

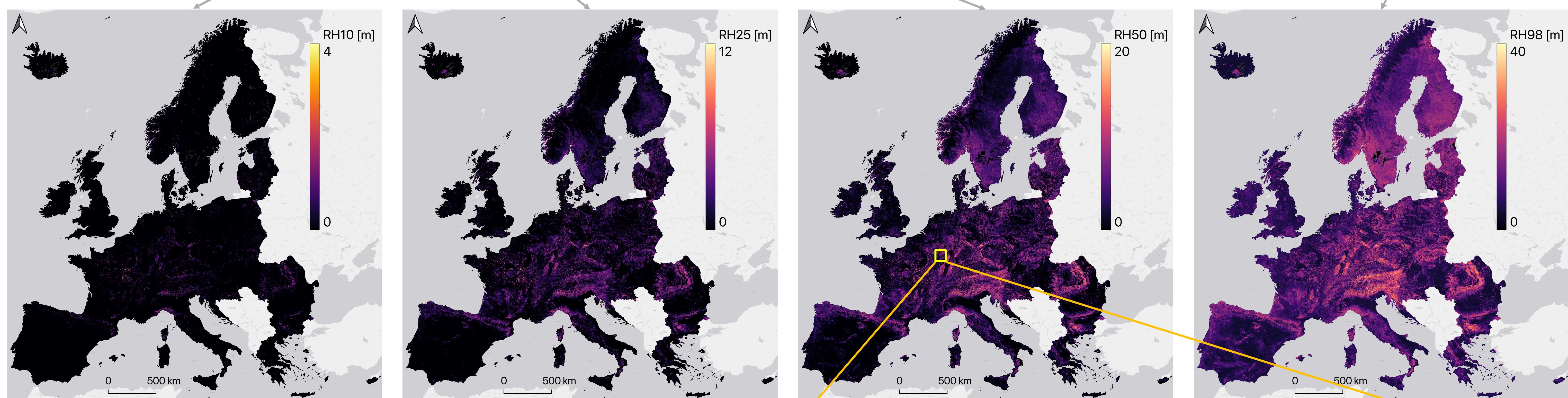
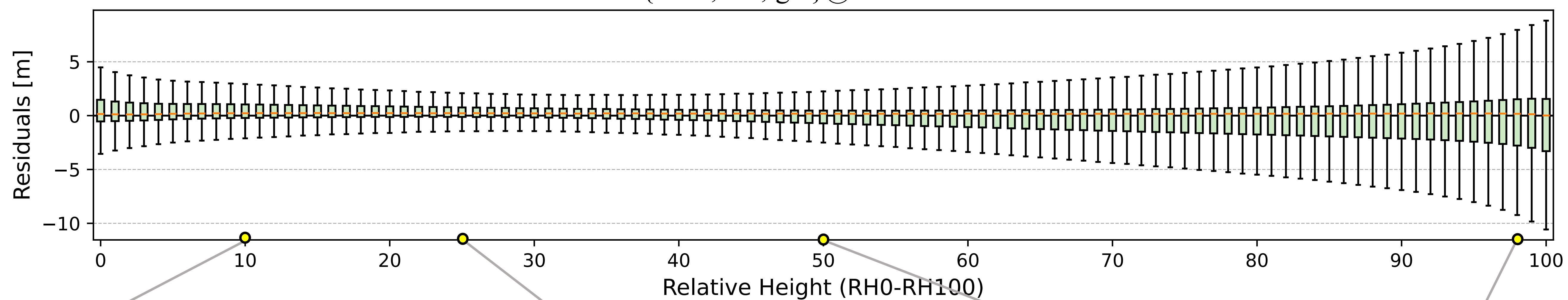


