Key Role of NASA Airborne Programs in Support of Decadal Survey Science:

Perspectives from a Pathfinder Mission

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GEDI
ECOSYSTEM LIDAR

The Path from Question to Answer

E-1	**Ecosystem Structure, Function, and Biodiversity.** What are the structure, function, and biodiversity of Earth's ecosystems, and how and why are they changing in time and space?
E-2	**Fluxes Between Ecosystems, Atmosphere, Oceans, and Solid Earth.**
E-3	**Fluxes Within Ecosystems.**
E-4	**Carbon Accounting.**
E-5	**Carbon Sinks.**

Measurement Priorities
- Ecosystem structure, etc.

Mission Science Requirements
- "80% of 1 km cells have estimate of mean biomass within 20%"

Requirements Cascade
- Instrumentation (e.g. lidar)
- TRL assessment
- Algorithm development
- Data products
- Data quality/quantity
- Calibration/validation

AIRBORNE PROGRAM

The GEDI Example of Biomass

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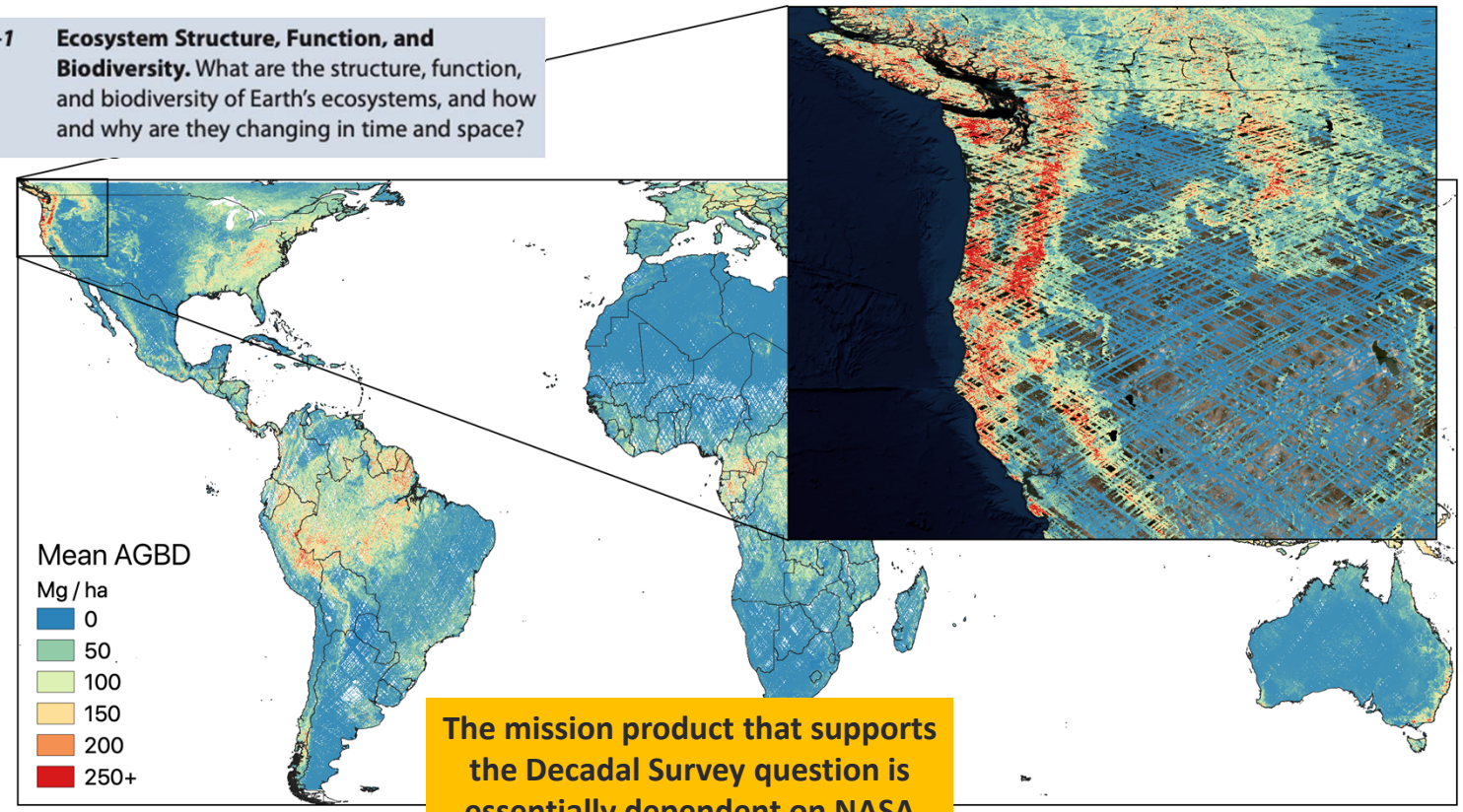
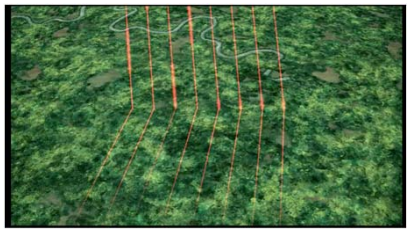
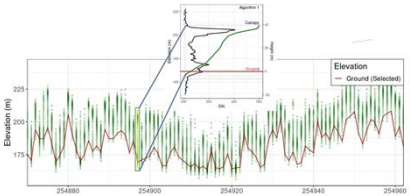


