Understanding soil moisture and salinity effects on greenhouse gas fluxes from coastal soils

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Abstract

How will coastal forests respond to rising sea levels, disturbances such as storms, drought, and climate change, which are combining to cause widespread impacts on ecosystems at the terrestrial-aquatic interface? One particular area of uncertainty is how these processes may mobilize soil organic carbon, resulting in changes in the dissolved or gaseous greenhouse gas (GHG) fluxes. We present results from the first year of a manipulative experiment looking at the effects of changes in salinity exposure and water availability on soil GHG fluxes. Large (40 cm diameter) soil cores were transplanted along natural salinity and elevation gradients in a Maryland, USA, coastal forest subject to rapid sea level rise. Comparative observations were also made in a western Washington, USA watershed with slow sea level rise but strong tidal fluctuations. Disturbed and undisturbed control cores allow us to distinguish transplant from salinity effects; soil respiration measurements were made every 7-10 days. Cores transplanted to lower-salinity sites, and to higher-elevation plots, exhibited elevated GHG fluxes relative to disturbance controls. These preliminary results suggest that changes in salinity exposure and water availability may exert significant effects on coastal forest GHG fluxes and the stability of soil carbon.

Understanding soil moisture and salinity effects on greenhouse gas fluxes from coastal soils

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Background

Greenhouse gas (GHG) fluxes uncertainties, and potential destabilization of soil carbon, are high at the terrestrial-aquatic interface. Faced with sea level rise, how will coastal forests respond? This project tests the hypothesis that soil fluxes will be suppressed by salt water intrusion, mediated by both landscape position and vegetation community.

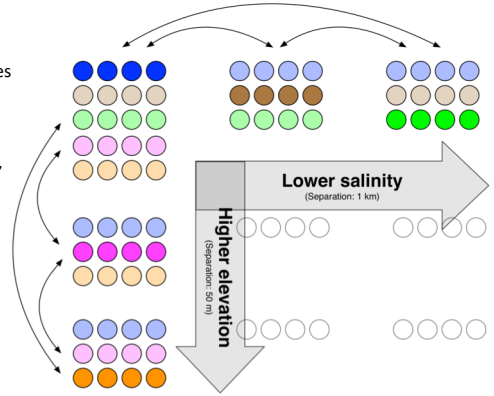
Left: Three sampling sites along Muddy Creek at the Smithsonian Environmental Research Center (SERC; Maryland, eastern USA), taking advantage of a natural salinity gradient as the creek descends to Chesapeake Bay.

Rationale and objectives

- Terrestrial-aquatic interface ecosystems may exhibit particular sensitivities to changes in climate and sea level.
- We want to understand how changes in water availability and salinity may affect soil and ecosystem carbon cycling.

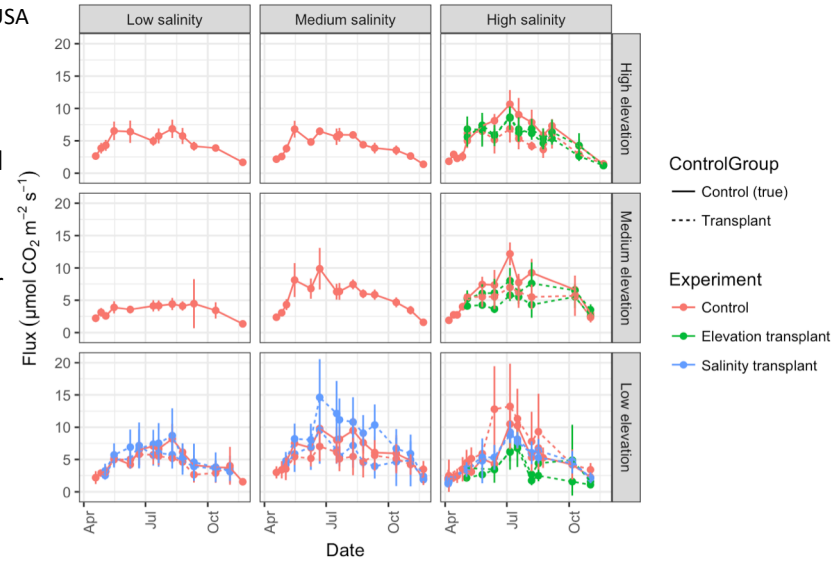
Transplant experiment

Large (40 cm diameter) soil cores transplanted along both salinity and elevation gradients at SERC in Maryland. Disturbed and undisturbed controls allow us to distinguish transplant from salinity effects, taking into account water availability, soil temperature, creek salinity and water level, and other factors.



Above: Crossing reciprocal transplant design used at SERC and Beaver Creek. Large soil cores are transplanted along salinity and elevation gradients.

Right: A dug-out core ready for transplant along Muddy Creek at SERC.



Above: Ongoing 2018 soil respiration data collected from the nine experimental plots along Muddy Creek. All experimental code and data are posted at https://github.com/PNNL-PREMIS/PREMIS-ghg

Activity and Results to date:

- Soil cores transplanted March 2018
- Measurements of GHG fluxes made every 10-14 days. Parallel measurements will be made in 2019 at Beaver Creek in Washington, USA
- Ancillary ecosystem data: inventory, litterfall, etc. Continuous soil/weather monitoring stations installed
- Transplanted cores exhibiting different dynamics than the control and disturbance control cores.

B21H-2419
An analysis of tree distribution and spatial variation of soil respiration in a mid-Atlantic, temperate deciduous forest

B24A-07
Soil, Water, and Plants: Water Chemistry and Inundation Influence Biogeochemical Fluxes through Coastal Forests

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