

Biomazon

A Multimodal Benchmark for Full Vertical Structure and Biomass Modeling in the Amazon Basin

SAYAN MANDAL^{1,2}, ROCCO SEDONA¹, SIMON BESNARD³, MIKHAIL URBAZAEV³, EHSAN ZANDI¹,
GABRIELE CAVALLARO^{1,2}

1. JÜLICH SUPERCOMPUTING CENTRE, FORSCHUNGSZENTRUM JÜLICH, 2. FACULTY OF ELECTRICAL AND COMPUTER ENGINEERING, UNIVERSITY OF ICELAND,
3. GFZ GERMAN RESEARCH CENTRE FOR GEOSCIENCES

Speakers:



Sayan Mandal
PhD Researcher,
Simulation and Data Lab,
AI/ML for Remote Sensing,
Jülich Supercomputing Centre (JSC)

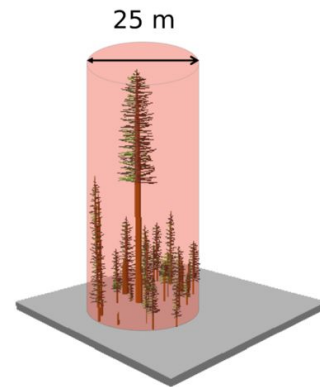
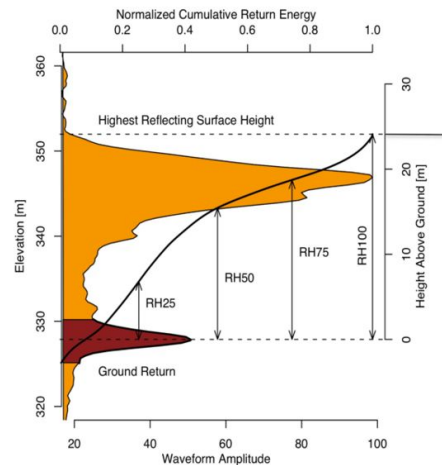


Rocco Sedona
Deputy Head,
Simulation and Data Lab,
AI/ML for Remote Sensing,
Jülich Supercomputing Centre (JSC)

1. Biomazon

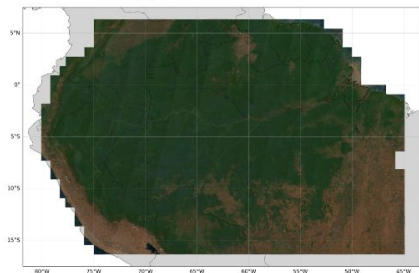
- Problem: ML pipelines predict canopy top-height (RH95/RH98) or AGBD as single scalars and discard the vertical structure GEDI measures.
- Biomazon: a 20 m ML-ready multimodal benchmark over the Amazon Basin (913 tiles, 1.33 M patches, 2019 to 2023) to model full RH profile + AGBD.
- Standardized spatial splits and product-aligned comparisons.

