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Note on Global Forest Simulations and Climate Controls

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Abstract

Forest structure complexity is important in determining the roles of forest ecosystems and has a significant impact on biodiversity. Nonetheless, understanding of global forest structural complexity dynamics and drivers is limited. We use a structural complexity index based on terrestrial laser scanning, temperate, subtropical, and tropical primary forests to measure the structural complexity of boreal complexity. We find that annual precipitation and precipitation seasonality (R2 = 0.89) is primarily explained by the global heterogeneity in forest structural complexity. We model the potential structural complexity across biomes using the structural complexity of primary forests as a benchmark and present a global map of the potential structural complexity of the Eco regions of the Earth's forest. Our studies show distinct latitudinal trends of forest structure and illustrate that high structural complexity hotspots correlate with plant diversity hotspots. Our findings propose spatially comparing shifts in forest structure with climate change within and through biomes, taking into account the mechanistic underpinnings of forest structural complexity.

Climate change will alter the composition and functionality of boreal, temperate, and tropical forest ecosystems, with opposing, yet unknown, effects on habitats and ecosystem services across biomes. Changes in the systemic complexity of forests are directly tied to changes in land biodiversity responses and ecological roles in response to climate change. As a result, detecting the effects of climate change on forest habitats and habitat functions necessitates a thorough understanding of the forest's systemic complexity via climate controls. Climate forms forest compositional and functional variability, which are important determinants of the complexity of forest structure. It remains uncertain, however, how environment and compositional and functional diversity interactions transform into global forest structural complexity trends. To help forecast how biodiversity Understanding the climatic causes and global dynamics of forest structural complexity, as well as how ecosystem functions will respond to climate change, could provide the badly required foundation.

The goal of forest structural complexity is to measure the distribution of trees and their canopies in three-dimensional space, thereby extending structural characteristics such as biomass, leaf area or canopy height beyond summarizing forest structure. At the stand level, a larger range of tree sizes and crown morphologies represents greater structural sophistication, this result in multi-layered and more denselypacked canopies and a higher relation between individual canopies of the tree. The degree of heterogeneity in biomass distribution in threedimensional space may thus be described by forest structural complexity and depends on the spatial trends and efficiency of canopy space occupation. Tests of forest structural complexity, first used to answer core ecological questions such as the relationship between habitat heterogeneity and biodiversity, have recently proven useful for explaining relationships between three-dimensional forest structure, biodiversity, and ecosystem functions. The enhanced availability of LiDAR airborne and terrestrial (Light Detection and Ranging) Technologies for the implementation of forest ecology, which offer an ability to measure the three-dimensional existence of forest systems, have contributed to the creation of new methodologies and measurements to quantify the complexity of forest structures. Important characteristics of forest growth, such as filled canopy area connectedness of tree canopies, and hence light absorption, are accounted for in structural complexity metrics, which have proven to be efficient predictors of net primary efficiency.