The influence of elevated CO_2 and soil depth on rhizosphere activity and nutrient availability in a mature Eucalypt woodland

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INTRODUCTION

Elevated carbon dioxide (eCO_2) in the atmosphere is thought to increase forest biomass productivity, but only where soil nutrients, particularly nitrogen (N) and phosphorus (P), are not limiting growth. Our current understanding of nutrient cycling under eCO_2 is mainly derived from surface soil experiments, leaving mechanisms of the impact of eCO_2 on rhizosphere nutrient availability at deeper depths unexplored.

To investigate the influence of eCO_2 on nutrient availability in soil at depth, we studied various C, N and P pools (extractable, microbial biomass, total soil C and N, and mineral associated P) and nutrient cycling processes (enzyme activity and gross N mineralisation) associated with C, N, and P cycling in both bulk and rhizosphere soil at different depths at the Free Air CO_2 enrichment facility in a native Australian mature *Eucalyptus* woodland (EucFACE) with highly weathered and nutrient poor soil.

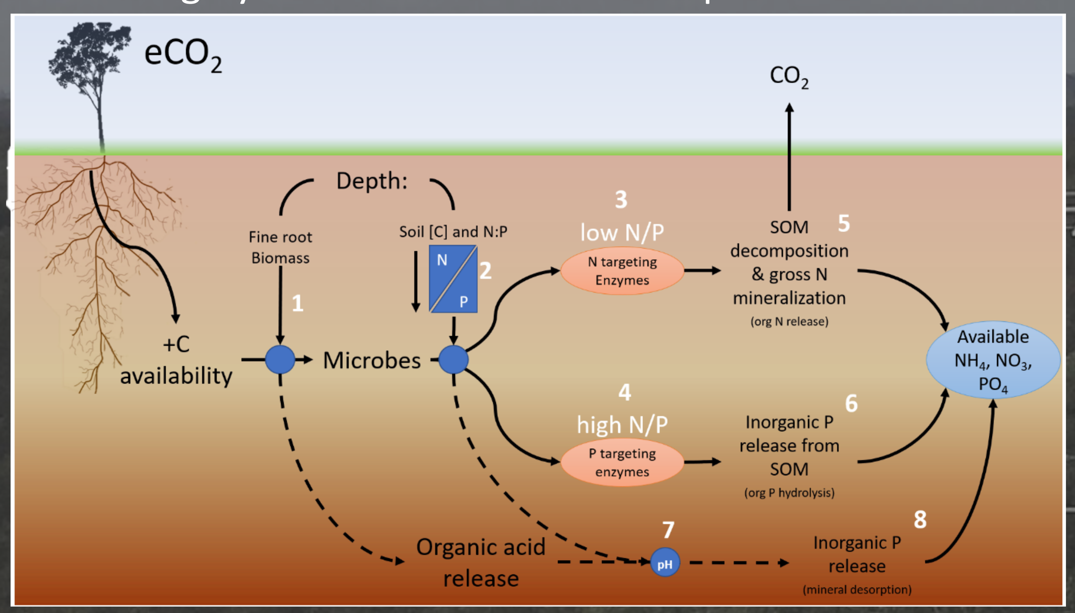

Figure 1: Conceptual representation of the mechanisms affecting nutrient availability as influenced by depth. *Elevated CO_2 increases C availability belowground, but the effect of that extra C is moderated by depth dependent mechanisms. Root exudation in the rhizosphere soil is proportional to fine root biomass which decreases with depth (1). The microbial strategy to release nutrients is a function of soil C content and N to P ratio, which also can change with depth (2). The microbial strategy is a response to the N to P ratio either producing N targeting enzymes in low N to P conditions (3) or P targeting enzymes in high N to P conditions (4). Nitrogen targeting enzymes act to decompose SOM and increase gross N mineralisation all transforming N into NH_4^+ and ultimately NO_3^- which are available for plant uptake (5). P targeting enzymes cut phosphates from organic molecules at hydrolysis (6). Soil pH is changed, impacting the soil sorption capacity, by the organic acid exudates from roots and microbial mineralisation thereof (7) and desorption (8).*

