The quest to reach a more reliable representation of functional diversity in vegetation models and, supposedly, as a consequence, a higher confidence in its projections lead to the development of trait-based models. However, few studies so far have investigated in depth if the inclusion of trait variability in fact improves the representation of ecosystem properties such as NPP and biomass, an important refinement that could improve reliability of projections with future climatology. Additionally, trait-based models also provide an unique opportunity to promote insights in active ecology areas of debate, such as the role of functional diversity in ecosystem response to projected disturbances like climate change, and how functional diversity itself responds to these disturbances. However, this potentiality of trait-based models has yet to be fully accessed and can be considered a far-reaching achievement especially to community ecology.

Here, in this modeling exercise, we compared for the first time how the use of a PFT approach (widely used by vegetation models) differs from a trait-based approach in terms of current representation of carbon storage and NPP; the impacts of a reduced precipitation scenario on how these two approaches simulate carbon storage and functional diversity and how changes on functional diversity components are connected to carbon storage responses.

In this study, the use of a PFT based approach and a trait-based approach applied to the same model, constituted a proof of concept to strengthens the significance of incorporating functional diversity in vegetation models. For example, our results evidenced that the inclusion of trait variability can improve accuracy in representing biogeochemical variables and also show that trait-based models, such as CAETÊ, are important tools to investigate community ecology mechanisms and processes that link biodiversity (mainly functional diversity) and ecosystem functioning. For instance, we found, consistent with expectations, that more diverse communities (trait-based approach) could deal better with environmental changes since it provided a higher range of responses, which enabled a community functional reorganization that could buffer, by maintaining or diminishing, the impacts of disturbances in ecosystem properties. On the other hand, because of its limited capacity to change community functional structure, the use of PFTs may overestimate the impacts of environmental changes.

Besides that, our trait-based framework showed to be a first step into the study of the different components of functional diversity (richness, evenness and divergence) against climate change and its connection with ecosystem functioning. As an example, we found, unexpectedly, that a harsher environment can increase functional richness instead of decreasing it, which can be attributed to a reduction in hyperdominance and then creation of new ecological niches for new combinations of functional traits to occupy in the functional space, and as a consequence, a lower sensibility of the ecosystem. This type of result can also be used to understand mechanisms such as community assembly rules.

In conclusion, this study demonstrated that the CAETÊ framework for including trait diversity in vegetation model is feasible and can be used in future studies, being flexible enough to be applied in several climatic scenarios and using different variable functional traits, hence, constructing a robust foundation to advance in the understanding of the impacts of climate change in Amazon forest and other natural ecosystems.