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Quantifying Soil Percolation Dynamics and Biogeochemical Transport in Tropical Soils near Manaus, Brazil

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Understanding soil moisture dynamics and associated transport of biogeochemical species is challenging in tropical systems because of the physical nature of tropical soils and the coupled ecohydrological impacts on flow and transport. We utilized an unusual type of passive wick flux meter (or drainage lysimeter) to measure real-time percolation fluxes and to sample percolation chemistry and stable isotopes along two topographic transects at the ZF2 field area near Manaus, Brazil. Percolation flux is often an inferred or modeled process and as such has significant uncertainties especially in forested soils where preferential flow paths are often important. Direct measurement of fluxes provides a way to inversely calibrate hydrological model parameters which should yield more representative simulations of actual field conditions. In addition, by coupling percolation flux measurements with biogeochemistry we can understand transport dynamics of nutrients and other geochemical species. The field site is characterized by a plateau, slope, and valley type of topography, and two flux meters were installed in each of the three topographic positions. The flux meters were installed to measure the percolation flux at 60 cm below the top of the soil (which is well below the densest part of the root zone). The percolation flux results show that percolation is highly pulsed and is seasonally affected. In addition, topography is important where percolation is greatest in the valley, intermediate on the slope, and lowest on the plateau. Evapotranspiration is clearly the dominant flux relative to precipitation amounts (or throughfall), but percolation to 60 cm occurs frequently in all sites suggesting deep percolation is common even during the dry season, and that it is an important part of the site water balance. There are substantial variations in ion concentrations (e.g., calcium, sodium) through time, but the most remarkable biogeochemical behavior is associated with nitrate. Nitrate concentrations are extremely high at all locations with values sometimes exceeding 100 mg/L, and are often more than double that of chloride. Nitrate varies with topography where the slope and valley areas appear to be more pulsed, and the plateau is less variable over time. The highest concentrations were observed in the valley. These results demonstrate that nitrogen cycling is very dynamic and suggest that nitrogen is unlikely to be a co-limiting nutrient in these forests. Phosphate concentrations are frequently below the limit of detection (0.01 mg/L) although they do occasionally exceed 0.1 mg/L.