* Figure taken from <https://gedi.umd.edu/mission/technology/>

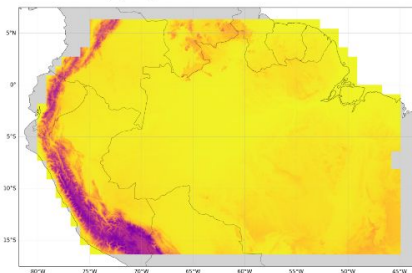


2. Coverage

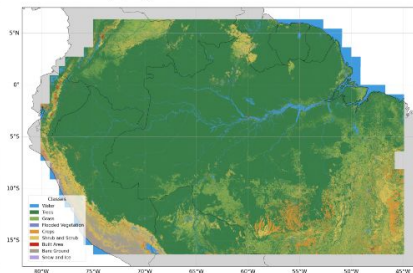
(a) Sentinel-2 L2A SR



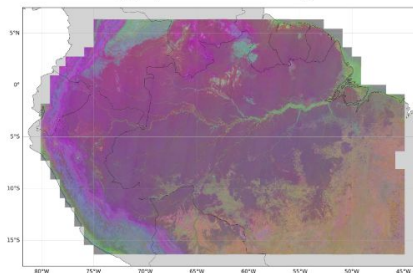
(b) Copernicus DEM GLO-30



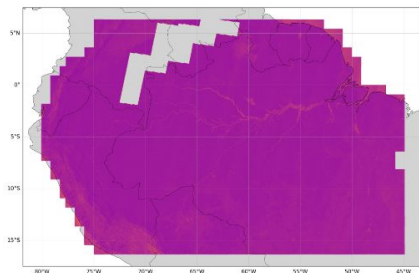
(c) Dynamic World V1 LULC



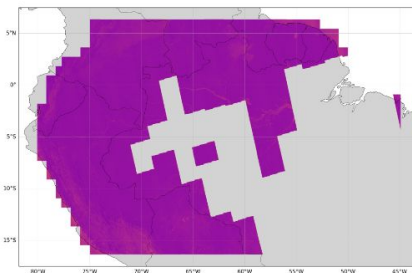
(d) AlphaEarth Embedding



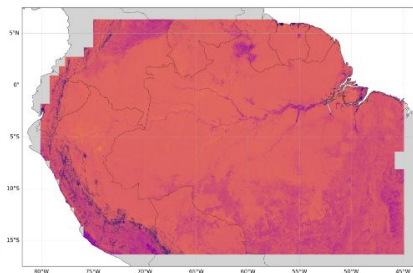
(e) Sentinel-1 SAR GRD Descending



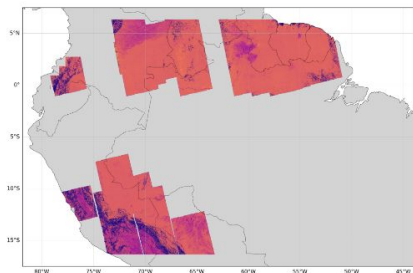
(f) Sentinel-1 SAR GRD Ascending



(g) ALOS PALSAR-2 ScanSAR Level 2.2 Descending



(h) ALOS PALSAR-2 ScanSAR Level 2.2 Ascending



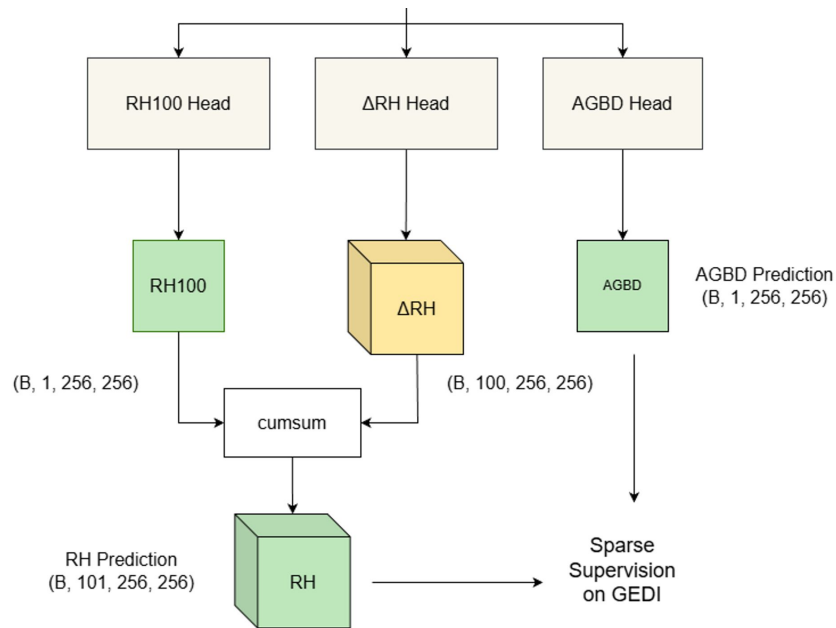
3. Task-specific Head Formulation

In order to enforce monotonicity in RH predictions, the heads predict:

