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The measurement and analysis of the isotopic signature of soil respiration derived from subsurface carbon dioxide

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Measurement of the isotopic signal of soil respiration ($\delta^{13}C_{R-s}$) has the potential to provide insight into the mechanisms behind the subsurface carbon cycle. There have been several advances in the measurement and analysis of $\delta^{13}C_{R-s,}$ ranging from methodology to models and analysis. In this presentation, we describe the culmination of our work on the methodology, implementation and analysis of $\delta^{13}C_{R-s}$ in a forest ecosystem. Our approach is unique in the sense that we focused on measuring $\delta^{13}C_{R-s}$ in the subsurface profile. Unlike the many studies using chambers, subsurface approaches allow for validating assumptions, particularly the assumption of steady-state. We report the results of field and laboratory experiments addressing the methodology of using gas wells to measure $\delta^{13}C_{R-s}$. We describe our findings on the use of mixing models when applied to high concentration regimes such as soil respiration. Using our data, we discuss the challenges of partitioning carbon sources of $\delta^{13}C_{R-s}$. And, we present our results from the measurement of $\delta^{13}C_{R-s}$ over two growing seasons in a forested watershed. The goals for this study were to 1) detect and quantify deviations of $\delta^{13}C_{R-s}$ from steady-state, and 2) evaluate the impact of measured soil bio-physical factors on non steady-state events. While the research we present is broad, it is not definitive, and our aim is to highlight areas for discussion and future research concerning the flux of this potent greenhouse gas.