Net mineralization of N at deeper soil depths as a potential mechanism for sustained forest production under elevated $[CO_2]$

Contact: Colleen Iversen, 865-241-3961, iversencm@ornl.gov

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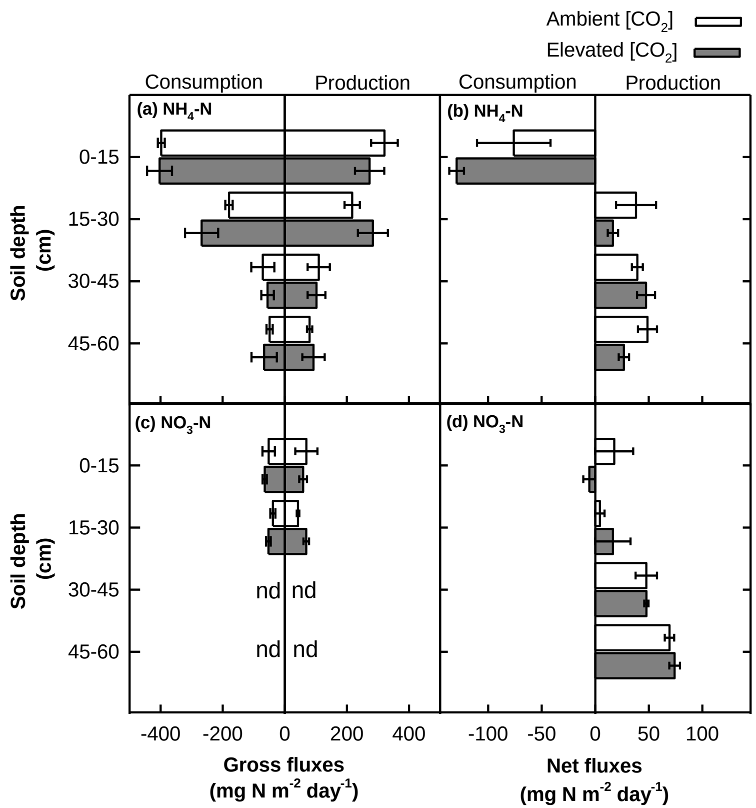
- Deeper fine-root distributions observed in nearly three-quarters of forested CO_2-enrichment experiments could alter nitrogen (N) cycling throughout the soil profile.
- We used ^{15}N isotope pool dilution methodology in a CO_2-enriched sweetgum plantation in Oak Ridge, Tennessee, to determine whether nitrogen (N) is available for root acquisition in deeper soil, and whether greater fine-root biomass inputs at depth have altered N cycling rates.
- Greater rates of potential net N mineralization in deeper soils (i.e., deeper than 15 cm) coincide with the stimulation of root production at deeper soil depths under elevated $[CO_2]$.
- Elevated $[CO_2]$, however, had no effect on potential gross or net N mineralization rates.
- These results indicate that N mineralization at depth in the soil, combined with increased root exploration of the soil volume under elevated $[CO_2]$, may be more important than changes in potential gross N cycling rates in sustaining forest responses to rising atmospheric CO_2.



Relatively more N is potentially available for roots to access at deeper soil depths where reduced rates of microbial consumption of mineral N relative to production resulted in positive net fluxes.

U.S. DEPARTMENT OF ENERGY

OAK RIDGE NATIONAL LABORATORY
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Abstract:

Elevated atmospheric [CO_2] is projected to increase forest production, which could increase ecosystem carbon (C) storage. This study contributes to our broad goal of understanding the causes and consequences of increased fine-root production and mortality under elevated CO_2 by examining potential gross nitrogen (N) cycling rates throughout the soil profile. Our study was conducted in a CO_2-enriched sweetgum (*Liquidambar styraciflua* L.) plantation in Oak Ridge, TN, USA. We used ^{15}N isotope pool dilution methodology to measure potential gross N cycling rates in laboratory incubations of soil from four depth increments to 60 cm. Our objectives were two-fold: (1) determine whether N is available for root acquisition in deeper soil, and (2) determine whether elevated [CO_2], which has increased inputs of labile C resulting from greater fine-root mortality at depth, has altered N cycling rates. While gross N fluxes declined with soil depth, we found that N is potentially available for roots to access, especially below 15 cm depth where rates of microbial consumption of mineral N were reduced relative to production. Overall, up to 60% of potential gross N mineralization, and 100% of potential net N mineralization, occurred below 15-cm depth at this site. This finding was supported by *in situ* measurements from ion-exchange resins, where total inorganic N availability at 55 cm depth was equal to or greater than N availability at 15 cm depth. While it is likely that trees grown under elevated [CO_2] are accessing a larger pool of inorganic N by mining deeper soil, we found no effect of elevated [CO_2] on potential gross or net N cycling rates. Thus, increased root exploration of the soil volume under elevated [CO_2] may be more important than changes in potential gross N cycling rates in sustaining forest responses to rising atmospheric CO_2.

Citation:

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