Dear Editor,

Thank you for these suggestions. I believe they are very interesting points and led to new insights on the modelling results´ implications to soil ecology.

- An important hypothesis of your modelling work is that the plant-microbial competition for N acquisition increases and nutrient availability for plants decreases with altitude (and decreasing temperature), explaining the higher plant investment in mycorrhizal fungi. Consistently, you could dedicate some lines to explain we need more experimental works to test/support this hypothesis, including "new" methods that better qualifies nutrition status of wild plants and plant-soil competition for nutrients.

To address this, the following text was added to section 5.1

"Field studies in our elevation gradient sites agree with our modelling results and hypothesis that plant-microbial competition for N acquisition intensifies with altitude. For instance, experimental additions of N (50 kg N ha^{-1} y^{-1}) and P (10 kg P ha^{-1} y^{-1}) during 5 years resulted in increased CH_4 uptake for the 2,000 and 3,000 m.a.s.l. sites, indicating strong nutrient competition (Martinson et al., 2021). Also, To expand on this, future studies should integrate field and laboratory experiments across different ecosystems and altitudinal gradients. Some methods offer promising avenues to improve our understanding of plant nutritional status and plant-soil competition for nutrients. For instance, stable isotope tracing (e.g., ^{15}N labelling) can help track N uptake by plants and microbes, while enzyme activity assays can reveal microbial nutrient acquisition strategies under varying temperature conditions (Dunn et al., 2006). Additionally, soil sterilization bioassays can offer insights into the role of soil microbes affecting plant performance (Waring et al., 2016), whilst metagenomics and metatranscriptomics can provide insights into shifts in microbial communities and their functional roles in nutrient cycling (Mendes et al., 2017). Expanding empirical research in these areas will be essential to refine our understanding of plant-microbial interactions in response to changing environmental conditions."

- Your discussions omit the key role of free microbial decomposers in the supply of soluble nutrients for plants, including those suppling nutrients from evolved organic matter and mineral associated organic matter (e.g. https://doi.org/10.1111/gcb.17034; https://doi.org/10.1111/1365-2435.14038). Try to better balance your discussions by adding some lines on the role of these microbes.

Thank you, this paragraph was added to the section 5.1

"While microbial competition for nutrients can limit plant nutrient acquisition, free-living microbial decomposers play a crucial role in breaking down evolved organic matter and mineral-associated organic matter, thereby releasing soluble nutrients to plants synchronizing supply and demand (Fontaine et al., 2024). These microbes, including saprotrophic fungi and bacteria, drive nutrient mineralization processes that can enhance plant nutrient uptake, particularly in nutrient-limited

environments such as our studied elevation gradient. In our sites, the N cycle is closely coupled (i.e., gross N mineralization is equal to NH_4 immobilization, and gross nitrification is equal to NO_3 immobilization), and experimental nutrient additions can alter this equilibrium (Baldos et al., 2015). This is particularly alarming due to the observed increase of anthropogenic N deposition in these areas (Wilcke et al., 2013). Other global environmental changes such as CO_2 and temperature increase may impact plant controls on soil organic matter dynamics which are mediated by microbes through priming effects, leading to the loss of nutrients and ecosystem degradation (Bernard et al., 2022). Balancing the interactions between decomposer activity and plant-microbial competition is, therefore, essential for understanding nutrient dynamics along environmental gradients."

I hope the new additions were satisfactory and provide new clarity into the implication of the results.

Best regards,

Mateus Dantas de Paula, in behalf of all authors

References

Baldos, A. P., Corre, M. D., and Veldkamp, E.: Response of N cycling to nutrient inputs in forest soils across a 1000-3000 m elevation gradient in the Ecuadorian Andes, Ecology, 96, 749–761, https://doi.org/10.1890/14-0295.1, 2015.

Bernard, L., Basile-Doelsch, I., Derrien, D., Fanin, N., Fontaine, S., Guenet, B., Karimi, B., Marsden, C., and Maron, P. A.: Advancing the mechanistic understanding of the priming effect on soil organic matter mineralisation, Funct. Ecol., 36, 1355–1377, https://doi.org/10.1111/1365-2435.14038, 2022.

Dunn, R. M., Mikola, J., Bol, R., and Bardgett, R. D.: Influence of microbial activity on plant-microbial competition for organic and inorganic nitrogen, Plant Soil, 289, 321–334, https://doi.org/10.1007/s11104-006-9142-z, 2006.

Fontaine, S., Abbadie, L., Aubert, M., Barot, S., Bloor, J. M. G., Derrien, D., Duchene, O., Gross, N., Henneron, L., Le Roux, X., Loeuille, N., Michel, J., Recous, S., Wipf, D., and Alvarez, G.: Plant–soil synchrony in nutrient cycles: Learning from ecosystems to design sustainable agrosystems, Glob. Chang. Biol., 30, 1–24, https://doi.org/10.1111/gcb.17034, 2024.

Martinson, G. O., Müller, A. K., Matson, A. L., Corre, M. D., and Veldkamp, E.: Nitrogen and Phosphorus Control Soil Methane Uptake in Tropical Montane Forests, J. Geophys. Res. Biogeosciences, 126, 1–14, https://doi.org/10.1029/2020JG005970, 2021.

Mendes, L. W., Braga, L. P. P., Navarrete, A. A., Souza, D. G. de, Silva, G. G. Z., and Tsai, S. M.: Using Metagenomics to Connect Microbial Community Biodiversity and Functions, Curr. Issues Mol. Biol., 24, 103–118, https://doi.org/10.21775/CIMB.024.103, 2017.

Waring, B. G., Gei, M. G., Rosenthal, L., and Powers, J. S.: Plant-microbe interactions along a gradient of soil fertility in tropical dry forest, J. Trop. Ecol., 32, 314–323, https://doi.org/10.1017/S0266467416000286, 2016.

Wilcke, W., Leimer, S., Peters, T., Emck, P., Rollenbeck, R., Trachte, K., Valarezo, C., and Bendix, J.: The nitrogen cycle of tropical montane forest in Ecuador turns inorganic under environmental change, Global Biogeochem. Cycles, 27, 1194–1204, https://doi.org/10.1002/2012GB004471, 2013.