Geophysical Research Abstracts
Vol. 17, EGU2015-7399, 2015
EGU General Assembly 2015
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The influence of C_3 and C_4 vegetation on SOM dynamics across contrasting semi-natural ecosystems in West Africa

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A progressive 'thickening' of woody vegetation in tropical grasslands and savannas is a widespread phenomenon being promoted by increasing atmospheric CO_2 concentrations, climate change, variations in fire regimes and other human-related activities such as intensified grazing. The impact of these vegetation dynamics on ecosystem biogeochemistry and the global carbon cycle may be highly significant given the large extent of grass dominated ecosystems, which represent about 30% of primary production of all terrestrial vegetation and store 10-30% of all soil organic carbon (SOC). However, improved predictions of the impacts of future climate-driven changes on the tropical soil organic matter (SOM) pool requires a more detailed and predictive understanding of the interactions between vegetation, climate, edaphic and disturbance effects than is currently available. Field studies using the stable carbon isotopic composition of SOM can help assessing the influence of C_3 and C_4 vegetation on SOM dynamics, enabling a test to determine whether there are differential patterns in their mineralisation potential as previously reported in laboratory-based studies. To this end, variations in the carbon isotopic composition of SOM in bulk and fractionated samples were used to assess the influence of C_3 and C_4 vegetation on SOM dynamics in semi-natural tropical ecosystems sampled along a precipitation gradient in West Africa. Moreover, results were also interpreted in light of the relative change in C/N ratios observed between contrasting SOM fractions in order to assess potential differences in SOM dynamics between Grass- and Tree-dominated sampling locations. Differential patterns in SOM dynamics in C_3/C_4 mixed ecosystems occurred at various spatial scales. At the site scale, differing degrees of SOM decomposition were observed between locations dominated locally by either tree or grass vegetation as indicated by the relative change in C/N ratios between contrasting SOM fractions. While at the transect scale, the non-linear nature of the relationship between δ^{13}C and SOC content observed across the gradient strongly suggests that in addition to the inherent differences in the input rates and turnover times of tree and grass-derived carbon, the broad range of edaphic characteristics exert a strong influence on both the physical protection and chemical stabilization of SOM. Finally, we show that the interdependence between biotic and abiotic factors ultimately determine whether SOM dynamics of C_3- and C_4-derived vegetation are at variance in ecosystems where both vegetation types coexist.