Leveraging Geospatial Foundation Model to estimate Aboveground Biomass and studying its effect on forest temperature

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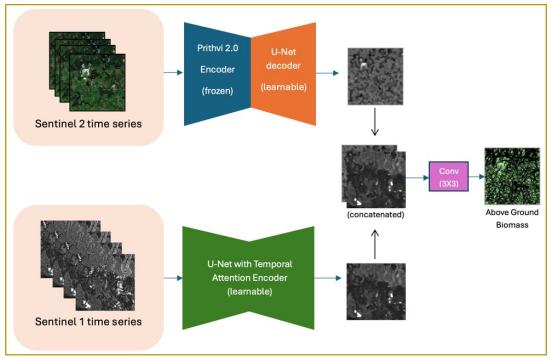
ABSTRACT

Accurate estimation of above-ground biomass (AGB) is essential for monitoring forest health and carbon sequestration. This study leverages NASA/IBM's Prithvi 2.0 foundation model with Sentinel-1 and Sentinel-2 data to estimate AGB.

By incorporating a geospatial foundation model, our approach significantly reduces the reliance on large-scale ground-truth data and computational resources while enabling cost-effective, global-scale AGB monitoring.

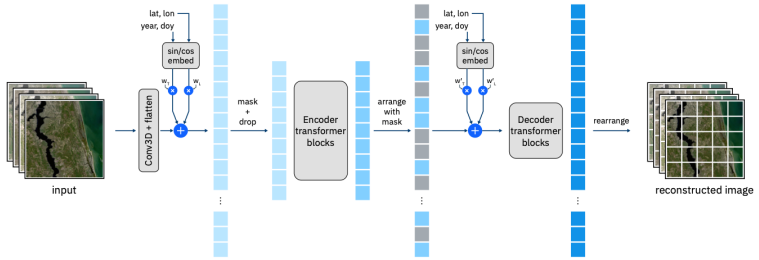
Finally, with the aim of developing a spatiotemporally aware AGB estimation model, we plan on studying the changing patterns of Land Surface Temperature with Above Ground Biomass, providing essential information for forest conservation and climate change mitigation strategies.

Model Architecture



In our model, we input Sentinel 1 and Sentinel 2 data through separate channels. The **Sentinel 2** time series goes through a frozen Prithvi 2.0 encoder that captures relevant features from the image. The **Sentinel 1** time series goes through a modified U-Net block. Finally, we concatenate these encoded features and pass them through a final convolutional layer to get the Above Ground Biomass.

NASA/IBM Prithvi 2.0[1]



A geospatial foundation model trained on 4.2M global time series samples from NASA's Harmonized Landsat Sentinel 2 data archive. It's a vision transformer trained as a masked autoencoder to encode relevant features from time series satellite imagery. It uses the six multispectral bandwidths that are common between Landsat/Sentinel 2 --- **Blue, Green Red, Narrow IR, SWIR 1 and SWIR 2.**

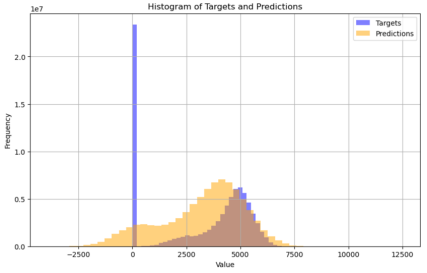
Data Utilized

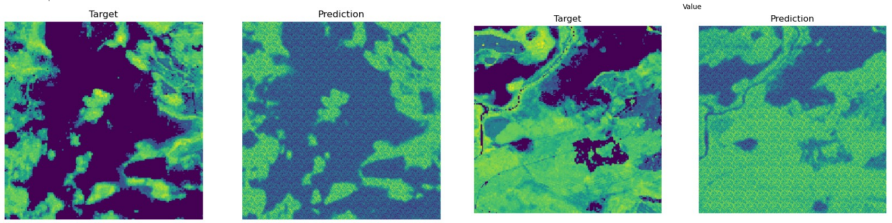
Due to heterogenous nature of available reference data, we adopt a multi-resolution training strategy. For the **Boreal** Forests in Finland, we use the Biomassters dataset which provides 10m AGB reference maps[2]. For the **Tropical** Forests in India and Central Africa, we use 40m AGB reference maps[3]. For the **Temperate** Forests in the USA, we use AGB point samples from GEDI L4A data product,

Preliminary Results

Here we present the results we got after training our model over Finland. The Biomassters dataset provides monthly Sentinel 1 and Sentinel 2 imagery, along with 10M AGB reference map.

Trained over **4841** samples, the histogram on the left shows the performance of the model over **1292** set-aside test samples.





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[1] Szwarcman, Daniela, et al. "Prithvi-EO-2.0: A Versatile Multi-Temporal Foundation Model for Earth Observation Applications." arXiv preprint arXiv:2412.02732 (2024).
[2] Nascetti, Andrea et. al. "BioMassters: A Benchmark Dataset for Forest Biomass Estimation using Multi-modal Satellite Time-series." https://openreview.net/forum?id=hrWslC4Cmz
[3] Rodda, Suraj et. al. "Lidar-based reference above-ground biomass maps for tropical forests of south asia and central africa. https://doi.org/10.1038/s41597-024-03162-x