

Supplementary Materials: In addition to the forest parameters aboveground biomass (AGB), gross primary productivity (GPP) and net ecosystem exchange (NEE), the turnover time for the Amazon region was calculated and a map was produced (Figure S1). Turnover rates between 0 and 120 years can be seen (Figure S2), with a mean turnover time of 42 years.

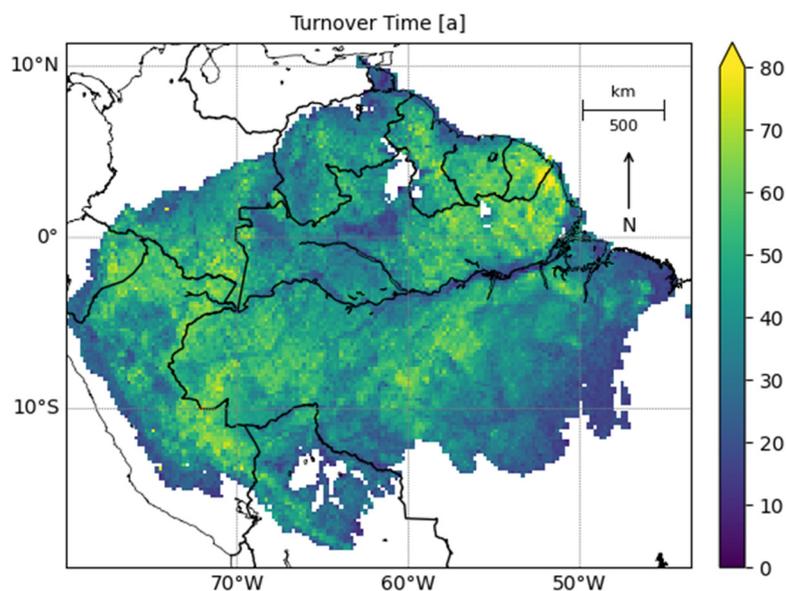


Figure S1. Map of turnover time [a] with a resolution of 20×20 km². Each pixel describes the mean attribute value of all GEDI lidar shots located in a 20×20 km² area.

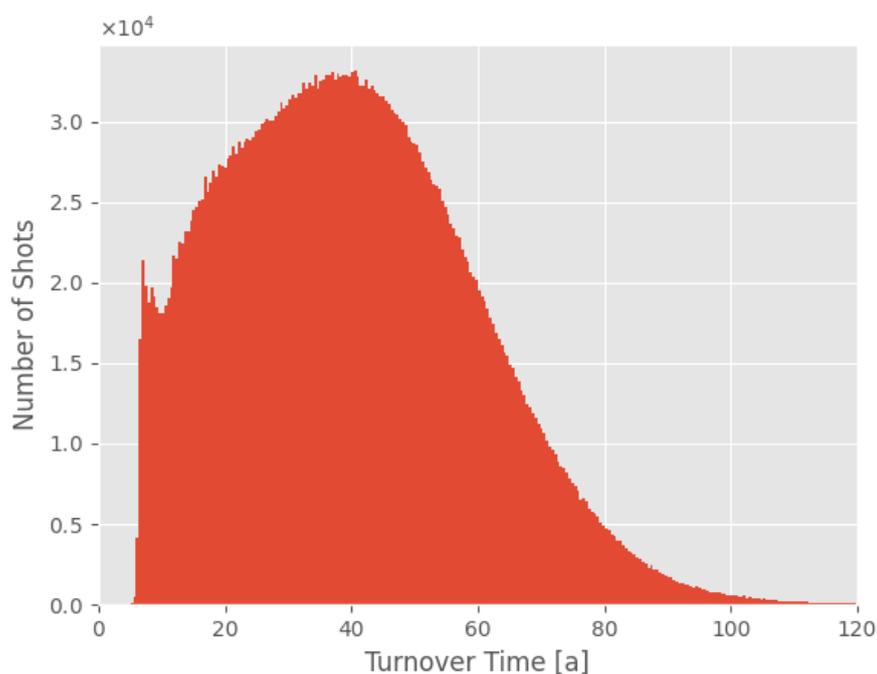


Figure S2. Frequency distributions associated with the map in Figure S1 with a resolution of 1 km² for the Amazon based on 110 million lidar waveforms.

