





#### Forest structure and biomass mapping using the fusion of GEDI and TanDEM-X data

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## Motivation of GEDI-TanDEM-X Data Fusion

• GEDI provides unprecedented lidar observations of ecosystem structure in tropical and temperate forests



- GEDI's sampling nature limits the spatial resolution of the gridded products to >=1km.
- Finer resolution (<=1 ha) maps are needed





## **Goal and Objectives**

**Goal:** Development and application of methods for mapping forest structure, carbon stocks and their changes using observations from GEDI and TDX.









# **Background and Fusion Advantages**

- TanDEM-X (TDX) provides high-resolution interferometric coherence observations
  - Capable of deriving topography and elements of canopy structure globally
  - 2010 2025 (complete global coverage every 3 years; potential for structure and biomass change study)
- Limitations in height estimation from TDX
  - Lack of penetration by X-band in vegetation
  - Single-polarization data at global scale
  - Prerequisite forest structure information improves height inversion from TDX coherence
- Higher resolution and more accurate products than from either mission alone







#### **Current Fusion Framework**







# Pantropical Study Areas

- Processed 30,000 TDX scenes covering 10,000,000 sq. km.
- Canopy Height and Biomass (gap-free)
  - 25 m, 100 m, 1 km
  - Mexico, Amazon Basin, French Guiana, Gabon
  - Uncertainty layers available
- Maps were submitted to DAAC:
- Entire pantropics and U.S. forests will be covered to map structure, biomass and their changes in support of MRV activities







## Canopy Height (25 m)



#### Biomass (25 m)



### Canopy Height Uncertainty (25 m)



Saarela, S., Holm, S., Healey, S.P., Patterson, P.L., Yang, Z., Andersen, H.E., Dubayah, R.O., Qi, W., Duncanson, L.I., Armston, J.D. and Gobakken, T. (2022). "Comparing frameworks for biomass prediction for the Global Ecosystem Dynamics Investigation." Remote Sensing of Environment 278: 113074.





#### Biomass Uncertainty (25 m)



The GHMB framework allows for explicit uncertainty estimates at pixel and aggregate scales







## Filling Up GEDI L4B Gaps



Study Sites	GEDI L4B Grids	GTDX 1 km Grid	Grids Filled	RMSE between GEDI L4B and GTDX
Gabon	81,985	215,199	133,214 ( <mark>61.9%</mark> )	54.2 mg/ha
Mexico	1,455,461	1,737,098	281,637 (16.2%)	28.5 mg/ha
French Guiana	38,837	67,004	28,167 ( <mark>42.0%</mark> )	63.3 mg/ha
Amazon	4,025,716	5,762,814	1,737,098 ( <mark>30.1%</mark> )	45.1 mg/ha





#### US Forest Sites (Canopy height)







#### US Forest Sites (Biomass)









#### Summary and Future Work

- Efficacy of GEDI and TDX data fusion in pantropical and US temperate canopy height and biomass estimation
- Demonstrative height and biomass products are delivered for the GEDI mission
- Future work
  - Expand the fusion framework to other pantropical countries (e.g., <u>ASEAN countries: Indonesia, Vietnam,</u> <u>Fiji, Laos, Brunei Darussalam, Philippines, Cambodia, Malaysia, Myanmar, Singapore, Thailand</u>), temperate US (<u>Maryland, Washington</u>) and Hawaii via CMS project
  - Overcoming limitations data transfer pipeline within DLR and between DLR and UMD
  - Incorporation of all GEDI data and TDX acquisitions from different epochs
    - Higher spatial resolutions, accuracies, and change are facilitated





# Thank You!

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