The power of GEDI: Investigate the efficacy of spaceborne Lidar to model biodiversity and characterize habitat heterogeneity at the continental and global scales

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NASA

GEDI
ECOSYSTEM LIDAR

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Background

- Vegetation's three-dimensional (3-D) structure is a key predictor of biodiversity.
- Vegetation vertical structure, often difficult to observe by optical remote sensing instruments, is a critical but rarely examined component of habitat heterogeneity
- Most previous studies are limited to relatively small spatial extents or focused only on canopy height-related metrics
- Full-waveform Lidar sensors such as Land Vegetation and Ice Sensor (LVIS) provide us a window to gauge GEDI's capability.
- The availability of GEDI data provides an opportunity to evaluate the importance of habitat vertical structure on biodiversity at broad scales.

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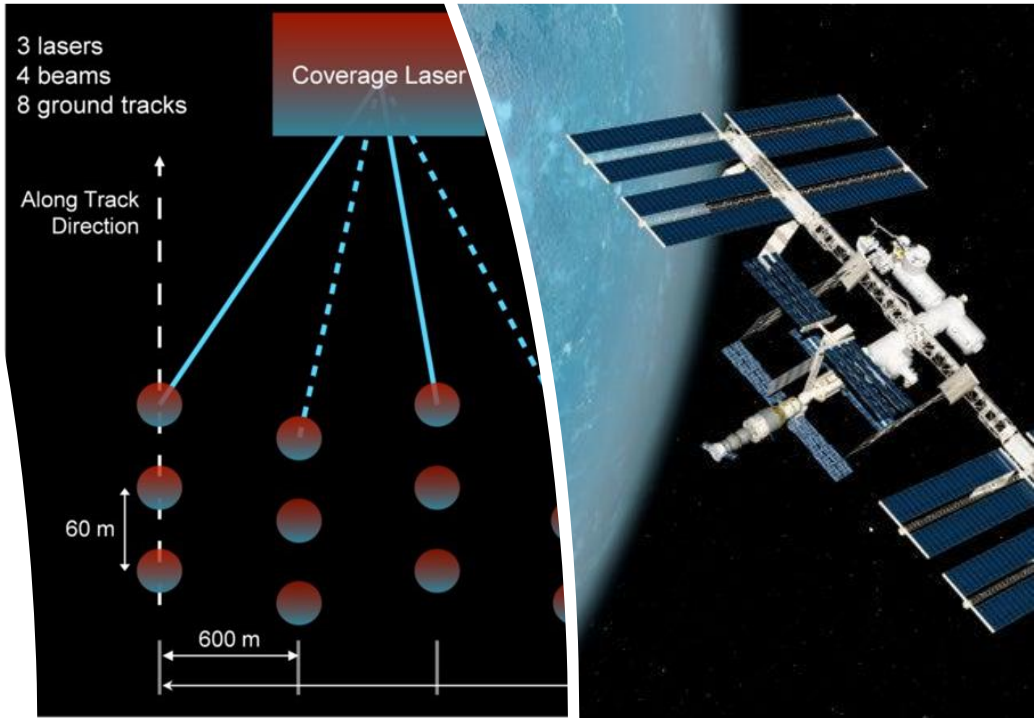
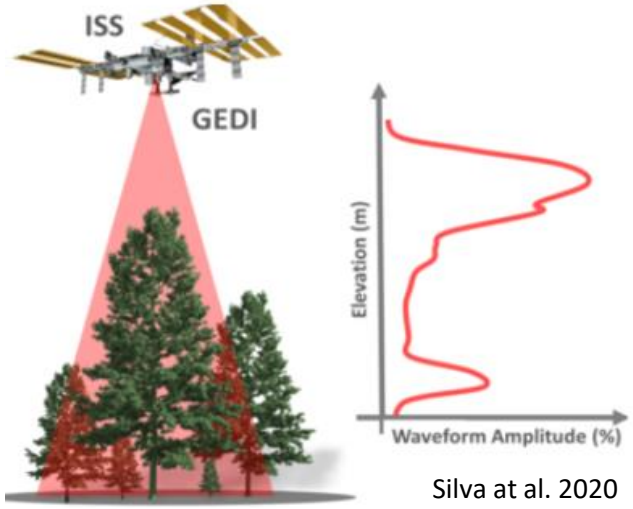
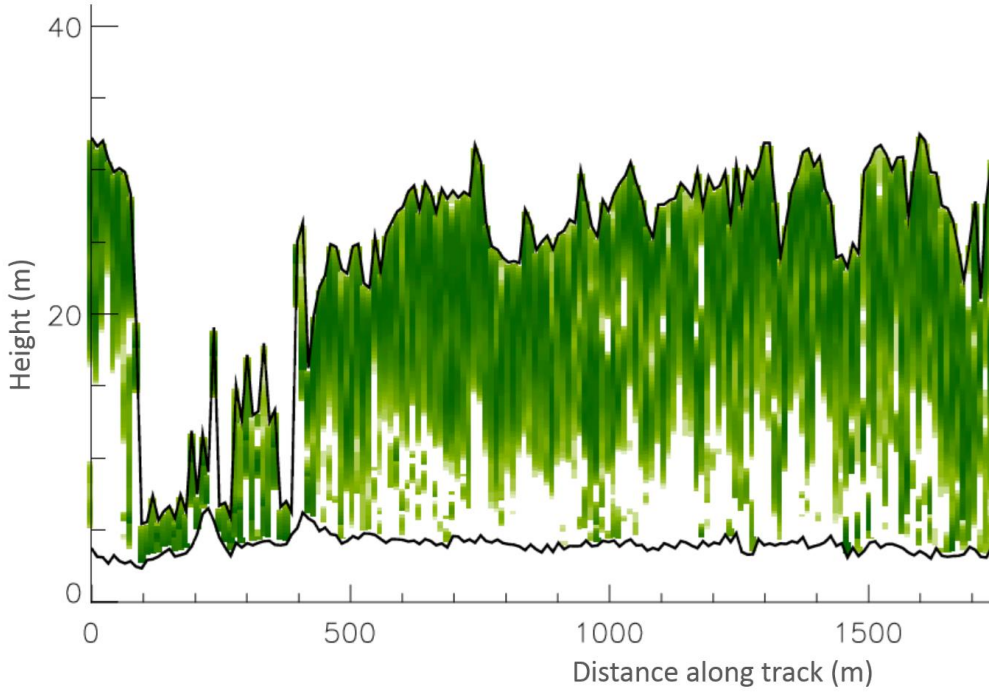
- **Research Objectives:**
- *1.* ***Model*** *avian richness in Western Hemisphere*.
- *2.* ***Produce*** *novel habitat heterogeneity products with global coverage.*
- *3.* ***Examine*** *model efficacies in explaining global bird, amphibian, and mammal richness* with the novel heterogeneity metrics.



