Modeling soil water availability for neotropical forest trees

Fabien Wagner[1], Bruno Herault [1], Damien Bonal[2] and Vivien Rossi[3]

[1] Université des Antilles et de la Guyane, UMR Ecologie des Forets de Guyane, Kourou, French Guiana
[2] INRA, UMR INRA-UHP 1137 Ecologie et Ecophysiologie Forestiere, Champenoux, France
[3] CIRAD, UMR Ecologie des Forets de Guyane, Kourou, French Guiana

The aim of this study was to model the soil water availability to neotropical trees. We developed a discrete-time deterministic water balance model and validated it on a large field data set. Because of some data inaccuracy, the validation step required us to develop a specific optimization procedure. The model computes daily water fluxes (tree transpiration, understorey evapotranspiration, rainfall interception, and drainage) and soil water content using 3 input variables: daily precipitation, potential evapotranspiration PET and solar radiation. Input data came from a flux tower (Guyaflux) located at the Paracou experimental site (5o 18' N, 52o 55 'W), a lowland tropical rain forest in French Guiana, provided on a half hourly basis a set of meteorological data among which precipitations, temperatures, solar radiations, wind and humidity and PET. The daily output is the relative water available for trees, i.e. the daily available water standardized by the potential available water. Since 2004, soil water moisture was measured monthly with a TDR probe in twenty 3-meters tubes on a representative topographic gradient of Paracou (hilltop, slope, lowland). As the probe was not calibrated with field measurements, we propose an original method to optimize model parameters. This method is based on the variance minimization of the ratio soil water predicted on the soil water probe measurements. Our soil water balance model succeeds in capturing the dynamics of available water for the trees for most of the topographic positions. A sensitivity analysis was performed to determine which parameters were the most influent on the model output. Our results provide a simple method to better use meteorological data in tropical forests and to understand the tropical forest responses to global change.