Nitrogen cycling in forest soils under elevated CO_2: response of a key soil nutrient to global change

Manon Rumeau, Michaela Reay, Rob Mackenzie, Yolima Carillo, Sami Ullah and Fotis Sgouridis

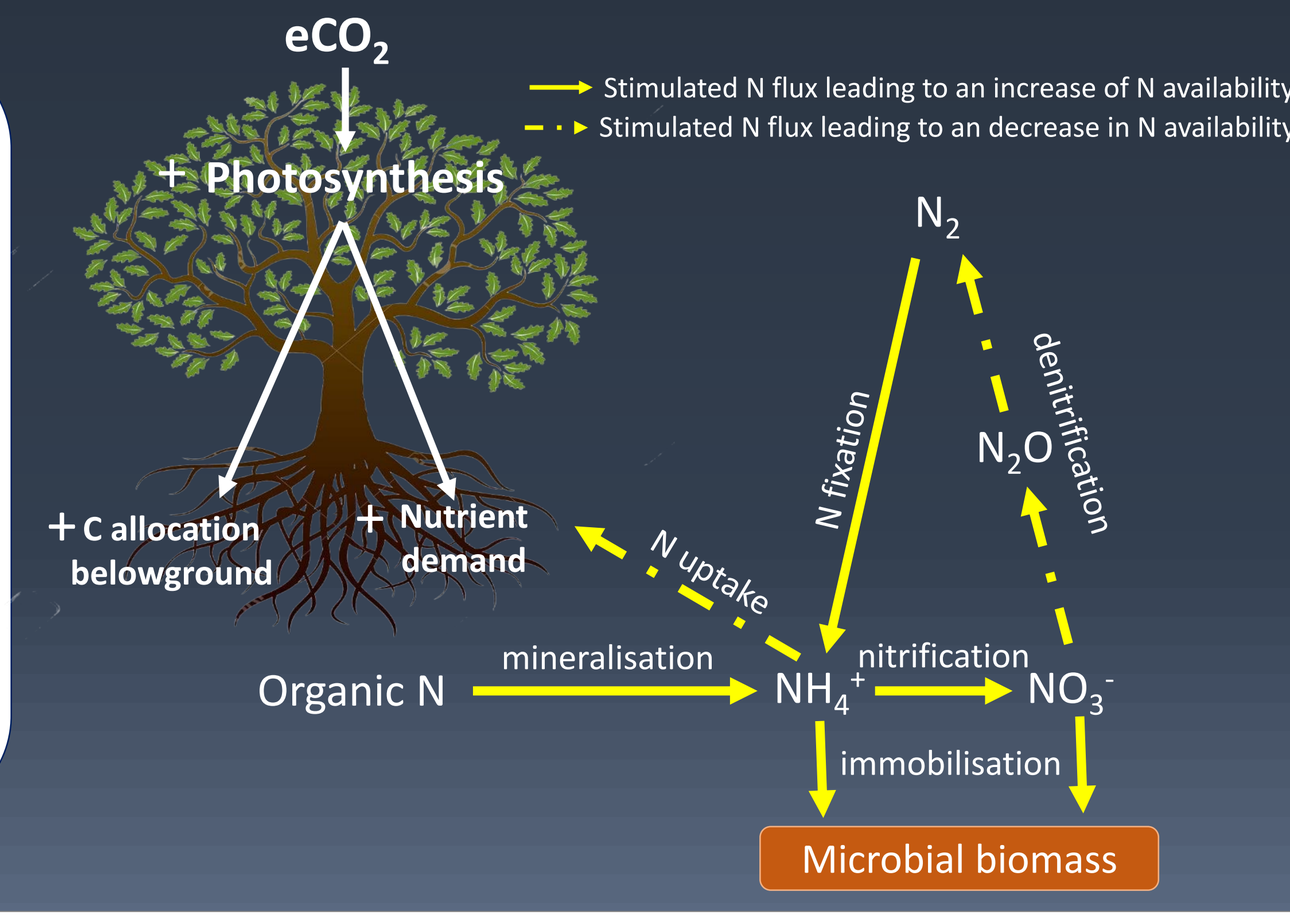
Context

Will N fixation and N mineralization compensate the higher demand for available nitrogen under elevated CO_2?

Why studying N fluxes ?

Increasing atmospheric CO_2 concentration is very likely to result in an enhanced demand for nitrogen.

A reduction of N availability can potentially negate the predicted C storage under future climates by forests.
→ **Progressive Nitrogen Limitation Hypothesis.**



Hypotheses

N limitation and C allocation belowground will enhance N fixation under elevated CO_2.