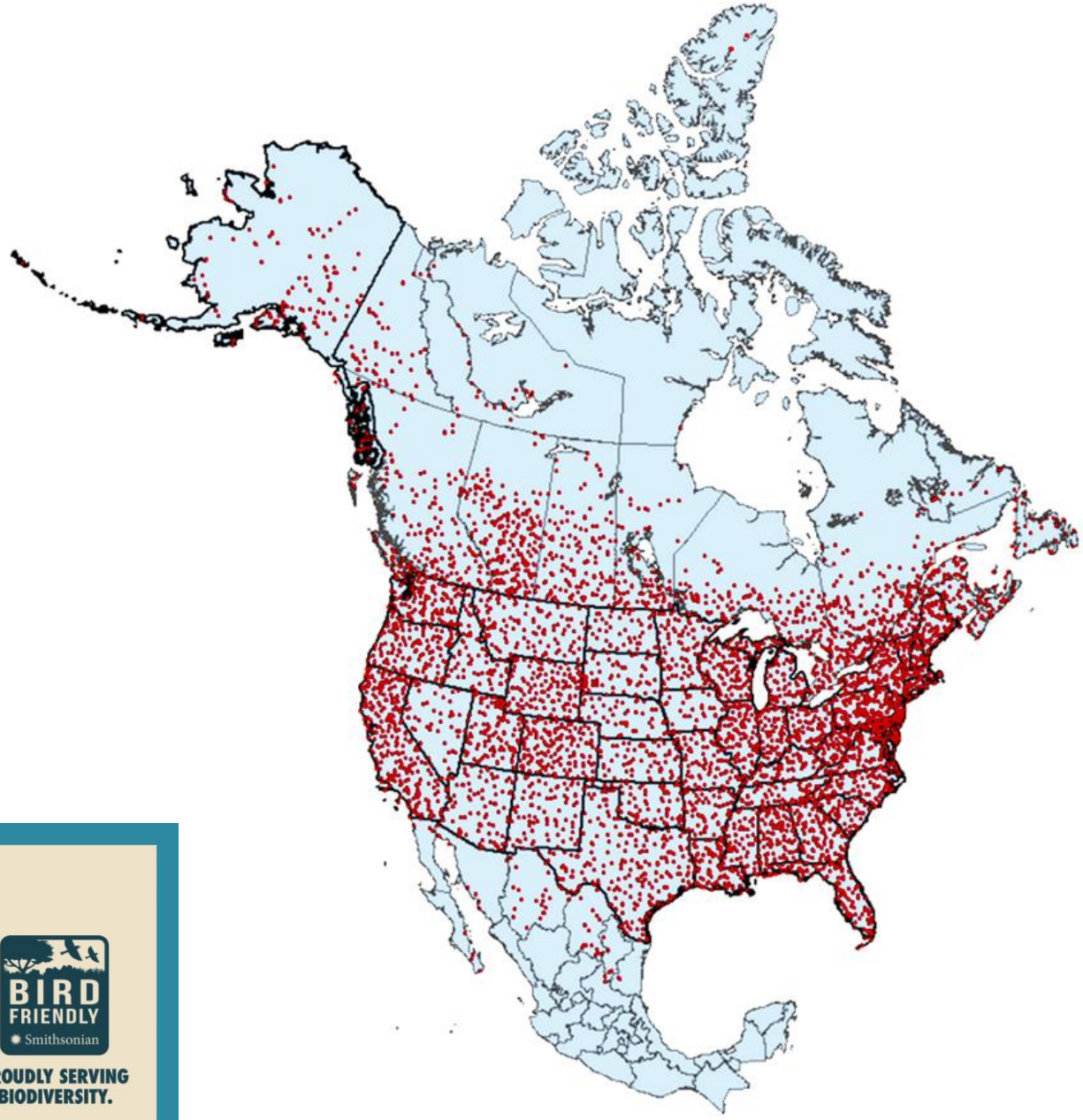


Silva at al. 2020



Project Progress

- Modeled North American breeding bird richness
- Model forest tree richness using ForestGEO and NEON data
- Map bird friendly shade coffee agroforestry in South America



