Gaining a predictive understanding of coastal ecosystem responses to press and pulse hydrologic disturbance

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Project Abstract: Coastal ecosystems are undergoing dramatic changes as sea-level rise (SLR) accelerates and precipitation and storm regimes change. SLR gradually exposes coastal landscapes to seawater (press disturbance) and increasing storm frequency and magnitude leads to acute seawater and freshwater saturation events (pulse disturbance). We implemented two manipulative, ecosystem-scale field experiments to understand and predict the influence of press and pulse disturbances on coastal ecosystems. The first investigated the initial (2-y) responses of soil C cycling and chemistry to novel hydrologic disturbances by transplanting soil monoliths between sites varying in natural salinity and inundation regimes (press). Coastal soil carbon dioxide (CO_2) flux, but not methane (CH_4) flux, was affected by changing hydrologic regimes; responses were dependent upon the salinity and inundation legacies of the monolith's original location. Soils with a history of exposure to salinity and inundation were resilient to novel disturbances, with CO_2 emissions increasing with rising salinity. Conversely, soils that lacked such legacies were vulnerable to shifting hydrologic conditions and soil respiration was suppressed. We propose that hydrologic legacies promoted the persistence of resilient, salt-tolerant microorganisms that were able to use increased resource availability (nutrients, electron acceptors) following seawater exposure. Lack of such legacies likely led to microbial communities that were sensitive to osmotic and redox stress following seawater exposure. Our second experiment – TEMPEST (Terrestrial Ecosystem Manipulation to Probe the Effects of Storm Treatments) – simulates ecosystem-scale freshwater and seawater soil saturation events in a well-drained, coastal upland forest (pulse). Our goal is to understand the initial and cumulative effects of soil saturation on deciduous upland forests. The experiment uses a large-unit (2,000 m^2), un-replicated experimental design, with control, freshwater, and seawater soil saturation treatment plots. Treatment plots will receive 300 m^3 of fresh- or seawater, saturating the soil to 30 cm for 10 hours. Treatment frequency will increase over a decade to identify tipping points where plant and microbial communities and biogeochemical cycles begin to change rapidly. Pre-treatment data collection began in 2019 and the first full simulation is scheduled for June 2022. This experiment provides us with an unparalleled opportunity to disentangle the effects of saturation and salinity under in-situ conditions and at an ecosystem-scale.