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Developing minirhizotron technology to study short-term root dynamics

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Minirhizotrons are a well-established method to study root dynamics in situ, using transparent below-ground observatories and dedicated camera systems. The key advantage of minirhizotrons is that this non-destructive approach allows repeat photography and assessment of root production and turnover in the field, as roots appear and disappear from successive images of the same area. However minirhizotron methods are also severely limited by constraints on image acquisition and processing which has limited their applicability to manipulation experiments (such as nutrient additions) and their use to study short-term events in the field (such as root responses to rain events in droughts). This is in contrast to whole-system and above-ground components of ecosystems, where flux-based and remote sensing methods allow assessment of above-ground changes over short-term and phenology-relevant timescales.

We are attempting to overcome these limits by developing both a relatively low-cost remote-operating minirhizotron camera which can remain deployed in observatories between site visits, collecting images on a daily timescale and methods to rapidly interpret gathered images using both manual and computer-vision based (i.e. machine or deep learning) approaches. We show results from a grassland mesocosm system where high resolution minirhizotron measurements can be paired with CO_2 fluxes and above-ground digital repeat photography imagery under manipulated water and nutrient treatments to study the pairing of above- and below- ground responses.