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Soil organic matter decomposition follows plant productivity response to sea-level rise

Peter Mueller (1), Kai Jensen (1), and James Patrick Megonigal (2)

(1) University of Hamburg, Biocenter Klein Flottbek, Biology, Hamburg, Germany (peter.mueller@uni-hamburg.de), (2) Smithsonian Environmental Research Center, Edgewater, MD, USA

The accumulation of soil organic matter (SOM) is an important mechanism for many tidal wetlands to keep pace with sea-level rise. SOM accumulation is governed by the rates of production and decomposition of organic matter. While plant productivity responses to sea-level rise are well understood, far less is known about the response of SOM decomposition to accelerated sea-level rise. Here we quantified the effects of sea-level rise on SOM decomposition by exposing planted and unplanted tidal marsh monoliths to experimentally manipulated flood duration. The study was performed in a field-based mesocosm facility at the Smithsonian Global Change Research Wetland, a micro tidal brackish marsh in Maryland, US. SOM decomposition was quantified as CO_2 efflux, with plant- and SOM-derived CO_2 separated using a stable carbon isotope approach. Despite the dogma that decomposition rates are inversely related to flooding, SOM mineralization was not sensitive to varying flood duration over a 35 cm range in surface elevation in unplanted mesocoms. In the presence of plants, decomposition rates were strongly and positively related to aboveground biomass ($p \leq 0.01$, $R2 \geq 0.59$). We conclude that rates of soil carbon loss through decomposition are driven by plant responses to sea level in this intensively studied tidal marsh. If our result applies more generally to tidal wetlands, it has important implications for modeling carbon sequestration and marsh accretion in response to accelerated sea-level rise.