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Biophysical impacts of global greening

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Decadal trends in global greening recently detected from long-term Earth observations have been largely attributed to the effect of CO_2 fertilisation. Associated changes in the structure and physiology of vegetation may affect a series of biogeochemical and biophysical processes, whose net effects on climate are not well understood. Nowadays, the large uncertainties in model-based assessments of vegetation-driven biophysical climate feedbacks can be corroborated with extensive and long-term satellite retrievals of surface properties. Here, we analyse remote-sensing-observed dynamics in leaf area index (*LAI*), surface energy fluxes and climate drivers at the global scale for the period 1982–2016 to explore how variations in vegetation cover have influenced the terrestrial energy balance and local climate.

We show that the increasing trend in LAI contributed to the warming of boreal zones through a reduction of surface albedo and to an evaporation-driven cooling in arid regions.

On average, we estimate a global biophysical cooling of –0.007 $\pm$ (3 $\times$ 10-4) K decade^{-1} related to long-term changes in LAI, which outweighs the recent estimates of climate warming driven by deforestation. The interplay between LAI and surface biophysics is amplified up to five times under extreme warm-dry and cold-wet years. Land surface models underestimate these vegetation feedbacks mainly because they misrepresent the sensitivity of biophysical processes to LAI changes. Altogether, these signals reveal that the recent dynamics in global vegetation have had relevant biophysical impacts on the local climates and should be considered in the design of local mitigation and adaptation plans.