The relationship between GPP, AGB and canopy height complexity with respect to different precipitation regions (Figure S3) are investigated. The purpose of this is to investigate whether precipitation has an influence on the relationships between the forest parameters. It was found that for all three areas (low precipitation ($< 1500 \text{ mm a}^{-1}$), medium precipitation ($1500\text{--}3000 \text{ mm a}^{-1}$) and high precipitation ($> 3000 \text{ mm a}^{-1}$)) the same correlations can be seen. These are that medium aboveground biomass forests with low productivity have a heterogeneous canopy height complexity and medium aboveground biomass forests with high productivity have a homogeneous canopy height complexity.

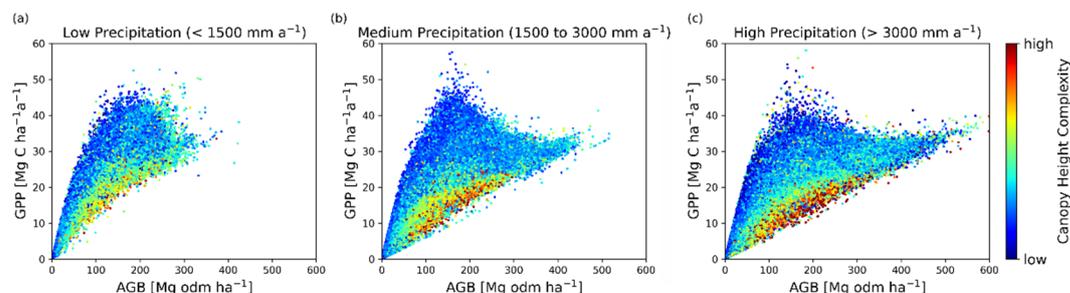


Figure S3. Comparison of aboveground biomass (AGB) with gross primary productivity (GPP) for three different precipitation areas ((a) low precipitation $< 1500 \text{ mm a}^{-1}$, (b) medium precipitation $1500\text{--}3000 \text{ mm a}^{-1}$ and (c) high precipitation $> 3000 \text{ mm a}^{-1}$). One point corresponds to a forest stand with an area of 1 km^2 whereby only areas containing more than 20 GEDI waveforms per 1 km^2 were considered. The points are colored according to the heterogeneity of canopy height (SD of RH95) within this 1 km^2 .

For our evaluations we used GEDI lidar waveforms (Figure S4) and fused them with simulated lidar data. We used the Level2A data and therefore had access to ground elevation, canopy top height and relative height percentiles. Then, by comparing the GEDI waveform with 50 simulated lidar waveforms in waveform matching, the simulated lidar waveform with the best overlap was determined.

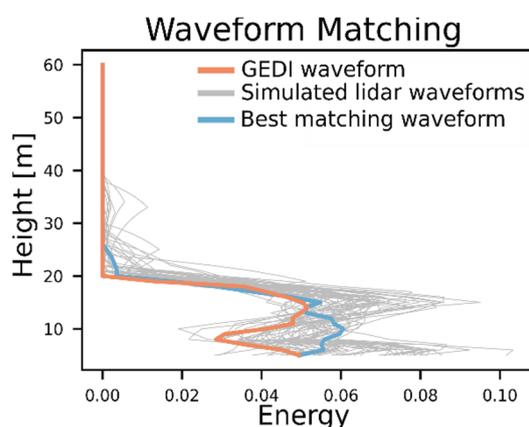


Figure S4. Representation of the waveform matching. By comparing the GEDI waveform with the 50 best simulated lidar waveforms, the simulated lidar waveform with the best overlap is found. This represents the current state of the forest in order to determine forest parameters.

For the visualisation of the 95th height percentile (RH95), AGB, GPP and NEE maps (Figure 3), all GEDI data were aggregated into a 1 km^2 grid. Figure S5 shows the frequency distribution of GEDI waveforms per 1 km^2 grid cell. Up to 100 GEDI waveforms can be located in a grid cell.

