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Spatial patterns of forest growth dynamics with mixed-source time series of canopy height, a novel approach using belgian temperate forests as case study.

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Canopy height growth is a key determinant of the state and functioning of forest ecosystems. As traditional ground-based inventories can not exhaustively capture growth and ensure hotspots detection, mixed-source canopy height time series from multiple remote sensing platforms now enable extensive characterization of these dynamics, provided that measurement biases between sources are addressed. We proposed a transferable workflow to map spatially explicit patterns of vertical growth across forested landscapes. By leveraging recent aerial imagery and lidar data regularly acquired across Belgian temperate forests over 2006-2021, standardized against ground-based inventories at ~1000m² spatial resolution, we estimated plot-level vertical growth and modeled species-specific reference trajectories from which we quantified plot-level deviations, providing both absolute and contextualized assessments. Across acquisitions, the standardization approach reduced the top-of-canopy height bias from 2.64±2.01 m to 0±1.77 m (RMSE = 1.77 m, R^2 = 0.92). Canopy structure, rather than acquisition parameters, was the main source of bias when estimating forest height from aerial imagery. Plot-level growth exhibited decreasing trends as initial height increased. Importantly, deviations from reference vertical growth displayed significant spatial clustering (Moran's I = 0.36, $p < 0.001$), suggesting systematic variations indicative of potentially declining or over-performing stands. Our workflow offers transferability, reproducibility, and multi-scale applicability for spatially exhaustive characterization of forest growth dynamics, providing actionable insights to support adaptive management and conservation planning.