Temperate Deciduous Woodlands under eCO_2 and Nitrogen Deposition: Biogeochemical tradeoffs and the fate of soil carbon

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Reference List

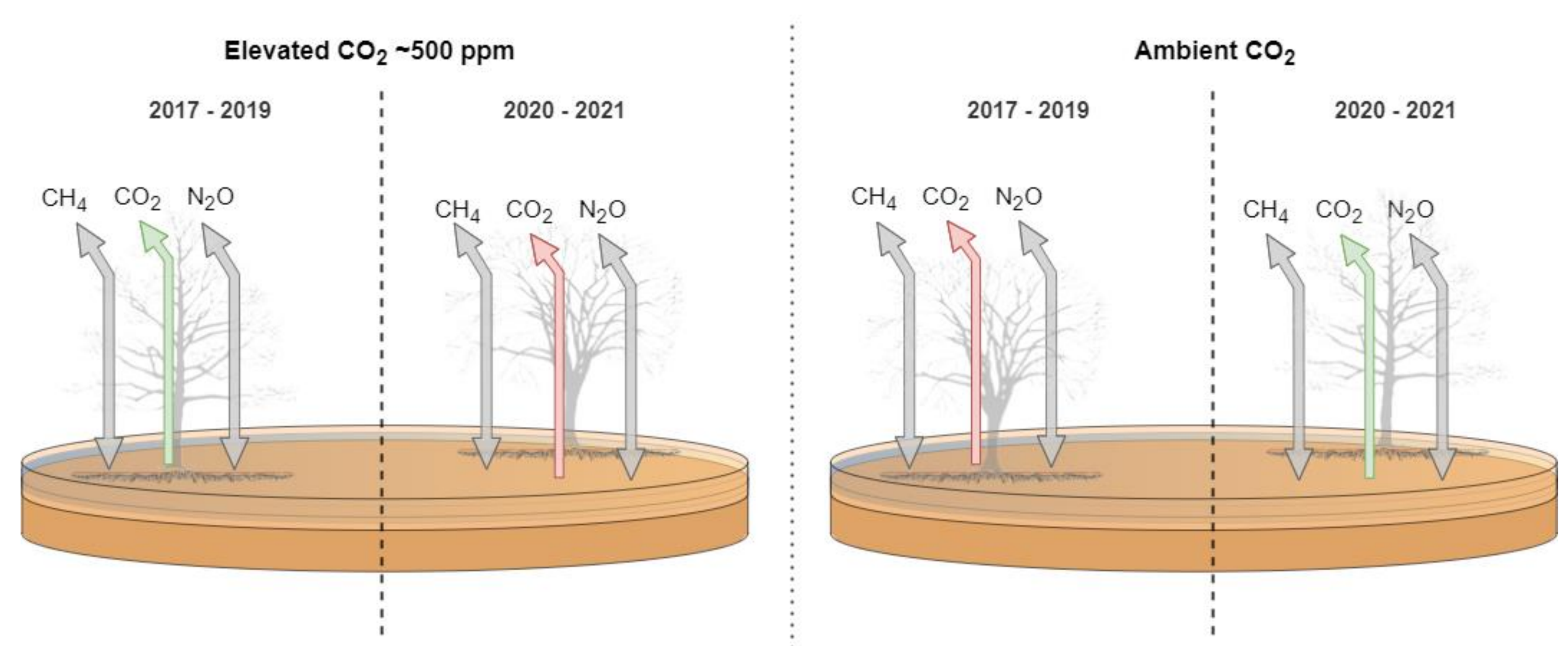
Introduction

Increasing atmospheric levels of **CO_2** coupled with **Nitrogen deposition** have been identified as global agents of change for temperate deciduous woodlands [1, 2]. Elevated CO_2 within these systems is expected to indirectly influence the edaphic relations with **soil microbial groups**, through enhanced **net primary productivity** and **root exudation** [2, 3]. As typically Nitrogen limited systems, symbiotic associations with mycorrhizal fungi underpin nutrient acquisition and litter decomposition in deciduous woodlands. Enhanced **Nitrogen** along woodland edges triggers a shift from **Fungi dominated oligotrophic** assemblies to **copiotrophic bacterial** communities [4, 5]. Parallel changes in functional activity occur, which can alter the rates of **litter decomposition**, **heterotrophic respiration** and therefore the **flux of greenhouse gases** along woodland edges [6, 7].

