Sink or Source: Response of Tropical Forest Carbon to Climate Warming

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The universally observed exponential increase in soil surface CO2 efflux ('soil respiration' or FS) with increasing temperature has led to speculation that global warming will accelerate soil organic carbon (SOC) decomposition, reduce SOC storage and drive a positive feedback to future warming. However, interpreting temperature – FS relationships are complicated by the many sources of respired carbon that contribute to FS. Further, while temperature driven increases in soil microbial processes and enzyme kinetics are anticipated to impact SOC storage, the temperature sensitivity of SOC decomposition remains poorly understood, and so model projections of terrestrial carbon balance in a warmer world are highly uncertain. In this talk, I will discuss recent directed at quantifying FS, litterfall, SOC pools, radiocarbon-based estimates of SOC turnover, and total belowground carbon flux (TBCF) across a highly constrained 5.2°C mean annual temperature (MAT) gradient in tropical montane forest. These measurements were used to test whether increases in FS with increasing MAT observed at our site result from increased SOC decomposition rates, increased belowground inputs of detrital C, or some combination, and whether the sum of these processes results in declining SOC storage with increasing MAT. Results from this study show that: (i) increases in TBCF and aboveground litterfall explain nearly all of the increase in FS with MAT; (ii) SOC storage and turnover do not vary with MAT; and (iii) SOC turnover is substrate limited and appears to be controlled by soil mineralogy and depth. These observations provide the first evidence from a natural field experiment that increased inputs in response to whole-ecosystem warming explain MAT-related increases in FS. These results also strongly refute the view that warming in upland forests will drive positive feedbacks to global climate through accelerated losses of SOC via direct effects on enzyme kinetics and via indirect priming effects through enhanced detrital inputs.