Preliminary results: modeling North American breeding bird richness

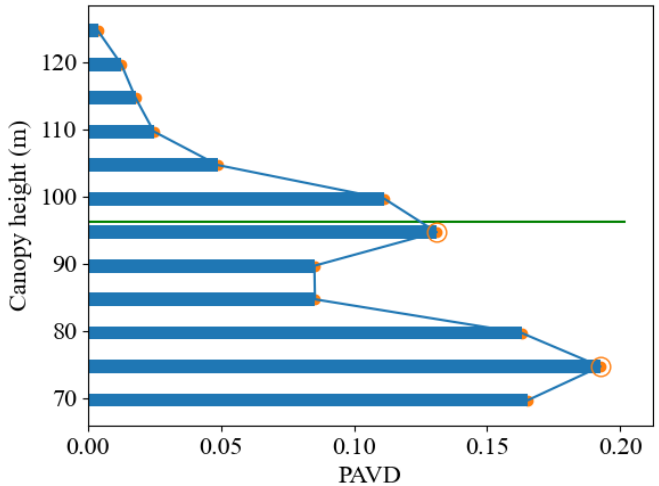
	R^2	RMSE
Neotropical migrant	0.51	5.68
Permanent resident	0.39	2.98
Short distance migrant	0.32	4.37
Cavity Nesting	0.58	2.56
Ground Nesting	0.32	3.76
Mid-story Nesting	0.58	5.41
Woodland	0.76	5.06

GEDI L2B Metrics

- Canopy Height (CH, RH100, m)
- Plant Area Index (PAI, m2/m2)
- Foliage Height Diversity (FHD, N/A)
- Plant Area Volume Density (PAVD, m2/m3)

Derivative Metrics

- Number of foliage layers
  - For example (bottom figure): two peaks
- canopy ratio: sum of PAVD in the top strata /sum of PAVD in bottom strata
  - For example (bottom figure): 0.22 / 0.66 = 0.33



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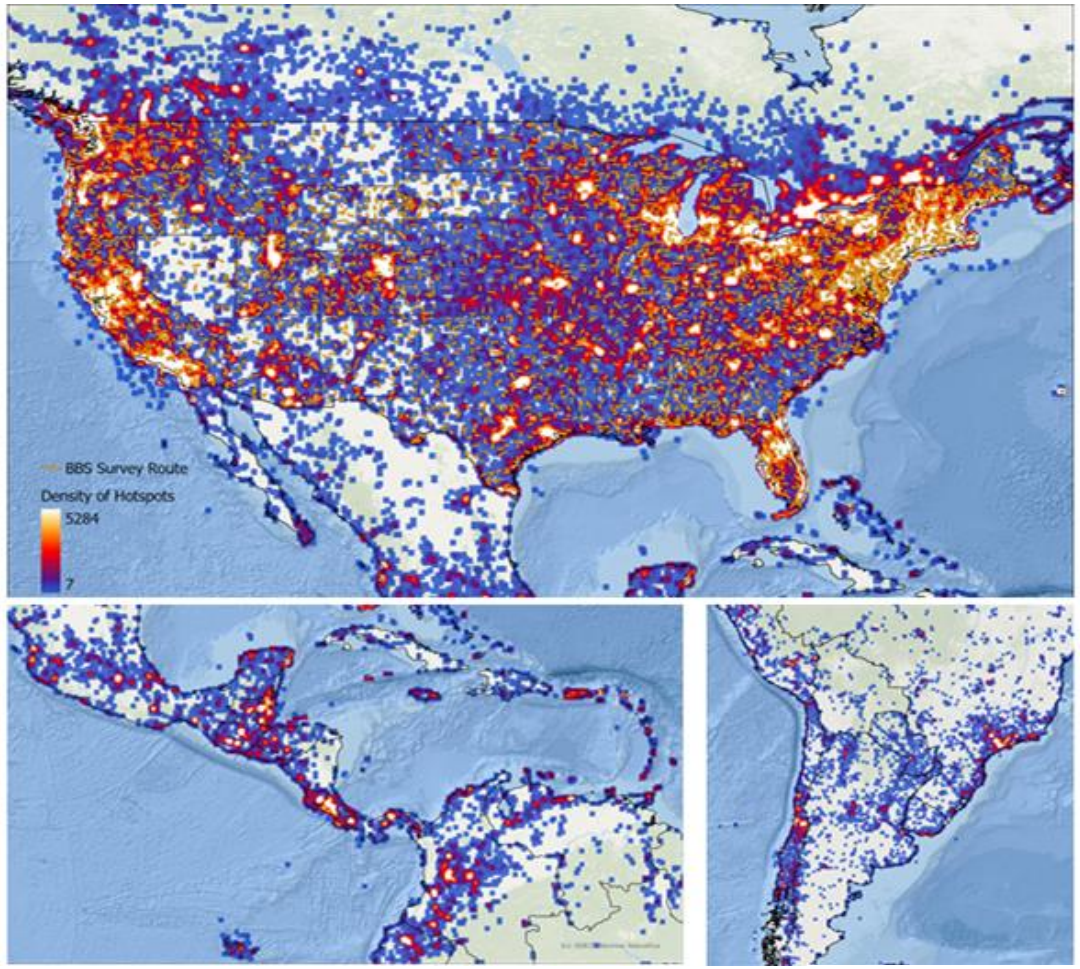
- Next Step:
- Integrating GEDI L2A products on NASA

MAAP (The multi-mission Algorithm and Analysis Platform).