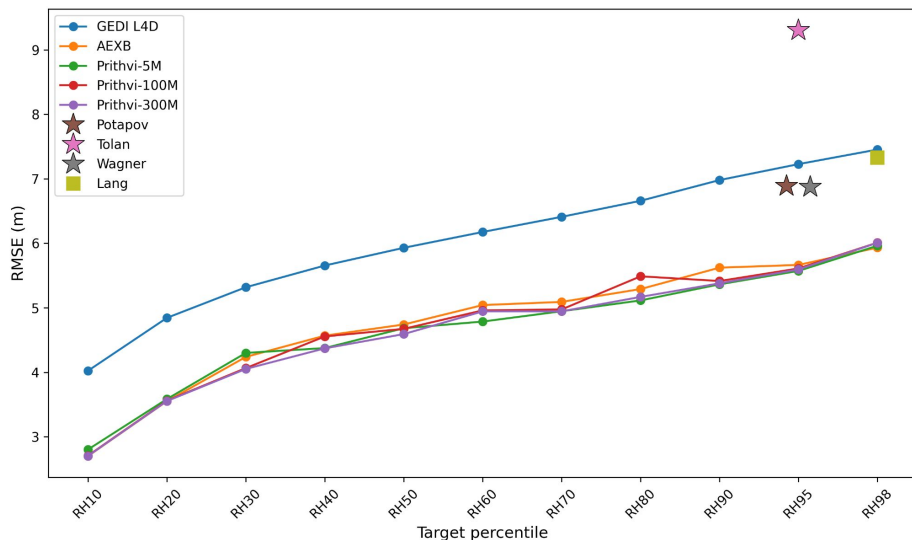
$$\hat{r}_{100}(\mathbf{x}) = \text{softplus}(a(\mathbf{x})) \quad d(\mathbf{x}) = \text{softplus}(v(\mathbf{x}))$$

From the above, we formulate:

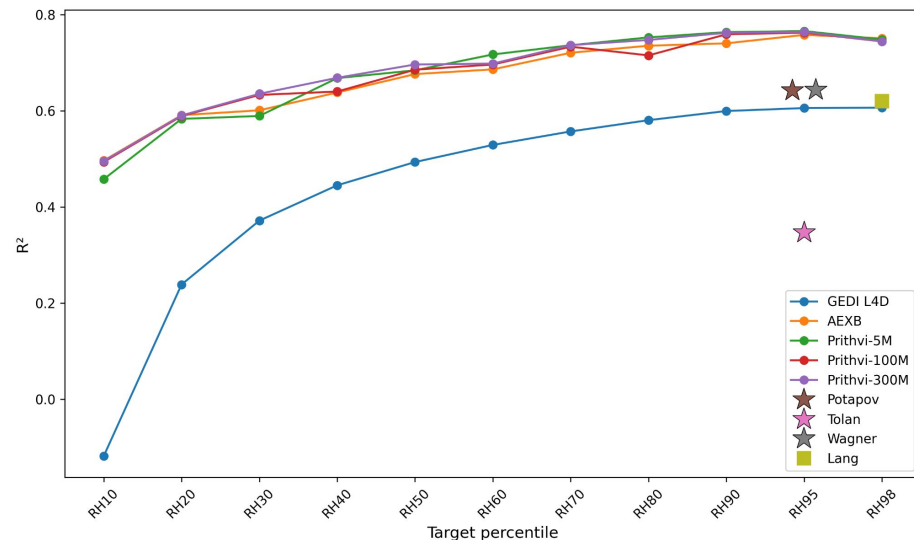
$$\hat{r}_{100-j}(\mathbf{x}) = \hat{r}_{100}(\mathbf{x}) - \sum_{t=1}^j d_t(\mathbf{x}), \quad j = 1, \dots, 100$$



