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

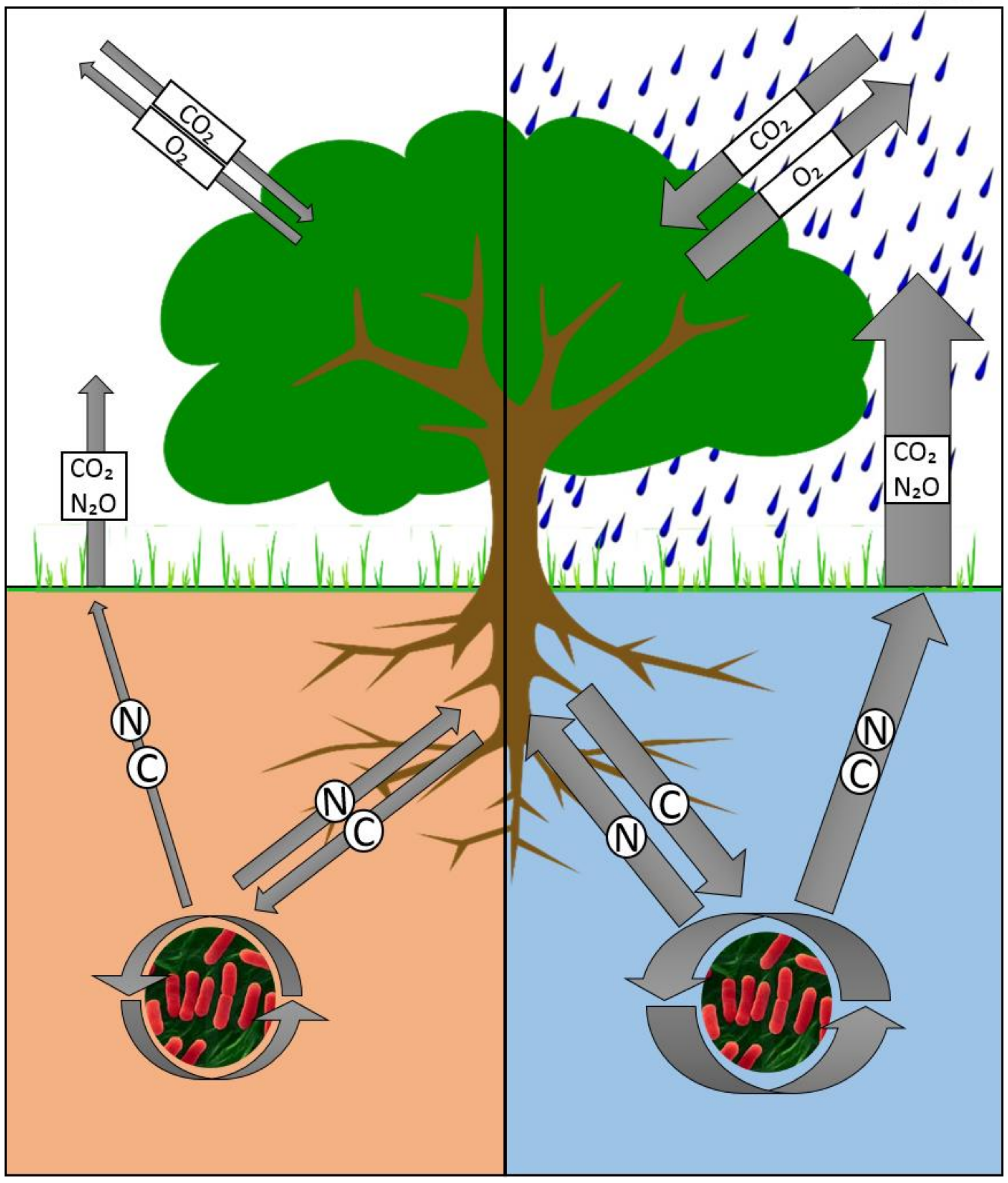

Fig. 1. Conceptual diagram of plant-soil interactions during and after a dry period. Arrow widths are proportional to flux rate.

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.

^{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).

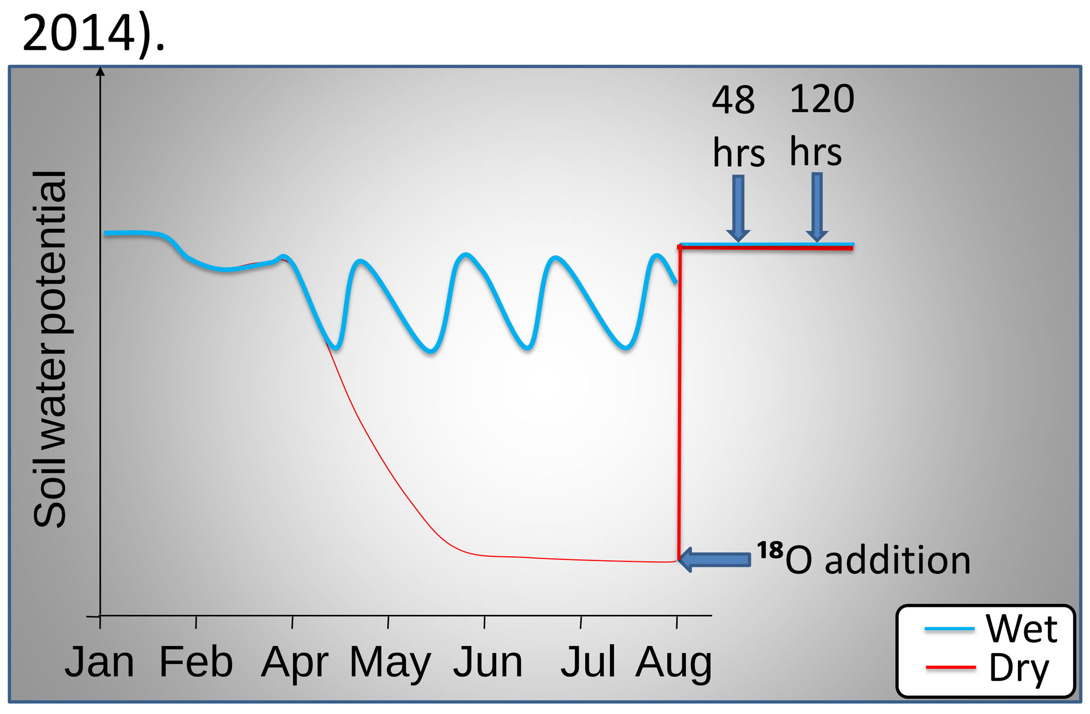

Fig. 2. Dynamics of soil water content in the precipitation pattern treatments and controlled wet-up (adapted from Barnard et al. 2015).

Approach

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

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