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Interactive comment on "Processes regulating progressive nitrogen limitation under elevated carbon dioxide: a meta-analysis" *by* J. Liang et al.

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Thanks for the comments.

Is it gross or net mineralization contributing to nitrogen supply to plant growth? Microbial organisms utilize soil organic matter for energy and nutrients to build body biomass and produce metabolic products, during which inorganic nitrogen can be released (i.e., mineralization). Meanwhile, microbial organisms can absorb inorganic nitrogen, which is immobilization. Net mineralization is the net change of gross mineralization and microbial immobilization. Rütting cited Davidson et al. (1992) work in conifer forests that net mineralization is a small fraction of gross mineralization. It is true that net mineralization is a small fraction of gross mineralization when nitrogen availability to microbial

organisms is low (the fraction goes up as nitrogen availability increases) (Chapin et al., 2011). These evidence indicate nitrogen supply to plant growth is low even if gross mineralization is high if microbial immobilization is also high. It is exactly these evidence refute, instead of support, his claim in the SC that "gross rates of mineralization are of importance and not the net rates". Therefore, while gross mineralization indicates the turnover rate of nitrogen from organic to inorganic forms, it is net mineralization that contributes to nitrogen supply to plant growth. Microbial organisms are energy-limited (i.e., carbon-limited) in most ecosystems, in which case, I quote Chapin et al. (2011), "net nitrogen mineralization is an excellent measure of the nitrogen supply to plants".

Given that net mineralization is usually a small fraction of gross mineralization (we both agree that), the contributions of nitrogen fixation and mineralization to plant growth are in similar magnitude. Our results (Liang et al., 2015) showed that CO_2 enrichment significantly increase nitrogen fixation, but had no effect on net mineralization, indicating the increased nitrogen fixation is one of the most important reasons that alleviate progressive nitrogen limitation. As we discussed in our original paper (Liang et al., 2015), the increased nitrogen fixation could be resulted from stimulated activities of symbiotic and/or free-lived heterotrophic nitrogen-fixing bacteria, or competition of nitrogen-fixing species, or their combinations.

Even if it is gross mineralization, instead of net mineralization, that contribute to nitrogen supply to plant growth, as claimed in Rütting's SC (I do not agree as discussed above), a previous meta-analysis by himself and co-author showed that CO_2 enrichment had no significant effect of gross mineralization (Rütting and Andresen, 2015).

Overall, our work was a comprehensive assessment of the effects of CO_2 enrichment on terrestrial N cycle, which helps improve the understanding of the N limitation to plant growth under elevated CO_2. Our results indicated that elevated CO_2 stimulates N influx via biological N fixation but reduces N loss via leaching, increasing N availability for plant growth. The extra N supply by the enhanced biological N fixation and reduced leaching may meet the increased N demand under elevated CO_2, potentially alleviating

PNL.

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