

# Quantifying microbial growth and carbon use efficiency in dry soil environments via $^{18}\text{O}$ water vapor equilibration

Alberto Canarini<sup>1</sup>, Wolfgang Wanek<sup>1</sup>, Margarete Watzka<sup>1</sup>, Taru Sandén<sup>2</sup>, Heide Spiegel<sup>2</sup>, Jiří Šantrůček<sup>3</sup>, Jörg Schnecker<sup>1</sup>

<sup>1</sup> Centre for Microbiology and Environmental Systems Science, University of Vienna, Austria

<sup>2</sup> Department for Soil Health and Plant Nutrition, Austrian Agency for Health and Food Safety, Austria.

<sup>3</sup> Faculty of Science, University of South Bohemia, České Budějovice, Czech Republic

## Overview

We developed a new method based on *in vivo*  $^{18}\text{O}$  water vapor equilibration to minimize soil rewetting effects. This method allows the isotopic labelling of soil water without any liquid water or dissolved substrate addition to the sample.

## Background

Currently available methods to determine microbial C metabolism in soil require the addition of water, which makes it practically impossible to measure microbial physiology in dry soil samples without stimulating microbial growth and respiration (namely, the “Birch effect”).

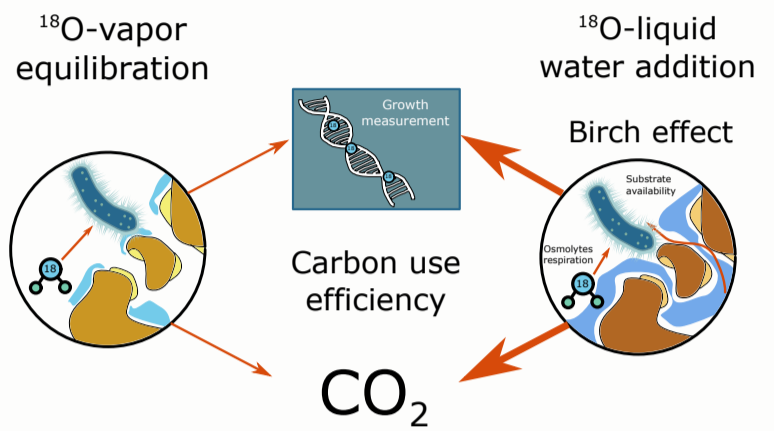


Fig. 1. schematic representation of current available method vs proposed method (on the left)

## Method development

Three main tests were carried on 3 different soils, in moist and dry conditions, in order to:

- 1) Determining  $^{18}\text{O}$  incorporation in soil water
- 2) Determining microbial activity stimulation by water vapor
- 3) Comparing new method to the  $^{18}\text{O}$  liquid water addition method

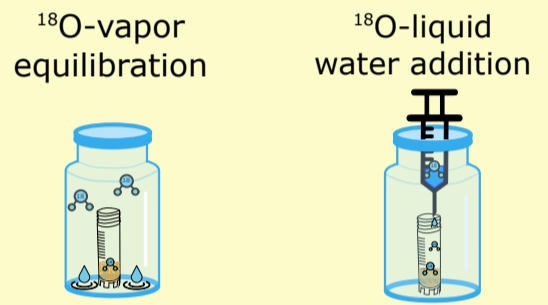


Fig. 2. schematic illustration of the two methods

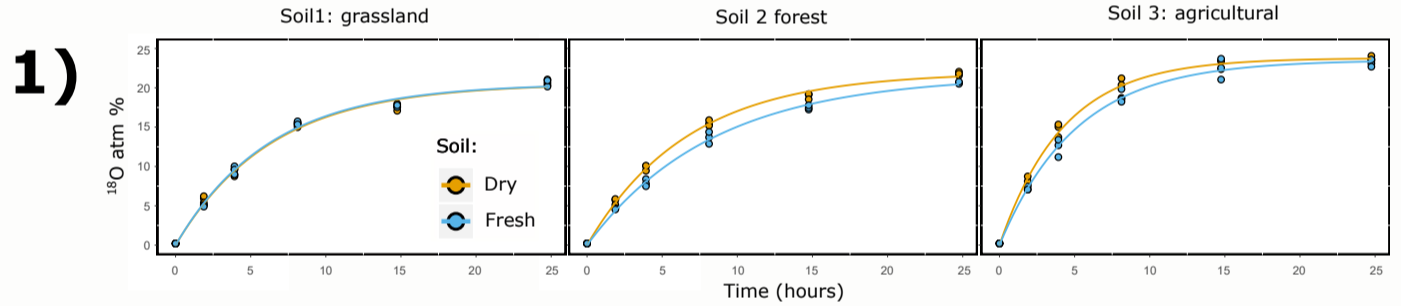


Fig. 3. Graphs showing kinetics of  $^{18}\text{O}$  incorporation in soil water during the 24 hours of the experiment. All soils reached the target  $^{18}\text{O}$  incorporation during the 24 hours of incubation.

