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Coastal Wetland Carbon Sequestration in a Warmer Climate

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Coastal wetlands are global hotspots of carbon storage. The future sink strength and carbon stock stability of these systems is uncertain because global change drivers such as temperature and elevated CO_2 perturb the complex biotic and abiotic feedbacks that drive high rates of soil carbon sequestration. Despite the leverage these ecosystems exert over the global carbon cycle, the dynamics of coastal wetland carbon pools are not presently represented in Earth system models.

In June 2016, we initiated an *in situ*, active, whole-ecosystem warming experiment and two integrated modeling activities focused on coastal wetlands. The experiment has a gradient design with four aboveground and soil warming treatments ranging from 0 to +5.1^{O}C, to a soil depth of 1.5 m. Elevated CO_2 is crossed with temperature at the treatment extremes (0, +5.1 ^{O}C). Replicate transects (n=3) are located in each of two plant communities that vary in flooding frequency.

C_3 and C_4 communities responded differently to warming. Net primary production (NPP) in the C_3 community increased initially at +1.7°C, but changed little with additional warming. By contrast, NPP in the C_4 community declined monotonically with increasing warming. Different responses may be due to greater heat-related stress in the relatively dry conditions of the C4 site compared to the C_3 site. Belowground NPP in the C_3 community doubled at +1.7°C, but declined with additional warming. The decline in belowground NPP was entirely compensated by higher aboveground NPP, which drove a decline in the root:shoot ratio. Nitrogen fertilization produces the same pattern in an elevated CO_2 x N study at our site (Langley et al. 2009), suggesting that the decline in root:shoot ratio is a response to a warming-induced rise in N mineralization rates. Plants typically shift growth allocation to aboveground tissue when N limitation is relieved. The C_4 community was generally less responsive to warming, particularly above +1.7^{O}C. Elevated CO2 increased total NPP at both the +0 ^{O}C and +5.1 ^{O}C treatments, especially belowground NPP at +5.1^{O}C.

CH_4 emissions increased non-linearly with temperature and gross primary production in both plant communities. Elevated CO_2 significantly decreased CH_4 emissions at +0 and +5.1^{O}C, which is likely due to higher root biomass, increased O_2 flux o from roots to the rhizosphere, and stimulation of aerobic CH_4 oxidation.

Our initial results suggest that warming alone will decrease soil C sequestration due to a decline in root production, and increase CH_4 emissions, causing net radiative forcings. However, elevated CO_2 may offset these effects in C_3-dominated plant communities.