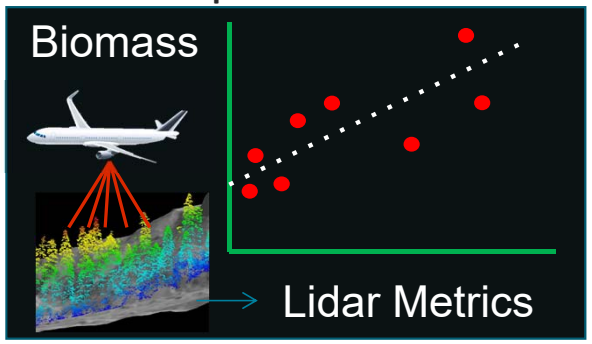


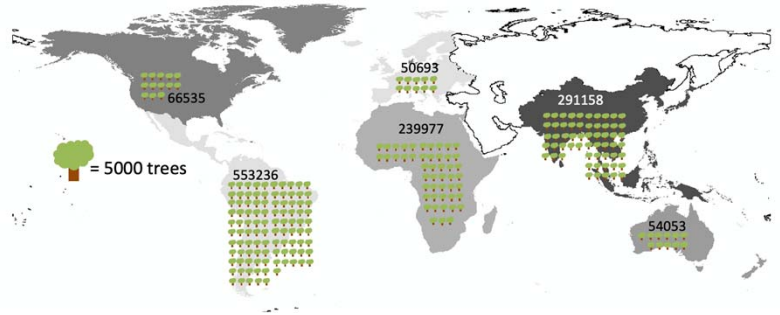


The mission product that supports the Decadal Survey question is essentially dependent on NASA airborne assets

GEDI Calibration Entirely From Airborne Data

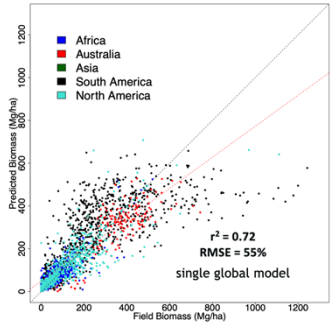
Develop calibrations between airborne lidar and field plots

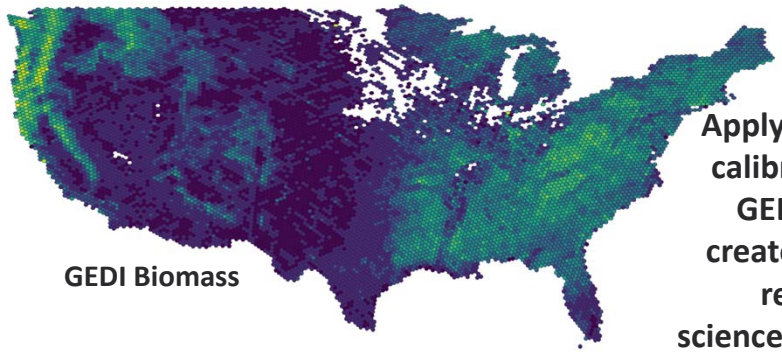




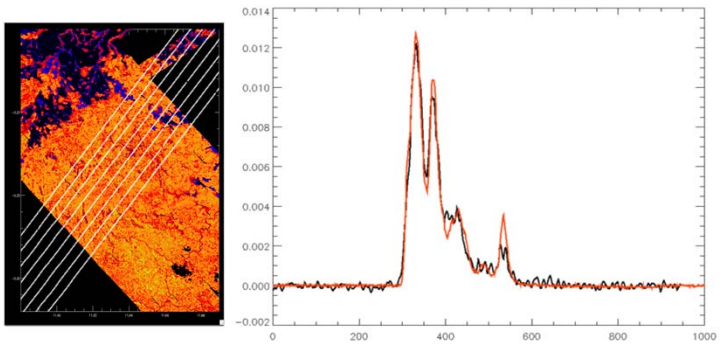
GEDI used NASA LVIS and lidar over 65 projects globally with field data base of 2 million trees.

