Different controls of CO_2 fertilization and stomatal conductance reduction on historical increase in global land ecosystem water-use efficiency

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Abstract: It is well known that global ecosystem water-use efficiency (EWUE) has noticeably increased over the last several decades. However, it remains unclear how individual environmental drivers contribute to EWUE changes, particularly from CO_2 fertilization and stomatal suppression effects. Using a satellite-driven water-carbon coupling model—Penman-Monteith-Leuning version 2 (PML-V2), we quantified individual contributions from the observational drivers (atmospheric CO_2, climate forcing, leaf area index (LAI), albedo and emissivity) across the globe over 1982–2014 (Zhang et al. 2022). The PML-V2 was well calibrated and showed a good performance for simulating EWUE (with a determination coefficient (R^2) of 0.56) compared to observational annual EWUE over 1982–2014 derived from global 95 eddy flux sites from the FLUXNET2015 dataset. Our results showed that global EWUE increasing trend (0.04±0.004 gC mm^{-1} H2O $decade^{-1}$) was largely contributed by increasing CO_2 (51%) and LAI (20%), but counteracted by climate forcing (-26%). Globally, the CO_2 fertilization effect on photosynthesis (23%) was similar to the CO_2 suppression effect on stomatal conductance (28%). Spatially, the fertilization effect dominated EWUE trend over semi-arid regions while the stomatal suppression effect controlled over tropical forests. These findings improve understanding of how environmental factors affect the long-term change of ecosystem water-use efficiency and can help policymakers for water use planning and ecosystem management.

REFERENCES

Zhang, X., Zhang, Y., Tian, J., Ma, N., Wang, Y.-P. 2022. CO_2 fertilization is spatially distinct from stomatal conductance reduction in controlling ecosystem water-use efficiency increase. Environmental Research Letters, 17(5). doi:10.1088/1748-9326/ac6c9c.

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