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Improving partitioning of ecosystem exchange of CO_2 using stable carbon isotopes: A study in restored and degraded wetlands

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The partitioning of net ecosystem exchange of CO_2 (NEE) measured via the eddy covariance technique into gross photosynthesis (GPP) and ecosystem respiration (Reco) is often associated with unknown amounts of uncertainty. Recent studies employing stable carbon isotope partitioning have shown that standard partitioning practices may strongly overestimate GPP and Reco, from 10-100%. This is potentially due to reduced leaf respiration during the day, aka the Kok effect. The Kok effect is most significant when Reco is dominated by leaf respiration such as in wetlands with anaerobic soils. We are collecting ecosystem exchange measurements of stable carbon and oxygen isotopes of CO_2 in degraded and restored wetlands in the Sacramento-San Joaquin River Delta, California. Ecosystem exchange measurements of stable carbon and oxygen isotopes of CO_2 were previously collected in a degraded peatland under alfalfa cultivation and found that standard partitioning approaches overestimated GPP by 10-13% relative to carbon isotope partitioning. Isotope measurements in a recently restored wetland began in summer 2017 and are currently on-going. The isotopic signature of Reco (δ13Cr) at the un-vegetated wetland (-34‰ $\pm$ 3.1) is more depleted compared to previous measurements in the degraded peatland alfalfa field (-30.7‰ $\pm$ 2.3) and forested sites on mineral soils ($\sim$-27‰, potentially due to older sources of soil carbon. We hypothesize that as plants colonize the wetland the δ13Cr will become enriched. These data are on-going and are being used to improve stable isotope partitioning methods mainly by developing measurement and modeling approaches for constraining δ13Cr, and developing theory to employ the stable isotopes of oxygen to partition NEE. Finally, we will use these partitioned fluxes to update an ecosystem model PEPRMT to account for the Kok effect, investigate potential recycling of CO_2 within leaves during the day, and improve estimates of GPP in wetlands. GPP derived from standard and isotope partitioning approaches will be compared to satellite-derived GPP products, specifically MODIS and Landsat. The results of this study have implications for global measurements and modeling of GPP, a critical parameter in climate models.