RED DGVM: simple approach to modelling vegetation with novel implications.

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The modelled global vegetation for the end of the 21st century is currently is insufficiently constrained by climate models. A significant proportion of that uncertainty has been attributed to the limitations of current Dynamic Global Vegetation Models (DGVMs), and the misrepresentation of mortality, disturbance and regrowth within forests. Improving the simulation of the underlying processes of demographic change is of primary importance in the development of predictors of future climate.

Here we present the Robust Ecosystem Demography (RED), a new dynamical vegetation model which simulates the size-structure of forests by partitioning the population of a Plant Functional Type (PFT) into mass classes. Allometric scaling of mortality and growth across mass classes allows for a variety of complex demographic processes to be captured, such as disturbances and regrowth. Competition among PFTs is done purely through restricting the recruitment of new vegetation to unshaded space.

RED represents a reduction of complexity from more numerically unwieldy cohort DGVMs which simulate both size and patch dimensions. The limited number of dimensions and simple competitive regime allows the equilibrium state to be solved for analytically, providing two potential functions - (i) Avoiding-spinning up by providing an equilibrium state for intilisation. (ii) Insights into the demography of vegetated areas, arising from parameter tuning to fit observation, such as coverage or carbon mass. When paired with a rate of mortality or carbon assimilate rate gives, respectfully, required assimilate or mortality rates.

We demonstrate the model functionality using offline UKESM PFT carbon assimilate rates, paired
with observed vegetation cover from the ESA LC_CCI datasets for the 9 different PFTs. From this dataset we calibrate a novel global equilibrium mortality map for each PFT and show the competitive and successional behaviour of dynamical runs with convergence to the fitted equilibrium. Finally, we explore underlying ecological questions that emerge from the equilibrium solutions.