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Vegetation controls on the biophysical surface properties at global scale

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Leaf area index (LAI) plays an important role in determining resistances to heat, moisture and momentum exchanges between the land surface and atmosphere. Exploring how variations in LAI may induce changes in the surface energy balance is a key to understanding vegetation-climate interactions and for predicting biophysical climate impacts associated to changes in land cover. To this end, we analyzed remote sensing-observed dynamics in LAI, surface energy fluxes and climate drivers at global scale. We investigated the link between interannual variability of LAI and the components of the surface energy budget under diverse climate gradients. Results show that a 25% increase in annual LAI may induce up to 2% increase in available surface energy, as consequence of higher short wave absorption due to reduced albedos, up to 20% increase and 10% decrease in latent and sensible heat, respectively, leading to a decrease of the Bowen ratio in densely vegetated canopies. Opposite patterns are found for a reduction in LAI of similar magnitude. Such changes are strongly modulated by concurrent year-to-year variations and climatological means of air temperature, precipitation and snow cover as well as by land cover-specific physiological processes. Boreal and semi-arid regions appear to be mostly exposed to large changes in biophysical surface processes induced by interannual fluctuations in LAI. The combination of the emergent patters translates into variations in the long-wave outgoing radiation that reflect the surface warming/cooling associated to LAI changes. These findings provide a deeper understanding of the vegetation control on biophysical surface properties and define a set of observational-based diagnostics of LAI-dependent land surface-atmosphere interactions.