From leaf to ecosystem level: controls of transpiration in seasonal tropical forests across a rainfall gradient

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Introduction

The role of environmental drivers in regulating gas exchange in tropical forests are still poorly understood. This inhibits the development of Earth System models that project responses to future climate scenarios. In order to better understand the responses of plants to climatic variation we need high quality environmental measurements in conjunction with plant physiological measurements on a broad range of temporal and spatial scales, which span leaf to ecosystem levels and climate gradients.

Central American moist tropical forests are characterized by a distinct dry season and a rainfall gradient, where the Pacific is drier than the Atlantic side. This normal seasonal cycle is often altered during ENSO events, which generally produce large interannual variability and warm/dry conditions over this part of the tropics.

We take advantage of this climatic gradient and a strong ENSO event to assess how plant transpiration responds to environmental drivers.

Experiment description

The three experimental sites, Parque Natural Metropilitano (PNM), Barro Colorado Island (BCI) and San Lorenzo National Park (SLZ), were located in central Panama across a rainfall gradient. Principal meteorological variables (solar radiation, air temperature, relative humidity) and soil moisture were monitored by automated stations. In addition, at BCI, a microclimatic station equipped with an eddy covariance system measured energy and CO_2/H_2O fluxes starting from 2012. Plant level measurements, starting from November 2015, included automated sapflow and canopy temperature. Periodically, through access with canopy cranes, leaf water potential and leaf gas exchange were measured.

Preliminary results

The climate in this region is characterized by a distinct dry season from mid-December to April, when soil moisture dropped quickly. At the same time, atmospheric demand of water increased, because of higher solar radiation from reduced cloud cover, lower relative humidity and sustained winds. In the wet season, direct radiation declined sensibly, but the diffuse component remained approximatively constant.

Ecosystem scale evapotranspiration, measured by the eddy covariance system, showed that water losses were approximatively constant across the year, despite increased atmospheric demand in the dry season. This may indicate stomatal control is active during the dry season to avoid excess water losses. Similar results were shown by sapflow measurements. However, sapflow exhibited high interspecific variability, with some species responding differently to environmental stimuli.

Across the rainfall gradient, large differences were observed in canopy temperature, where the dry site (PNM) showed higher temperature in the day and larger diurnal fluctuation.