We thank you for your time and your consideration of our work. This research article outlines a new technique for constraining soil carbon models using the radiocarbon signature of heterotrophic respiration (14C-CO2) measured in laboratory incubations of archived soils. Previous work by S.E. Trumbore and others demonstrated the value of “bomb-C” for quantifying decadal scale soil carbon cycling: an essential time scale for understanding the trajectory of global climate change in the coming century. Measuring 14C-CO2 was not possible during the peak years of atmospheric radiocarbon enrichment due to technological limitations. Returning to archived soils with the technology of today presents a unique opportunity to track the change in 14C-CO2 over time: a new constraint that could eliminate the problem of multiple radiocarbon ages that stems from estimates made with observations at just one point in time.

We demonstrate that air-drying and rewetting soils prior to incubation leads to small but significant changes in the radiocarbon signature of respired CO2 due to an increased contribution of older carbon to the respiration flux. This finding also sheds light on the longstanding question regarding the mechanism driving the “Birch effect” (in which dried soils exhibit a large temporary increase in respiration upon rewetting). However, as the corresponding increase in apparent turn over time due to air-drying and rewetting was only on the order of 2 to 4 years, we believe that the archive incubation technique has great promise for improving future soil carbon models.

The data and all scripts for generating the figures are currently available from the lead author’s github site (https://github.com/jb388/arc-inc), but will be uploaded to a permanent data repository if and when the manuscript is accepted. The authors have no conflicts of interest to declare.