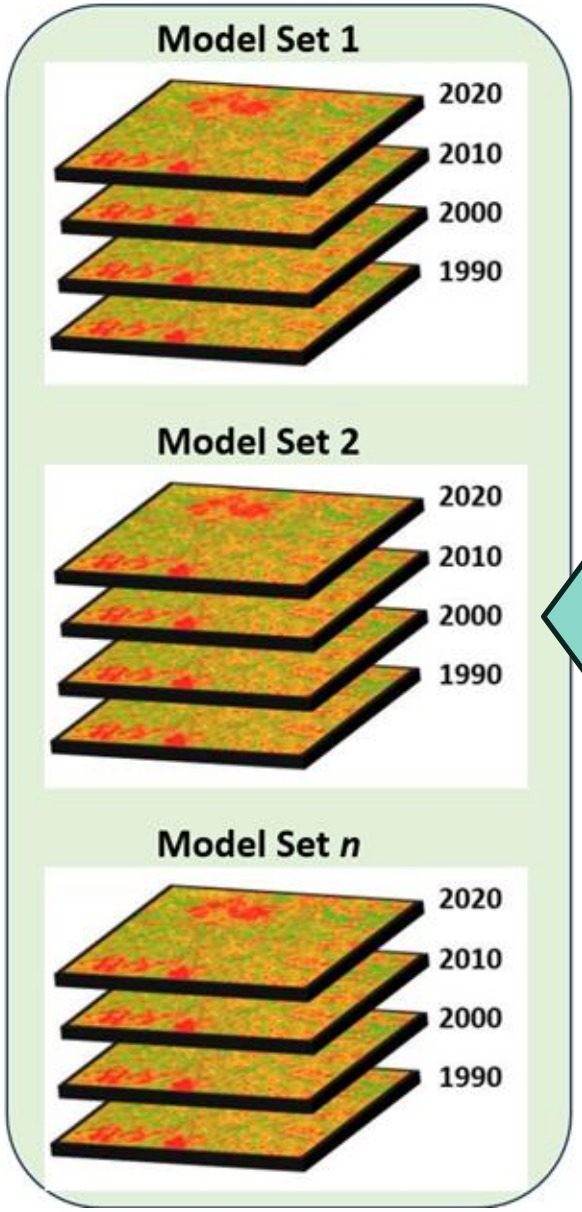
Rationale for OBIWAN API-Based Delivery Strategy

- We can't predict what years and places people will be interested in, and additionality options are almost infinite.
- Across market- and treaty-based commitment mechanisms, some users need security while others need transparency.
- Easy to standardize across affiliated clients (e.g., groups participating in the same market, jurisdictions supported by the same donors, etc.)
- Precomputation leads to faster query results
- Minimizes redundant computing, which controls costs

OBIWAN Delivery Paradigm

Google Cloud Asset (Contributed by Google)

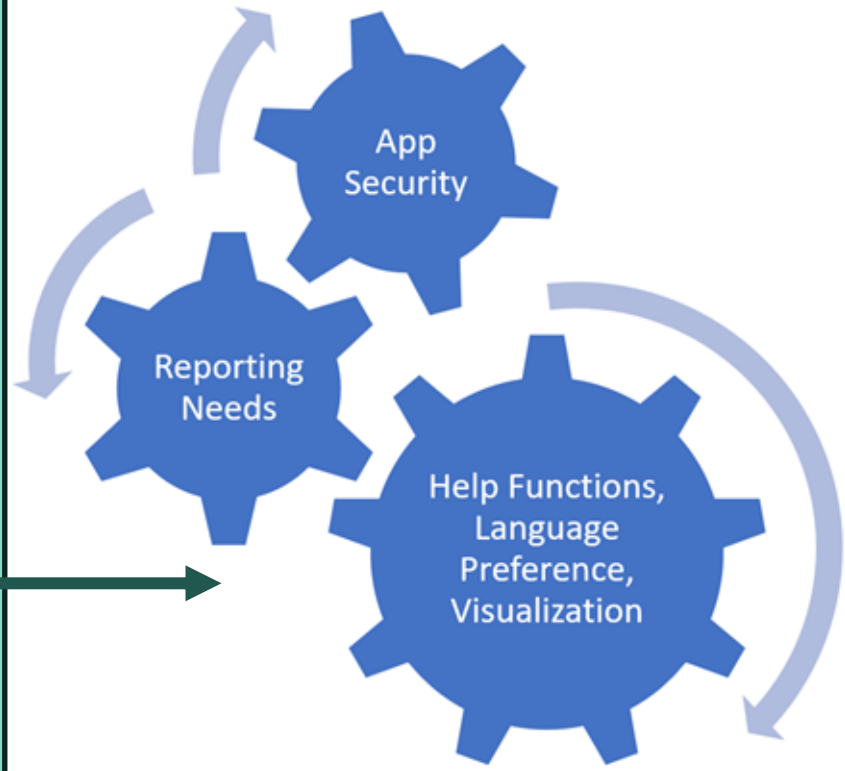
Bootstrapping of biomass models over time using GEDI lidar and Landsat time series