Do calibrations support meeting mission science requirements?





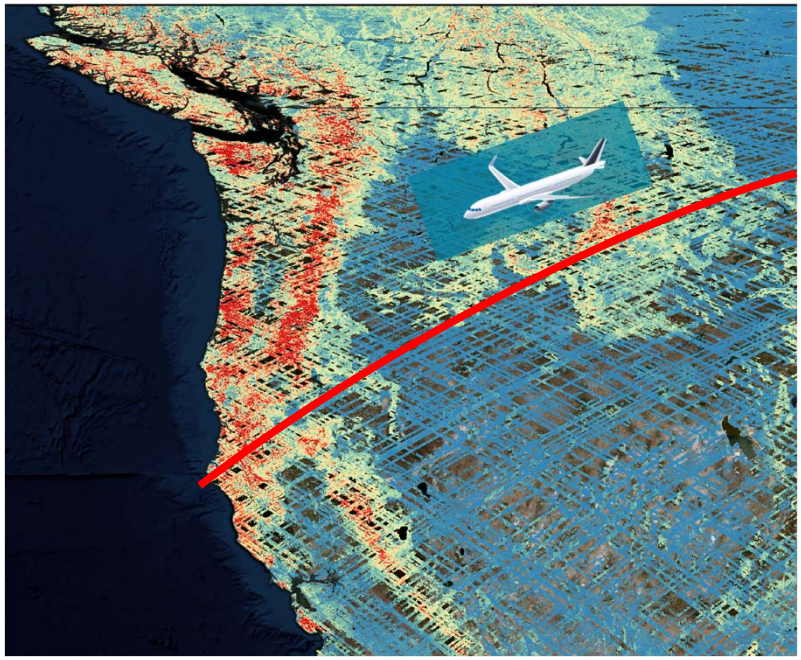
Apply airborne calibrations to GEDI data to create product relevant to science question



Compare on-orbit GEDI with LVIS to validate pre-launch assumptions.

Key Points of Airborne Programs for DS Science

- Development of algorithms, and their calibration and validation
- Validation of mission requirements pre-launch towards meeting science goals
- Post-launch calibration, validation and assessment
- Supporting pre-launch data bases that enable community expertise, facilitate international collaboration



Long transits with suite of sensors is desirable

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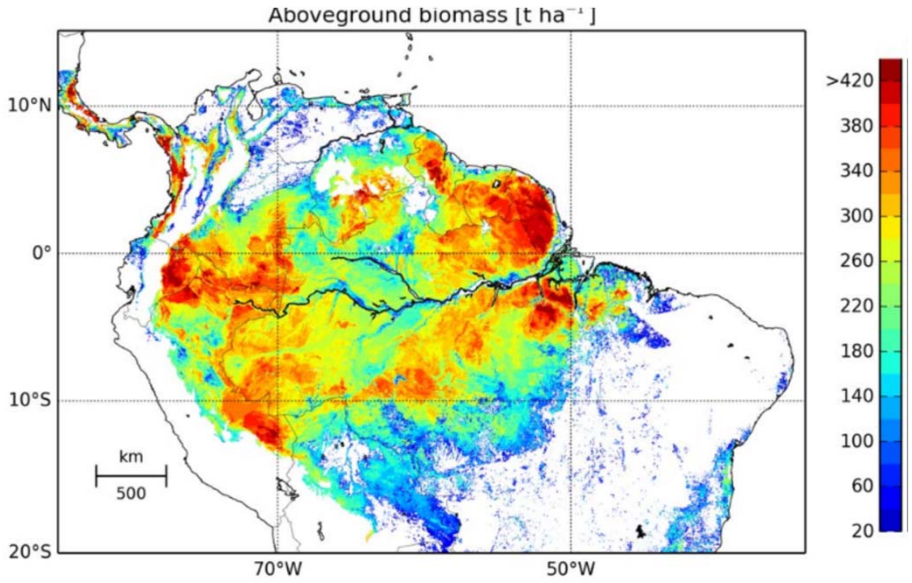
- Providing data for development of models that can use new data
  - Large-area validation of model-data integration



Rodig et al., 2018, *Glob. Ecol. and Biog.*

Validation of ecosystem models initialized with next generation of Decadal Survey observations

