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Improving Modeling of Water Table Dynamics by Incorporating Plant Hydraulics and Hillslope Based Drainage Function

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Spatial variability in water available for plant water use has an important control on how tropical forests respond to drought. Previous simulations performed over the Asu catchment, 80 km northwest of Manaus in the Amazon using ELM and CLM-Parflow identified development needs for modeling surface and subsurface hydrology in Earth system models. First, the drought index formulation and the simplicity of treating root water uptake as a sink term in soil hydrology in ELM lack mechanistic representation of the interaction of soil-plant system. Second, comparison between the one-dimensional ELM and three-dimensional Parflow model simulations indicated the importance of lateral flow in controlling groundwater table dynamics. To address the limitation in representing hydrodynamics of the soil-plant system, two simulations were performed at Manaus using plant hydraulics model within ELM. The model captured the hydraulic lift in the dry season, which is an important mechanism to prevent top soil moisture from depletion. The simulations showed that plants experience some water stress in the dry season, but the reduction in water availability is small even in simulations with water table depths differing by 6 meters. To model lateral flow, we introduced a representation of lateral fluxes as a drainage function using hillslopes to represent subgrid variability. This approach enables a realistic representation of lateral flow processes and their impact on hydrological and surface energy fluxes, while keeping additional computational cost minimal for Earth system modeling.