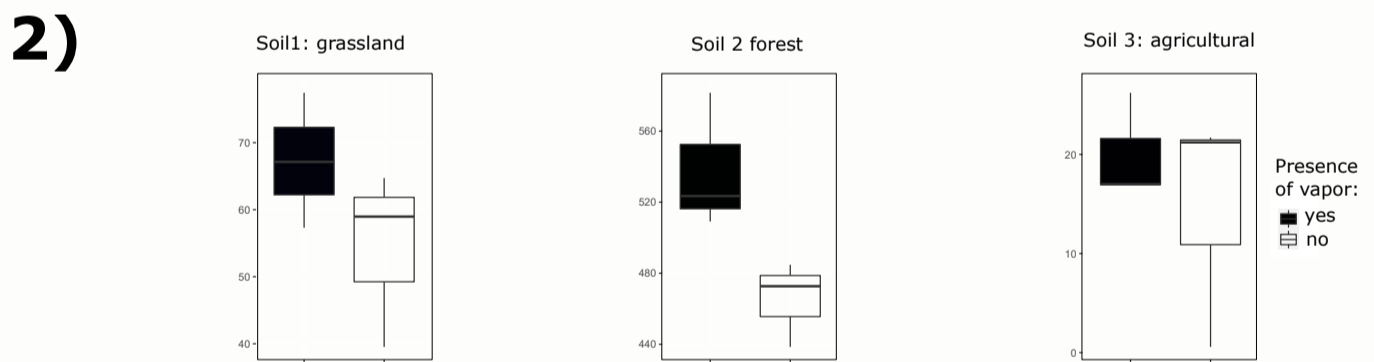


Fig. 4. Boxplots showing soil respiration rates of dry soil samples with or without presence of water vapor. Stimulation of respiration was minimal.

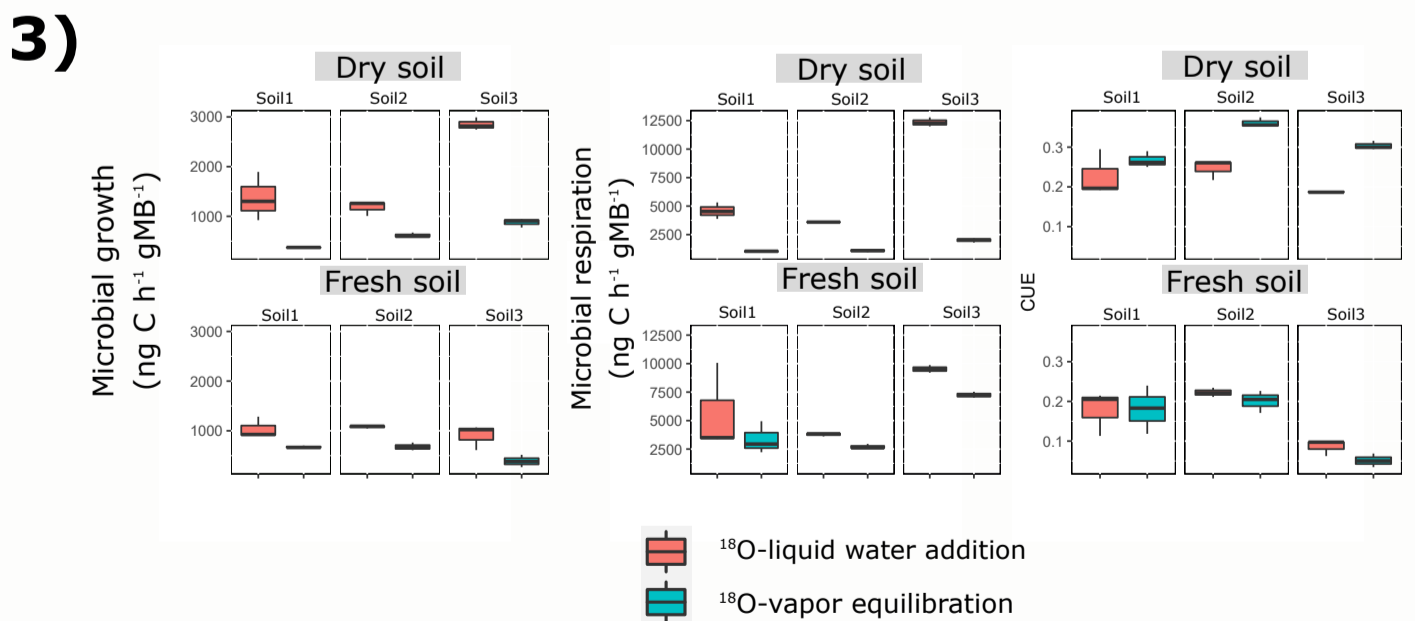


Fig. 5. Boxplots showing mass specific microbial growth (left), mass specific soil respiration rates (middle) and CUE (right) of  $^{18}\text{O}$ -vapor equilibration (red) vs  $^{18}\text{O}$ -liquid water addition (blue) in dry (top) or fresh soil samples (bottom).

## Summary

The proposed  $^{18}\text{O}$  vapor equilibration method provides similar results as the currently widely used method of liquid  $^{18}\text{O}$  water addition to determine microbial growth when used a near-optimal water holding capacity. However, when applied to dry soils the liquid  $^{18}\text{O}$  water addition method overestimated growth by up to 250%, respiration by up to 500%, and underestimated carbon use efficiency by up to 40%.