Supporting Material for ‘The MICE facility - a new tool to study plant-soil C cycling with a holistic approach’

# 1 Data extraction

The MICE software (GDU-28, DMP Ltd.) logs every five seconds the data of all sensors and instruments. Separate columns indicate the activation of relays, the measurement modes (e.g. zeroing, scan mode) and the pot number of the current measurement in the lower system. The data is analysed with the open source software R statistics (R Core Team 2014).

# 2 Calculations

## 2.1 Relative humidity calculation

The relative humidity is calculated according to Equations 1-3 based on the absolute H2O concentration and the air temperature measured in the upper chamber systems and the pressure detected in the IRGA of lower system (which is not influenced by the large membrane pumps as in the upper system).

, (1)

where rH is the relative air humidity (in %), e is the partial pressure of water vapour (Equation 2) and esat is the saturation vapour pressure (Equation 3).

 , (2)

where aH is the absolute humidity given as the mole fraction of water vapour (mmol mol-1) and plab is the atmospheric pressure (in kPa).

 , (3)

where Tch is the chamber air temperature (in °C).

## 2.2 Molar volume

The molar air volume (Vm) is calculated according to Equation 4, based on the current temperature (upper system) and pressure (lower system) conditions.

, (4)

where plab is the atmospheric pressure (in Pa) in the laboratory, R is the universal gas constant (= 8.3144621 J K-1 mol-1) and Tch is the air temperature (in K).

## 2.3 Shoot CO2 fluxes - photosynthesis and dark respiration

The changes of the atmospheric CO2 concentration due to shoot photosynthesis and respiration are measured by the IRGA and assessed by the slope of the linear regression during the monitoring time (function "lm(x ~ y)", R Core Team 2014). The daily mean net photosynthetic (pnet) and dark respiration (rdark) rates are calculated according to Equation 5 and 6.

, (5)

, (6)

where Δ[CO2]/Δt is the CO2 concentration change in the upper chamber system (in μmol mol-1 s-1), Vch is the chamber air volume (= 1.165 m3), Vm is the molar volume (Eqn 4) and LAtot is the total leaf area at the sampling date t = x, and ndaytime,t=x and nnighttime,t=x is the number of Δ[CO2]/Δt measurements made in the day- and at night-time, respectively.

The total amount of net assimilated C (Anet,t=x) is calculated for each plant individual based on its leaf area (Equation 7).

, (7)

where pnet,t=x and rdark,t=x are the daily photosynthetic or dark respiratory rates (Eqn 5 and 6, transformed in μmol C m-2 day-1), fday and fnight is the fraction of light and dark hours per day, respectively, LAt=x is the leaf area (in m2) of the plant individual and M(C) is the molar weight of C (12.011 x 10-3 mg μmol-1).

## 3.4 Total soil CO2 efflux

The soil CO2 efflux rate (rsoil,t=x) of the individual pots is assessed based on the CO2 concentration difference (Δ[CO2]in,out) in μmol mol-1) between the pot in- and outlet measured by the IRGA in the lower system (Equation 8). Δ[CO2]in,out is calculated by subtracting the average of the background air CO2 concentrations measured before and after ([CO2]in) each pot measurement from the average concentration of the pot outlet measurements ([CO2]out).

, (8)

where (Δ[CO2]in,out) is the CO2 concentration difference between the in- and outlet (in μmol mol-1), Fpot is the pot aeration rate, Vm is the molar volume (Eqn 4), nt=x is the amount of CO2 concentration change measurements on day t = x and PA is the pot area (= 0.0346 m2).

The daily amount of C released as CO2 belowground per pot (Rsoil,t=x in mg pot-1 day-1), is calculated by multiplying the daily respiration rates rsoil,t=x with the pot area and the molar C weight.

## 2.5 Partitioning of soil CO2 efflux

The plant-derived and the SOM-derived CO2 efflux can be partitioned in experiments with continuous 13C-CO2 labelling from first emergence of leaves (Kuzyakov & Domanski 2000). The estimation of the plant-derived respiration rate (Rpd,t=x) is based on the fraction of plant-derived on the total respiration (fRpd,t=x) assessed by a two end-members mixing model (Equation 9). The isotopic signature of the CO2 efflux measured (Rsoil,t=x) represents a mixture of the isotopic signatures of the two end-members: the SOM-derived (Rsoil,ctrl) and the plant-derived soil CO2 efflux (Rpd,t=x).

, (9)

where Rsoil,t=x, is the daily amount of respired C (in mg pot-1 day-1) and x(13C) is the 13C atom fraction (calculated according to Coplen 2011) of the soil efflux sampled during the experiment (x(13C)Rsoil,t=x), in before labelling or in the unlabelled control (x(13C)Rsoil,ctrl) and of the plant-derived efflux (x(13C)Rpd,t=x) estimated by the net C assimilation rates (Eqn 7) and the maximum label strength.

# Figures



Figure S1. The upper system. The figure illustrates the configuration of one upper system of the MICE facility with its main gas circuit that holds an infrared gas analyzer (IRGA) to monitor the CO2 and H2O concentrations and equipment to regulate the CO2 concentration (CO2 absorption by the scrubber and injection from the gas cylinder) and calibrate the IRGA (CO2 and H2O absorption).



Figure S2. Air conditioning, humidifier and heater system. The figure illustrates the equipment used to regulate the temperature and humidity in the upper system of the MICE facility. The lines indicate the cooling liquid circuit (light blue) and the direction of the water (dark blue) and the air flow (grey).