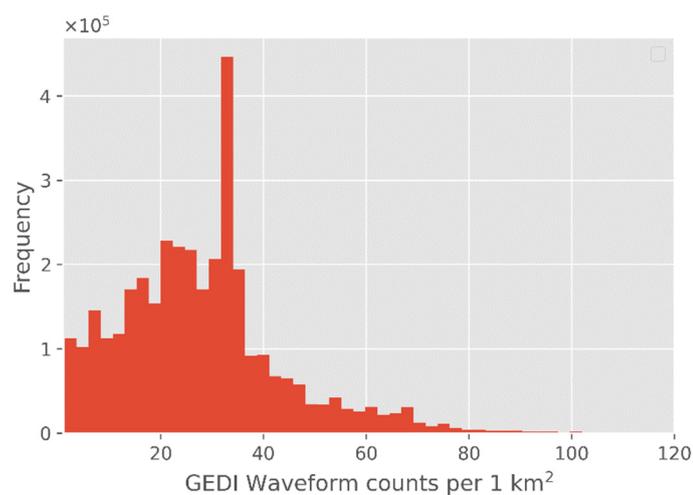


Figure S5. Frequency distribution for the number of GEDI waveforms per 1km² grid cell. All GEDI waveforms aggregated from footprint level to 1 km² resolution are shown.

In order to compare the results of this study area-wide, maps of comparison were created for above-ground biomass and gross primary productivity (Figure S6 and Figure S7). For the comparison with AGB, data from Rödiger et al. [12] were used, for the comparison of GPP, data from Rödiger et al. [24] and additionally MODIS data were used.

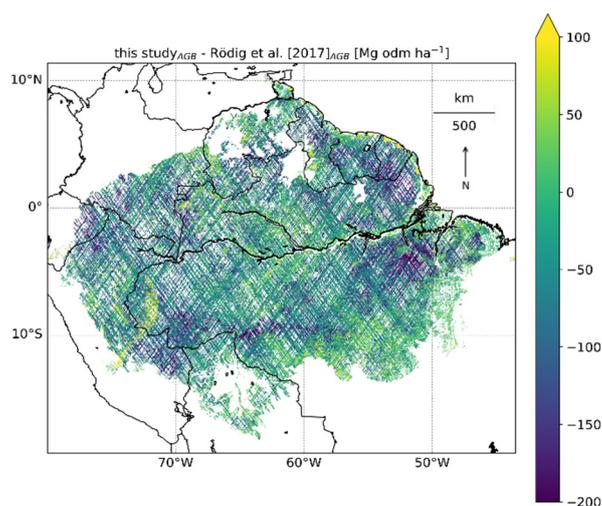


Figure S6. Map of the difference between AGB from this study, consisting of the combination of GEDI and FORMIND data, and data from Rödiger et al. [12] for a resolution of 1 km² for the Amazon Basin.

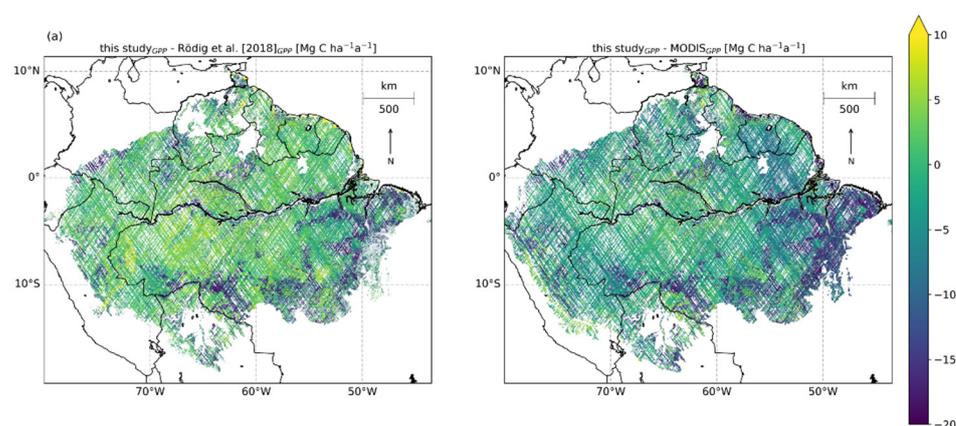


Figure S7. Map of the difference between GPP from this study, consisting of the combination of GEDI and FORMIND data, and (a) data from Rödiger et al. [24] and (b) MODIS data for a resolution of 1 km² for the Amazon Basin.