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Supporting Information for

Observations of $^{14}CO_2$ in ecosystem respiration from a temperate deciduous forest in Northern Wisconsin

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Introduction

This supporting information includes 1) methods used to convert $\Delta^{14}C$ respiration observations to age estimates, 2) a table with additional results for $\Delta^{14}C$ measurement uncertainty, and 3) additional results of sensitivity analysis used to assess the impact of stratified sampling conditions on Keeling intercept estimates.

Text S1. Methods for converting $\Delta^{14}C$ to age estimates.

Calibrated age ranges were determined by matching observed ^{14}C values to the monthly Northern Hemisphere Zone 1 atmospheric ^{14}C calibration record for 1950–2009 AD [*Hua et al.*, 2013] using Calibomb (http://calib.qub.ac.uk/CALIBomb/). This program gives a distribution of possible solutions based on variation in the atmospheric record over time and errors associated with the calibration dataset and measured/estimated ^{14}C value (Reimer et al., 2004). Decimal years were rounded to the nearest growing season (defined here as May through September). For respiration values with two-sigma age ranges that overlapped the end of the Northern Hemisphere Zone 1 record in 2009, the minimum age was determined by matching the values to weekly growing season measurements from Niwot Ridge through 2011 AD (Lehman et al., 2013). For the overlapping period, 2003-2009 these two atmospheric ^{14}C datasets are consistent with one another within one standard deviation. Radiocarbon values below the 2012 AD atmospheric ^{14}C value extrapolated from Lehman et al., 2013 ($\Delta^{14}C$ = 3‰), the minimum age was set to the end of the growing season in 2012, the year of sampling. All measured or estimated ^{14}C values yielded an alternative calibrated age, typically 1955-1957 AD, corresponding to the upswing of the atmospheric bomb $^{14}CO_2$ curve. However, we consider this set of age solutions unlikely considering our approach to measuring the ^{14}C of R_h and R_s (R_s, which includes root respiration, should be more contemporary than R_h, which excludes root respiration) and that it is unlikely that R_{eco}, R_s, and R_h would consistently fall within such a narrow range in age (57-59 years old).

Lehman, S. J., Miller, J. B., Wolak, C., Southon, J., Tans, P. P., Montzka, S. A., Sweeney, C., Andrews, A. E., LaFranchi, B. W., Guilderson, T. P. and Turnbull, J. C.: Allocation of terrestrial carbon sources using $^{14}CO_2$: Methods, Meaurement, and Modeling, Radiocarbon, 55(2-3), 1484–1495, 2013.

Reimer, P. J., Baillie, M., Bard, E., Bayliss, A., Beck, W., Bertrand, C. and Blackwell, P.: IntCal04 terrestrial radiocarbon age calibration, 0-26 cal kyr BP, 2004.

Figure S1. Theoretical $\Delta^{14}CO_2$ values and Keeling plots for CO_2 profiles for different assumed mixtures of foliar and soil respiration during nighttime sampling windows. $\Delta^{14}CO_2$ values were calculated by assuming CO_2 in excess of the background atmosphere was derived either from: 1) R_s only, 2) a stratified mixture of R_s and foliar respiration (R_f), with the contribution from R_s increasing linearly with proximity to ground from 0% at 21 m to100% at the soil surface, or 3) an even mixture of R_s and R_f, with R_s contributing 75% of excess CO_2 at all canopy heights. We assumed a background atmosphere of CO_2 = 380 ppm and $\Delta^{14}CO_2$ = 30‰; $\Delta^{14}C$-R_f = 30‰; and $\Delta^{14}C$-R_s = 54.6‰ in June and 45.6‰ in August, as measured from soil chambers. Panels a-f show analysis for June 30-July 1, and g-l show analysis for sampling window Aug 25-26, 2011. Panels a-c and g-i show computed $\Delta^{14}CO_2$ profiles, panels d-f and j-l show $\Delta^{14}C$ versus $1/CO_2$ (Keeling plots).

