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Long-term increase in local relief enhanced by forest competition: detrital 10Be and LiDAR topographic evidence in the tropical rainforest of Puerto Rico, Luquillo CZO

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The Luquillo Critical Zone Observatory of Puerto Rico is located in a mountainous tropical rainforest. The forest grows over two dominant types of bedrock: a thick pile of marine andesitic volcaniclastics and a stock of quartz diorite. The landscape over the quartz diorite varies with elevation: below 600 m, a wave of erosion has rejuvenated the landscape; streams are steep, slopes are straights, the saprolite is thin, soils contain weatherable primary minerals and the slopes are occupied by the Tabonuco forest. Above 600 m a relict landscape persists and its low-gradient alluvial streams and thick saprolite are thoroughly depleted in primary minerals. Field observations combined with the analysis of a recently acquired LiDAR topography show that the saprolite is dissected by concave coves that progressively unearth deeply buried corestones and bedrock. These coves are separated by broad flat ridges that define a pre-existing, more subdued topography. These observations suggest that the landscape is out of equilibrium, with an older subdued landscape being progressively dissected with an associated increase in local relief. This increase in local relief had been inferred from the 10Be signature of stream sediments by Brown et al. (1995) in this landscape, in one of the first studies of catchment-scale erosion using in situ produced 10Be in river-borne quartz. To better understand the spatial variability of the erosion rates in this landscape, we have undertaken a more systematic analysis of the contribution of the ridges and coves to the stream signal by analyzing in situ 10Be in soils and stream sediments all over the landscape. We find that erosion in the coves is significantly higher than on the ridges, confirming the increase in landscape dissection. The Palm forest and the Palo Colorado forest are the two types of forest that dominate in this upper landscape. Analysis of high-resolution satellite images were combined to the LiDAR topography and show an almost systematic association of the Palm forest to the coves and of the Palo Colorado to the ridges. We propose that the difference in ground exposure to runoff between the Palm forest and Palo Colorado provides a positive feedback whereby the presence of the Palm forest favors the incision of the coves and the Palo Colorado favors the protection of the ridges, thereby increasing the relief