Assessing the accuracy of GEDI for mapping resilience in the Amazon rainforest along a gradient of disturbance to recovery

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INTRODUCTION
The Amazon, the world’s largest continuous tropical forest, is identified as a potential tipping element in the Earth’s climate system (Lenton et al., 2008). Understanding the resilience of tropical vegetation, its ability to recover from disturbance, is fundamental to assess future responses to environmental and climatic fluctuations (Lenton et al., 2022). The Global Ecosystem Dynamics Investigation (GEDI) spaceborne LiDAR characterises a new era of large-scale forest height quantification, with capabilities to further understand forest structure, and therefore forest response to perturbation across the entire Amazon.

PRELIMINARY RESULTS

(A) Correspondence between ALS and GEDI metrics. Overall there is a significant positive correlation for all forest conditions. However, the correspondence is lower for intact forest, and particularly forest burned multiple times, supported by a very low Lin’s CCC score.

(B) GEDI canopy height by degradation. Generally height increases as forest recovers, whilst more frequent burn scans have a lasting legacy in forest recovery, both height and canopy.

(C) PCA analysis of GEDI metrics and forest disturbance. The first three PCAs explain 91.8% of the total variance. Overall the relative height metrics demonstrate the highest loading for capturing variation. After subsampling the data by degradation type: waveform summaries of intercept and slope had higher loading.

REFERENCES
Dorado-Roda et al. 2024, Remote sensing, doi.org/10.3390/rs13122279
Lenton et al. 2008, Nature, doi.org/10.1038/nature07191
Vedovato et al. 2018, Remote Sensing, doi.org/10.3390/rs10010043

METHODOLOGY

1 ALS: preprocessed (filtered, classified and normalised) data from Permian Global and Sustainable Landscapes Brazil project (dos Santos et al. 2019), using the LiDAR package in R.

2 GEDI: downloaded 2A, 2B and 4A products within ALS extents using the choosr package. Calculated regression models to summarise relative height (rh) 0-100 for canopy distribution metrics (slope, variance, intercept) using waveformliidar package (Dospatwa et al. 2021).

3 Forest classification: Obtained secondary forest stand age dataset (Silva et al. 2020), and MAPBIOMS burn frequency (1985-2023). Stand age was extended to current date. Forest was classified by degradation type and age since disturbance.

4 Analysis: Extract ALS relative height and canopy cover metrics within 25 m GEDI footprints. Correlation/ correspondence analysis between ALS and GEDI (Dorado-Roda et al. 2021). Principal Component Analysis (PCA) of GEDI metrics waveform summaries to understand which are most indicative of forest state.

PRELIMINARY CONCLUSIONS

☐ GEDI canopy height and cover metrics along a gradient of burned forest are comparable within literature to ALS degraded forest structure study (Vidovato et al. 2024), strengthening confidence in the ability of GEDI to portray structurally degraded forest state.

☐ The use of GEDI to differentiate between forest state with structural metrics has promise for resilience research, but also has potential to be used to improve carbon estimates by including degraded/ recovering forest, and to inform monitoring for forest management.

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