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Interpreting trace gas fluxes through eddy covariance from different land management types in the Sacramento-San Joaquin River Delta peatlands, California, USA

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The Sacramento-San Joaquin River Delta in California, USA, encompasses an area of about 30,350 km2 that was drained for agriculture and human settlement at the beginning of the twentieth century, transforming the Delta into a patchwork of different land-use types. As a result of this pattern of historic drainage, the peat soils within the Delta have subsided and continue to subside to this day, resulting in a decrease in surface elevation up to 15 meters below sea level. Due to concerns about mitigating subsidence and a desire to understand the significance of greenhouse gas emissions from different land uses, our analysis focuses on four different land-use types in the Delta: 1) a drained cow pasture invaded by a perennial plant, 2) a tidal wetland, 3) a former corn field converted to a rice paddy, and 4) a former pasture restored to a non-tidal wetland.

During the past two years, we analyzed the energy, carbon, and water fluxes in tandem from these different land-use types, which all share the same basic meteorology due to their spatial proximity, in order to achieve a holistic interpretation of ecosystem functioning. At each site, we deployed an eddy covariance tower with an LI-7500 to measure CO2 and water vapor fluxes, either a closed-path LGR fast-methane analyzer or LI-7700 to measure methane fluxes, a sonic anemometer to analyze 3-D wind speed and direction, and a suite of micrometeorological equipment to complete our measurements of energy fluxes.

Interpretation of the quasi-continuous CO2, H2O, and CH4 fluxes reveals different biological controls on the net balance trace gas fluxes for the different land-use types. Trace gas fluxes from the cow pasture are dominated by large, sporadic fluxes from cow metabolism throughout the year, water-logged soils near canals during the wet season, and invasive plant productivity during the dry season. The rice paddy fluxes are controlled by the high productivity of rice during the growing season and reflect slowly increasing levels of methane flux since land-use conversion. The trace gas fluxes from the tidal wetlands are controlled by dynamic changes of the water level, and fluxes from the restored non-tidal wetland show carbon uptake and burial by wetland plants and large, increasing emissions of methane. By analyzing the differences among the trace gas fluxes in these different land-use types, we gain insight into controls of water level, plant productivity, seasonality, and alteration of carbon pools upon wetland restoration.