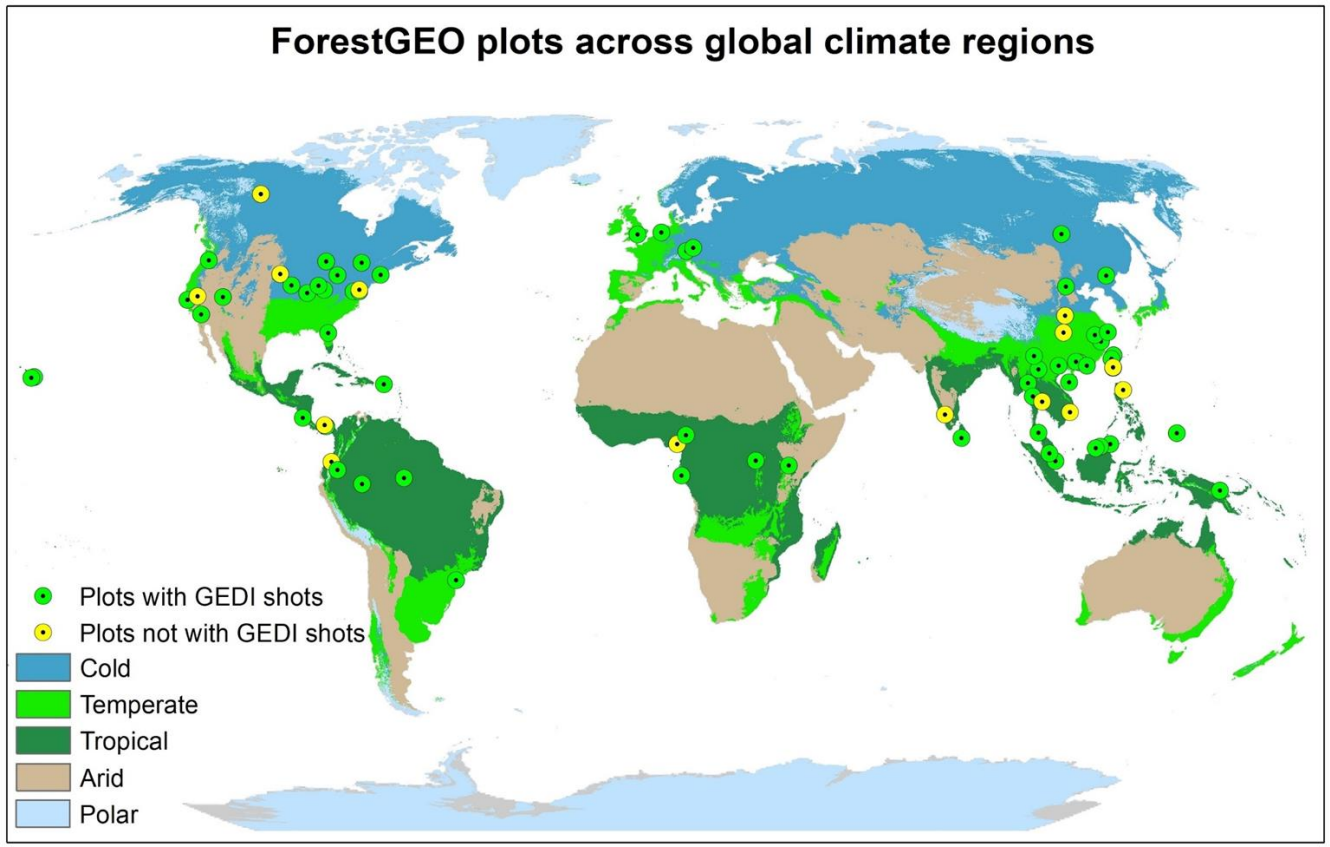
- Continental analyses using eBird data

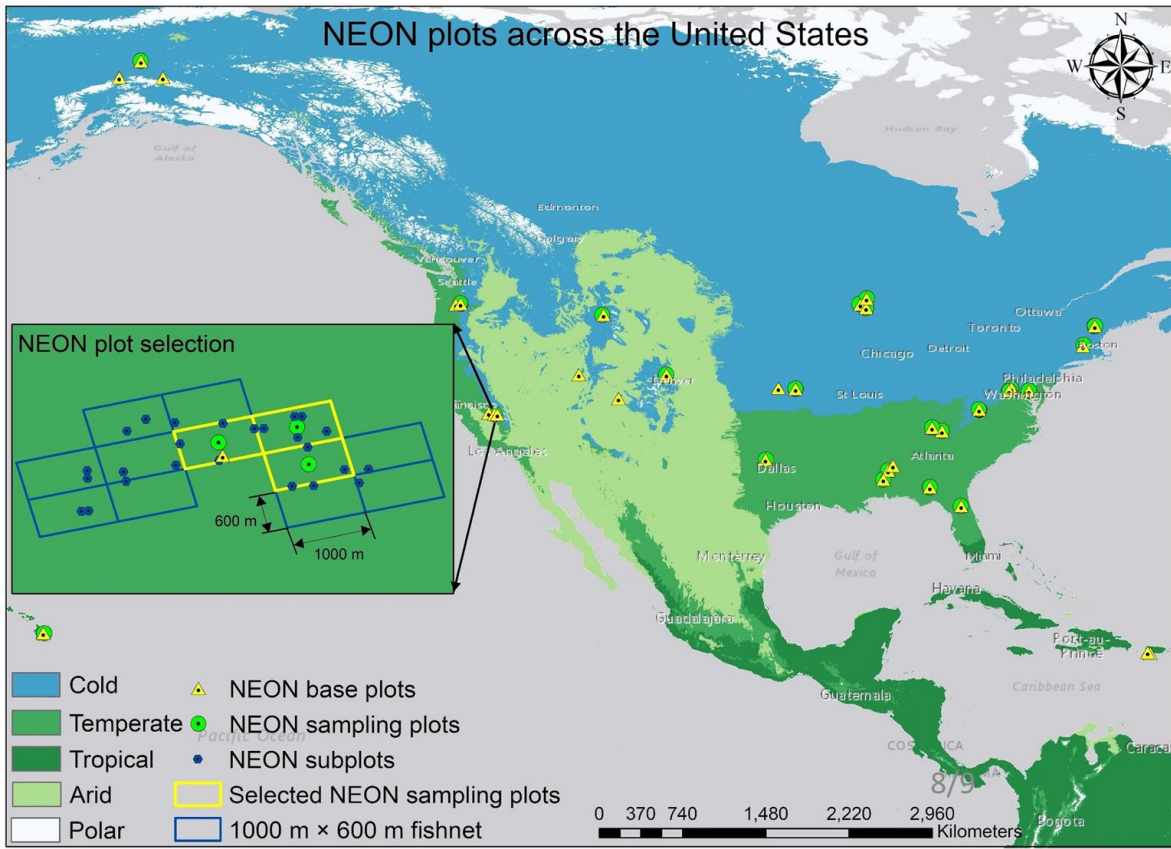


