Observing ^{13}C labelling kinetics in CO_2 respired by a temperate grassland ecosystem

Ulrike Gamnitzer [1], Rudi Schäufele [1], Andrew B. Moyes [2], David R. Bowling [2], Hans Schnyder [1]

[1] Technische Universität München, Lehrstuhl für Grünlandlehre, Am Hochanger 1, D-85350 Freising-Weihenstephan, Germany

[2] University of Utah, Department of Biology, 257 South 1400 East, Salt Lake City, UT 84112, USA

The kinetic characteristics of the main sources of ecosystem respiration are quite unknown, partly due to methodological constraints. We present a new open-top chamber (OTC) apparatus for continuous $^{13}C/^{12}C$ labelling and measurement of ecosystem CO_2 fluxes. It includes four dynamic flow-through OTCs, a unit mixing CO_2-free air with ^{13}C-depleted CO_2, and a CO_2 analyser and an online isotope ratio mass spectrometer. Two different methods were applied for observation of the tracer during nighttime respiration in the field: open dynamic and closed static chamber mode.

The concentration (367±6.5 µmol mol^{-1}) and $\delta^{13}C$ (-46.9±0.4‰) of CO_2 in the OTCs was stable during photosynthesis due to high air throughflux and minimal incursion through the buffered vent. Soil CO_2 efflux was not affected by pressure effects during respiration measurements. The labelling kinetics of respiratory CO_2 measured in the open dynamic mode in the field agreed with that of excised soil+vegetation blocks measured in a laboratory-based reference system. The kinetics fitted a two-source system, with a rapidly labelled source ($T_{1/2}$ 2.6 d) supplying 48% of respiration, and the other source (52%) releasing no tracer during 14 days of labelling. Measurements in the closed static mode resulted in a significantly larger fraction of observed tracer. This bias was largely explained by non-steady-state diffusion effects of labelling CO_2 stored in the soil gas and water pores during the preceeding labelling period.