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# Applying LPJ-GUESS on the Arctic: A model evaluation and benchmarking study

**Warming in the Arctic occurs at a much higher rate than the global average, which has a considerable impact on the Arctic terrestrial carbon cycle. Permafrost thawing can release substantial amounts of carbon, whilst tundra shrubification and tree-line advance, on the other hand, may compensate for this. To gain a better understanding of the Arctic carbon cycle in the future, global dynamic vegetation models (DGVMs) can be used to simulate vegetation properties and dynamics.**

The aim of this study was to evaluate the performance of LPJ-GUESS, a DGVM, when it is applied on the Arctic to gain a better understanding how well the model is able to capture certain key Arctic-related processes and variables. The study focussed primarily on gross primary productivity (GPP), ecosystem respiration ($R_{eco}$), active layer thickness (ALT) and snow depth. A total of 20 (sub-)Arctic FLUXNET sites were included. The model was forced with a bias-corrected climate forcing based on meteorological observations for each site. Different simulations were evaluated, including an upland, wetland and wet forest run.

This study has shown that LPJ-GUESS tends to underestimate GPP and $R_{eco}$, especially for high Arctic sites (>70ºN). ALT at the end of the season (August/September) is largely overestimated for the upland simulation, whereas it is underestimated for wetlands. Running the model as a wet forest (i.e. wetland with tree PFTs) resulted in a very good fit for ALT. However, it also led to a large decrease in the modelled GPP and $R_{eco}$. Snow depth was poorly captured by the model, with large underestimations at most sites.

In light of these insights, it is evident that refining the LPJ-GUESS model remains essential for comprehending the intricate dynamics of the Arctic carbon cycle. Furthermore, this study accentuates the capacity and promise associated with the utilization of DGVMs in emulating vegetation attributes and behaviours.

Keywords: Physical Geography and Ecosystem Analysis; LPJ-GUESS; Arctic; FLUXNET; Gross Primary Productivity; Ecosystem Respiration; Permafrost; Active Layer Thickness; Snow Depth

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