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Development of multiple-scale sensor and remote sensing technology to quantify carbon dioxide emission associated with pedogenic carbonate accumulation in irrigated soils of aridlands

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Many aridlands have been converted to farmlands to support food production and population growth. Due to intensive irrigation, high evapotranspiration, and slow infiltration, salts accumulate in these agricultural soils. As a consequence, the less soluble pedogenic carbonate (secondary calcite) also form at accelerated rates, releasing abiotic CO_2. Here we report an ongoing study in a pecan orchard in western Texas, USA, along the Rio Grande valley that are typical and representative of aridlands worldwide. We have developed multi-scalar approaches to directly detect this abiotic CO_2 signature in the soil atmosphere using carbon isotopes, to measure these abiotic CO_2 effluxes on the ground at high temporal and spatial scales, and to upscale and quantify the atmosphere-soil exchange using eddy covariance tower and remote sensing technology. More importantly, we aim to identify the major variables that control the production and transport of abiotic CO_2 (including irrigation intensity and chemistry, soil texture, and soil management practices). Special focus is also placed on quantifying the water fluxes in the orchard, especially estimating water loss rates via evaporation, as it will concentrate the soil solution and push the precipitation kinetics of secondary calcite. Datasets from this field-based study provide the first essential and systematic assessment on the potential of irrigated agriculture to modify the land-atmosphere carbon exchange at regional, national and even global scales.