Integrated response of plant, microbial and N-cycling interactions to precipitation patterns

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INTRODUCTION

Climate is changing towards more extreme precipitation patterns

	Dry period	Rewetting after dry period
SOIL	• Decreased water saturation of pore spaces	• Increased saturation of pore spaces • Breaking up of soil aggregates • Release of trapped nutrients • Increased respiration and release of greenhouse gases
MICROBES	• Decreased mobility of microbes and nutrients • Accumulation of intracellular osmolytes to prevent dehydration • Increased number of dormant and resistant forms • Increased fungal:bacterial ratio • Decreased N and C cycling rates	• Increase in competitive and fast growing species • Release of accumulated osmolytes to prevent cell lysis • Increase in microbial activity including N and C cycling
PLANT	• Reduced stomatal conductance to avoid water loss • Decreased photosynthesis rate • Access deeper water sources if possible	• Increased photosynthesis rate • Resumed transfer of rhizodeposits to the soil

OBJECTIVES

Gain insight into the dynamics of the interactions involved in the coupling between water and N cycles, as affected by changes in precipitations patterns.
A multidisciplinary approach is used to evaluate the response of soil microbial community, plant, and soil N cycle to repeated cycles of drying-rewetting patterns of contrasted frequency and magnitude.

FRAMEWORK

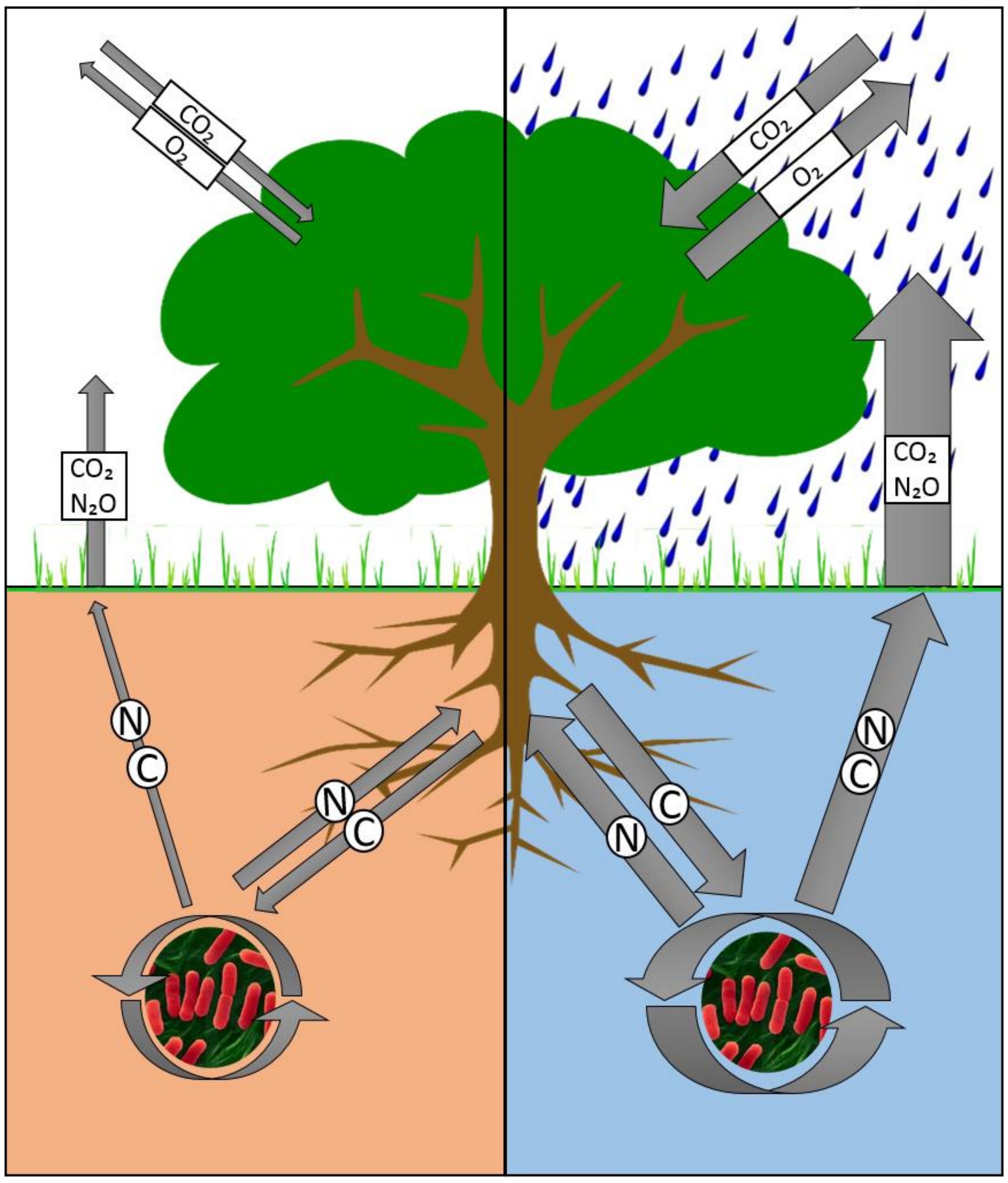


Fig. 1. Conceptual diagram of plant-soil interactions during and after a dry period. Arrow widths are proportional to flux rate.

