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Soil geochemistry as a major driver of carbon allocation, stocks and dynamics in vegetation and soils of African tropical forests

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The net primary productivity (NPP) of tropical forests is an important component of the global terrestrial carbon (C) cycle. The lack of field-based data, however, limits our mechanistic understanding of the drivers of NPP and C allocation. In consequence, the role of local edaphic factors for forest growth and C dynamics is unclear and introduces substantial uncertainty in estimating ecosystem C stock accrual. Here, we present data from field measurements on standing biomass as well as leaf, wood, and root production collected along topographic and geochemical gradients in old-growth African tropical mountain forests in the East African Rift System. We show that forests converge towards nutrient uptake more strongly when soil properties and parent material geochemistry indicate fertility constraints due to low amounts of rock-derived nutrients. In contrast, topography did not constrain the variability in C allocation and NPP fluxes. In consequence, aboveground:belowground biomass ratios and total NPP can differ greatly between geochemical regions for similar old-growth tropical forest types. Furthermore, soil organic carbon (SOC) stocks were not related to NPP C allocation and plant C input seemingly exceeding the maximum potential of these soils to stabilize C. We conclude that even after many millennia of weathering and the presence of deeply developed soils, tropical above and belowground C allocation, as well as soil C stocks, vary substantially due to the geochemical properties which soils inherit from parent material.