Geophysical Research Abstracts
Vol. 21, EGU2019-18989, 2019
EGU General Assembly 2019

Increasing global control of plant leaves on terrestrial energy fluxes

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Although the relevance of ongoing global greening for climate change has been recognized, its impact on the surface energy partitioning is yet to be quantified. Changes in vegetation structure and density are expected to influence the redistribution of heat and moisture across the climate system ultimately affecting water and energy cycles. Here, we analyse satellite leaf area index (LAI) and surface energy fluxes at the global scale for the period 1982¬–2016, and explore how variations in LAI have affected the energy partitioning. We show that latent fluxes (LE) increase and sensible fluxes (H) decrease with an increase in LAI, with sensitivities of 4.46±0.04 and -4.10±0.05 Wm-2 per unit change of LAI, respectively. These sensitivities show a remarkable increase of about 50% after 2000, possibly due to a more active stomatal control and an increased transpiration/evaporation ratio, triggered by decreasing soil moisture and/or increasing atmospheric evaporative demand. The long-term positive trend in LAI led to a decline in Bowen ratio (B=H/LE) prominently in arid zones (-0.031±0.002 decade-1) attributable to the increased evaporative surface and the consequent enhancement of transpiration. Overall, annual surface energy partitioning appears more strongly influenced by LAI (itself driven by climate and biotic factors) than directly by climate drivers. Land surface models in general tend to overestimate the vegetation control over tree biomes compared to observation-based records, due to the poor representation of LAI variability. Improving the model representation of vegetation dynamics and related biophysical processes is therefore crucial in view of the projected increases in LAI and aridity.