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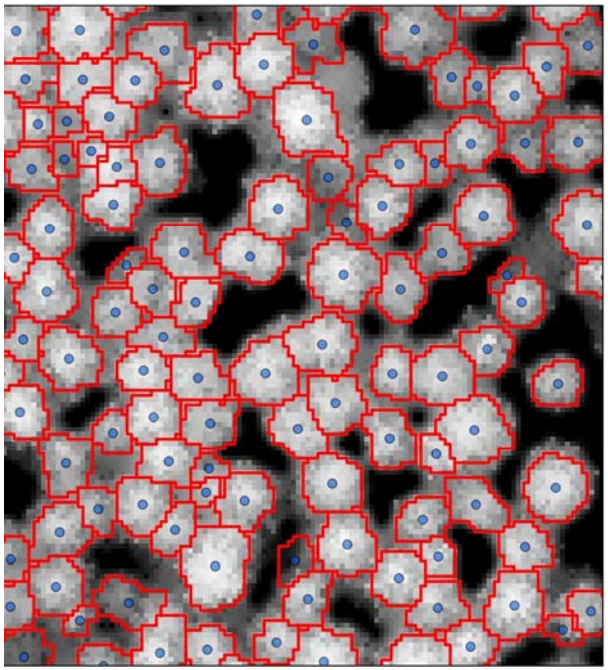
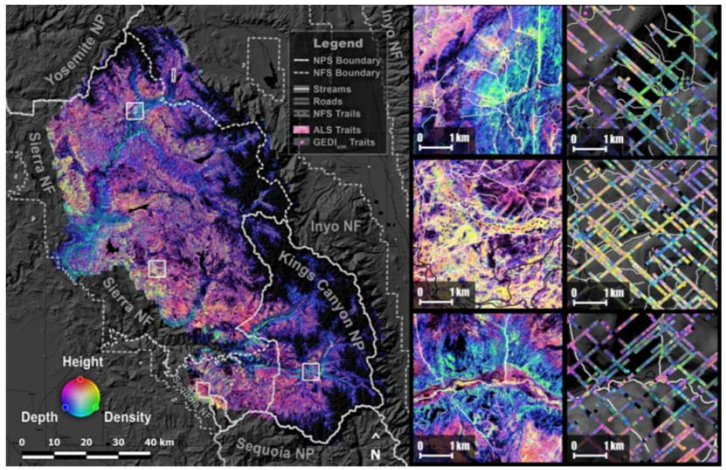
  - Large-area validation of model-data integration
- Prototyping & advancing TRL



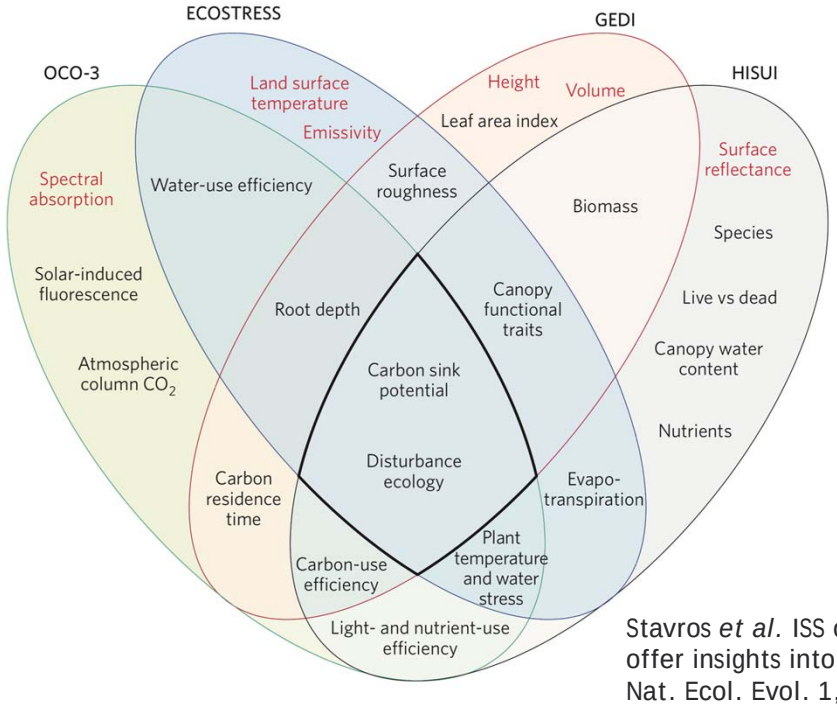
Measurement of high-resolution canopy structure over large areas will need investment

Key Points of Airborne Programs for DS Science

- **Development of multi-sensor fusion frameworks**



Schneider *et al.* Towards mapping the diversity of canopy structure from space with GEDI. *Env Res Ltrs* (in press).



Stavros *et al.* ISS observations offer insights into plant function. Nat. Ecol. Evol. 1, (2017).

Technology to simultaneously observe structure, function and composition remotely over large areas is nascent but a priority for Decadal Survey