Drivers of Spatial and Temporal Patterns in Methane Emissions from a Brackish Coastal Wetland

Genevieve L. Noyce*, Alia Al-Haj, Abigail Lewis, Roy Rich and J. Patrick Megonigal*
Smithsonian Environmental Research Center, Edgewater, MD, USA

Coastal wetlands are dynamic ecosystems, meaning that rates of biogeochemical cycling and thus greenhouse gas emissions can be not only spatially variable, but also temporally variable, presumably in response to episodic changes in inundation, salinity, temperature, or nutrient availability. While episodic events may have a disproportionate effect on annual-scale greenhouse gas emissions, we have a limited understanding of their relative frequency, magnitude, and duration as well as the underlying biogeochemical mechanisms. We also have a limited mechanistic understanding of how climate stressors interact with biological components, including vegetation, to regular greenhouse gas emissions. This constrains our ability to both fully represent greenhouse gas dynamics in biogeochemical and Earth systems models as well as develop carbon budgets. To address these gaps, we have been measuring methane (CH_4) emissions from long-term field experiments and companion mesocosm experiments using both static and automated chamber systems. The field experiments are located in Smithsonian's Global Change Research Wetland, a brackish high marsh on the western shore of the Chesapeake Bay. At this site, CH_4 emissions are typically higher from plots dominated by the grasses *Spartina patens* and *Distichlis spicata* compared to plots dominated by *Schoenoplectus americanus*, but in recent years this pattern has shifted. Fluxes increase with soil warming and longer periods of inundation but decrease as salinity increases; salinity appears to be a stronger control on the magnitude of CH_4 emissions than soil temperature. Despite this, our ability to forecast CH_4 emissions gets substantially worse as soil temperature increases, regardless of which forecast model is used. On a temporal basis, the highest CH_4 emissions occur on falling tides, as the water level drops back down to the soil surface. Surprisingly, initial results indicate that CH_4 emissions can have strong diurnal cycles with the highest emissions occurring at night, but that pattern also varies between years. Temporal analysis of the short-term effects of inundation, nitrogen loading, and heat waves on episodic CH_4 emissions is ongoing. Overall, these data illustrate that understanding the dynamics of CH_4 emissions from coastal wetlands requires assessing the effects of multiple drivers and how they interact across multiple scales.