Geophysical Research Abstracts
Vol. 19, EGU2017-13443, 2017
EGU General Assembly 2017
© Author(s) 2017. CC Attribution 3.0 License.

Trends in ecosystem water use efficiency are potentially amplified by plasticity in plant functional traits

Theodoros Mastrotheodoros (1), Christoforos Pappas (2), Peter Molnar (1), Paolo Burlando (1), Trevor F. Keenan (3), Pierre Gentine (4), and Simone Fatichi (1)

(1) ETH Zürich, Institute of Environmental Engineering, Zürich, Switzerland, (2) Département de Géographie, Université de Montréal, Pavillon 520, chemin de la Côte-Sainte-Catherine, Montréal, Québec H2V 2B8, Canada, (3) Earth and Environmental Sciences, Lawrence Berkeley National Lab, 1 Cyclotron Road, MS74R316C, Berkeley, CA 94720, USA, (4) Earth Institute, Department of Earth and Environmental Engineering, Columbia University, 918

Increasing atmospheric carbon dioxide concentrations stimulate photosynthesis and reduce stomatal conductance, modifying plant water use efficiency. We analyzed eddy covariance flux tower observations from 20 forested ecosystems across the Northern Hemisphere. For these sites, a previous study showed an increase in inherent water use efficiency (IWUE) five times greater than expectations. We used an updated dataset and robust uncertainty quantification to analyze these contemporary trends in IWUE. We found that IWUE increased in the last 15-20 years by roughly 1.4% yr^{-1}, which is less than previously reported, but still 2.8 times greater than theoretical expectations. Numerical simulations by means of an ecosystem model based on temporally static plant functional traits (i.e. model parameters) do not reproduce this increase. We tested the hypothesis that the observed increase in IWUE could be attributed to changes in plant functional traits, potentially triggered by environmental changes. Simulation results accounting for trait plasticity (i.e. by changing model parameters such as specific leaf area and maximum Rubisco capacity) match the observed trends in IWUE, with an increase in both leaf internal CO_2 concentration and gross ecosystem production (GEP), and with a negligible trend in evapotranspiration (ET). This supports the hypothesis that changes in plant functional traits of about 1.0% yr^{-1} can explain the observed IWUE trends and are consistent with observed trends of GEP and ET at larger scales. Our results highlight that at decadal or longer time scales trait plasticity can considerably influence the water, carbon and energy fluxes with implications for both the monitoring of temporal changes in plant traits and their representation in Earth system models.