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Linkages among Canopy Nitrogen, Carbon Assimilation and Albedo in Forests: An Overlooked Role for Nitrogen in the Climate System?

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The availability of nitrogen represents a key constraint on carbon cycling in terrestrial ecosystems and it is in this capacity that the role of nitrogen in the Earth's climate system has been considered. Despite this, few studies have included continuous variation in plant N status as a driver of broad-scale carbon cycle analyses. This is partly due to uncertainties in how leaf-level physiological relationships scale to whole ecosystems and because methods for regional to continental detection of plant N concentrations have yet to be developed. In recent work, we have shown that that ecosystem CO2 uptake capacity in temperate and boreal forests scales directly with whole-canopy nitrogen concentrations, mirroring a leaf-level trend that has been observed for woody plants worldwide. We further show that both CO2 uptake capacity and canopy nitrogen concentration are strongly and positively correlated with shortwave surface albedo. These results suggest that nitrogen may play an additional, and previously overlooked, role in the climate system via its influence on vegetation reflectivity and shortwave surface energy exchange. As yet, the underlying mechanism for the nitrogen-albedo relationship remains unknown. Resolving this question is important because different mechanisms will respond differently to altered N availability. Here, we expand on this work by examining the relationship over a broader range of ecosystems and exploring potential underlying mechanisms.