

Review comment 1:

- *Use of heavily calibrated model:*

The study makes use of the coupled JULES-RED model to simulate carbon dynamics of afforestations along a wide environmental gradient in the UK, based on 300 site-specific simulations. The simulated vegetation dynamics in the model depends heavily on the parametrisation of Sitka spruce, which was based on a generic Plant Functional Type, whose parameters were heavily calibrated to only one Sitka spruce forest. This raises the question of over-calibration because (1) tree growth at this site is highly unlikely to be representative for all other 299 sites where simulation studies are conducted, and (2) one site is not representative for the environmental gradient covered by the study. Furthermore, no model validation against independent data was performed, thus not providing any assessment of model accuracy beyond the calibration site. This is scientifically highly questionable and raises doubts about the reliability of the study results overall.

We thank the reviewer for raising this important point around the reliability/validation of the results. The JULES-RED model represents plant growth based on well understood and constrained biogeophysical relationships that are dependent on the local environment such as, temperature, surface energy balance, water balance, and soil type (Best, et al., 2011, Clark et al., 2011). As such, these physically “processed based” models should capture environmental gradients of tree growth across the UK.

The reviewer’s other concerns about the validity of the results given limited validation datasets are common to many process-based vegetation modelling studies. Many previous studies have validated JULES equations and plant functional parameters across many observations and locations (e.g., Blyth, et al., 2011, Williams, et al., 2015, Harper, et al., 2016, 2018, 2023). UK specific studies and evaluations using JULES have previously been published (Szczykulska, et al., 2024). We have included some additional statements in the discussion section to further acknowledge that this study is subject to these limitations.

- *Lack of evidence for model suitability for studying stand-scale dynamics:*

JULES was developed to simulate carbon and other fluxes between the land surface and the atmosphere. Such models are usually applied at regional, country, or global scale. However, in this study the model is used at the stand scale, but the authors provide little evidence that the coupled JULES-RED model is suitable to represent forest dynamics at this spatial scale. Examples for this are the excessively simple mortality formulation (which is not sensitive to climate, as it appears) and the simple formulation of competition for light. As a matter of fact, the statements in the manuscript that refer to the model and its suitability are based on a limited number of studies, predominantly from the same author group (e.g. Argles et al., Clark et al.). Furthermore, the introduction focuses only on the model JULES but misses any broader review of forest modelling literature which would be important to put the model into context. It is everything but clear that JULES-RED is the most appropriate approach for studying stand-scale forest dynamics across 300 sites in the UK.

We thank the reviewer for raising points concerning model suitability and literature cited. On the suitability of the model for stand level studies, while such Land Surface Models (LSMs) (the set of which JULES-RED belongs) are in general applied at large scales, we would refer to the large number of papers that have evaluated such models at sites. An independent literature review of JULES-RED type models is offered by Fisher and Koven, 2020. Increasingly, the vegetation dynamics of these models are dictated by more realistic demographic model that are evaluated at sites. For instance, a recent study, Eckes-Shephard, et al., (2025) evaluated nine different demographic LSM across boreal, temperate, and tropical sites and chronosequences. Furthermore, this is a comparison against eight independently developed demographic LSMs, with varying degrees of process representation, for the JULES-RED model.

We agree with the reviewer that the implementation of mortality in JULES-RED is simplistic. However, there are new developments ongoing to introduce both drought, wildfire and windthrow mortality. We do simulate the impact of drought on plant productivity due to water availability. JULES uses a canopy layered scheme to estimate light interception and the resultant productivity and respiration based on the locations LAI. This productivity is truncated based on the overall canopy coverage, when a stand approaches full canopy coverage with the Crown Area Index greater than one, assimilate is limited. The self-thinning relationship is an emergent property of the model driven by a restriction of seedlings entering the population and the mortality and growth of the original cohort (Eckes-Shephard et al., 2024).

Clark et al. (2011) is the standard reference for the JULES model and Argles et al. (2022, 2023) describe the development and use of the JULES-RED model. It would be inaccurate and not useful to neglect to cite these sources. Perhaps we were not clear enough in the introduction of JULES-RED that it is a relatively new model in active development and as such this is one of the first few studies that use it. We will review the language in the manuscript to check that this point is made sufficiently clear.

We have also discussed the strengths and weaknesses of how JULES-RED compares with existing UK based forestry models such as C-FLOW (Milne, et al., 1998), ESC (Clare and Ray 2001), CARBINE (Forest Research), and hybrid-models (empirical and processed based) such as 3PG (Minunno, et al., 2010). ESC has been used in conjunction with vulnerability to disturbance models to study windthrow in Wales (Ray, et al., 2015) and drought (Davies et al., 2020). JULES-RED is entirely a processed based forest model, JULES estimates productivity on a sub-daily timestep, vegetation dynamics on a daily timestep to our knowledge this is the first study that has evaluated the sensitivity of tree growth within the LSM framework.

- *Standards of scientific writing are not met:*

The text is often not logical and quite difficult to follow. The Introduction is lacking clear research questions or hypotheses, but it already contains descriptions of the methods. The Method section is incomplete and lacks transparency (for more details, cf. annotated PDF).

The Result section describes the results only poorly and contains many additional explanations of the methods. The Discussion section is largely a re-cap of things from the Results section together with the presentation of new results, whereas this section actually lacks a proper discussion (i.e. putting the results achieved in this paper in the context of the broader literature). Lastly, the Conclusions section is far too long, unfocused, and contains surprising statements that are not warranted by the substance of the paper.

We thank this reviewer for this useful and frank critique. We will revise the manuscript for language, grammar, and clarity.

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