EGU25-5663, updated on 16 May 2025
https://doi.org/10.5194/egusphere-egu25-5663
EGU General Assembly 2025

Integrating a Dynamic Global Vegetation Model (LPJ-GUESS-NTD) and Earth Observation data for mapping functional traits of vegetation

Mateus Dantas de Paula and Thomas Hickler

Understanding global biodiversity patterns and the impacts of climate change on these patterns remains a critical challenge in Earth system science. Shifts in plant functional diversity are pivotal drivers of ecosystem processes, including the carbon cycle. Fundamental plant traits—governing photosynthesis, carbon storage, and water/nutrient uptake—directly influence vegetation function. Therefore, high-resolution global maps of these traits are essential for studying ecosystem dynamics, identifying environmental threats, and guiding conservation strategies. However, existing trait maps are limited by sparse, regionally biased observations and reliance on statistical extrapolations, leading to low explanatory power and ecological inconsistencies across diverse environments.

The VESTA (Vegetation Spatialization of Traits Algorithm) project addresses these challenges by integrating a trait-based dynamic global vegetation model (DGVM) with Earth observation (EO) data to produce global maps of above- and below-ground plant traits for both current and future scenarios. Trait-based DGVMs offer process-based approaches that directly link environmental factors to plant ecology and vegetation patterns. The VESTA model is initialized with data from comprehensive global trait databases, while EO data are used to calibrate and optimize the model. This calibration adjusts trait-relationship curves to align model outputs with satellite-derived measurements of vegetation structure and productivity.

A critical aspect of VESTA is accounting for the distinctiveness of plant functional types (PFTs) in trait-relationship modeling. Analysis of global plant trait databases confirms that relationships between traits, such as specific leaf area (SLA) and carbon-to-nitrogen ratios (C:N), vary significantly across PFTs. Grouping these relationships by functional type enhances explanatory power compared to assuming a single global relationship. For example, plots of trait relationships grouped by PFT reveal distinct patterns, with PFT-specific ranges and correlations that are essential for improving model accuracy.

Preliminary global simulations at a 0.5° resolution using climatic data from the CRUJRA dataset and fixed global trait relationships reproduce general SLA spatial patterns, such as lower values in boreal regions. However, comparisons with reference SLA maps highlight the limitations of the fixed-relationship approach, underscoring the need for VESTA's optimization methods. By addressing these limitations, the VESTA project aims to provide robust, ecologically consistent trait maps that enhance our understanding of global biodiversity patterns and support effective ecosystem management under changing environmental conditions.