Global and landscape level predictions suggest an enhanced demand for Nitrogen and Phosphorous under **eCO_2, enhancing respiration** and potentially altering microbial group activity. Whilst high exogenous inputs of **Nitrogen** is seen to **suppress respiration** and **reduce the decomposition** of recalcitrant organic matter [6]. Albeit, this response is highly variable, especially on the microscale. Thus, this research will attempt to further investigate the mechanistic drivers behind altered microbial communities, respiration rates and **soil carbon dynamics** in response to eCO_2 and Nitrogen deposition.

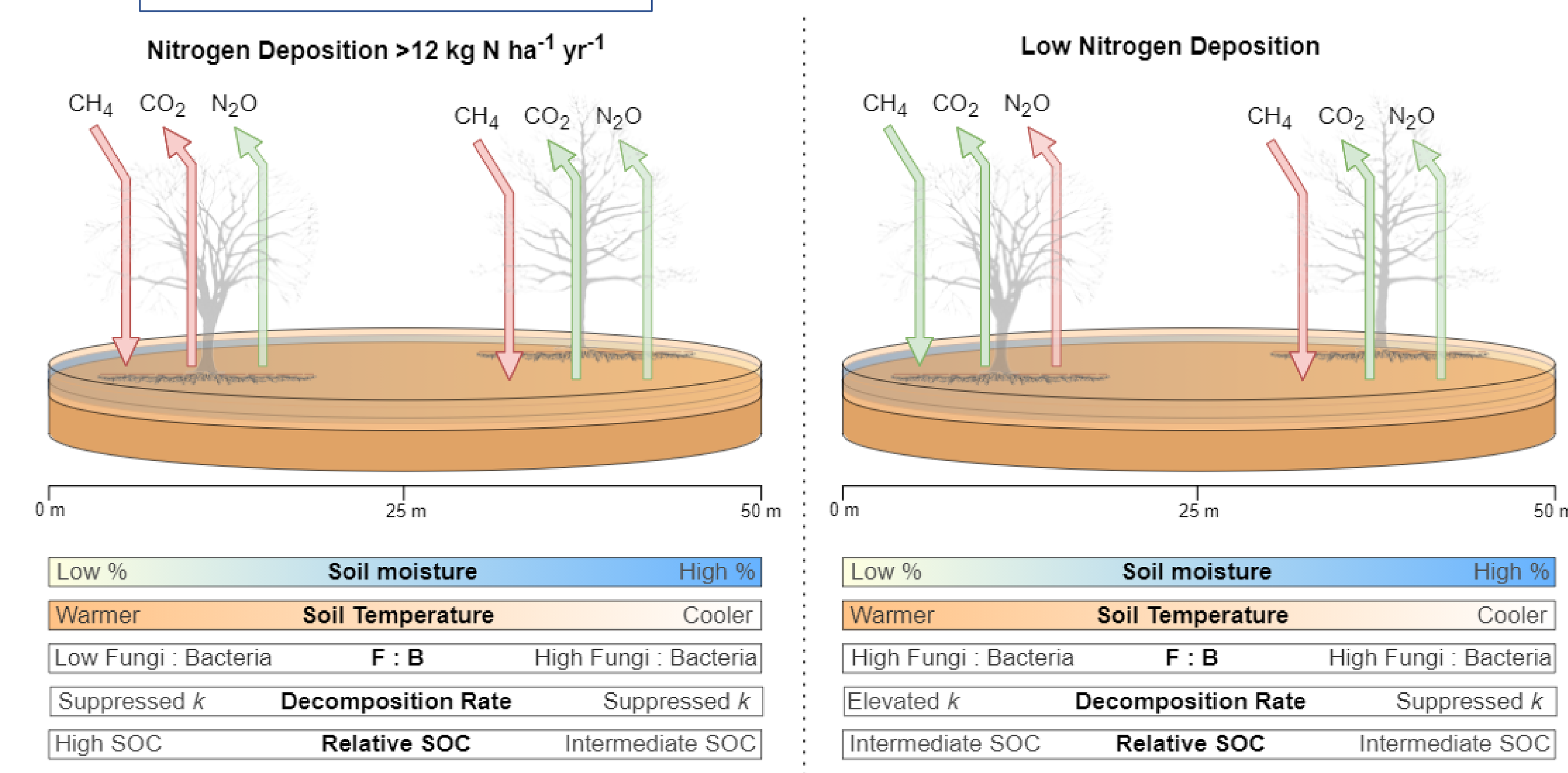
eCO_2

- eCO2 -> typically enhanced primary productivity and C inputs into soils [2].
- Leads to higher rates of soil respiration (autotrophic & heterotrophic). [8]
- Similar trend seen at BIFoR until 2019, since then soil respiration in eC02 arrays have dropped below respiration rates in aCO2 arrays. [9]



Nitrogen

- Nitrogen deposition alters soil stoichiometry and acidity, eliciting a shift towards lower Fungi : Bacteria ratio [10].
