Title: **Temperature and Elevated CO_2 Effects on Coastal Wetland Resilience and Carbon Accumulation**

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Project Abstract:

Coastal wetlands are hotspots of carbon sequestration that regulate the biogeochemistry of coastal rivers, estuaries, and continental shelves, yet these ecosystems are highly vulnerable to global change. The Salt Marsh Accretion Response to Temperature eXperiment (SMARTX) was established at the Smithsonian's Global Change Research Wetland in 2016 to advance model representations of the complex interactions between plants, microbes, and hydrology in forecasts of coastal wetland responses to global climate change. We actively manipulate whole-ecosystem temperature through feedback-controlled heating from the plant canopy to 1.5 m soil depth as well as atmospheric CO_2 concentration.

Warming temperatures may increase wetland productivity and organic matter accumulation, but feedbacks between productivity and decomposition make it difficult to model how wetlands will respond to climate warming. A moderate amount of warming (1.7 °C above ambient) consistently maximized marsh elevation gain and below-ground carbon accumulation since the beginning of the experiment, consistent with our previously-observed non-linear effects on belowground net primary productivity. At higher temperatures, marsh elevation loss increased and was associated with increased carbon mineralization and microtopographic heterogeneity, a potential early warning signal of marsh drowning.

Elevation gain was highest in the wetter site, offering empirical support to our previous numerical modeling suggesting that the positive impacts of temperature on marsh carbon accumulation are maximized at high rates of sea-level rise, but also highlighting that warming-

induced gains in one part of the system may be offset by losses elsewhere. Elevation was also consistently maximized in early spring and minimized in the fall, which we attribute to seasonal changes in organic matter accumulation. The observed summer elevation loss indicates that, under warming conditions, the balance between decomposition and production is largely negative, with high rates of decomposition (inferred from methane emissions) reducing organic matter storage. This likely interacts with plant effects, where high root growth during the summer brings in oxygen and organic carbon, increasing rates of decomposition.

Elevated CO_2 also stimulated changes in plant morphology that led to a decline in carbon accumulation, especially when combined with warming, despite increased inputs of belowground primary productivity. This indicates that enhanced root production under future climate conditions may not increase marsh resilience, due to feedbacks resulting in high rates of aerobic decomposition. In addition, even though elevated CO_2 also reduced methane emissions, it did not substantially alter the radiative forcing potential of the marsh, due to the decrease in soil carbon sequestration.