eBird

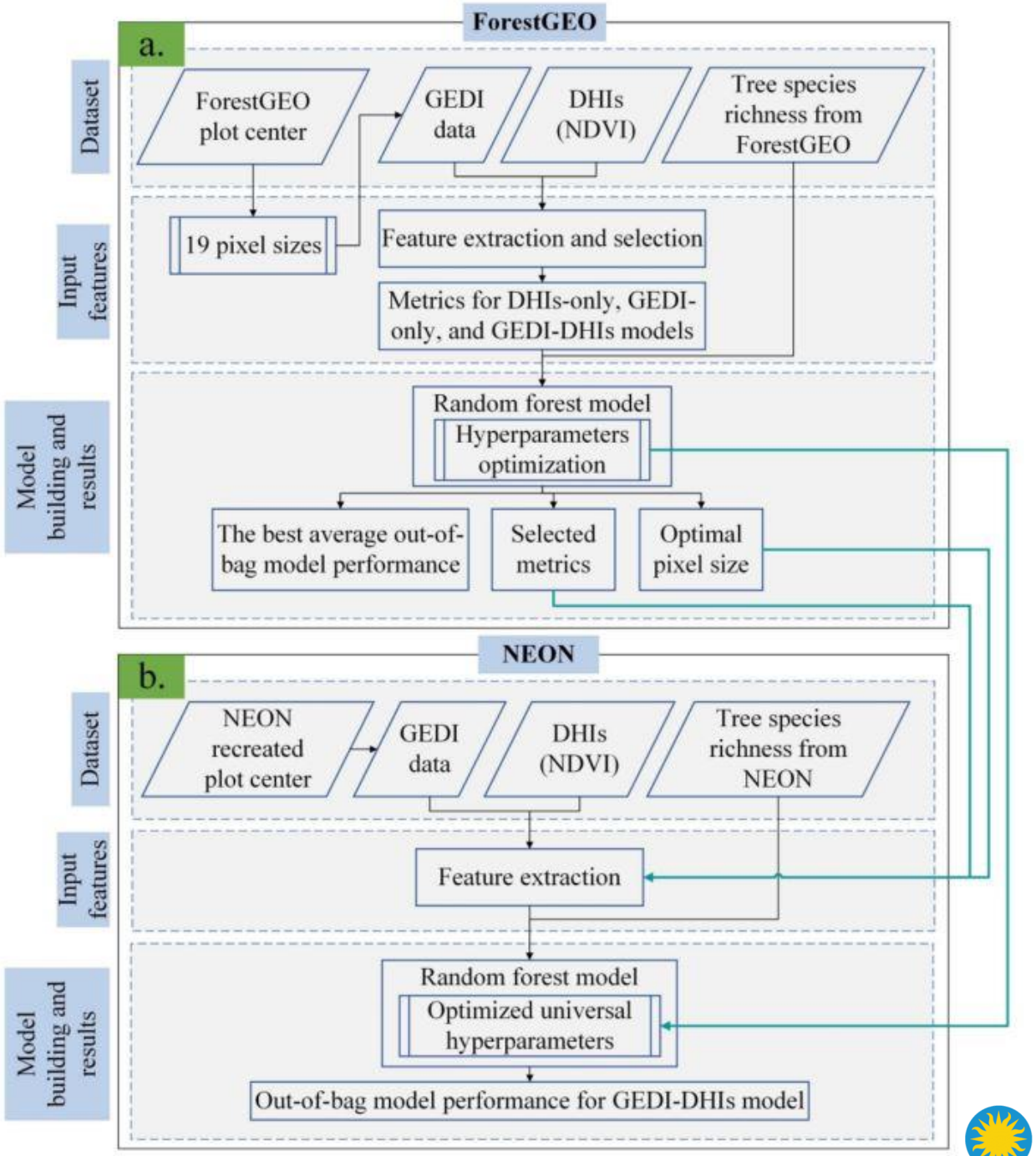
Modeling Global Forest Tree Biodiversity

