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Understanding the microscale biogeochemical mechanisms controlling methane production in riverine floodplains

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Terrestrial-aquatic interfaces (TAIs), such as riverine floodplains generate and export anaerobic biogeochemical products, such as methane (CH_4), and the net CH_4 flux is tightly coupled with the metal redox chemistry and the microbial activity at these TAIs. While methanogenesis is well-studied in wetlands, a knowledge gap persists in understanding how redox heterogeneities such as anoxic microsites influence bulk CH_4 emissions in predominantly oxic soils**.** Therefore, the main objectives of this study are: (i) to compare macroscale observations on the field scale for CH_4 emissions as a function of spatial and moisture gradient; and (ii) to link the CH_4 flux data to the distribution of anoxic microsites; and the relative abundance and composition of CH_4 cycling microbial community of methanogens and methanotrophs. Preliminary field data collected over the past two years within the Greater East River Watershed Observatory in Colorado, USA indicate that floodplains exhibit positive CH_4 fluxes across seasonal variations. Bulk Fe(II) and soil organic C concentrations, quantified as a function of depth and moisture contents, correlate positively with *in-situ* bulk CH_4 flux measurements, further confirming methanogenic potential even in predominantly oxic soils. These macro-scale observations were corroborated by micro-scale synchrotron-based micro-X-ray fluorescence mapping via the Laboratory for Observing Anoxic Microsites (LOAMS) approach, where we detected, quantified, and characterized redox heterogeneities in intact soil cores. Additionally, the association of Fe(II)-rich microsites with variable Mn redox states reveal microsites with distinct biogeochemical functions and environmental responses. Ongoing microbial analyses indicate the relative distribution of the CH_4 cycling microbial communities. By combining molecular-scale techniques with field and bulk measurements to capture spatio-temporal dynamics, results from this study will provide much needed quantification of redox heterogeneities and microbial activity in relation to trace greenhouse gas emissions at TAIs.