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UNH Study: Forests May Play Overlooked Role In Regulating Climate

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DURHAM, N.H. -- In a study to be published this week in the Proceedings of the National Academy of Sciences, scientists led by a team at the University of New Hampshire show that forests may influence the Earth's climate in important ways that have not previously been recognized. Their work makes several important discoveries. They found that forests with high levels of foliar nitrogen have a two-fold effect on climate by simultaneously reflecting more solar radiation and by absorbing more CO2 than their low-nitrogen counterparts. They also discovered that variation in forest canopy nitrogen can accurately be detected using satellites, making it possible to continuously track these global-scale effects of forests on the Earth's climate system.

When sunlight reaches the Earth's surface it can either be absorbed and converted to heat or reflected back to outer space, where it doesn't influence the Earth's temperature. Scott Ollinger, associate professor in the UNH Institute for the Study of Earth, Oceans, and Space and the Department of Natural Resources and the Environment, and colleagues discovered that, of the total amount of sunlight that falls on forests, the fraction that gets reflected back to space is directly related to levels of nitrogen in their foliage. This new discovery suggests that nitrogen plays an important role in the Earth's climate system that has never before been considered.

While scientists have long known that individual leaves that are rich in nitrogen are usually more efficient at pulling carbon dioxide out of the atmosphere, it was previously unclear whether this applied to entire ecosystems. Ollinger and his team found that ecosystem carbon uptake—in essence the photosynthetic capacity of the entire forest—was proportional to the whole-canopy nitrogen concentration, and that both variables were strongly related to the overall reflectivity of forest canopies.

Ollinger and UNH colleagues Andrew Richardson, Mary Martin, Dave Hollinger, Steve Frolking, and others, stumbled upon the discovery while poring over six years' worth of data they have collected from research sites across North America. The study involved a novel combination of NASA satellite- and aircraft-based instruments, along with meteorological towers from the AmeriFlux network and leaf-level measurements to analyze various aspects of forest canopies. When Ollinger noticed that the overall reflectivity of forest canopies (also known as albedo) rose and fell in conjunction with leaf nitrogen, he had a eureka moment.

"Bits and pieces of evidence for this have been around for years but nobody put them together before because it's not a question we had even thought to ask," Ollinger says. "Scientists have long been aware of the importance of albedo, but no one had suspected that the albedo of forests might be influenced by nitrogen. And because most of the effect is in the infra-red region of the sun's spectrum, beyond that which human eyes can detect, the pattern isn't immediately obvious."
The newly discovered link between foliar nitrogen and canopy albedo adds an interesting new twist to the understanding of the climate system and raises intriguing questions about the underlying nature of ecosystem-climate interactions.

Changes in climate, rising CO2 levels, air pollution, land use and species composition all influence nitrogen levels in foliage and all of these may be part of a climate feedback mechanisms that climate models have not yet examined. Future research planned by the team will involve examining the underlying causes for why the relationship exists and working with climate modelers to determine how the nitrogen-albedo mechanism will influence predictions of climate change.

The University of New Hampshire, founded in 1866, is a New England liberal arts college and a major research university with a strong focus on undergraduate-oriented research. A land, sea and space-grant university, UNH is the state's flagship public institution, enrolling 11,800 undergraduate and 2,400 graduate students.

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