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Tight coupling between photosynthesis and soil carbon turnover indicative of rhizosphere priming in the field

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While rhizosphere priming effects are well-documented under laboratory and controlled-environment conditions, their significance in undisturbed systems under field conditions is less clear. This is in part because it is impracticable to measure rates of rhizodeposition in the field with high resolution over a substantial period. We propose that photosynthesis, closely linked to rhizodeposition, can be used as a proxy for plant root activity.

We have used a field system containing 24 0.8-m diameter, 1-m deep lysimeters holding naturally-structured soil monoliths from two contrasting C_3 soils sown with a C_4 grass (*Bouteloua dactyloides*) to measure carbon (C) fluxes at a high temporal resolution, exploiting isotopic differences to allow partitioning of plant and soil fluxes. These fluxes are coupled to high-resolution measurements of soil temperature and moisture, alongside atmospheric temperature and solar radiation. This system has allowed measurement of both ecosystem resolution and net ecosystem exchange, and the partitioning of respiration between plant and soil sources using stable isotope methods. Using this system we have generated a dataset of measured and modelled respiration and photosynthesis fluxes over two years.

Our dataset has revealed clear seasonal and diurnal patterns in plant and soil fluxes. We have assessed the relationship between diurnal patterns in soil respiration and potential drivers, and examined whether model estimates of soil respiration are improved by the inclusion of photosynthesis as an explanatory variable alongside soil moisture and temperature. We found a significant positive relationship between photosynthesis and soil respiration, and inclusion of photosynthesis improves models of soil respiration. This is best explained by rhizosphere priming enhancing soil C turnover.