LETTER

Canopy nitrogen and albedo from remote sensing: What exactly are we seeing?

Ollinger *et al.* (1) report that albedo depends on canopy nitrogen. A critic may dismiss this as correlation-does-not-equal-causation because the underlying mechanisms linking albedo with nitrogen are unclear. Albedo is controlled by processes other than nitrogen, for instance, canopy water content (2, 3). Moist dark soil has a lower albedo than dry bright soil (4), so a drier canopy should change the albedo without changing the canopy nitrogen. Similarly, within the spatial resolution of a MODIS pixel, a tree may fall, revealing bare soil and thus changing the albedo of the pixel (5). Would the canopy nitrogen change appropriately? Ollinger *et al*. (1) excluded patterns in photosynthetically active radiation wavelengths, thus making it difficult to separate albedo from the canopy versus other objects (essentially the basis of vegetation indices). The albedo of the surface would increase with snowfall (not predicted by canopy nitrogen), though this effect can easily be excluded.

Although Ollinger *et al.*'s study is imperfect, there is potential to uncover mechanisms linking canopy nitrogen with albedo. What should be learned is that their results are not conclusive but, rather, hypothesis-generating. They have provided insight into further studies in which we can control for variables that they have missed. We could look at the albedo over hundreds of nitrogen fertilization studies, where control and fertilized plots sit within the same structure of species, age, height, roughness, and climate, but vary in canopy nitrogen. Skeptics may expect that the albedo would not change in these experiments, but what if it does?

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Author contributions: J.B.F. wrote the paper.
The author declares no conflict of interest.

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www.pnas.org/cgi/doi/10.1073/pnas.0813124106