Linkages Between Hydrologic Processes and Biogeochemical Cycling in Salt Marshes

Margaret Zimmer[1*], Maya Montalvo[1], Emilio Grande[1], Corianne Tatariw[2], Erin Seybold[3], Anna Braswell[4], Alice Kleinhuizen[1], Ate Visser[5] and Bhavna Arora[6]

[1]University of California, Santa Cruz, CA
[2]University of Alabama, Tuscaloosa, AL
[3]Kansas Geological Survey, University of Kansas; Lawrence, KS
[4]University of Florida, Gainesville, FL
[5]Lawrence Livermore National Laboratory; Livermore, CA
[6]Lawrence Berkeley National Laboratory; Berkeley, CA

(margaret.zimmer@ucsc.edu)

Project Lead Principal Investigator (PI): Margaret Zimmer
BER Program: ESS
Project: University Award (DE-FOA-000218)
Project Website: http://mzimmer.weebly.com/nitrates.html

Salt marshes exist at the terrestrial-aquatic interface between watersheds and the ocean. These tidal systems are hot spots of biogeochemical activity within coastal watersheds. Yet, we have limited understanding regarding how short-term (e.g. daily tidal cycles) and long-term (e.g. seasonal precipitation and climate patterns) hydrologic forcings may interact within these systems. These interactions will affect the temporal dynamics, or hot moments, of nutrient processing as well as the physical zonation of biogeochemical processing in the subsurface, or hot spots. 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 dissolved inorganic nitrogen (DIN) species concentrations at a high frequency (~15 min). We also conducted seasonal sediment incubation experiments to quantify nitrogen processing rates. We found that DIN 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, but the impacts of seasonal and event-driven freshwater contributions affected 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.