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Soil CO_2 efflux exchanged with the atmosphere is a small fraction of the soil respiration

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Commonly, soil CO_2 efflux (F_{soil}) is often considered equal to soil CO_2 production (R_{soil}), and the two terms are used interchangeably. However, a considerable fraction of the CO_2 produced can fail to emerge from the soil surface due to a host of different processes, such as aqueous phase partitioning, calcite dissolution reactions, gravitational percolation due to a higher air density, or CO_2 dissolution in xylem water. Therefore, simple measures or estimations of F_{soil} are likely lower than actual rates of R_{soil}.

Here we present continuous ARQ estimates to evaluate annual CO_2 losses of carbon from R_{soil}. Our goals were to quantify the values, patterns, and seasonality of ARQ at different soil depths within a semi-arid coniferous forest and then to estimate the amount of soil CO_2 removed through biological and non-biological processes to illustrate the disparity between F_{soil} and actual rates of R_{soil}. We found that 1/3 of R_{soil} was emitted directly to the atmosphere, and 2/3 of R_{soil} was removed by subsurface processes. These losses could be explained by dissolution in water biological processes and chemical reactions. Misrepresenting F_{soil} as R_{soil} can have significant consequences for interpretation of both biotic and abiotic processes because it not only underestimates the contributions of aboveground function to belowground activities, but it also yields a misguided understanding of the rates and drivers of subsurface biogeochemistry and the potential for carbon exports from the system through hydrological processes.