Elevated CO_2, sea level rise and the biotic controls on marsh soil elevation change

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Objectives: Sea-level rise threatens the ability of salt marshes to provide a variety of ecosystem services such as sustaining water quality, providing fish habitat, sequestering carbon and protecting human populations from devastating storms. Salt marsh plants strongly influence soil accretion rates, and therefore the sustainability, of the ecosystems they build and inhabit. The objective of the proposed research is to determine how the effects of elevated CO_2 on plants will influence the ability of marsh ecosystems to maintain a constant elevation relative to a rising sea level.

Questions: Past research has focused on the inorganic processes that influence salt marsh maintenance and collapse such as patterns of inorganic sediment deposition. However, many salt marshes have deep, organic soil profiles indicating that organic processes drive soil accretion and ecosystem maintenance. Increased plant productivity alone, through increased litter production and peat-formation, should increase accretion rates, but enhanced plant productivity may also stimulate decomposition of soil organic matter. This raises the critical question: ***What will be the net effect of elevated CO_2 on marsh soil elevation change and marsh sustainability?***

Location: The proposed research will be carried out at the Smithsonian Climate Change Facility in a brackish marsh on the Rhode River, a sub-estuary of the Chesapeake Bay. This site is representative of threatened marshes on the Atlantic coast. In addition, it has a long history of climate change research, extensive technical resources, and a great deal of the infrastructure required to perform the proposed study.

Methods: A novel “marsh organ” approach will be implemented to simulate sea-level rise in an array of mesocosms deployed in the field at varying heights. Experimental chambers will allow us to experimentally manipulate atmospheric CO_2 concentrations and determine how elevated CO_2 and sea level interact to influence plant performance. Further, we will measure plant influences on soil oxygen availability and soil organic matter decomposition in an ongoing, ecosystem-scale elevated CO_2 experiment. These data will allow us to close gaps in the organic matter budget for which we already have extensive data on plant productivity and soil elevation dynamics.

Deliverables: This will be the first field manipulation examining the effects of rising atmospheric CO_2 and rising sea level on the geomorphology of an ecosystem. The results of the study will be projected forward in time using an existing model of marsh responses to sea-level rise. The results will also contribute to an existing network of salt marsh sites designed to predict soil elevation change throughout North America. The information garnered from the proposed research will bear heavily on management practices aimed at protecting and restoring coastal wetlands.