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Improving vegetation heterogeneity by incorporating sub-pixel site conditions in a Dynamic Global Vegetation Model

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Dynamic Global Vegetation Models (DGVMs) are a prominent tool in addressing questions of future dynamics and feedbacks within the earth system and global carbon and nitrogen cycles. Their capability to simulate vegetation disturbances and state transitions expected to occur under project climatic conditions also make them valuable tools to address questions of ecosystem services provided to society. Most of these global models (like the presented improved version of LPJ-GUESS) commonly operate on coarse gridded data (resolution 0.5 degrees) and thus cannot capture small-scale variability and diversity of site conditions and the resulting states of vegetation or soil. Regional applications with higher spatial resolutions are possible, but also require more detailed model drivers and much higher computational costs.

Here we present an approach of incorporating sub-pixel site conditions to enhance the local diversity captured in the model without increasing computational costs. As LPJ-GUESS already uses patch replication in order to account for gap dynamics and vegetation heterogeneity (commonly n=100), we allocated high-resolution climatic and pedological sub-pixel site conditions that are correlated with topography to these patches. We can thus account for actual topographic variability without increasing the simulation resolution and computational cost.

Observed changes in the model outcome are most prominent in areas of steep topographic gradients, allowing for a broader variety of occurring vegetation types (wider climatic envelope within a grid cell). However, an increase in variability of vegetation state and composition can also be observed in other regions. One implication of this model modification is, that the model now presents larger vegetation diversity in complex terrain areas and thus more realistic estimates of possible local biodiversity.