# A Vertical Vegetation Structure Model of Europe

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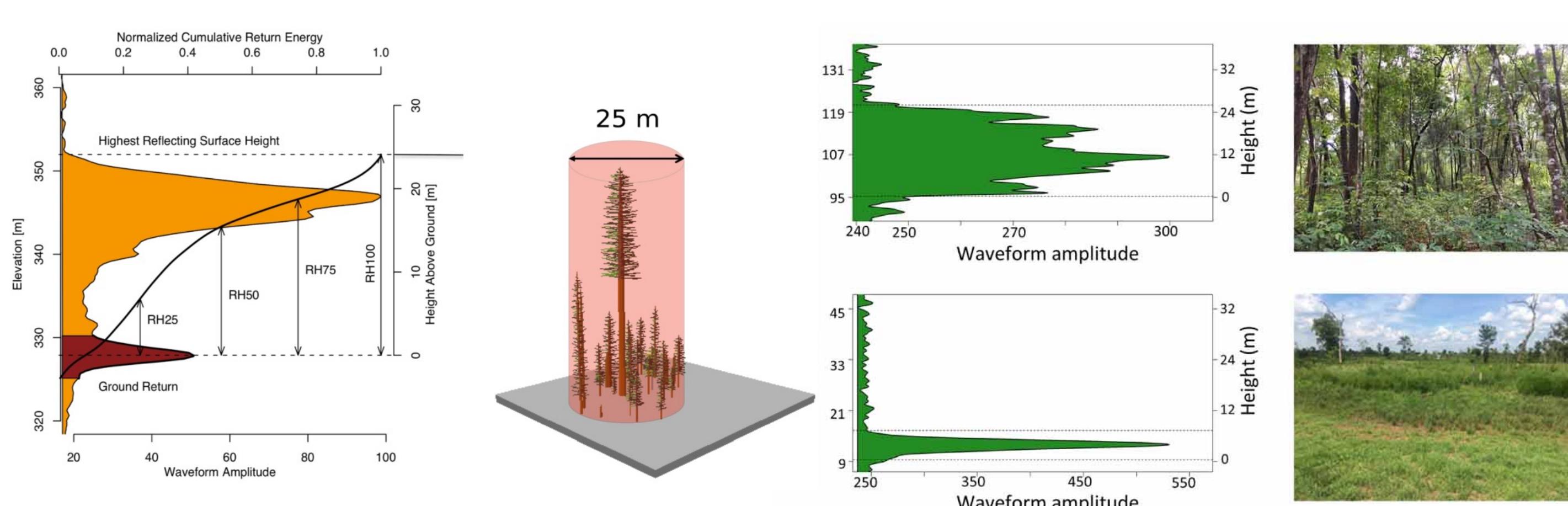
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## Highlights

- ✓ **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<sup>4</sup>, UMD<sup>3</sup>), RH98 (ETH<sup>1</sup>), RH100 (UM<sup>2</sup>).