- Reduced endogenous mining for Nitrogen reduces decomposition [11].
- Lower redox potential of Bacterially dominated copiotrophs reduces respiration [6].
- Reduced methanotrophic activity and CH4 uptake [12].



Objectives

Investigate the influence of **eCO_2** on **soil respiration** and the efflux of greenhouse gases from a temperate deciduous woodland. Focusing on the regulatory role of eCO_2 and **microclimatic factors** (**soil moisture** and **temperature**) on **microbial community composition** and functional activity. To provide insight into the microbially mediated mechanistic shifts in the flux of **CO_2**, **CH_4** and **N_2O** under eCO_2.

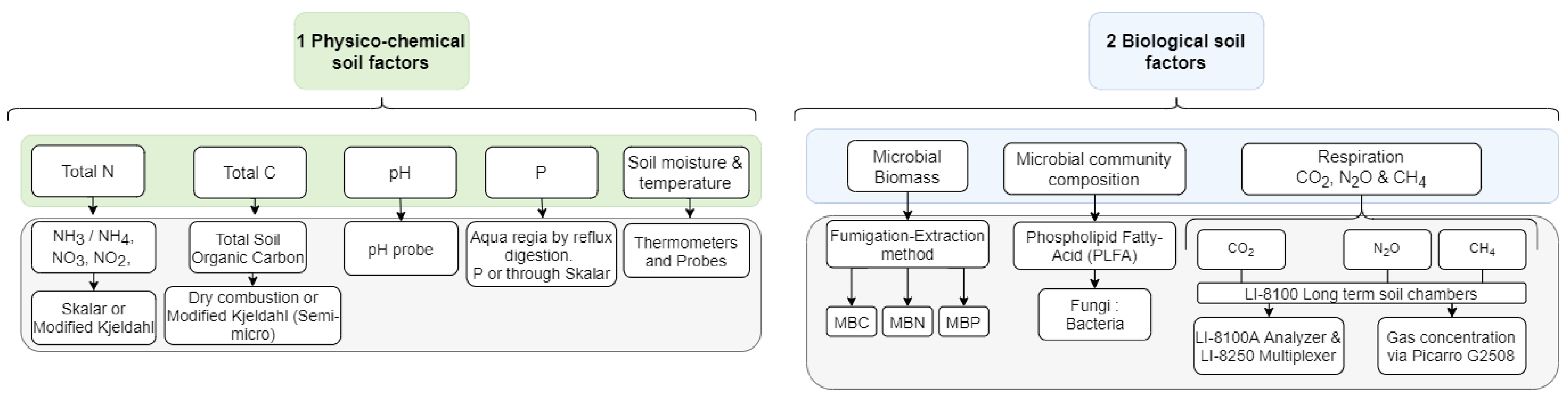
1. How does soil respiration and the efflux of CO_2, N_2O and CH_4 change under elevated atmospheric CO_2?
2. How does microbial community composition and functional activity change under eCO_2?
3. Does Nitrogen deposition impose an influence upon biogeochemistry in Arrays with a proximity edge effect?

