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Do we acknowledge enough the effect of climate change scenario uncertainty on primary production of boreal forests?

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Time window for the success in the restricting global warming under 2°C is closing rapidly. We need urgent and effective measures for reducing greenhouse gas (GHG) emissions and strengthening ecosystem carbon sinks. Most of the mitigation scenarios show the temperature overshooting or rely on significant amount of 'negative emissions' during latter part of the 21st century. Currently, increasing forest and land carbon stocks are considered as the most cost-efficient and feasible carbon dioxide removal measures to generate the negative emissions required. However, uncertainties of the development of forest productivity in a changing environment are still large even in countries of long forest management history like Finland.

Forest productivity is primarily driven by Gross Primary Production (GPP) which is the source for all carbon fluxes in forest ecosystems. In this study, we dissected the uncertainty of GPP projections of Finnish boreal forests between input, mechanistic and parametric uncertainty. Downscaled projections for the 21st century of global circulation models, GCMs, (both RCP and SRES) formed the input for the stand level flux model, PRELES. Mechanistic uncertainty was derived from the sensitivity analysis between atmospheric CO_2 concentrations (Ca), photosynthesis and water use of trees, while parametric uncertainty was assembled from the posteriori distribution of PRELES parameters.

Our results show the productivity of Finnish forest will increase during this century with high probability due to profound change even in the lowest climate projections. However, uncertainty around this mean response is very large and our decomposition of its sources demonstrates that more constraining information is needed equally on the biological mechanisms and on the expected environmental drivers. The GCM variability was the major source of uncertainty until 2060 after which emission scenario/pathway became the dominant factor. This underlines the need of transparency in modelling studies about how input uncertainty from emission scenarios and different GCMs and their assumptions propagates to ecological impacts. Large uncertainties with a wide range of projections can make it more difficult to draw ecologically meaningful conclusions especially on the local to regional scales, yet a thorough assessment of uncertainties is important to draw robust conclusions.