



Constrained projections of high northern latitudinal photosynthesis increase by satellite observations of vegetation greenness

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Satellite observations of the last three decades provide strong evidence that the Earth is greening. Especially in northern high latitudes, a substantial increase of the leaf area index (LAI), an indicator of greening, is observed. For these regions, it is assumed that plant growth benefits from higher temperature (radiative effect) and rising atmospheric CO₂ concentration (CO₂ fertilization effect). This greening trend, in terms of increasing LAI, is also simulated by various global ecosystem models. We also found a persistent greening trend analyzing historical simulations of Earth system models (ESM) participating in Phase 5 of the Coupled Model Intercomparison Project (CMIP5). However, a wide spread in magnitude of an associated increase of terrestrial gross primary production (GPP) among the ESMs is found, and thus contributes to pronounced uncertainties in projections of future climate change.

Here we demonstrate that the tight correlation between enhanced GPP of high northern latitudinal ecosystems and their LAI sensitivity to both key environmental factors, temperature and CO₂ concentration, opens up the possibility of an *Emergent Constraint* on plant photosynthesis. Combining this almost linear relationship across the ensemble of CMIP5 models with the LAI trends in the long-term satellite records, we are able to constrain projections of vegetation growth increase for respective ecosystems.