Rainforest greener during 'dry' season

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Although the Amazon Jungle may appear to be perpetually green, a University of Illinois researcher believes there are actually seasonal differences of photosynthesis, with more occurring during the dry season and less during the wet season. Understanding how a rainforest that occupies 2.7 million square miles of South America functions is crucial to the future health of the entire planet.

"With the potential negative effects of climate change, one key question we are trying to answer in the study of tropical ecology is how a tropical forest responds during a long-term drought," says Kaiyu Guan, an environmental scientist at the University of Illinois. "If we don't know their daily performance or their seasonal performance, what confidence can we have to predict the forests' future 20 years, 30 years, or longer?"

Analyzing data from several sources, including individual leaves, camera data from towers above the leaf canopy, and decadal long satellite images, Guan and his colleagues measured the photosynthesis rate over the landscape. Photosynthesis—the process green plants use to convert energy from the sun that plants use to grow—from tropical forests, plays a huge role in determining global atmospheric CO_2 concentration, which is closely linked the global temperature and rate of climate change.

"Bringing all of the data together, we find that the dry season in the Amazon has increased photosynthesis," says Guan. "There may be less photosynthesis in the wet season because of the cloud cover which limits the amount of light the plants can use."

Guan explains that understanding the seasonality of photosynthesis can help scientists assess whether or not the Amazon is under stress and how it handles and recovers from stress.

"During the dry season, you would think that the plants would be water stressed and photosynthesis would decrease, but looking at multiple sources of data over the years we find that the plants are not stressed because there is ground water carried over from the previous year," he says.

It does not appear to be just the quantity of leaves driving the higher photosynthesis during the dry season. Guan and his collaborators believe it is actually leaf quality which changes over leaf age that is at work.

"Leaf amount can only explain about 5 percent of all the photosynthesis variations, so what's really going on? It's the leaf quality. Putting it in a different way, when you are a baby, you aren't very productive. When you become more mature, you're more productive. Then, when you're older, your productivity goes down again. It's true for humans and it's also true for plants. Leaves in tropical forests that are 3 or 4 months old are more productive. As you get to the end of the dry season, the leaves are aging and their productivity decreases again. So the combination of the leaf amount and the leaf quality together can satisfactorily explain the pattern," Guan says.

Guan cautions that if the forest experiences several droughts, the carryover of water is depleted—the tropical forest responds to the climate.

"The rainforest also absorbs the majority of carbon," Guan says. "It's the engine that drives the carbon cycle for the whole world, which makes it important when we discuss climate changes. Global warming is dependent upon the atmospheric CO2 concentration, so we need to care about carbon.

"Most of the climate models are showing a drying down trend in tropical forests, with a longer dry season. That's a cause for concern for the future of the Amazon," Guan says. "If we neglect it, it can have consequences around the globe. We need to recognize the importance of this rainforest pattern in which our entire global ecosystem functions. The healthiness of these systems is highly relevant for human beings."

In addition to being an assistant professor in ecohydrology and geoinformatics in the Department of Natural Resources and Environmental Sciences in the College of Agricultural, Consumer and Environmental Sciences at U of I, Guan has a joint appointment as a Blue Waters professor affiliated with the National Center for Supercomputing Applications (NCSA).

Using the same satellite technology, Guan is currently looking at agricultural systems in tropical and temperate regions like the U.S. Corn Belt. "We'd like to build a satellite-based system to monitor the entire United States food productivity in order to predict the crop yield."

The above report is based on four recent articles that appear in *Science*, *Nature*, *Nature Geoscience*, and *Global Change Biology* with Guan as lead author or co-author along with researchers from institutions in the United States from Arizona, Massachusetts, Michigan, New Mexico, and California, as well as from Brazil, Australia, and Japan.

Provided by University of Illinois at Urbana-Champaign

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