Title: What Regulates the Seasonality of Photosynthetic Metabolism in Tropical Forests?

Program: TES

P.I.: Dennis G. Dye, USGS

Authors:

Dennis G. Dye[1] (ddye@usgs.gov), Scott R. Saleska[2] (saleska@email.arizona.edu), Valeriy Ivanov[3] (ivanov@umich.edu), Alfredo Huete[4] (Alfredo.Huete@uts.edu.au), Jin Wu[2] (geo.woo.jin@gmail.com), Loren Albert[2] (lalbert@email.arizona.edu), Rodrigo da Silva[5] (rodrigo.silva@ufopa.edu.br), Bruce Nelson[6] (bnelsonbr@gmail.com), Luiz Aragao[7] (leocaragao@gmail.com), Marciel J. Ferreira[8] (marciel@inpa.gov.br)

[1]U.S. Geological Survey, Western Geographic Science Center
[2]University of Arizona, Dept. of Ecology and Evolutionary Biology
[3]University of Michigan, Dept. of Civil and Environmental Engineering
[4]University of Technology, Sydney, Australia
[5]Federal University of West-Para (UFOPa), Santarem, Brazil
[6]National Institute of Amazonian Research (INPA), Brazil
[7]National Institute for Space Research (INPE), Brazil
[8]Federal University of Amazonas (UFAM), Brazil

Abstract:

This U.S-Brazil collaboration investigates a basic yet unanswered question in Earth system and global carbon cycle science: what controls the response of photosynthesis in Amazon tropical forests to seasonal variations in climate? This question, despite its apparent simplicity, is the subject of an ongoing scientific puzzle that has so far been remarkably difficult to solve with confidence. For example, seasonal patterns of photosynthesis simulated by several state-of-the-art, computer-based models of the Earth system disagree with seasonal patterns seen in vegetation "greenness" recorded by Earth-observing satellites, and with measurements of ecosystem-atmosphere carbon dioxide exchange at monitoring sites in the central Amazon. The project is designed to resolve these disagreements by developing new knowledge and deeper understanding of seasonal climate-photosynthesis relations in tropical forests of the Brazilian Amazon, across a gradient of dry season length between Manaus (with a short dry season) and Santarem (with a long dry season). We use intensive field campaigns to measure physiological and ecohydrologic properties of leaves and trees, innovative remote sensing instruments to monitor forest optical properties and the effects of clouds and smoke on solar radiation, and photosynthesis modeling that accounts for 3-dimensional variation in the forest structure and light environment to guide improvements in the treatment of tropical forest photosynthesis in Earth system models, and help establish a foundation for the planned Next Generation Ecosystem Experiments (NGEE) in the Tropics. Our initial findings suggest that biological factors, specifically the canopy-scale composite of leaf ontogeny (age-dependent physiology) and demography (the distribution of age across different cohorts of leaves) can successfully reconcile disparate patterns of central Amazon forest seasonality observed from eddy flux towers and satellites. Our related, preliminary findings provide additional insights on what regulates the seasonality of photosynthetic metabolism in tropical forests by illustrating tree-to-patch-scale relationships between growth, water flow, and the hydraulic state of the canopy.