**Towards Three Decades of Accurate, Sub-hectare Resolution Forest Biomass maps with Global DEM data and a Coarse Digital Terrain Model**

**Introduction**

Accurate, global, high-resolution maps of above-ground forest biomass density (AGBD) are needed for carbon accounting, forest resource management, and biodiversity research. Partly, these needs will be addressed by European Space Agency’s BIOMASS satellite, expected to launch in late 2025. The eponymous objective of BIOMASS will be near-global, quasi-annual mapping of AGBD at 200 m resolution, for about five years. BIOMASS will use an innovative interferometric synthetic aperture radar (InSAR) sensor operating at P-band (wavelength: 67 cm) and capable of penetrating thick forest canopies. This will allow BIOMASS to see the biomass-rich tree trunks, also in the dense tropical rainforests, although the relatively coarse resolution, limited coverage, and short life-span of the BIOMASS mission will make it less suited for fine-scale forest monitoring applications. A by-product of BIOMASS will be the first near-global digital terrain model (DTM), with an expected best-case resolution of 100 m. In contrast to the AGBD estimates, which quickly become obsolete due to growth, deforestation, and forest degradation, topography under forests is usually stable in time and the DTM can remain valid for decades.

In this paper we propose and discuss a new pathway to near-global AGBD mapping, with the potential to provide accurate, 50 m resolution AGBD estimates for about three decades and using existing and forthcoming datasets.

**Methods**

The approach uses phase height (PH), which is the difference between a radar-based digital elevation model (DEM) and a DTM. PH is a height metric modulated by canopy density and as such, it has many similarities with mean canopy height from airborne laser scanning, a well-known proxy of AGBD. By subtracting the BIOMASS DTM from available DEM data from the SRTM (February 2000) and TanDEM-X (2010-late 2020s) missions, near-global maps of PH can be obtained at sub-hectare resolutions.

**Results**

Our results from eleven test sites on four continents indicate that PH derived from Copernicus DEM and a 100 m DTM has a consistent, near-linear relationship and strong correlation with AGBD. Moreover, the PH-to-AGBD scaling constant has smaller spatial variability than presented in literature. Furthermore, at 200 m resolution, the PH-based approach outperforms current AGBD estimates from spaceborne lidars and C- and L-band SARs.

**Conclusions**

We conclude that by using existing, global data from the SRTM and TanDEM-X missions together with the forthcoming BIOMASS DTM, unprecedented information on AGBD can be unveiled. The proposed approach can be used already now for AGBD mapping in areas with topography known from regional and national laser scanning campaigns (e.g., Netherlands, Spain, New Zealand). A clear advantage of the proposed approach, compared with many other approaches presented in the literature, is that it is simple and does not require technical knowledge typically needed to process raw TanDEM-X data. Nevertheless, further work is needed to validate the proposed method using accurate *in situ* data and develop an operational algorithm for AGBD mapping and monitoring.