SI Methods

Linear mixed models

We compared the results of the paired mean difference analysis approach discussed in the main text with a linear mixed modeling framework. For the first set of models we set ∆14C-CO2 observed in the second enclosure period as the response variable, and used sample as a random intercept term to account for the imbalance in the number of laboratory replicates analyzed for control versus treatment incubations. We assessed the interaction of ecosystem type with the treatment effect, as well as the three-way interaction with treament, ecosystem type, and experiment for the combine dataset of Experiment 1 and Experiment 2 samples. We evaluated the significance of the treatment effect by looking at the contrasts between control and treatment samples across experiments but within ecosystem types. These models were also run for δ13C-CO2­.

We extended the model for the Experiment 1 and Experiment 2 dataset to assess the interaction of additional explanatory variables beyond treatment and ecosystem type: the difference in CO2 respired between control and treatment samples, soil carbon and nitrogen content, and the sum of clay and silt content. These models were not run for Experiment 3 samples owing to a lack of data for the explanatory variables.

We tested our hypothesis that changes in ∆14C-CO2 due to treatment would be limited to the rewetting pulse alone by combining ∆14C-CO2 observed in both the first and second enclosure period for the response variable, and adding enclosure period as an additional dependent variable. This model was restricted to the experiments and treatments where we measured ∆14C-CO2 in both enclosure periods. We looked at the overal significance of the paremeter estimates as well as the contrasts from this model by each experiment, treatment, and ecosystem type.

We tested the effect of storage duration on observed ∆14C-CO2 using a combined dataset of Experiments 1 and Experiment 3 samples. We used ∆14C-CO2 observed in the second enclosure period for all samples except the Experiment 3 treatment samples for which only a single enclosure period was observed. We constructed a linear mixed model with storage duration, treatment, and the interaction of these two variables as fixed effects. As with the previous models we allowed for a random intercept term for each sample. We did not include ecosystem type in this model as all of the grassland samples were collected at the same point in time. We also exluded the effect of experiment, since this could lead to a spurious relationship due to the change in ∆14C of the atmosphere over time and the fact that samples were collected and analyszed at different times. This model was run first with and then without the Oak Ridge samples, as we considered these samples to be a separate population as they contain 14C from a labelling experiment in addition to atmospheric 14C.

All statistical analyses were performed in R (R Core Team 2019). We used the package lme4 (cite) to perform the mixed modeling, and for contrast analysis we used the package emmeans (cite). When performing statistical tests we employed Tukey’s honestly significant difference test to account for multiple comparisons and the Kenward-Roger method for estimating degrees of freedom, which has shown to perform well for small sample sizes (Kenward and Roger, 1997).