4. Test Results - RH



(a) Percentile-wise RMSE

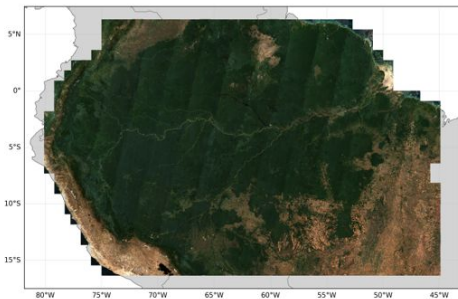


(b) Percentile-wise R^2

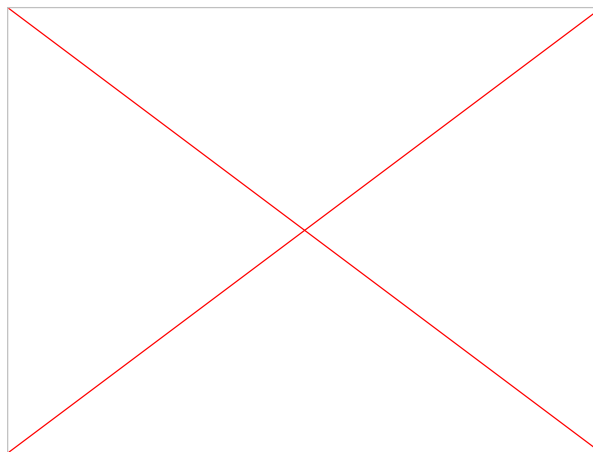
5. Test Results - AGBD

Name	RMSE ↓	MAE ↓	R2 ↑	Bias
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GED I L4D	88.83	42.44	0.451	-6.66
ESA CCI	117.74	85.63	0.04	60.92
AEXB	74.35	49.93	0.62	15
Prithvi-5M	73.31	48.88	0.63	13.81
Prithvi-100M	73.32	48.52	0.63	12.82
Prithvi-300M	72.9	48.3	0.63	11.61

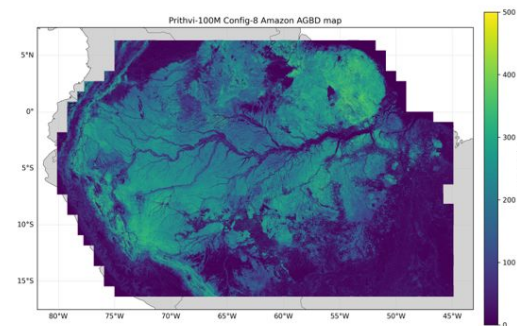
6. Dense Map Products



(a) Sentinel-2 TCI RGB



(b) Prithvi-EO-2.0 Config 8
predicted RH profile, RH0 to
RH100 sweep (meters)



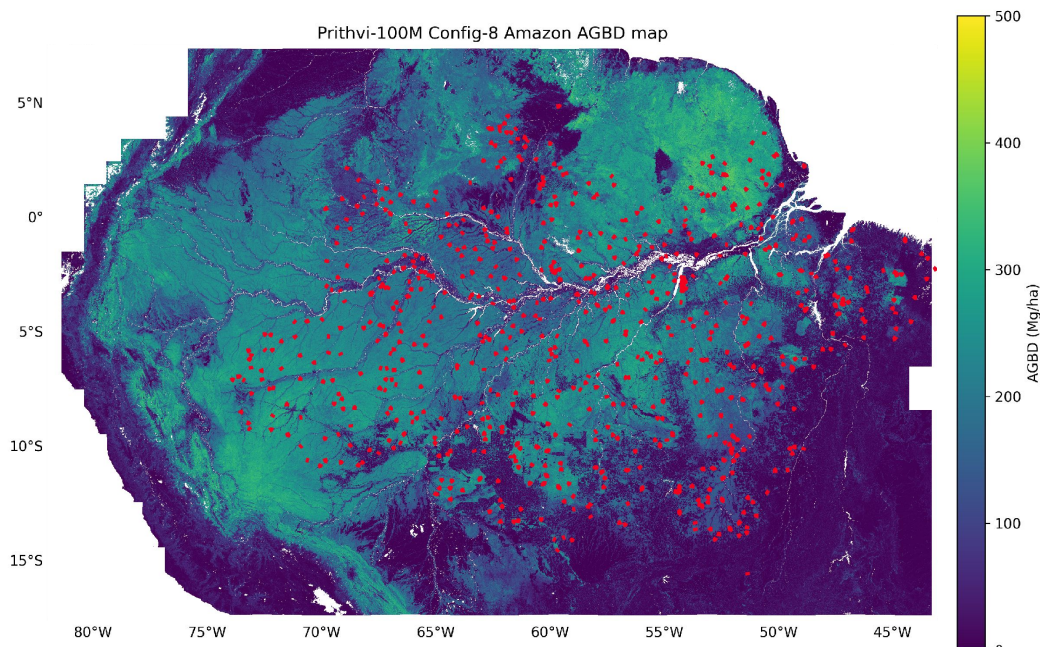
(c) Prithvi-EO-2.0 Config 8
predicted Above Ground
Biomass Density, AGBD
(Mg/ha)