- The Forest Global Earth Observatory (ForestGEO, n = 74)
- National Ecological Observatory Network (NEON, n = 51)





Workflow



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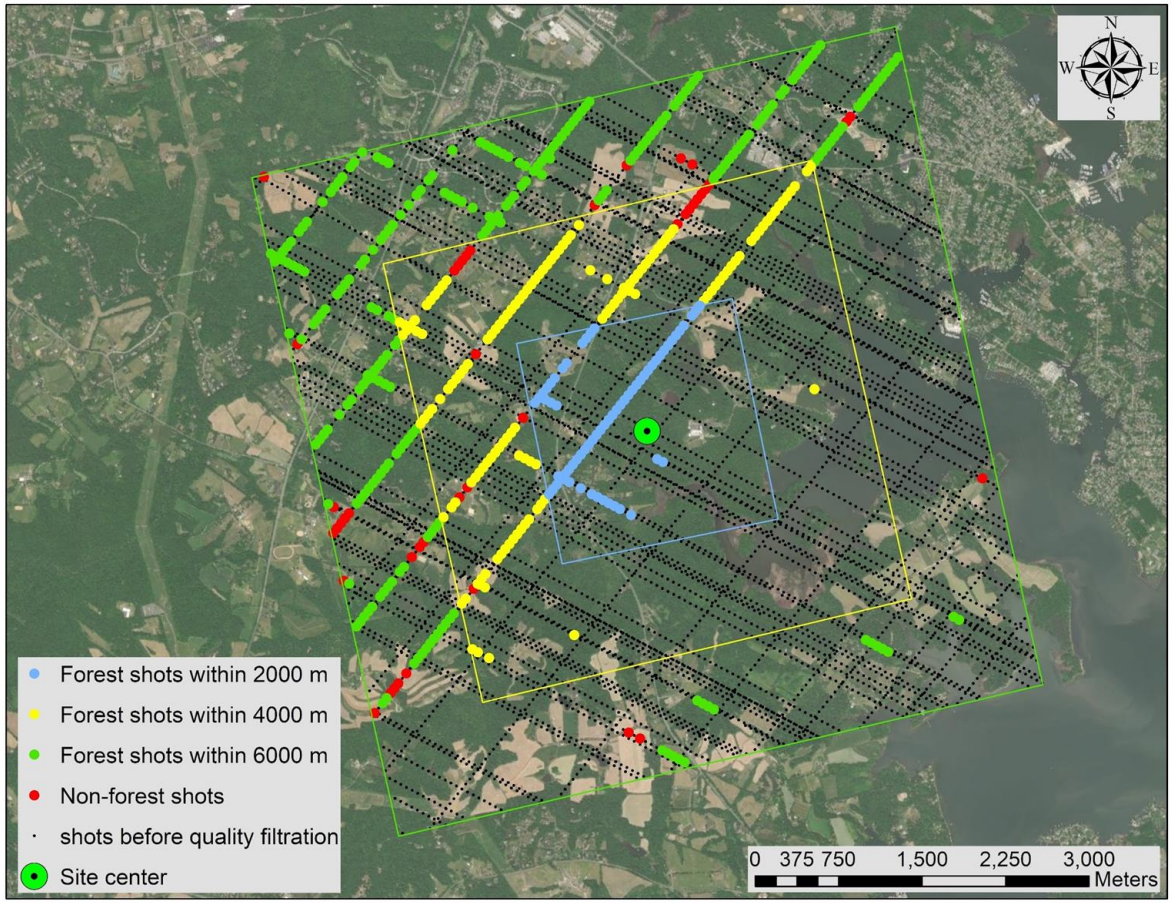
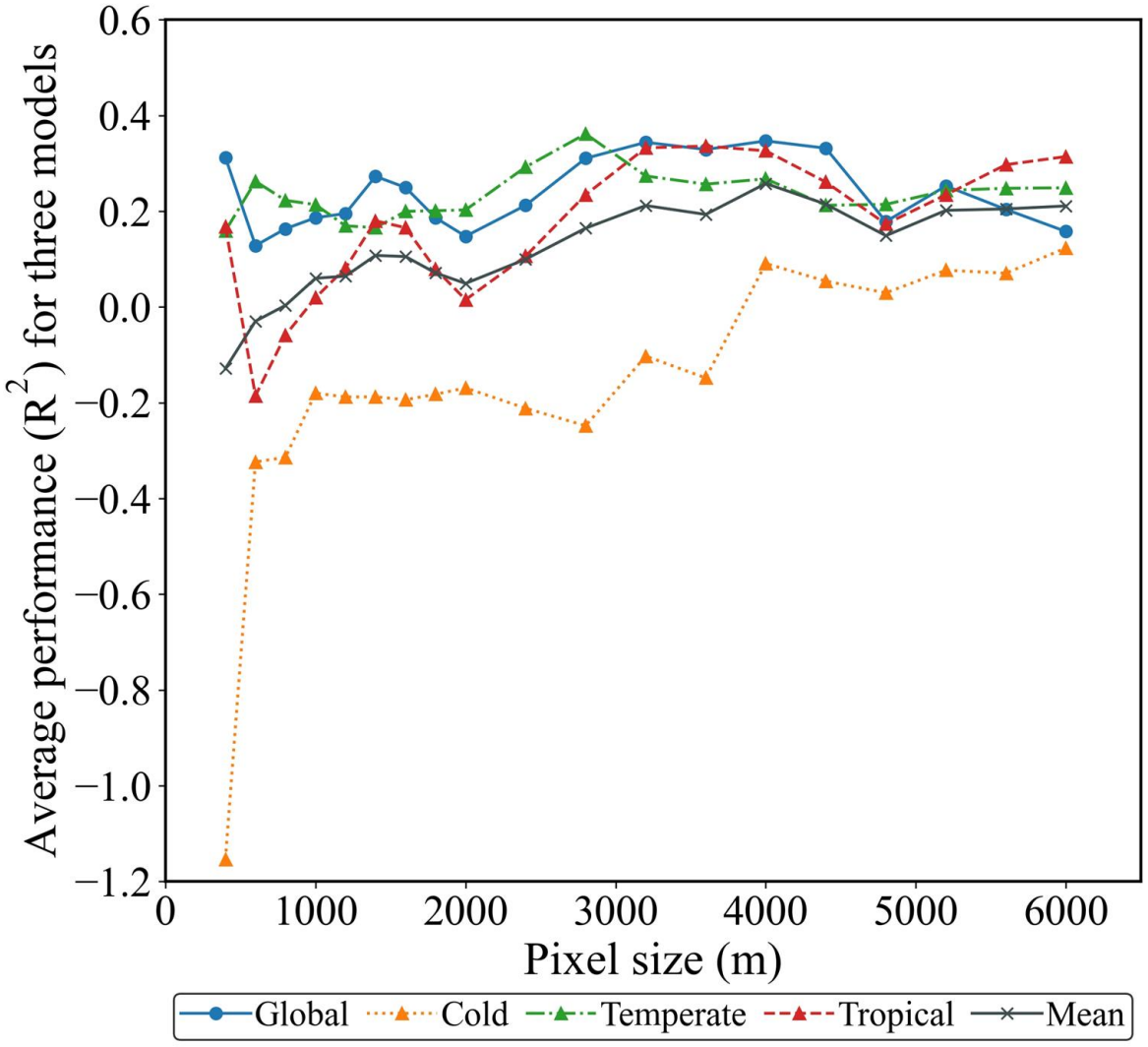
Spatial Buffer Size :

