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How does leaf functional diversity affect the light environment in forest canopies? An in-silico biodiversity experiment

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Global change is affecting biodiversity, with consequences on carbon, water, and energy fluxes between the atmosphere, vegetation, and soil. The interaction of shortwave radiation with vegetation drives basic processes of the biosphere, such as primary productivity or species interactions through light competition.

In our study, we aim to understand the effects of biodiversity on canopy light absorption. We focus on the diversity of three key functional traits that influence the light-canopy interaction: leaf area index, leaf angle distribution and leaf optical properties. Our study is based on the in-silico combination of process-based modelling of radiation (3D radiative transfer model DART) with the well-established design of biodiversity experiments. We used this novel method to study the effects of leaf functional diversity on a light proxy for productivity (the fraction of absorbed photosynthetically active radiation (FAPAR)) and net radiation (shortwave albedo). We found that diverse canopies had lower albedo and higher FAPAR than the average of the corresponding monoculture values. In mixtures, FAPAR was unequally re-distributed between trees with distinct leaf traits and the net biodiversity effect on absorptance was greater when combining plant functional types with more distinct traits. Our results support the mechanistic understanding of overyielding effects in functionally diverse canopies and may partially explain some of the growth-promoting mechanisms in biodiversity-ecosystem functioning experiments. They can further help to account for biodiversity effects in dynamic vegetation and climate models.

We would like to present this study in the BG3.22 session, because it 1) contributes to the understanding of fundamental ecosystem functions related to light interaction 2) describes a novel in-silico combination of process-based modelling of radiation with the well-established design of biodiversity experiments.