Assessing the dual influence of **Nitrogen deposition** and **microclimate** along a woodland's **edge** to **interior**. Investigating the change in **microbial community composition**, by investigating **extracellular enzyme activity**, **decomposition**, and **respiration** along a gradient of altered **nutrient availability** and transitioning microclimates. Providing insight into the mechanisms behind **soil carbon storage** dynamics along woodland edges.

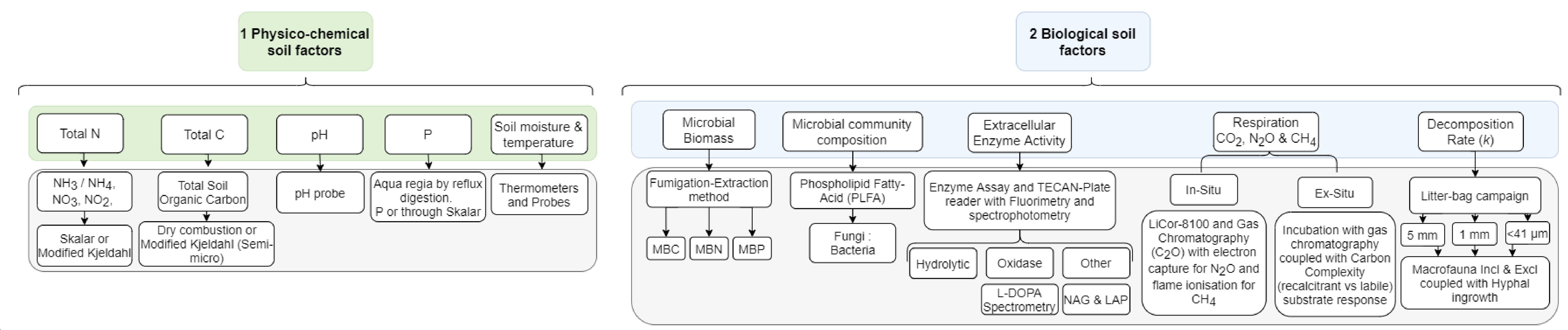
1. How do Nitrogen and Carbon soil stocks vary along a gradient of nitrogen deposition and microclimatic variability?
2. How does microbial community composition and function regarding extracellular enzyme activity vary and therefore influence decomposition?
3. Do altered microbial communities influence heterotrophic respiration and the flux of CO_2, CH_4 and N_2O?

Methods

- Two networks consisting of 9 soil chambers connected to a LI-8100A gas analyzer provides high resolution and near continuous measures of CO_2, CH_4 & N_2O for both eCO_2 and aCO_2 arrays. System is rotated fortnightly to capture plot heterogeneity, with the Picarro G2508 (CH_4 & N_2O) rotating between arrays.
- Data is analyzed in *'SoilFluxPro'* to process soil gas flux data which can be paired with soil moisture and temperature data to provide flux data in µ moles CO_2 m^{-2} s^{-1}.
- Sampling for microbial biomass and community composition will be performed during the Spring and Autumn period.



- Forestry England plot in Thetford Forest composed of semi-mature Oak or Beech with proximal source of Nitrogen deposition will be selected.
- 3 x 125m transects perpendicular to the edge will be established. Sample sub-sites will be at 25m intervals. Soil collars will be installed at varying depths and litter-bags of varying mesh-sizes filled with leaf's collected from litterfall traps.
- Litter-bags will be placed on the forest floor and coupled with buried root ingrowth bags in October 2022. At three-monthly intervals, litter-bags and ingrowth bags alongside soil samples will be obtained for an 18-month campaign.



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