## Data & Method

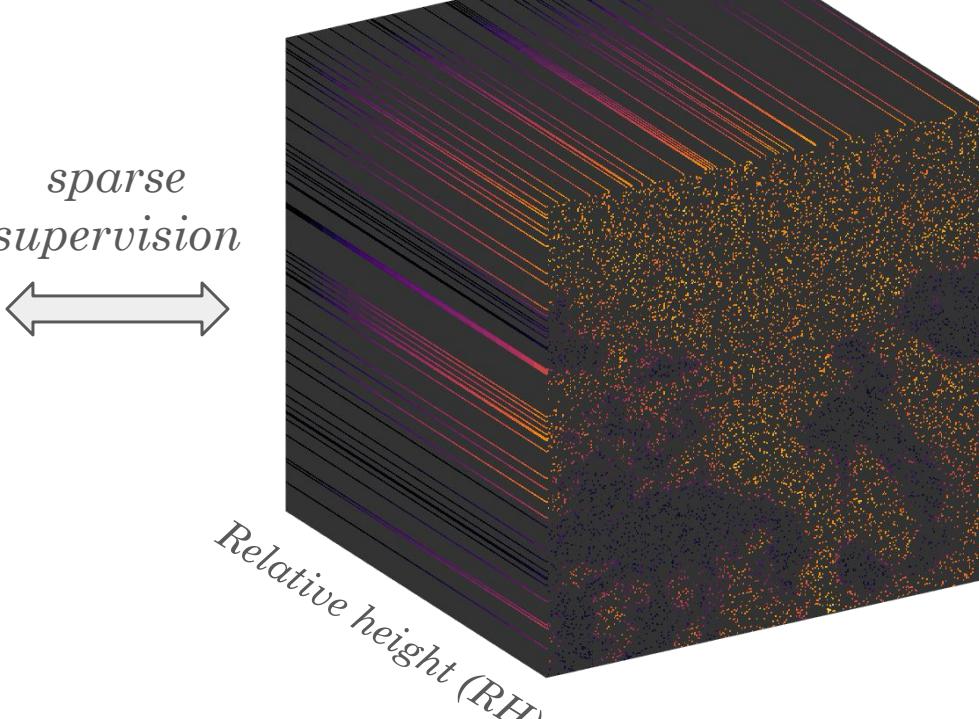
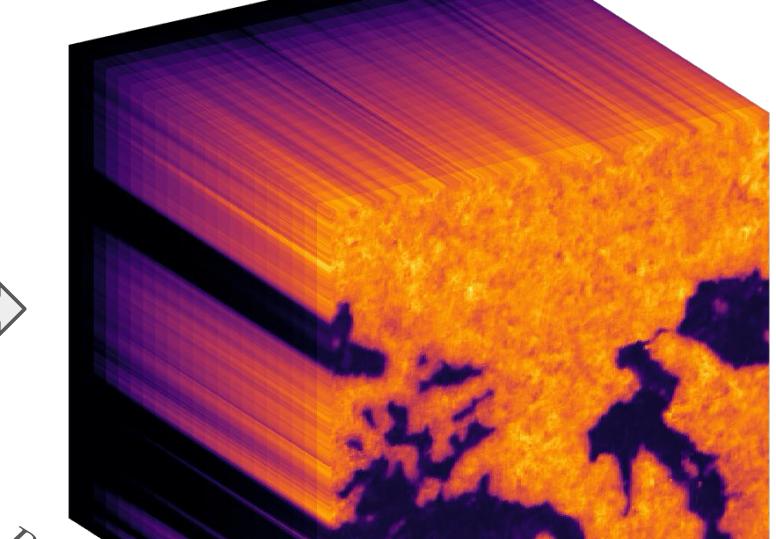
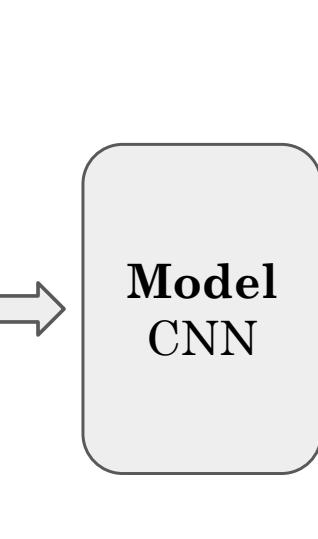


- ✓ Sampled over **300 million** locations worldwide from 2019 to 2022.
- ✓ Included **slope data** (from Copernicus DEM) to reduce misinterpretation of GEDI signals in steep or low-vegetation areas (e.g., grasslands, moss/lichen).
- ✓ Used **ESA World Cover** to fill GEDI gaps and improve **generalization**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

S2: Optical Images  
Dense 2D

Vertical Structure Model (VSM)  
Dense 3D

GEDI: Structure Profiles  
Sparse 3D



## References

- [1] Lang, Jetz, Schindler, Wegner. A high-resolution canopy height model of the Earth. *Nature Ecology & Evolution*, 2023
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- [4] Tolan, Yang, Nosarzewski, Couairon, Vo, Brandt, Spore, Majumdar, Haziza, Vamaraju, Moutakanni, Bojanowski, Johns, White, Tiecke, Couprie. Very high resolution canopy height maps from RGB imagery using self-supervised vision transformer and convolutional decoder trained on aerial lidar. *Remote Sensing of Environment*, 2024

**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.

## Acknowledgments

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