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A Vertical Vegetation Structure Model of Europe

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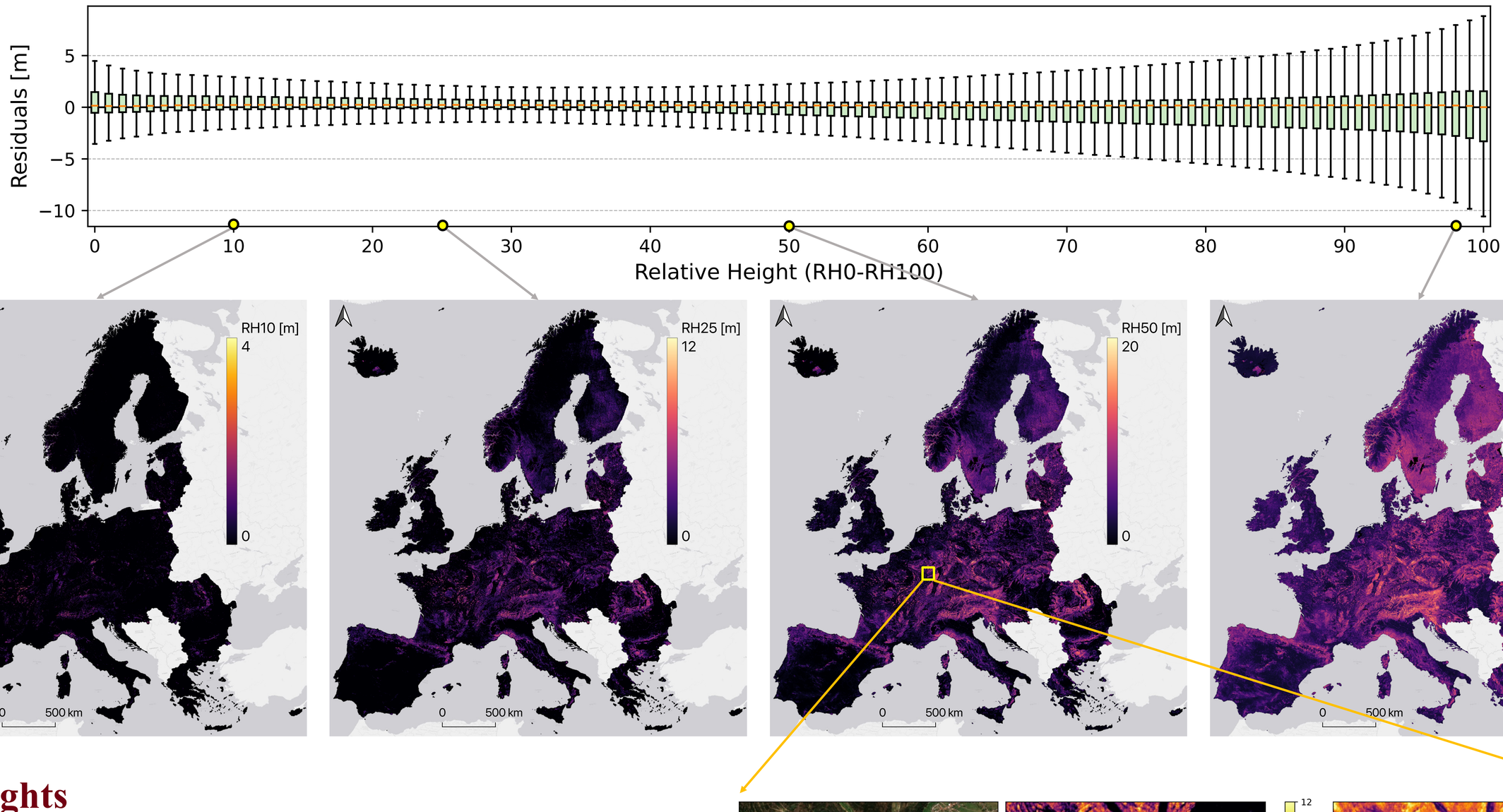
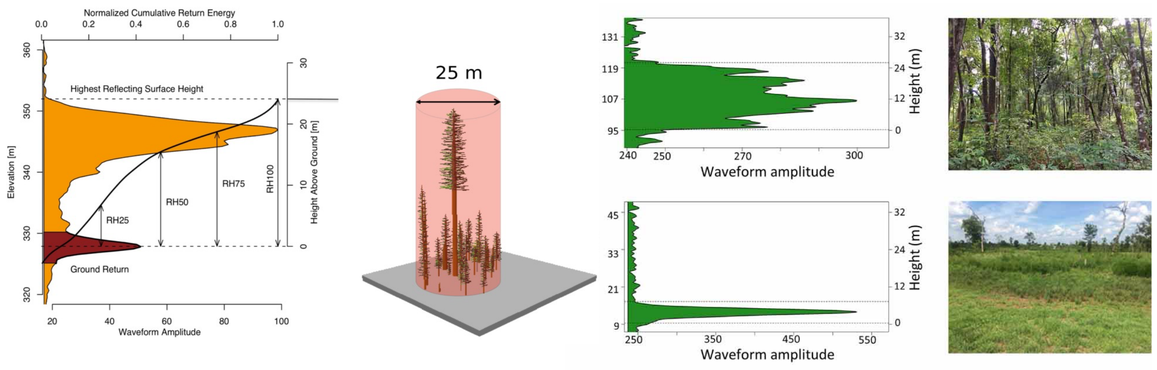