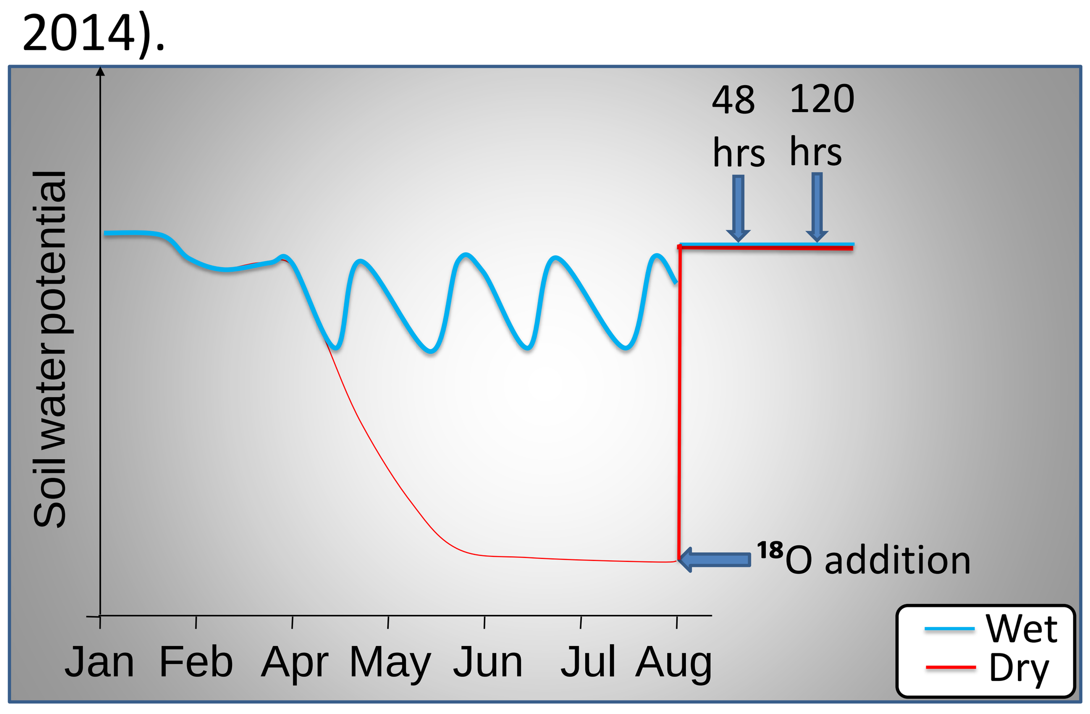
^{18}O Stable Isotope Probing (^{18}O-SIP)

Capture the temporal dynamics of metabolically active soil microorganisms upon rewetting after contrasted water availability.

Aim
- Identify bacterial strategies
- Relate to soil N cycling and N_2O emissions

Principle

^{18}O-labelled water allows identification of metabolically active communities in soil without the addition of external nutrient sources (Blazewicz et al. 2014).



Approach
- Isolate metabolically active community – SIP
- Identify community composition – sequencing
- Evaluate abundance of N cycling genes - qPCR

Fig. 2. Dynamics of soil water content in the precipitation pattern treatments and controlled wet-up (adapted from Barnard et al. 2015).

GREENHOUSE EXPERIMENT

Evaluate integrated response of system as a whole (plant, microbiota, soil) to rewetting after different precipitation regimes

Aim
- Establish fate of N by tracking ^{15}N-NH_4 tracer as plants and microbes compete for resources
- Link to interaction between plant performance and soil microbial activity

Approach
- Soil microbial community: metagenomics, taxonomic diversity
- Plants: high thoughput phenotyping platform
- Soil N cycling: nitrification, denitrification, N_2O efflux rate

REFERENCES

Barnard RL, Osborne CA, Firestone MK. 2015. Changing precipitation pattern alters soil microbial community response to wet-up under a Mediterranean-type climate. ISME J. in press.

Blazewicz SJ, Schwartz E. 2014. Growth and death of bacteria and fungi underlie rainfall-induced carbon dioxide pulses from seasonally dried soil. Ecology **95**:1162–1172.