RESULTS

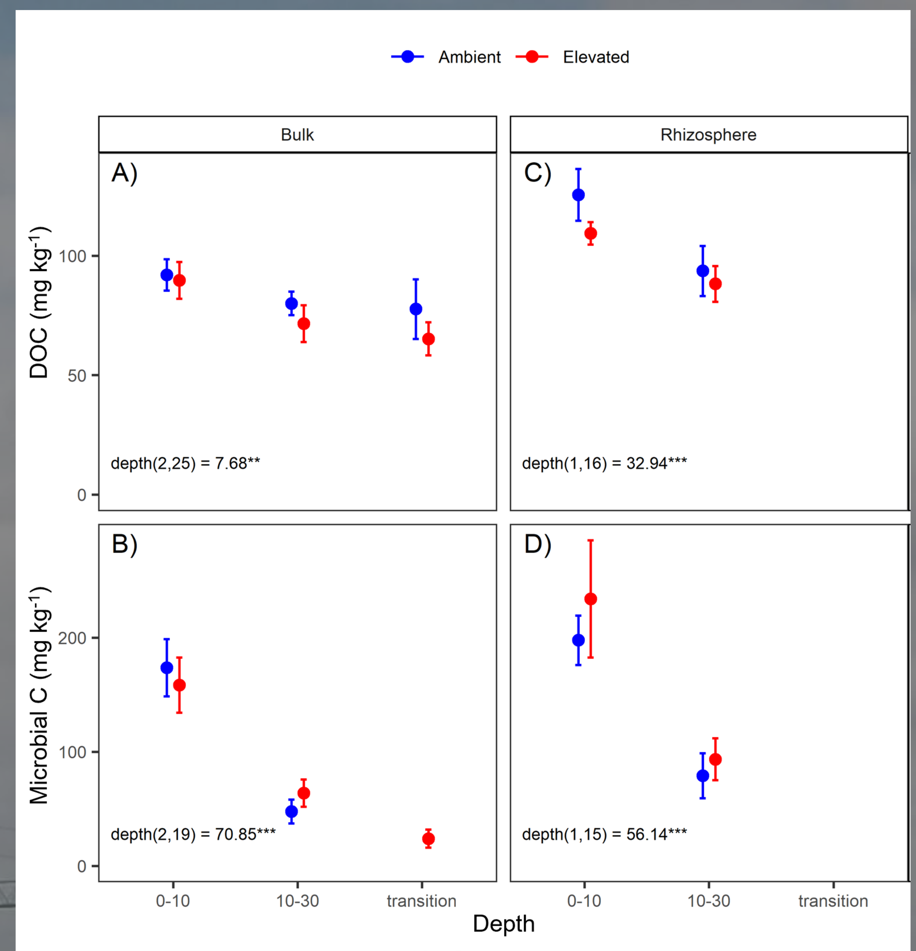

Figure 2: C pools; DOC and Microbial biomass C concentrations decrease with depth and increase in rhizosphere.

