*Carbon stocks under reduced precipitation: does the modeling approach matter?*

As expected, the 50% reduction in precipitation caused a pervasive decrease in the basin carbon stock for both modeling approaches, concentrated mainly on the Amazon basin edges and other naturally drier regions (Fig. 2a and 2b). This massive decrease of Amazon forest ability to store carbon in moisture stress scenarios is in agreement with experimental (da Costa et al., 2010; Nepstad, Tohver, Ray, Moutinho, & Cardinot, 2007)⁠⁠, observational (Brienen, Phillips, Feldpausch, & et al., 2015; Enquist & Enquist, 2011; Phillips et al., 2009, 2010)⁠⁠ and previous modeling studies (Lapola, Oyama, & Nobre, 2009; Powell et al., 2013; Rammig et al., 2010)⁠. In our model, this decrease is a result of the strengthened soil moisture stress that reduces photosynthetic rates and net primary productivity, meaning that the carbon available to be invested in plant compartments is reduced, a mechanism also known as carbon starvation (Doughty et al., 2015; Rowland et al., 2015)⁠.

Despite the general decrease in carbon stocks, we found important differences between PFTA and TBA regarding the geographical pattern of carbon loss: firstly, it is noteworthy that for TBA it occurred in a much smoother gradient between a grid cell value and its neighboring cells, and also across different basin regions; and second, TBA was able to maintain carbon stocks in some areas where in PFTA carbon stocks were completely lost, that is, none PFT was able to establish. This was more evident in naturally drier areas, such as the transition between the Amazon forest and the savannah (*cerrado*) and central Amazon, that, in general, were the more affected regions. It corroborates with our H1 and with previous literature in which it is widely accepted that a more diverse (both taxonomically and functionally speaking) ecosystem tends to be less impacted by environmental changes (Cadotte, Carscadden, & Mirotchnick, 2011; Mori et al., 2013; Sakschewski et al., 2016; Schmitt et al., 2019)⁠.

This connection between functional diversity and resilience to environmental changes emerges from the fact that higher variability of traits (and plant strategies) also provides higher diversity of responses under new conditions, so that the community can restructure and maintain the ecosystem processes or decrease the impact of change, showing, hence, higher resilience (Fauset et al., 2015; Lohbeck, Bongers, Martinez-Ramos, & Poorter, 2016;Mori et al., 2013; Yachi & Loreau, 1999)⁠. Previous theoretical, experimental and modeling literature have already shown that environmental change is able to cause a modification on functional structure (Enquist & Enquist, 2011; Hillebrand, Bennett, & Cadotte, 2008; Mouillot, Villéger, Scherer-Lorenzen, & Mason, 2011)⁠, dominance (Hillebrand et al., 2008; Schmitt et al., 2019; Valencia et al., 2015)⁠, composition (Aguirre-Gutiérrez et al., 2019; Esquivel-Muelbert et al., 2018; Nepstad, Tohver, Ray, Moutinho, & Cardinot, 2007)⁠ and diversity components (Hillebrand et al., 2008; Zhang, Chen, & Reich, 2012)⁠. In fact, our results showed that the modeling approach with higher diversity (TBA) presented a significant functional community reorganization of Amazon forest in terms of composition, dominance relationship, functional richness, evenness and divergence with the applied precipitation reduction scenario (Fig. 3, Fig 4 and fig. Com os plots separados).

Functional reorganization can occur through a compensatory dynamic process so called as “functional density compensation” when the composition (that is, the occurrence or abundance of trait values) of a community adjust to the new conditions enabling types of plants - or trait combinations, in our case - that previously exerted a less relevant functional role (i.e. low density) to increase their dominance and vice-versa (Gonzalez & Loreau, 2009; Mori, Furukawa, & Sasaki, 2013; Sakschewski et al., 2016), then, changing the way that community occupy the functional space⁠. Such a functional density compensation followed by functional reorganization and its restriction by traits variability was well captured in our modeling results: reduced precipitation led to an expressive wider range of traits values in functional space for all the considered traits for TBA, while PFTA presented a restricted probability of the occurrence of new trait values, presenting trimodal curves with moisture stress, product of *a priori* defined trait values. This was also observed in the multi-trait analysis of functional diversity: the wider occupation of the functional space with the reduced precipitation was much stronger in the TBA when compared to the PFTA, as well as the centroid distance before and after disturbance.

The capacity to functionally reorganize enabled a paramount change on TBA that corroborates with our H2: the increase in the abundance of traits with higher values of allocation and residence time for fine roots (Fig. XXX) led to higher investment in this plant compartment to the detriment of investment in leaves and ABGW (Fig. XXX), a result imposed by the CAETÊ trade-offs. It reflected in carbon partitioning for TBA, that is, a bigger root:shoot when compared to the regular climate condition (Fig. XX). The higher investment in fine roots increased the uptake of water, which makes the community better able to deal with drought and maintain carbon stocks or reduce the degree of loss. These results corroborate with the well known effect of climatic change, such as drought, in inducing changes on C partitioning patterns (Doughty et al., 2014; Kannenberg et al., 2019)⁠ including a prioritization of root investment at the expense of other tissues (Doughty et al., 2014; Phillips et al., 2016; Rowland et al., 2014)⁠. On the other hand, given the limited trait variability, PFTA did not show this plasticity in carbon partitioning, avoiding its PFTs to establish in some grid cells, especially those that naturally show lower levels of precipitation (Fig. XXX).

Understanding the shift in carbon partitioning due to climate is of primary relevance for the future of Amazon carbon stocks (Doughty et al., 2015; Friedlingstein et al., 2006)⁠ and is especially important if the carbon is allocated towards pools with shorter turnover, such as fine roots or even root exudates (Jiang et al., 2020)⁠, that contribute to a lesser extent to total carbon storage comparatively with other pools such as wood tissues (Chave et al., 2009; De Kauwe et al., 2014; Kannenberg et al., 2019; Luo, 2003)⁠. Our modeling exercise was able to capture this process: the reduce moisture triggered an increase in investment in fine roots in the TBA that provided greater resistance to drought, preventing the total loss of carbon in several grid-cells, and also caused a lower carbon storage in other tissues, mainly on ABGW and led to a relative lower carbon storage in some locations when compared to the PFTA. In that sense, if the ability to store carbon is used as the only proxy for ecosystem resilience, as is commonly used, e.g., Sakschewski et al. 2016; Huntingford et al., 2013; Levine et al., 2016, it may result in limited interpretations about the response of tropical forests to climate change. Also, our results showed that the approach used in vegetation models that seek to represent the impacts of environmental change in ecosystems indeed matters: the use of a small set of PFTs with fixed parameters to represent vegetation can overestimate the impacts of these changes and impose limitation on looking into processes such as the change in communities functional structure.