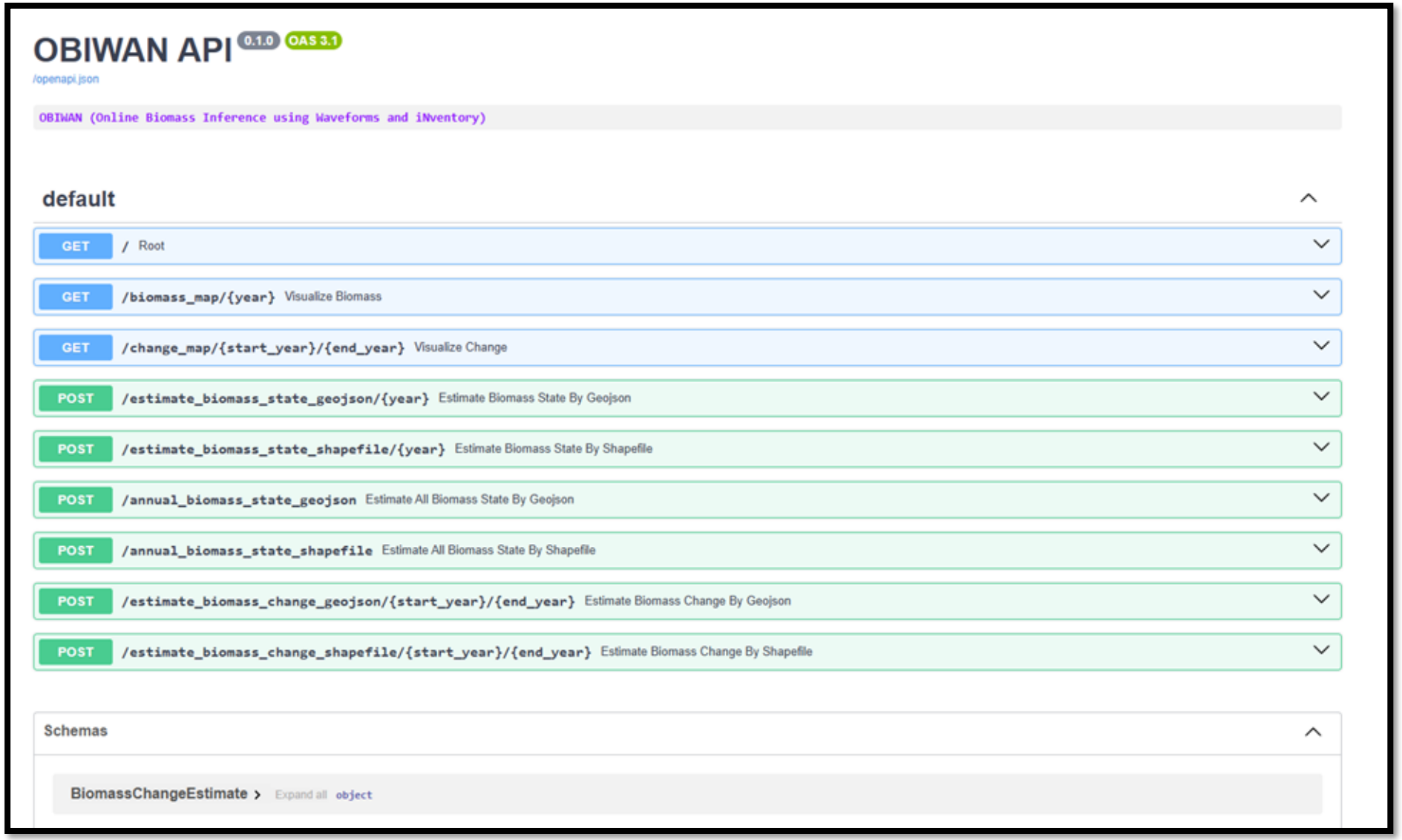
OBIWAN API

Functions that access the saved predictions to estimate biomass change, **with uncertainty**, for user defined areas and date ranges