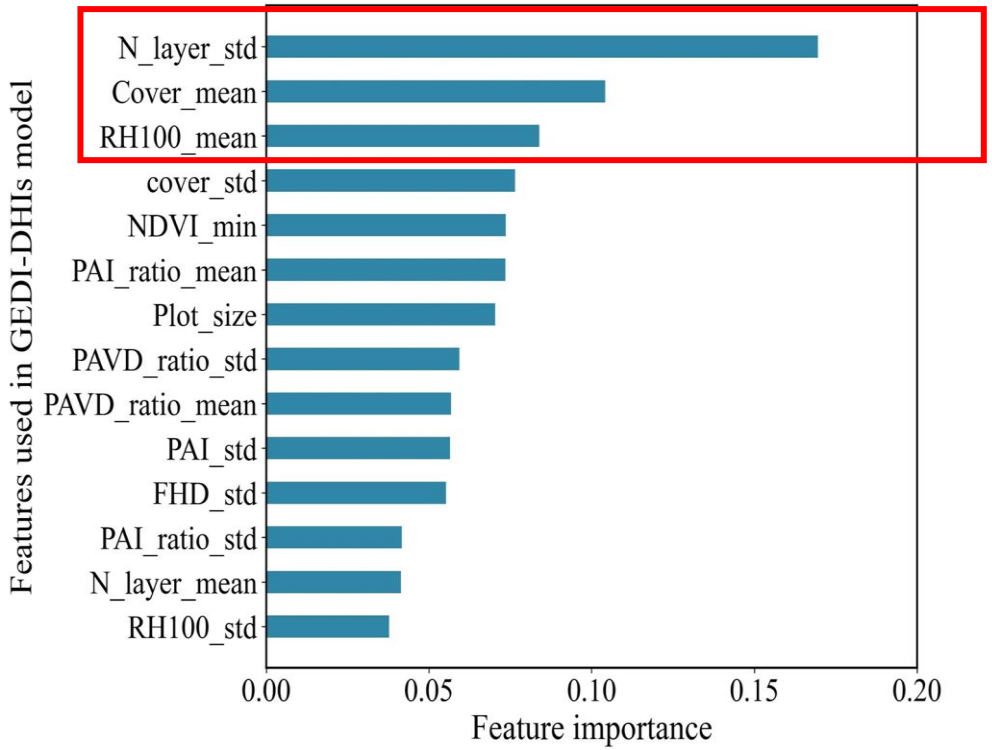
- Tested 19 buffer sizes ranging between 400 m – 6000 m



ForestGEO plot located at Smithsonian Environmental Research Center (Edgewater, MD) with 2000 m (blue), 4000 m (yellow), and 6000 m (green) buffer sizes.



