Geophysical Research Abstracts
Vol. 21, EGU2019-13103-3, 2019
EGU General Assembly 2019

Transpiration responses to soil drying in two differently aged tropical forests in upland eastern Madagascar

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Secondary forests in various stages of regeneration now constitute the dominant vegetation in many tropical landscapes, but our understanding of their ecohydrological functioning remains limited. For example, it has been suggested that water use of vigorously growing young tropical forests may be higher than that of old-growth forests, with potentially adverse consequences for catchment water yields. Likewise, deep soil water uptake has been proposed as a mechanism to explain the absence of seasonal water stress in old-growth tropical forests, but little (if anything) is known in this regard for secondary forests. As a result, we know little about their potential response to future climatic warming and drying. We, therefore, examined the transpiration (Et) response of dominant over- and understorey species to different levels of soil water availability in a young (5–7 years) and a semi-mature (∼20 years) forest in upland eastern Madagascar. Concurrent measurements were made of microclimate, sap flow and soil water content to characterise seasonal changes in the rate of Et. Soil and xylem water were sampled for their stable isotope (hydrogen and oxygen) composition to infer the dominant depth of water uptake. Annual fractions of net radiant energy input used for Et were low for both forests (0.15 and 0.26 for the young- and the semi-mature forest, respectively), possibly due to the low fertility of the soils, and mirrored the Leaf Area Index of the two forests (1.83 and 3.39 m2 m-2). Transpiration rates for both forests were relatively stable during the dry season and were only slightly affected by top-soil moisture content by the end of the dry season. The isotope data suggest a progressively greater depth of water uptake during the dry season for both stands, which was more pronounced for the semi-mature forest.