Applications by Individual Users



API (Application Programming Interface) Endpoint

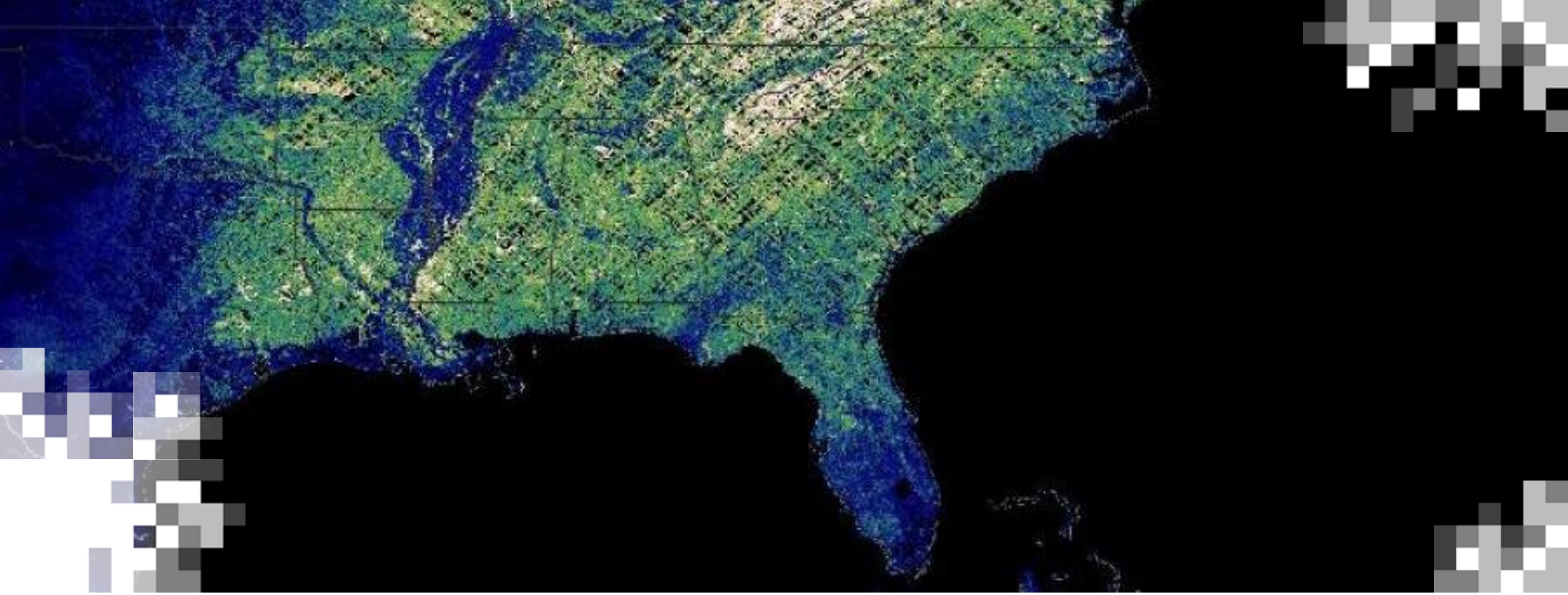


Resources

- A Closer Look at Uncertainties in Model-based Estimation of Forests
  - https://papers.ssrn.com/sol3/papers.cfm?abstract_id=5236489

- World Bank Background Regarding Monitoring, Reporting, and Verification of Carbon Credits
  - https://www.worldbank.org/en/news/feature/2022/07/27/what-you-need-to-know-about-the-measurement-reporting-and-verification-mrv-of-carbon-credits

- GEDI Launches a New Era of Biomass Estimation from Space
  - https://iopscience.iop.org/article/10.1088/1748-9326/ac8694/meta

