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A first-principles approach to modelling the recent increase in global terrestrial primary production

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The total carbon uptake by terrestrial plants, Gross Primary Production (GPP), is one of the largest fluxes in the global carbon cycle. Understanding how and to what extent GPP is affected by global environmental changes is crucial for quantifying carbon cycle-climate feedbacks and establishing the policy-relevant link between emissions and concentrations of atmospheric CO_2.
Using a newly-developed universal, first-principles light use efficiency model (the "P" model) in combination with an empirical treatment of the effect of low soil moisture on GPP, we are able to reproduce the trends of GPP during the satellite era in comparison with in situ GPP data from eddy covariance. Globally this method estimates that GPP increased by 0.5 ± 0.03 Pg C yr-1, which is similar to an independent analysis based on carbonyl sulphide (COS). Increasing CO_2 is the principal driver of this modelled trend, while negative effects of climate change (including soil moisture depletion) proved to be important in arid and semi-arid regions.
Increasing GPP has partially offset the effect of CO_2 emissions on climate, and therefore provide some degree of buffering against global warming. Nonetheless, still-increasing CO_2 emissions and concentrations have led to renewed calls for stronger emissions curbs. Meanwhile, reliable GPP monitoring and prediction are important for assessment of the impacts of environmental change on terrestrial carbon uptake. The simple, first-principles modelling approach embedded in the P model provides a complement to simulations with more complex models.