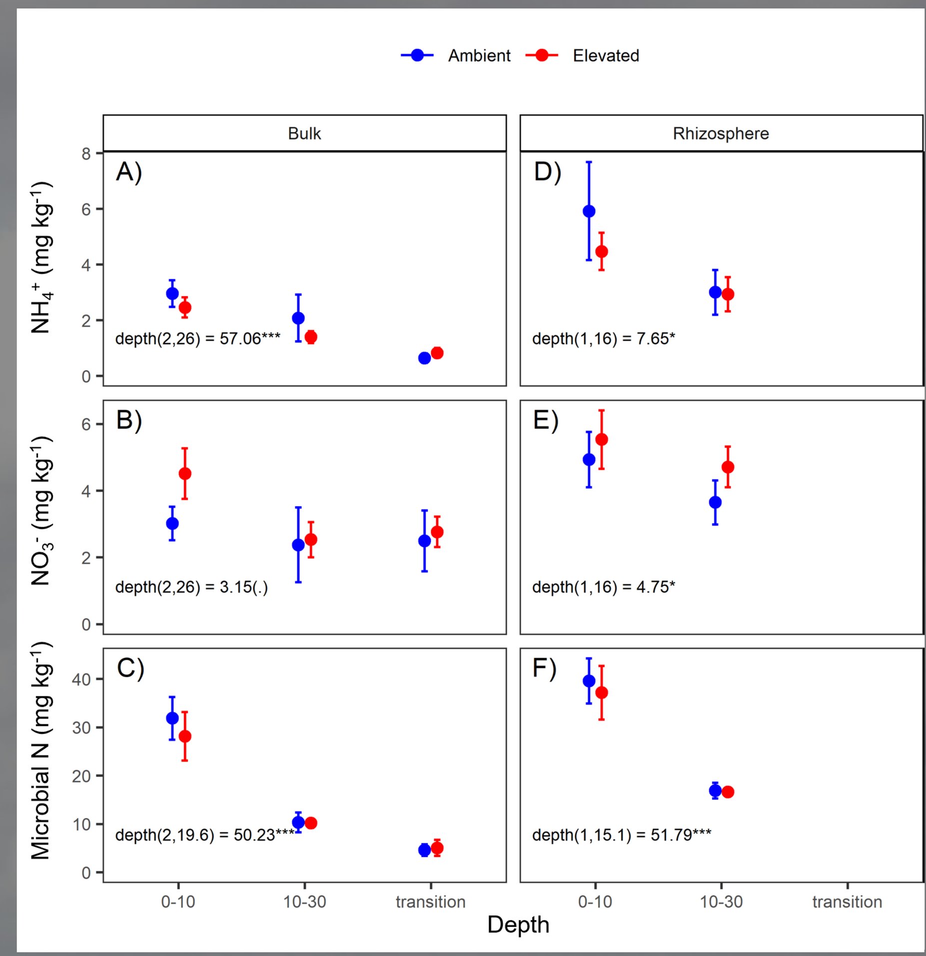

Figure 3: N pools; ammonium, nitrate and Microbial biomass N concentrations decrease with depth and increase in rhizosphere.

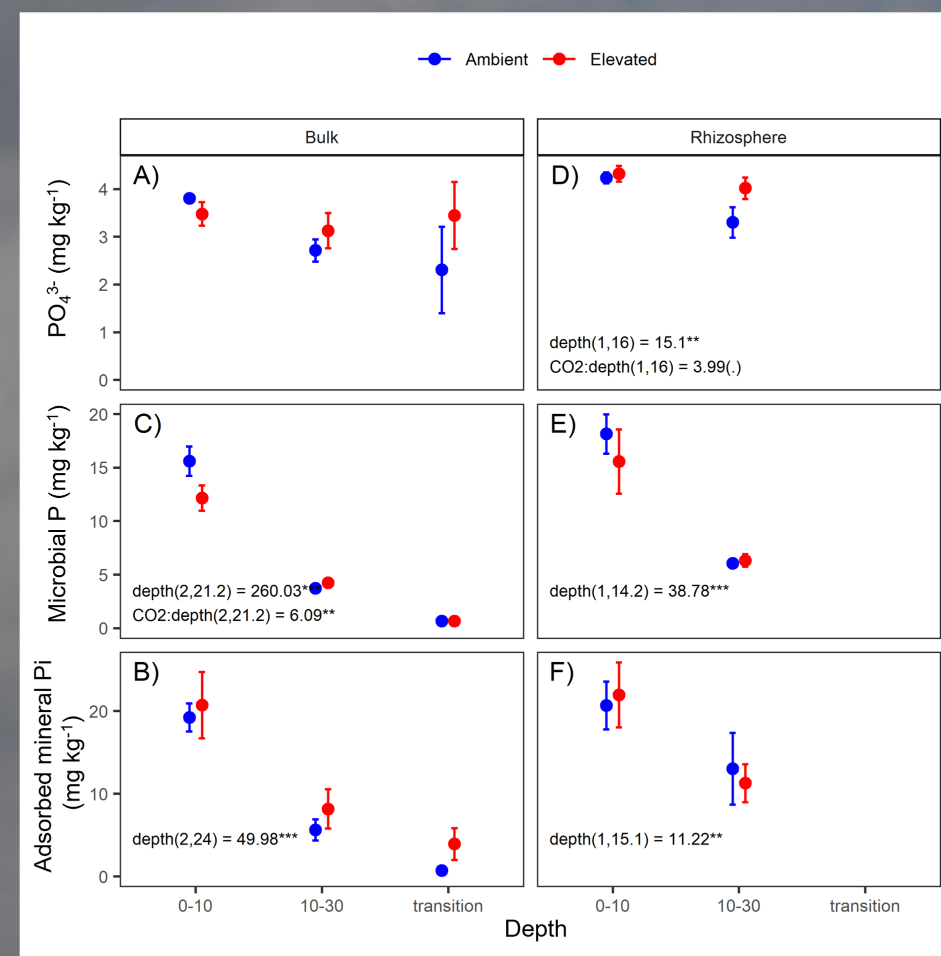

Figure 4: P pools; Phosphate Microbial biomass P, and mineral adsorbed phosphate concentrations decrease with depth and increase in rhizosphere. However, phosphate concentration did not decrease with depth in the rhizosphere.

