# 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<br>• Breaking up of soil aggregates<br>• Release of trapped nutrients<br>• Increased respiration and release of greenhouse gases |
| MICROBES | • Decreased mobility of microbes and nutrients<br>• Accumulation of intracellular osmolytes to prevent dehydration<br>• Increased number of dormant and resistant forms<br>• Increased fungal:bacterial ratio<br>• Decreased N and C cycling rates | • Increase in competitive and fast growing species<br>• Release of accumulated osmolytes to prevent cell lysis<br>• Increase in microbial activity including N and C cycling |
| PLANT | • Reduced stomatal conductance to avoid water loss<br>• Decreased photosynthesis rate<br>• Access deeper water sources if possible | • Increased photosynthesis rate<br>• 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

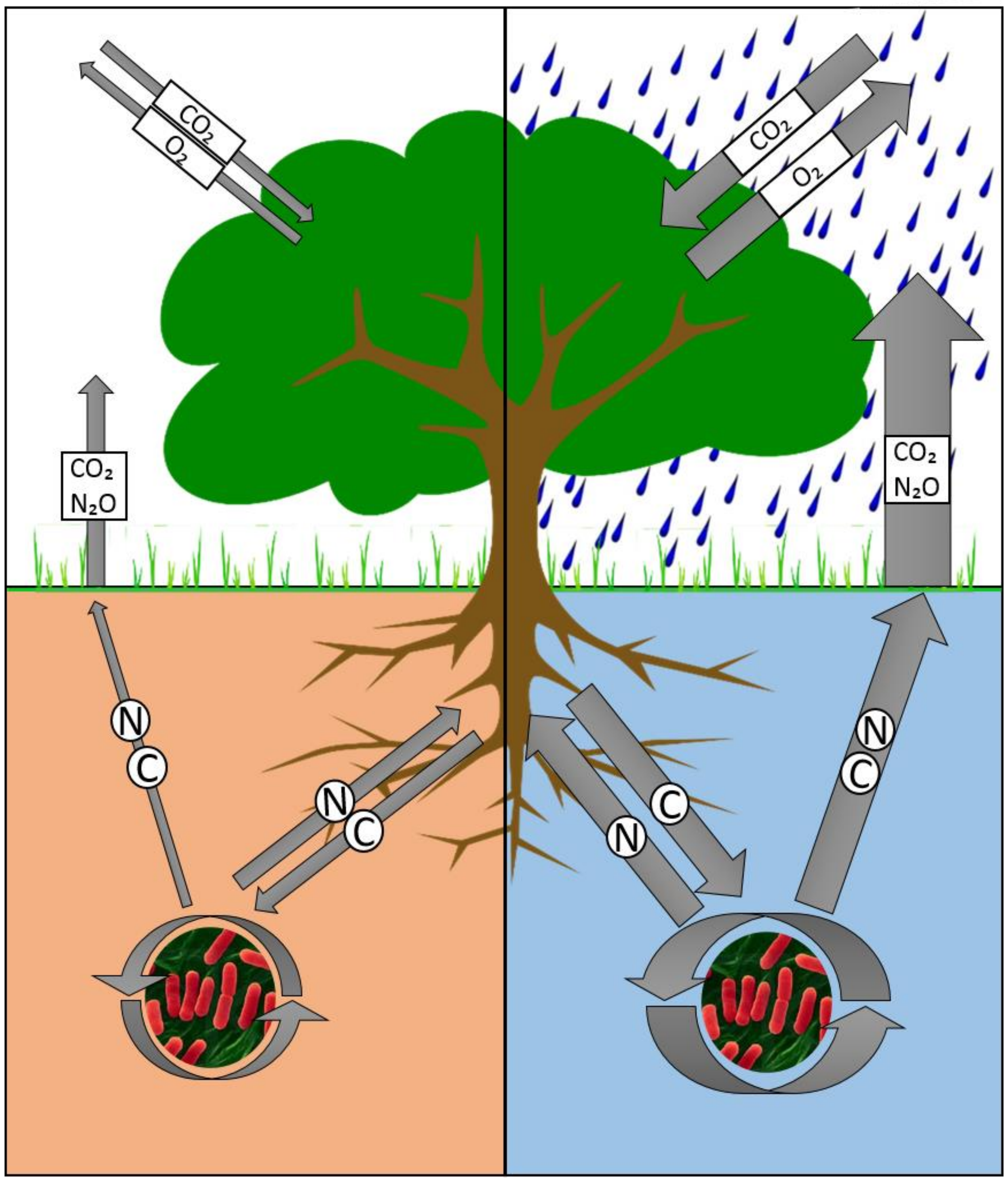



Fig. 1. Conceptual diagram of plant-soil interactions during and after a dry period. Arrow widths are proportional to flux rate.

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

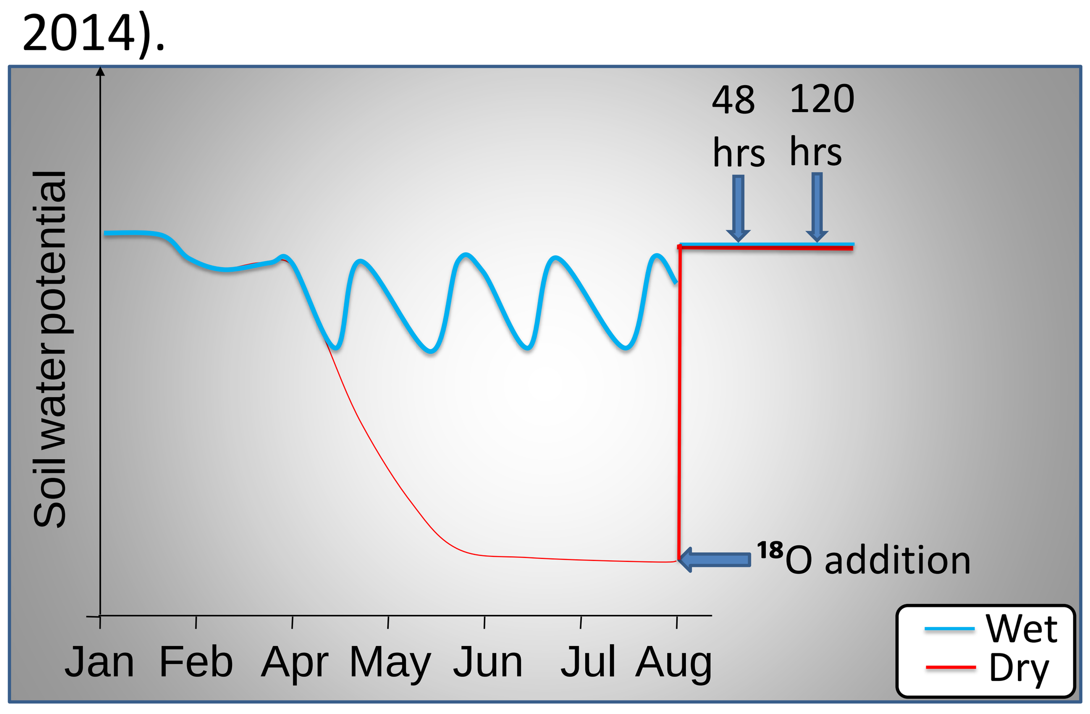
Capture the temporal dynamics of metabolically active soil microorganisms upon rewetting after contrasted water availability.

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.