A new chamber method for the simultaneous determination of $\delta^{13}\text{C}$ and $\delta^{18}\text{O}$ in soil derived CO$_2$

Nils Prolingheuer (1), Harry Vereecken (1), and Jens-Arne Subke (2)
(1) Agrosphere (IBG-3), Institute of Bio- and Geosciences, Forschungszentrum Jülich, 52425 Jülich, Germany (n.prolingheuer@fz-juelich.de, h.vereecken@fz-juelich.de), (2) School of Natural Sciences, Institute of Biological and Environmental Sciences, University of Stirling, United Kingdom (jens-arne.subke@stir.ac.uk)

Stable carbon (C) isotopes have been instrumental in constraining current estimates of the terrestrial C balance. Recently, Wingate et al. (2010; Global Change Biology, 16, 3048-3064) have shown a strong disequilibrium in $\delta^{18}\text{O}$ between leaf and soil derived CO$_2$, raising hopes that different respiratory sources (e.g. plant vs. soil) can be distinguished using the atmospheric abundance of CO$_{18}$O at larger spatial scales. However, uncertainty remains about the role of carbonic anhydrase (CA), an enzyme that efficiently catalyzes the exchange of O during CO$_2$ hydration in soils. The activity of CA determines the degree to which soil derived CO$_2$ carries the isotopic signature of soil surface water (e.g. in the litter layer). Experimental work is needed to clarify this exchange of $^{18}\text{O}$ in the soil, and the potential to identify root and rhizosphere-derived CO$_2$ using $^{18}\text{O}$.

In order to constrain ecosystem C exchange estimates on the basis of $^{18}\text{O}$ abundance in atmospheric CO$_2$, we now require new measuring systems that allow simultaneous capture of $\delta^{13}\text{C}$ and $\delta^{18}\text{O}$ signatures of soil derived CO$_2$. To date, many laser absorption methodologies require considerable electric power and frequent calibration. However, a new generation of analysers based on a cavity enhanced laser absorption spectroscopy technique has recently become available and has considerable potential to deliver fast isotopic measurements with dramatically reduced power consumption and calibration requirements. We present first results from a new analytical set-up based on such a fast isotope analyser (model CCIA-306d, Los Gatos Research) coupled to a dynamic soil chamber. We use the changes in isotopic abundance (of both $^{13}\text{C}$ and $^{18}\text{O}$) as CO$_2$ concentrations build up during chamber closure to determine soil $^{13}$CO$_2$ and CO$_{18}$O fluxes. Using a series of replicated soil microcosms, we assess the role of (1) rooted vs. un-rooted soil, (2) simulated rain events, and (3) soil warming on the $\delta^{18}\text{O}$ and $\delta^{13}\text{C}$ signatures of soil derived CO$_2$. 