7. Ongoing



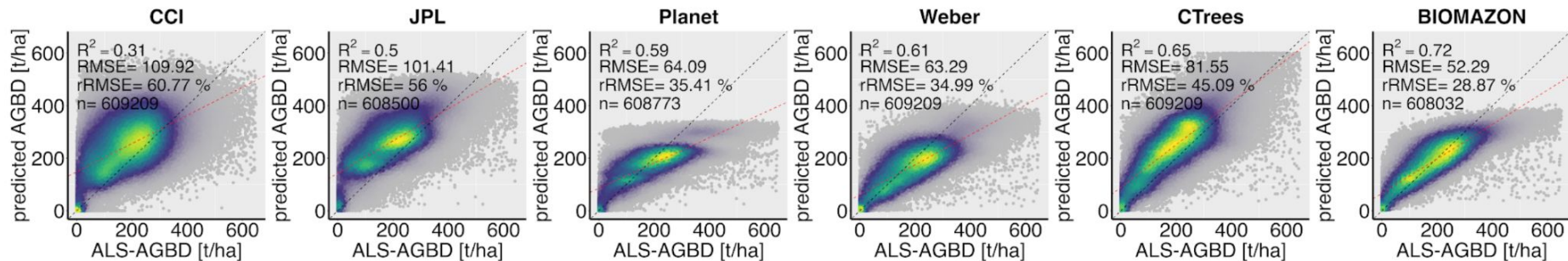
- ALS validation for both RH and AGB
- Evaluation of profile shape of RH predictions
- Test generalization to Congo Basin
- Biomazon paper under review. Arxiv: <https://arxiv.org/abs/2606.05368>
- Biomazon dataset: <https://doi.org/10.26165/JUELICH-DATA/2YP2PZ>

8. ALS Data - Amazon Basin



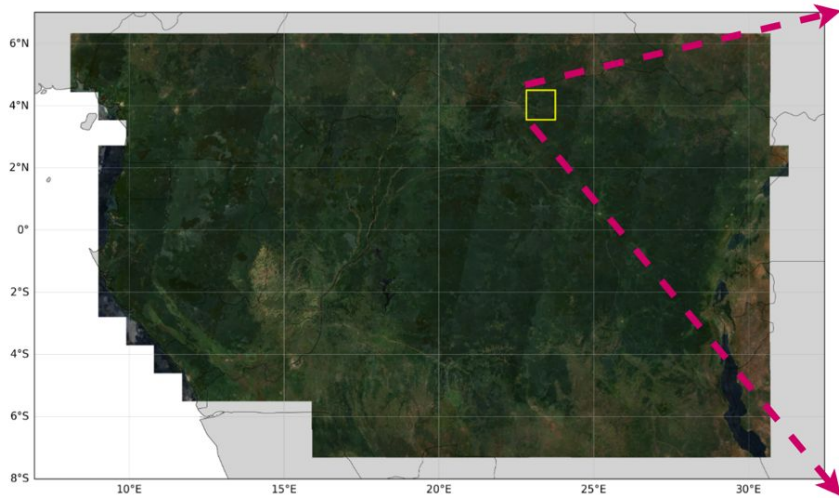
Comparison of BIOMAZON-AGB with ALS-AGB (red areas) →