N mineralization will be upregulate to meet tree nutrient demand.

Denitrification will be enhanced as a result of higher microbial activity.

Material & Methods

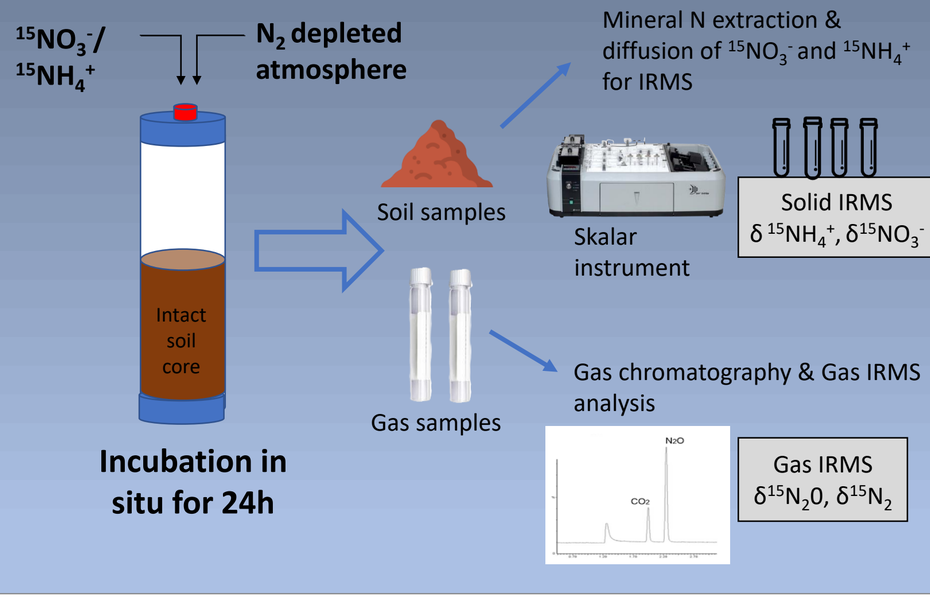
^{15}N assays to measure N fluxes:

- ^{15}N assimilation method: determine the amount of N fixed in soil by free living N fixers.
- ^{15}N pool dilution method + ^{15}N Gas Flux method: mineralisation, immobilisation, nitrification and N_2O/N_2 emission).
- Net mineralization/nitrification on 28 days incubation.

Metagenomic method:

- qPCR on N cycling related RNA (nifH, chiA, amoA, nirK/S, nosZ).

^{15}N pool dilution + ^{15}N Gas Flux method:



Fluxes estimated:

- Mineralisation
- Nitrification
- NH_4^+/NO_3^- immobilisation
- NH_4^+/NO_3^- residence time
- N_2/N_2O emission

