Comment on bg-2022-145
Anonymous Referee #2


This manuscript describes the shifts that might occur in nutrient cycling under elevated CO$_2$. The manuscript focuses on bulk soil and the rhizosphere interface across several depths representing shallow soils to the soil-saprolite transition area. These measurements took place at the EucFACE experimental site, which is predominantly limited by phosphorus.

Broadly, this is an interesting manuscript that provides additional data on nutrient cycling below the shallower 0-10 cm zone typically measured. The most interesting finding, from my perspective, is that the acceleration of nutrient cycling under eCO$_2$ satisfies the nutrient demand for plants, more so than the broader increase in nutrient stocks. However, maybe when one extrapolates this to the level of warming expected for this atmospheric CO$_2$ concentration that might not be the case.

I don't have any broad comments, and believe this manuscript will be a good contribution to the broader literature on eCO$_2$ impacts (as reviewed by Walker et al., New Phytologist, 2021). However, while the authors generate interesting metrics showing that nutrient cycling at deeper soil depths is accelerated by eCO$_2$, I remain unclear how much of the plant's nutritional demand is derived from these deeper regions relative to the shallower soils (< 10 cm) where the bulk of nutrient stocks and roots are located?

Minor comments:

Ln 17-18: I think this is one of the more interesting aspects of the study, however, this sentence in the abstract is very vague, and doesn't really tell me how eCO$_2$ influenced nutrient availability. A stronger sentence would help the abstract.
Ln 33-34: The sentence structure here is rather awkward, can it be re-written for clarity?

Ln 38: Referencing of these two Iverson pprs needs to be fixed.

Ln 47: 'thus promote' is a little awkward too - 'and thus promote' might work, or 'thus promoting', maybe?

Ln 90: Is there any information on belowground activity under eCO2? Could water also be limited at this site? Also, what is the average rooting depth for these trees? How much for that is below 10 cm?

Ln 143: I thought enzyme measurements were traditionally done on fresh soil samples. Why were these performed on (presumably)thawed samples, and how slowly were they thawed? Thawing too quickly will likely impose selection for tolerant members of the community. Maybe it's not a problem if all the samples are treated the same (enzymes measurements are potentials after all).

Ln 200: comma after 'where'.

Ln 264: I'm not sure I quite understand the connection between microbial P and plant roots here. Maybe I missed the broader point, but I found this a little unclear.

Ln 271: What is the average water table depth at this site? I assume there is little strong redox chemistry occurring here that might impact the N-cycle and favor N-loss.

Ln 287: I'm not sure I'm convinced by this argument. The site is not limited by N or C, right? And the allocation to enzymes is trivial relative to that required to build microbial biomass (which increases under eCO2). I guess this interpretation also depends on how you interpret the enzyme data, which can be notoriously difficult. Does an increase in enzymes represent the availability of a given substrate (feast mode), or microbial limitation by a given substrate (bet-hedging approach). How you interpret your enzyme data goes some way to how you interpret the enzyme response.

Ln 335: I tend to think it means the 'potential' is there to decompose plant material down the soil column.