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Impact of soil drought on leaf growth of a teak plantation in a dry tropical region and the subsequent impact of leaf area on both canopy net assimilation and evapotranspiration

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The current study demonstrated the interannual variations from the beginning of leaf expansion to the peak at a stand level in a dry tropical climate of northern Thailand. Radiative transmittance was measured from March-July in 2001-2008, and seasonal changes in leaf area were qualitatively estimated based on this time series. Soil moisture was also measured, and its influence on leaf growth was shown. Next, a soil–plant–air (SPAC) continuum multilayer model was used to numerically simulate net canopy assimilation (An) and evapotranspiration (ET) for 8 years, to examine the seasonal changes in LAI on An and ET. Two numerical experiments with different seasonal patterns of LAI were carried out using above-canopy hydro-meteorological data as input data. The first experiment involved seasonally varying LAI estimated based on time-series of radiative transmittance through the canopy, and the second experiment applied a constant LAI (or the peak values of LAI) after the flushing. In the first simulation, the simulated transpiration agreed with seasonal changes in heat pulse velocity, corresponding to the water use of individual trees. In the second numerical simulations, the constant LAI increased transpiration at small LAI, particularly immediately after leaf flush. But, the seasonal changes in simulated transpiration were apparently similar to those in observed heat pulse velocity. This implies that soil water, which is balanced in SPAC systems by precipitation, canopy interception, soil evaporation, soil water uptake by transpiration, and discharge, can mainly control the seasonal changes in transpiration. The simulated An became negative under soil drought during the leaf expansion stage in the second simulation, while it became positive or slightly negative even under soil drought in the first simulation. Thus, the limitation of leaf expansion rate caused by soil drought can be favorable for carbon gain.