Results & Discussion

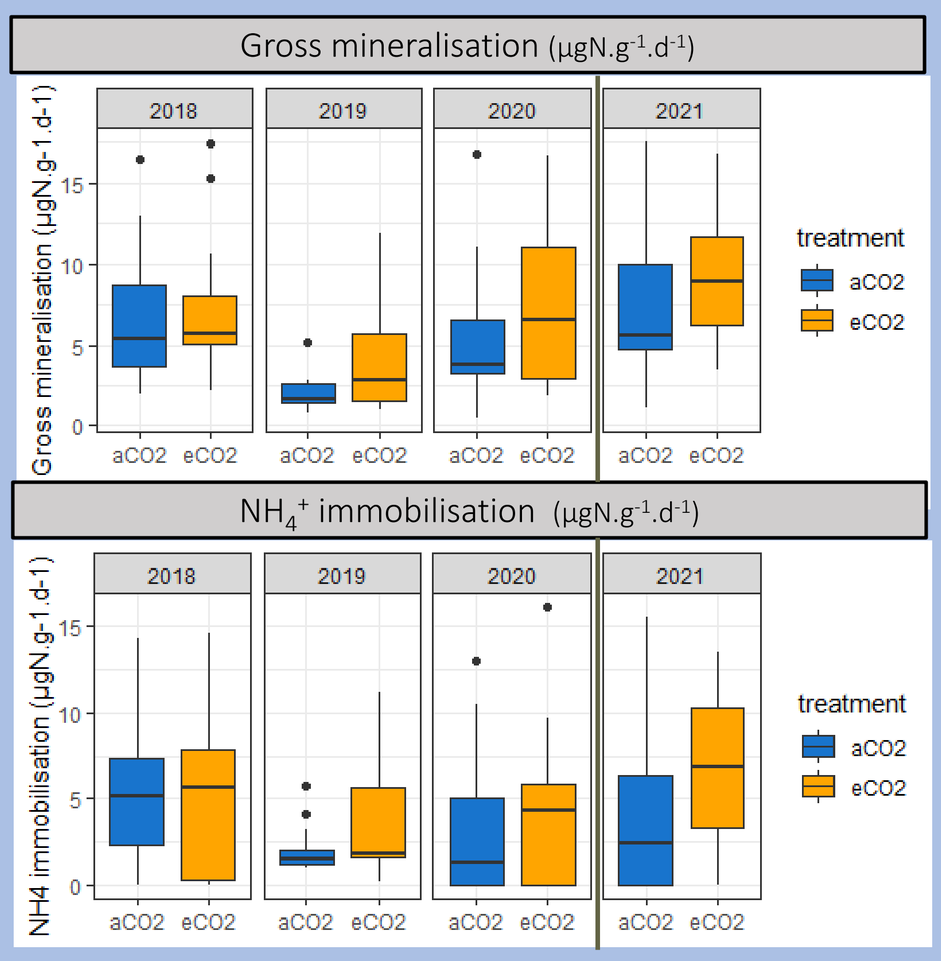


Fig 1: Gross mineralisation and NH_4 immobilization rates from summer 2018 to 2021. (n=15). Analysis from 2018 to 2020 were made by F. Sgouridis, S. Cotchim, J. Ma under lab condition while 2021 was performed on intact soil cores in the field. eCO2 = elevated CO_2 concentration, aCO2 = ambient CO_2 concentration.

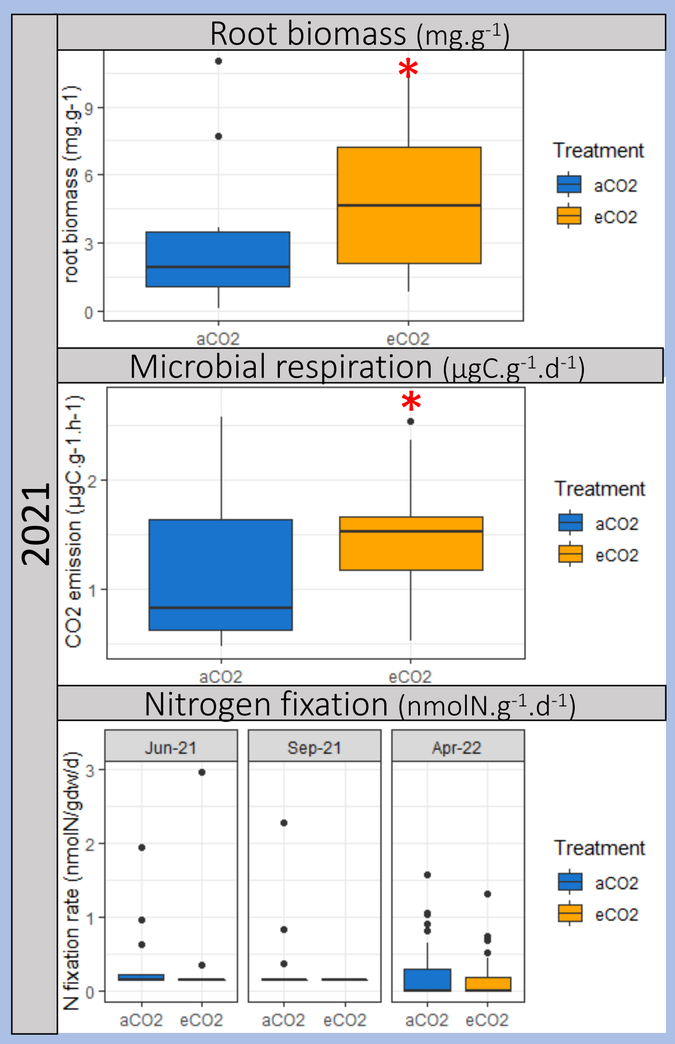


Fig 2: Root biomass and microbial respiration in samples of the 2021 mineralisation campaign (n-15). Nitrogen fixation measured 3 times across 2021/2022 (n=15).

Results & Discussion

- The mineralisation/immobilisation loop is the main driver of N availability in this system.
- These 2 processes are slightly enhanced under eCO_2 as a result of a faster root growth and higher microbial activity.
- N fixation in soils is extremely low and does not seem to be enhanced under eCO_2.

New hypothesis: Tight collaboration between trees and microbes to support the higher N demand though RPE (rhizosphere priming effect).

Natural Environment Research Council
UNIVERSITY OF BIRMINGHAM | BIFOR
PhD funded by NERC/QUINTUS

Manon Rumeau
MLR094@student.bham.ac.uk