Variations in soil chemical and physical properties explain basin-wide Amazon forest soil carbon concentrations

Carlos Alberto Quesada¹, Claudia Paz¹², Erick Oblitas¹, Oliver Phillips³, Gustavo Saiz⁴⁵, and Jon Lloyd⁶⁷

¹INPA, manaus, Brazil (quesada.beto@gmail.com)
²Universidade Estadual Paulista, Rio Claro, Brazil
³School of Geography, University of Leeds, UK
⁴Department of Life Sciences, Imperial College London, UK
⁵Department of Environmental Chemistry, Universidad Católica de la Santísima Concepción, Chile
⁶School of Tropical and Marine Sciences and Centre for Terrestrial Environmental and Sustainability Sciences, James Cook University, Cairns, Australia
⁷Universidade de São Paulo, Ribeirão Preto, Brazil

We investigate the edaphic, mineralogical and climatic controls of soil organic carbon (SOC) concentration utilising data from 147 primary forest soils (0-30 cm depth) sampled in eight different countries across the Amazon Basin. Sampling across 14 different World Reference Base soil groups our data suggest that stabilisation mechanism varies with pedogenetic level. Specifically, although SOC concentrations in Ferralsols and Acrisols were best explained by simple variations in clay content – this presumably being due to their relatively uniform kaolinitic mineralogy – this was not the case for less weathered soils such as Alisols, Cambisols and Plinthosols for which interactions between Al species, soil pH and litter quality are argued to be much more important. Although for more strongly weathered soils the majority of SOC is located within the aggregate fraction, for the less weathered soils most of the SOC is located within the silt and clay fractions. It thus seems that for highly weathered soils SOC storage is mostly influenced by surface area variations arising from clay content, with physical protection inside aggregates rendering an additional level of protection against decomposition. On the other hand, most of SOC in less weathered soils are associated with the precipitation of aluminium-carbon complexes within the fine soil fraction, with this mechanism enhanced by the presence of high levels of aromatic, carboxyl-rich organic matter compounds. Also examined as part of this study were a relatively small number of arenic soils (viz. Arenosols and Podzols) for which there was a small but significant influence of clay and silt content variations on SOM storage and with fractionation studies showing that particulate organic matter may accounting for up to 0.60 of arenic soil SOC. In contrast to what were in all cases strong influences of soil and/or litter quality properties, after accounting for these effects neither wood productivity, above ground biomass nor precipitation/temperature variations were found to exert any significant influence on SOC stocks. These results have important implications for our understanding of how Amazon forest soils are likely to respond to ongoing and future climate changes.