9. ALS-AGB Comparison

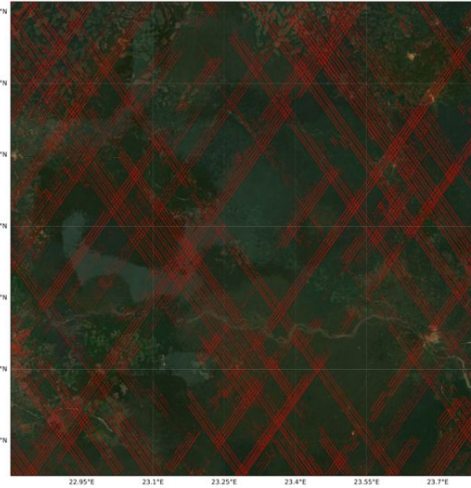


Density scatter plots of available gridded AGBD products vs our Prithvi-EO-2.0 100M Config 8 AGBD

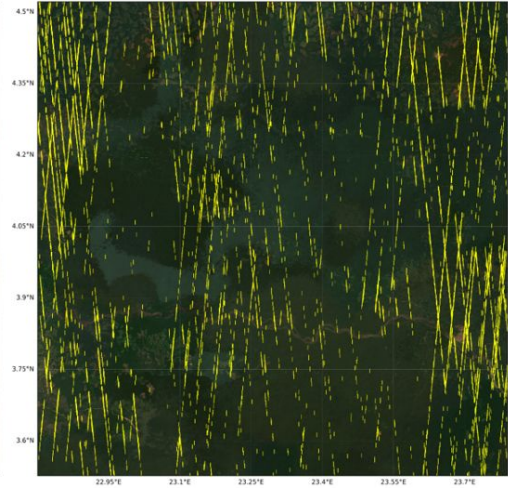
10. BioCongo - GEDI & ICESat2



(a) Sentinel-2 TCI RGB

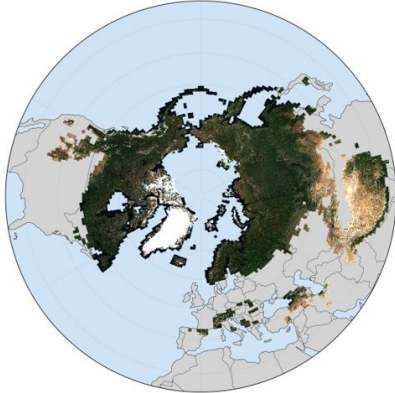


(b) 34NGK GEDI shots

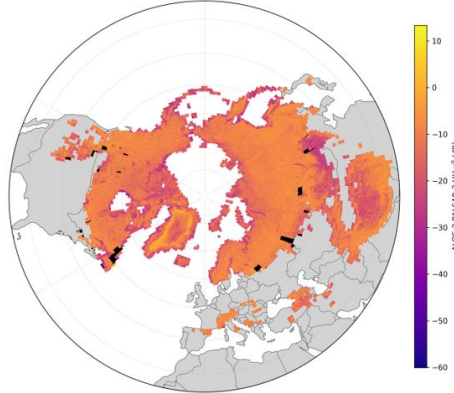


(c) ICESat-2 ATL08 segments

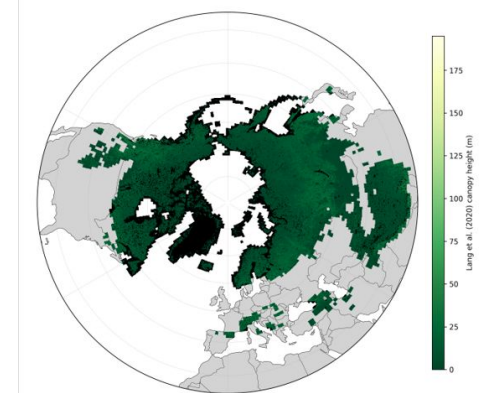
11. BiFrost - Arctic-Boreal Permafrost Dataset



(a) Sentinel-2 TCI RGB



(b) ALOS-2 PALSAR-2



(c) Lang et al. RH98 CHM



Thank you for attending!
Any questions? :)

*Image of Groot © Marvel Characters, Inc.