Coupled iron and carbon redox dynamics in tropical forest soils of Puerto Rico

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In wet tropical ecosystems, soils frequently alternate between fully oxygenated and anaerobic conditions, thereby making them biogeochemical 'hotspots' for redox reactions. Carbon and iron are two of the most abundant and important elements in these soils, with their cycling fundamentally coupled. Using a 44 day redox manipulation and isotope tracing experiment with forest soils from Puerto Rico, we examined patterns of Fe and C transformations when soils were exposed to different redox regimes - static oxic, static anoxic, flux 4-day or flux 8-day. Replicate microcosms were harvested throughout the incubation to understand how the periodicity of redox oscillation altered soil chemistry and analyzed with bulk extractions, EXAFS, STXM Mossabuer and NanoSIMS. DOC and Fe^{2+} concentrations were positively correlated for all four redox treatments and rapidly increased following a switch from oxic to anoxic conditions. Soils under fluctuating treatments exhibited EXAFS features similar to that of crystalline Fe oxides. STXM-NANOSIMS isotope ratio images show chemical alterations of organic matter in 13C enriched soils (relative to the added substrate) are dependent on redox treatment. C-Fe coupling may control redox-driven biogeochemistry in these soils that includes electron transfer reactions (i.e. oxidation of carbon and reduction of iron or other acceptors). Our findings highlight the need for a more explicit representation of fluctuating soil redox dynamics in soil carbon cycle models.