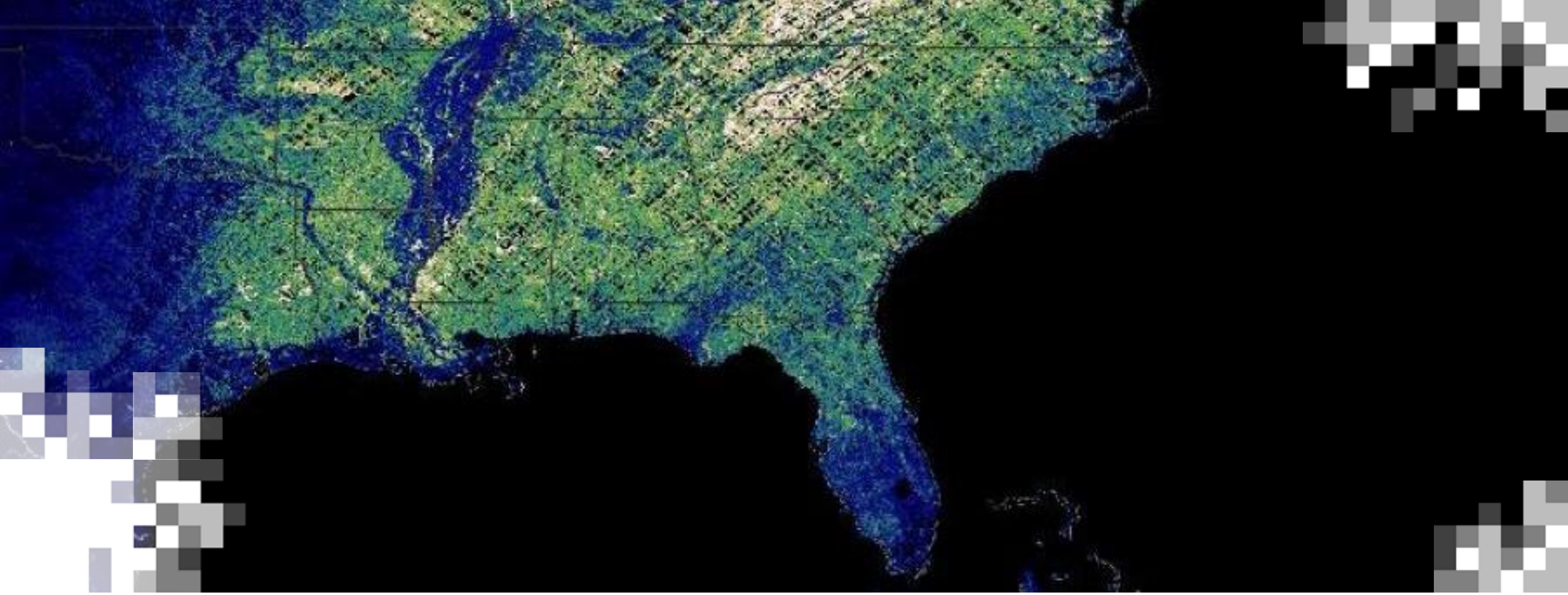


Hands-On Activity

OBI-WAN
Forest Carbon Reporting

In this hands-on session, we will use a Google Colab notebook to…

- Make calls to the API over Alabama (USA) to visualize and analyze changes in biomass for periods of interest
- Experiment with different options for establishing additionality
- Experience the impact of using calibration data to reduce OBIWAN biases
- See how simple API calls to the bootstrapped biomass asset on Google Cloud can return powerful inferences about biomass change



Session 2: Estimating Biomass Change with GEDI and the OBIWAN API

Summary

OBI-WAN
Forest Carbon Reporting

Summary

- OBIWAN can address climate change mitigation across different sectors by identifying management practices that reduce impacts.
- Uncertainty framework for carbon estimates is critical.
- Additionality is the concept of how management practices contribute to carbon storage trends. What would happen if you were not doing what you were doing?
- OBIWAN uses hierarchical bootstrapping to get a distribution of predicted changes.
- Optical imagery from sensors like Landsat do not 'see' through the canopy and are likely to:
  - Underpredict high biomass while overpredicting low biomass for a single point in time.
  - Underpredict changes between high- and low-biomass conditions.
- Calibration is a simple correction based on independent data and applied to the predictions to minimize bias.

Homework and Certificates

- **Homework:**
  - One homework assignment
  - Opens on 05/28/2026
  - Access from the training webpage
  - Answers must be submitted via Google Forms
  - **Due by June 18, 2026**

- **Certificate of Completion:**
  - Attend both live webinars (attendance is recorded automatically)
  - Complete the homework assignment by the deadline
  - You will receive a certificate via email approximately two months after completion of the course.

Contact Information

Sean Healey: sean.healey@usda.gov

- ARSET Website
- ARSET YouTube


APPLIED REMOTE SENSING TRAINING PROGRAM
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Thank You!