Title: Coupled Modeling of Hillslope Hydrology and Ecosystem Dynamics at Manaus and BCI

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Project Abstract:
Tropical forests play essential roles in the coupled land-atmosphere system by contributing to a large fraction of precipitation through evapotranspiration. Combined climate change and topography are likely to have considerable and diverse impacts on plant water availability, with consequential effects on vegetation dynamics and the regional and global water cycles. We have developed an integrated model that couples E3SM Land Model (ELM), an ecosystem dynamics model (FATES), and a three-dimensional hydrology model (ParFlow) to explicitly resolve hillslope topography and subsurface flow for a better understanding of the processes that drive plant water availability and tropical forest dynamics. Numerical experiments are conducted at Barro Colorado Island, Panama, and the Asu catchment, Manaus. Differing in terrain features and rainfall seasonality, the two sites provide useful testbeds for evaluating the coupled model. Machine learning-based surrogate models are built to help calibrate ELM–FATES–ParFlow based on multiple observations, including measured soil moisture, groundwater table, energy and carbon fluxes, and forest inventory data. Experiment results are analyzed to identify the main physical processes that drive the observed forest structure and dynamics and to study the modulation of hillslope processes on how drought affects plant water availability and vegetation.