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The role of climate and plant trade-offs in shaping global biome and biodiversity patterns

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Regional plant communities are the result of functional trade-offs that individuals face when dealing with the constraints imposed by their biotic and abiotic environment (Tilman 1988, 1990). Among the oldest observations in plant geography we find the increase of plant biodiversity from the poles towards the tropics and the geographic distribution of vegetation physiognomy (biomes). Here, we will show how these two observations can be understood from climatic constraints and plant functional trade-offs.

We used the model of Kleidon & Mooney (2000) to generate predictions on the relationship between plant functional richness (identity) and the global patterns of species richness (biomes). Based on a suite of traits controlling the costs and benefits of plant allocation, phenology and ecophysiological processes, the model selects growth strategies that can tolerate the regional climatic constraints. Then, we quantify the functional richness and identity of each simulated regional community and show how the two compare to observed patterns of plant species richness and biome classifications.

The correlation between modeled richness and observed vascular plant species richness (Kier et al. 2005) shows a correlation coefficient of 0.67. The pattern derived from clustering regional plant communities according to their functional identity is in reasonable agreement with potential natural vegetation derived from satellite imagery (Ramankutty & Foley 2003, kappa = 0.39) as well as with empirical relationships implemented in a global biogeography model (BIOME1, Prentice et al. 1992, kappa = 0.43). Furthermore, our analysis reveals plant trade-offs acting upon plant functional traits and diversity as underlying processes for shaping these patterns.

We conclude that global biogeography can be modeled from first principle on climatic constraints and plant functional trade-offs. The implications for dynamic global vegetation modelling will be discussed.

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