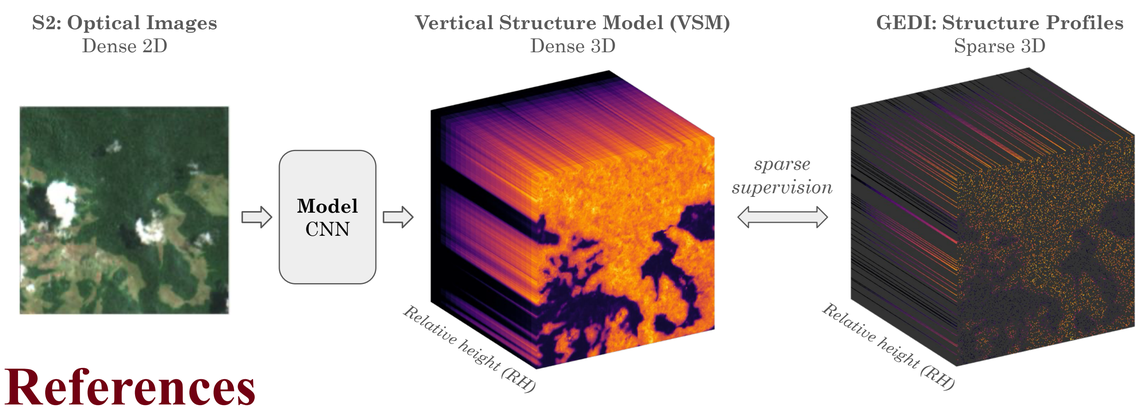
Highlights

- ✓ **Beyond canopy top height:** We reveal the full relative height profiles of forests, which may provide new insights about biodiversity, carbon sequestration, human activity, etc.
- ✓ **Multi-year coverage:** Unlike existing 2020-only maps, our 3D vegetation structure spans 2019–2022, enabling time series analysis.
- ✓ **Definition-agnostic**: Full-profile modeling allows direct comparison with canopy height maps using RH95 (Meta[4], UMD[3]), RH98 (ETH[1]), RH100 (UM[2]).

Data & Method



- ✓ Sampled over **300 million** locations worldwide from 2019 to 2022.
- ✓ Included **slope data** (from Copernicus DEM) to reduce misinterpretation of GEDI signals in steep or low-vegetation areas (e.g., grasslands, moss/lichen).
- ✓ Used **ESA World Cover** to fill GEDI gaps and improve **generalization** in areas without lidar reference.



	RMSE			MAE			ME		
	RH95	RH98	RH100	RH95	RH98	RH100	RH95	RH98	RH100
UMD	7.54			5.03			−2.86		
ETH		6.96			4.85			0.72	
UM			**6.41**			**3.63**			−1.78
META*	8.06			5.34			−4.44		
Ours	**6.19**	**6.41**	6.56	**3.65**	**3.85**	4.03	**0.01**	**0.01**	**0.01**

Table 1. Comparison of canopy top height maps. *Max sampled within a circular footprint corresponding to GEDI (25m diameter)

VSM advantages

- Captures vertical structure details missed by standard canopy height models
- Successfully estimates lower height metrics (understory structure) using GEDI & Sentinel-2
- Provides critical information for diversifying forests under changing climate zones

Limitations & future work

- Current optical models cannot ”see through” closed canopies.
- Integrating SAR data (e.g., ESA BIOMASS mission) to resolve canopy penetration issues.

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