



CO₂ and greening observations indicate increasing light use efficiency in northern terrestrial ecosystems

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Observations show an increasing amplitude in the seasonal cycle of CO₂ (SCA) north of 45° N of 56±9.8% over the last 50 years and an increase in vegetation greenness of 7.5-15% in high northern latitudes since the 1980's. However the causes of these changes remain uncertain. Historical simulations from terrestrial biosphere models in the Multi-scale Synthesis and Terrestrial Model Inter-comparison Project (MsTMIP) are compared to these observations, using the TM3 atmospheric transport model to translate surface fluxes into CO₂ concentrations. We find that models underestimate the absolute change in SCA by 47-105% but capture the mean greening trend. Modelled increases in greenness are driven by warming, whereas SCA changes are driven by increasing CO₂. We suggest that a key factor contributing to observed SCA increase is increased vegetation light use efficiency (LUE), and that LUE is likely to have increased more strongly than simulated in current models over 1960-2010. We highlight several mechanisms, not adequately simulated by current models, that could be responsible for this LUE increase.