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Carbon Dynamics Across the Terrestrial-Aquatic Landscape of Subtropical Florida

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Low-latitude landscapes are a complex mosaic of natural ecosystems and built environments interconnected by hydrology from xeric forests to hydric wetlands which are vulnerable to land use changes and climate change. Perched on the boundary of subtropical and temperate climates, the low-relief landscapes of the central Florida peninsula are an archetype of a heterogeneous terrestrial-aquatic landscape under both natural and anthropogenic stress. Our study quantifies carbon dynamics at multiple scales along a terrestrial-aquatic ecosystem gradient in central Florida using multi-disciplinary techniques to understand pore-to-watershed movement of carbon and water. Our TES-funded effort has focused on eddy covariance (EC) measurements of CO_2, CH_4, and H_2O along a hydrologic gradient at three sites: pine flatwoods, seasonal depression marshes, and peat accumulating wetlands. Over the past three years all sites have been a terrestrial carbon sink. However, greenhouse gas contributions of methane emissions from the wetland sites have somewhat offset CO_2 sequestration of the landscape. Soil biogenic gas releases were mainly episodic and rapid, with greater emissions from herbaceous wetlands (44-56 mg C m^{-2} day^{-1}) than forested wetlands (0.6-1.5 mg C m^{-2} day^{-1}) based on laboratory incubations and field surveys with ground penetrating radar (GPR). Closed and open-topped chamber experiments showed increased C exchange with 2-3^{o}C daytime warming, with a 50-60% increase in net C uptake at the depression marsh and flatwoods despite increased ecosystem respiration. While drought-induced encroachment of woody shrubs enhanced wetland carbon sequestration, evapotranspiration (ET) losses of water were elevated for wetlands potentially compromising their long-term stability in a warmer climate regime. Litter decomposition rates had a predictable inverse relationship with moisture across the ecosystem gradient, with a similar pattern of root productivity being greatest in the pine flatwoods compared to the wetland soils. The soils of these small isolated wetlands are a considerable stock of organic carbon and may play a vital role in the lateral movement of water and nutrients across terrestrial-aquatic interfaces, particularly given the seasonally pulsed precipitation regimes characteristic of low-latitude regions. Given the importance of low-latitude watersheds for regional and global carbon cycling, Earth System Models will be able to leverage our information and synergistic activities at a co-located NEON site, a nearby agricultural research site at Archbold Biological Station, and AmeriFlux supported coastal ecosystem research at Kennedy Space Center to unravel the processes and vulnerabilities of carbon cycling across a mixed-use terrestrial-aquatic landscape.