Title: High-Frequency Greenhouse Gas Emissions from a Coastal Wetland

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Project Abstract:

The dynamic nature of the coastal terrestrial-aquatic interface (TAI) means that the processes the regulate decomposition and greenhouse gas (GHG) emissions are of particular significance to incorporate into Earth systems models. Despite this, we have a limited mechanistic understanding of how climate stressors interact with biological components to regulate the electron acceptors and donors that determine decomposition pathways within TAIs. Accurately modeling these processes is critical for incorporating the coastal TAI in Earth systems models, but doing so requires a better understanding of the processes that couple climate stressors, decomposition pathways, and net primary productivity in order to characterize feedbacks between biological, physical, and biogeochemical processes.

In 2021, we installed a network of 12 linked chambers in a mixed vegetation community in Smithsonian's Global Change Research Wetland, on an estuary of the Chesapeake Bay. These chambers automatically measure methane (CH_4) and CO_2 fluxes, with each chamber closing every 72 minutes during the growing season and every 132 minutes during the winter. Since system was started in April 2022, we have measured GHG fluxes from plant emergence to senescence, over soil temperatures ranging from 0 – 25 °C, and over water depth ranging from 80 cm above the surface to 20 cm below the surface. This wide range of data allows us to identify, and thus model, environmental conditions that lead to "hot moments", with the ultimate goal of using these data to improve modeling of decomposition and CH_4 cycling in PFLOTRAN. Methane fluxes exhibited strong seasonal effects, as expected, but also unexpected diurnal trends. Preliminary results suggest that CH_4 fluxes from this site are higher and more variable overnight than during the day, potentially due to shifting patterns of CH_4 oxidation or transport. Vegetation composition and flooding conditions also affected the magnitude and dynamics of CH_4 emissions. In February 2022, we added 1.5 m of soil heating to the automated chamber system; the chambers now span a range from ambient soil temperature to 6 °C above ambient. During the first three weeks of warming, GHG fluxes from the heated chambers were noticeably higher than ambient fluxes; we will continue assessing changes in GHG dynamics over the growing season, including how warming interacts with flooding and vegetation dynamics.