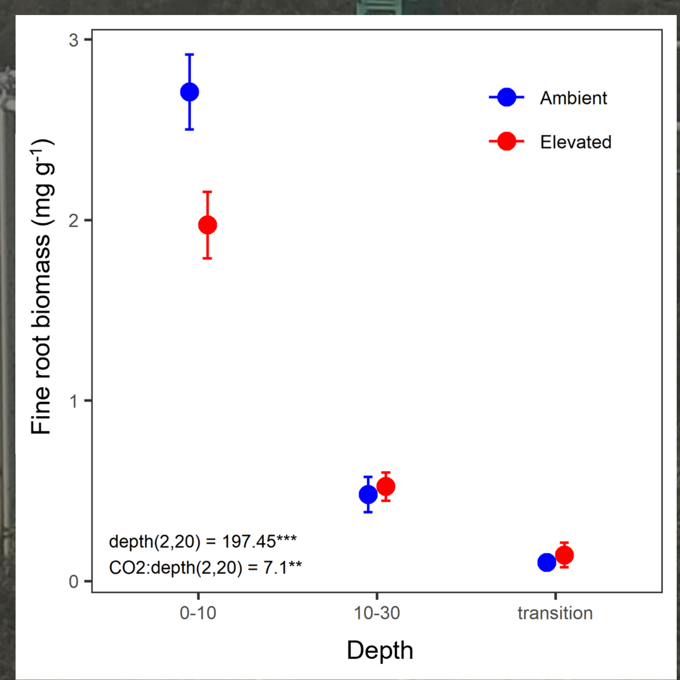

Figure 5: fine root density is highest in the surface soil and decrease with depth. However, in the top 10 cm the fine root density decreased under elevated CO_2

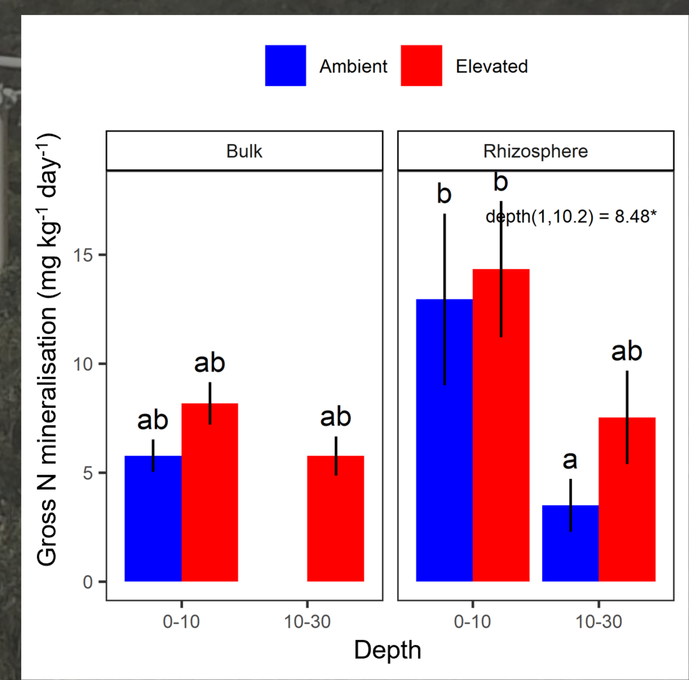

Figure 6: Gross N mineralization, decreased with depth, and the rate was highest in the 0-10 cm rhizosphere soil. There was no effect of elevated CO_2

'Plant roots counteract the effects of depth on nutrient availability. increase phosphate availability at depth under eCO_2 in a mature Eucalyptus woodland exposed to elevated CO_2. However, driving mechanisms are unclear.'