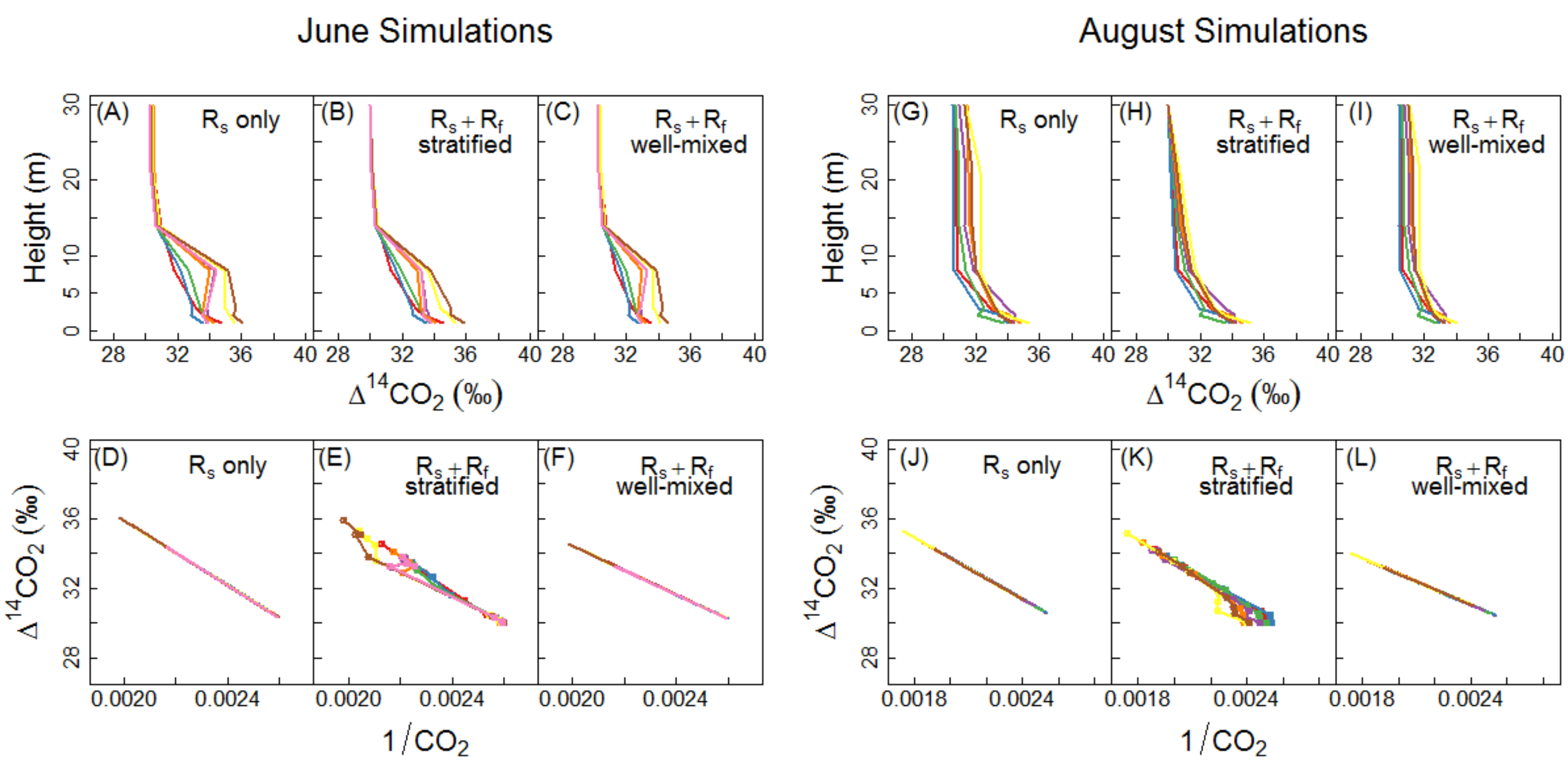
June Simulations
August Simulations
(A)
Rs only
(B)
Rs + Rf
stratified
(C)
Rs + Rf
well-mixed
(G)
Rs only
(H)
Rs + Rf
stratified
(I)
Rs + Rf
well-mixed
Height (m)
Δ14CO2 (‰)
(D)
Rs only
(E)
Rs + Rf
stratified
(F)
Rs + Rf
well-mixed
(J)
Rs only
(K)
Rs + Rf
stratified
(L)
Rs + Rf
well-mixed
1/CO2

Table S1. Performance of high precision AMS methods based on two surveillance standards (La Jolla Atmospheric Radiocarbon Standard, LARS). Both tanks contain air sampled from Scripps pier in 2010. LARS2 has been spiked with additional fossil CO_2. The standard deviation of *N* unique samples is σ, and mean standard deviation of counting statistics from *N* samples is AMS uncertainty. The $\Delta^{14}C$ of these cylinders has not been independently validated by other AMS facilities. Samples taken directly from control cylinders or via PFPs yielded measurement values that are the same within uncertainties for repeat measurements.

Standard	**Extraction Method**	***N***	**σ (‰)**	**mean AMS uncertainty (‰)**	**$\Delta^{14}C$ (‰)**
LARS1	from cylinder	11	3.65	1.93	31.1
LARS2	from cylinder	5	3.27	1.55	-51.7
LARS1	from PFP	5	3.24	1.84	32.9
LARS2	from PFP	2		1.99	-51.6
	overall	**23**	**3.4**	**1.8**	