Geophysical Research Abstracts
Vol. 13, EGU2011-7723, 2011
EGU General Assembly 2011

A pantropical analyses of soil organic carbon storage in tropical forests and savannas

Gustavo Saiz (1,2), Michael Bird (1), Tomas Domingues (3), Ted Feldpausch (4), Elmar Veenendaal (5), and Jonathan Lloyd (6)

(1) School of Earth and Environmental Science, James Cook University, Cairns, Australia (gustavo.saiz@jcu.edu.au), (2) School of Geography and Geosciences, St Andrews University, Scotland, UK, (3) School of Geosciences, University of Edinburgh, Scotland, UK, (4) School of Geography, University of Leeds, England, UK, (5) WU Environmental Sciences, Wageningen University, The Netherlands, (6) University of Queensland, Brsibane, Australia

Tropical forests and savannas contain ∼28% of the world's soil organic carbon (SOC), and consequently have considerable potential to impact the global carbon cycle and hence global climate. Despite their significance, our knowledge of the drivers of SOC stocks and fluxes remains incomplete for these ecosystems. Within the framework of the TROBIT (TROpical Biomes In Transition) project, 63 permanent plots have been established covering tropical forest and savannas across three continents. Large differences in SOC stocks are observed between different geographical areas. These differences are mostly explained by climatic and soil characteristics of the sites, as demonstrated by significant correlations between SOC stocks and variables such as temperature, precipitation, and relative abundance of minerals characteristic of these highly weathered tropical soils. It is generally the case that higher aboveground biomass will be present in 'mature' tropical forest compared to 'mature' tropical savanna under similar environmental conditions. However, this may not always be the case for SOC. This is because SOC storage in tropical areas is not just a function of environmental conditions and vegetation type, which directly influence the inputs of organic matter to the soil, but is also strongly dependant on complex interactions of the different soil organic compounds with minerals and aggregates in the soil.

To further advance our understanding of tropical SOC dynamics, this project focused on implementing a combined physical and chemical fractionation scheme aimed at validating conceptual SOC pools predicted by the process-based RothC model across the soils of the TROBIT plot network. It is expected that this will enable better characterization of interactions between individual site conditions and SOC dynamics as well as enhance confidence in the use of models to predict SOC dynamics in these ecosystems. Invariably, most of the carbon is stored in the physical protected fractions forming aggregates. The results revealed strong regression coefficients ($r^2 > 0.75$, with slopes close to 1) between SOC stocks in measured soil fractions and most equilibrium-modelled pools in Roth-C. However, the model consistently failed to satisfactorily predict the highly resistant SOC measured fraction. To address this issue, the elemental and stable carbon isotopic composition of the bulk soil and the chemically resistant fraction (defined as that fraction surviving dichromate oxidation at 60° for 72 hours) were used as a proxy for the role of fire in producing chemically resistant compounds 'pyrogenic carbon' in the soils. Using this proxy we found that, sites with higher soil $\delta^{13}C$ values (indicative of C_4-containing ecosystems likely susceptible to fire) contained relatively larger amounts of resistant carbon compared to those soils with low $\delta^{13}C$ values characteristic of C_3-only environments.

However, pyrogenic carbon still failed to account for most of the resistant carbon observed in forests with a presumed low (if any) incidence of fire, and in some savannas established on rich basalt soil environments. This suggests that physical protection has to be playing a major role in the occurrence of chemically resistant organic carbon compounds in some of the soils from the TROBIT sites. An attempt was made to include both forests and savannas in a single predictive function for resistant SOC based on total SOC and the relative abundance of soil mineral components, with either quartz or iron contents giving excellent results ($r^2 > 0.79$). These results indicate that failure to account for stocks of pyrogenic carbon and the role of aggregates protecting SOM in these fire-prone and highly weathered ecosystems may result in underestimation of a significant C pool (∼20% of TOC on average) with a long mean residence time, with implications for accurate predictions of future SOC dynamics in tropical ecosystems.