Phosphorus Transformation in Saharan Dust during Trans-Atlantic Dust Transport

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Sahara Desert provides a considerable amount of phosphorus (P) in mineral dust to P-limited American rainforests. Phosphorus speciation in dust ultimately controls the fate and availability of P after dust deposition, but the P speciation in the dust deposited in the rainforests and its change during the long-range trans-Atlantic transport remain unclear. Using P K-edge XANES spectroscopy, we characterized P speciation in Saharan dust source soils, and the Saharan dusts deposited in Cape Verde archipelago and Puerto Rico, ~ 600 km and ~ 4000 km, respectively, downwind from the African west coast. Along the dust transport pathway, Ca-bound P (Ca-P) decreased while Fe/Al-P increased substantially, ascribed to both particle sorting and atmospheric acidification during the transport. The Puerto Rico dust contained 35 - 53% of total P as Ca-P, suggesting atmospheric acidification unable to dissolve most dust-borne Ca-P despite such a long-range transport. The dust-borne Ca-P may persist in the rainforest soils (average soil pH 4.2 - 4.9) for a certain period before becoming available. A pH substantially higher than pH 2 should be used for atmospheric acidification simulation of Saharan dust to avoid overestimation of its enhancement on P solubility and transformation. We also found that biomass-burning particulates were uncommon in the dust.