Phenolic Compounds and Black Carbon Feedback Controls on Peat Decomposition and Carbon Accumulation in southern Peatlands

Curtis J. Richardson[a], H. Wang [a], N. Flanagan[a], M. Ho[a], B. Cooper[b], and J. Chanton[c]

[a] *Duke University Wetland Ctr., Nicholas School of the Environment, Durham, NC 27708, USA curtr@duke.edu*
[b] *Department of Chemistry and Biogeochemistry, Florida State University, Tallahassee, FL, 32306, USA*
[c] *Department of Earth, Ocean and Atmospheric Science, Florida State University, Tallahassee,FL,32306, USA*

Earth System Models (ESMs) predict increased frequency of extreme wet and dry periods in the subtropics and tropics over the next century, resulting in uncertain carbon (C) budgets and greenhouse gases (GHG) fluxes. Globally, approximately 1/3 of peat stores are found in subtropical and tropical peatlands (STPs) formed from high-lignin woody biomass. These peatlands have persisted through changing climate and sea level over the last 4000 years and continue to accrete peat from Virginia/North Carolina, to Florida to tropical Panama, even under climate driven conditions of drought, warmer temperatures and fire. Our main hypothesize is that the subtropical and tropical native-fire-adapted shrubs/trees communities produce higher polyphenol containing litter than northern *Sphagnum/Carex* communities. High phenolic concentrations in plant tissues prevent microbial decay of litter. In addition, low intensity fire produces black carbon and pyrogenic organic matter (PyOM) resulting in buildup of recalcitrant organic matter (OM) in the soil and leading to the formation and long-term storage of peat. Phenolic differences in conjunction with climate induced regimes of frequent low-intensity fire creates refractory decomposition-resistant peat by a dual “latch key mechanism” consisting of high phenolic and black carbon (i.e., the black carbon/PyOM complex from fire forms decay resistant aromatics). Together these retard GHG flux, and C decomposition of OM even under altered hydrologic conditions, higher temperatures and drought. Here, linking field and microcosm experiments, we show how the previously unrecognized interactions between these dual mechanisms may regulate the buildup of phenolics and black carbon/PyOM, which protect stored C directly by reducing phenolic oxidase activity during short-term drought, and indirectly through a shift from low-phenolic containing *Sphagnum/ herbs* to high-phenolic shrubs after long-term moderate drought. We also investigate whether shrub expansion caused by drought/warming in boreal peatlands might be a long-term self-adaptive mechanism not only increasing C sequestration, but also by protecting historic soil C. We therefore propose that the projected “catastrophic feedback loop” between C emissions and climatic drought and fire in peatlands is down regulated in the long-term.