Response variable	Models	Predictors
ForestGEO tree species richness	NDVI-based DHIs-only	Plot size + spectral vegetation metrics
	GEDI-only	Plot size + GEDI metrics
	GEDI + NDVI-based DHIs	Plot size + GEDI metrics + spectral vegetation metrics



Model Performance	DHIs-only (ForestGEO)	GEDI-only (ForestGEO)	GEDI + DHIs (ForestGEO)	GEDI + DHIs (NEON)
	R^2	R^2	R^2	R^2
Global	**0.24**	**0.39**	**0.41**	**0.64**
Cold	0.05	0.10	0.12	**0.47**
Temperate	**0.09**	**0.35**	**0.37**	**0.77**
Tropical	0.28	0.37	0.32	-

Jin Xu, Volker C. Radeloff, Melissa Songer, Kjirsten Coleman, Qiongyu Huang **Modeling Worldwide Tree Biodiversity Using Canopy Structure Metrics from Global Ecosystem Dynamics Investigation (GEDI) data** (under revision) *Global Ecology and Biogeography*.

Bird Friendly Canopy Structure Requirements

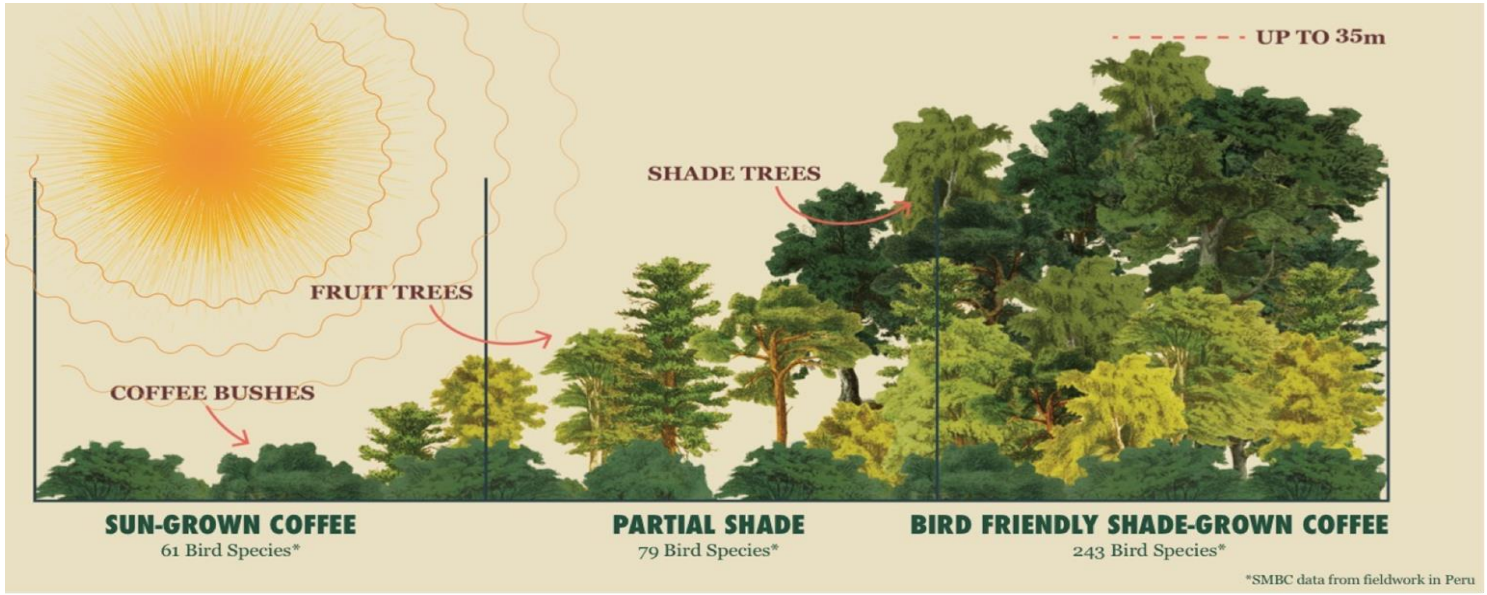
40% shade cover

Canopy height > 12 m

Structural diversity (3 canopy layers)

Epiphytes such as ferns, orchids, bromeliads

	Classification accuracy	GEDI, All variables + elevation
Footprint-level	Shade coffee, sun coffee, natural forest, shrub, settlement (5 classes)	78.1%
	natural forest V.S. shade coffee (2 classes)	83.9%
Polygon-level	Shade coffee, sun coffee, natural forest, shrub, settlement (5 classes)	77.8%
	natural forest V.S. shade coffee (2 classes)	77.1%



What is the feasibility of using remote sensing, particularly spaceborne lidar, to identify areas of coffee agroforestry offering high quality habitat for birds?

Thank You!

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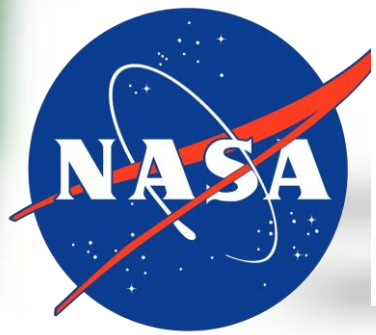

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