EGU26-16975, updated on 10 Nov 2026
https://doi.org/10.5194/egusphere-egu26-16975
EGU General Assembly 2026
© Author(s) 2026. This work is distributed under
the Creative Commons Attribution 4.0 License.

Attributing Global Carbon and Water Cycle Trends Using Factorial Ecosystem Simulations

Ananda Kurth, Francesco Grossi, Fabian Bernhard, and Benjamin David Stocker
University of Bern, Geography, Oeschger Centre for Climate Sciences, Bern, Switzerland (ananda.kurth@unibe.ch)

Satellite observations show widespread vegetation greening over the last few decades, which is partially due to intensified agricultural activity, longer growing seasons, and the CO fertilization effect (Zhu et al., 2016). At the same time, changes in drought and heat stress show a strong spatial heterogeneity, which complicates the attribution of observed trends in the carbon and water cycles (Greve et al., 2014). To better understand these apparently contrasting signals, we calculate trends in variables affected by water-stress dynamics and assess how trends in greenness, climate, and CO influence these patterns.
To analyze these coupled processes and disentangle the effects of individual forcing variables on simulated ecosystem responses, we perform global simulations using a version of the P-model that is coupled with a Penman-Monteith evapotranspiration scheme, thereby explicitly representing coupled carbon-water processes at the land surface (Stocker et al., 2020). The model is driven by a satellite-derived, natural-vegetation-only fAPAR dataset. Within these simulations (1982 - 2024 at 0.5° spatial resolution), transpiration is separated from soil evaporation; a fixed leaf area index is used, and carbon pool dynamics are omitted. A factorial design is utilized, in which one factor (greenness, climate, or CO) is held constant at a time to identify the primary drivers of change. These simulations address our research question of which drivers, including CO, Vapor Pressure Deficit (VPD), precipitation, and Fraction of Absorbed Photosynthetically Active Radiation (fAPAR), contribute to changes in variables that are likely to respond differently to drought trends, such as gross primary productivity (GPP), evapotranspiration (ET), soil moisture, runoff, and water-use efficiency of photosynthesis.
This study provides a consistent quantification of trends across multiple interrelated variables associated with global water and carbon cycling and clarifies the mechanistic basis for apparently contrasting trends reported for individual variables.

Sources

Zhu, Z. et al. (2016) “Greening of the Earth and its drivers,” Nature Climate Change, 6(8), pp. 791–795. doi: 10.1038/nclimate3004.
Greve, P. et al. (2014) “Global assessment of trends in wetting and drying over land,” Nature Geoscience, 7(10), pp. 716–721. doi: 10.1038/ngeo2247.
Stocker, B. D. et al. (2020) “P-model v1.0: an optimality-based light use efficiency model for simulating ecosystem gross primary production,” Geoscientific Model Development, 13(3), pp. 1545–1581. doi: 10.5194/gmd-13-1545-2020.