Title: Seasonal Hydrologic Forcings Drive Salt Marsh Function

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Project Abstract:

Salt marshes exist at the terrestrial-aquatic interface (TAI) between watersheds and the ocean. These tidal systems are hot spots of biogeochemical activity, yet we have limited understanding of their hot moments, or temporal dynamics of nutrient processing. Specifically, we have limited understanding of how daily tidal cycles and seasonal terrestrial water inputs (e.g., seasonally elevated groundwater) interact within these TAIs to drive biogeochemical processing in the subsurface. To address this knowledge gap, we instrumented a 25 m transect along a representative salt marsh platform at the Elkhorn Slough National Estuarine Research Reserve in California, USA. We installed variable-depth redox probes, nested piezometers, and a field-deployable spectrophotometer with a multi-source pump at lower, mid, and upper marsh positions to allow for characterization of subsurface hydrologic cycling and biogeochemical behavior at a high frequency (~15 min). We also conducted seasonal sediment incubation experiments to quantify nitrogen processing rates as well as monthly vegetation surveys, monthly pore water sampling campaigns, and subsurface sediment characterization (e.g., porosity, texture, organic matter). Finally, we paired these observations with measurements of terrestrial groundwater dynamics in adjacent uplands with tidal surface water monitoring to understand potential water inputs into the marsh through time. We found that biogeochemical behavior ranged as a function of time-scale. Dissolved inorganic nitrogen concentrations fluctuated hourly due to frequent tidal flushing that introduced oxygen and ammonium-rich surface water into sediments under reduced conditions, with the largest change in concentrations observed in lower marsh positions. Sediment core incubations showed a dominance of net N_2 flux out of the marsh, indicating removal by denitrification. However, we identified that the impacts of seasonal and event-driven freshwater contributions affected the biogeochemical behavior of marsh elevations differently, with the largest changes seen in upper marsh positions. Together, our findings suggest that intra-annual changes in source water contributions across the marsh result in functional zonation, where lower marsh position functions may be regulated by tidal flushing and upper marsh position functions may be regulated by freshwater contributions.