Carbon Dynamics of the Greater Everglades Watershed and Implications of Climate Change

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Peatlands play a critical role in the carbon (C) cycle in two main ways: 1) by sequestering and storing a large fraction of the global soil C pool; and 2) by producing and releasing significant amounts of greenhouse gasses (CO_2, CH_4) into the atmosphere. While most studies exploring these attributes have traditionally focused on boreal and subarctic biomes, wetlands in temperate and tropical climates (such as the Florida Everglades) have been understudied despite accounting for more than 20% of the global peatland C stock.

To estimate below ground C stocks we use a combination of indirect non-invasive geophysical methods (ground penetrating radar, GPR), aerial imagery, and direct measurements (coring) to estimate the contribution of subtropical depressional wetlands to the total C stock of the pine flatwoods landscape at the Disney Wilderness Preserve (DWP, Poinciana, FL). Three-dimensional GPR surveys are used to define total peat volumes (i.e. from the surface to the mineral soil interface) within five depressional wetlands. Depth-profile cores are used in conjunction with C core analysis to determine changes in soil C content with depth. By combining both GPR and C content variability with depth, a total C stock for each depressional wetland is determined. Aerial photographs are used to estimate surface area for each depressional wetland and develop a relationship between surface area and total wetland C stock. This relationship is then applied to every depressional wetland in the Preserve to estimate total C stock for all depressional wetlands. Additionally, low-frequency GPR surveys prove stratigraphic controls on the development of depressional wetlands by showing collapse structures underneath the depressions that extend to depths exceeding 30 meters.

Spatial and temporal variability in natural greenhouse gas production and release from peat soils in the Preserve has been investigated in several samples at the laboratory scale from three different wetland ecosystems in central Florida (sawgrass peatland, a wet prairie, and a depressional wetland within a pine flatwood). Gas content variability (i.e. build-up and release) within the peat matrix is estimated over a period of five months using a series of high frequency (1.2 GHz) GPR surveys constrained with gas traps fitted with time-lapse cameras. Gas entrapped is analyzed with a gas chromatograph to determine CH_4 and CO_2 content. Additionally, variability in gas build-up and release at high temporal resolution (i.e. sub-hourly) is investigated in a peat monolith using a unique autonomous rail system that provides continuous, uninterrupted GPR transects.