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Testing a dynamic global vegetation model for pre-industrial and Last Glacial Maximum boundary conditions

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Achieving better comparison between dynamic global vegetation models (DGVM) with pollen or plant data is important for the climate-vegetation modeling community. Our study tried to find a scheme that can be applied consistently to compare DGVMs with pollen data sets. We tested two models, the Top-down Representation of Interactive Foliage and Flora Including Dynamics (TRIFFID) and the Community Land Model's Dynamic Global Vegetation Model (CLM-DGVM), which we both ran for pre-industrial boundary conditions. In addition, we ran the TRIFFID model using boundary conditions for the Last Glacial Maximum (LGM, ∼19,000- 23,000 years before present). For comparisons, we used the modern vegetation of the BIOME4 model and the reconstruction for the year 18000 after pollen data from the BIOME6000 (Version 4.2) project. Differences in the number of PFTs in each DGVMs lead to different results of the biome distribution even if models and data qualitatively agree.

In the CLM-DGVM pre-industrial run, northern South America is covered by savanna or desert biome, which is associated with more growing degree days and lower rates of precipitation. Meanwhile, the TRIFFID model simulated a tropical forest in northern South America and a desert biome in Australia, probably because of higher values of growing degree days and different precipitation rates, which is lower in South America and higher in Australia. The climate parameters from both models show a similar pattern as in the BIOME4 model, but the values are higher in the DGVMs.

Biome distributions of the pre-industrial simulation show similarities and differences between dynamic vegetation modeling and data reconstructions. Both models reveal a fair agreement simulating savanna and desert biomes around the Sahel, tropical forest in western Africa, boreal forest in eastern North America and in Siberia, and tundra in northern Canada. Some discrepancies appear in South America and Africa, where pollen data indicate a combination of tropical forest, grassland, and savanna biomes whereas TRIFFID indicates a tropical forest biome and CLM-DGVM a savanna one. In Europe, both models failed to come up with temperate forest (i.e. combination of boreal forest and grassland biome) which is dominant in the pollen data set.

During the LGM, southern Europe is covered by grassland and shrubland biome according to the TRIFFID model and paleo-data. In southeast Africa the TRIFFID model simulates temperate and boreal forest, where the pollen reconstruction indicates savanna and grassland.

The results show that the CLM-DGVM model is insufficient in representing tree PFTs over South America and Europe, while at the same time the TRIFFID model exaggerates the amount of tree PFTs in South America and Africa. This suggests that the number of PFTs in DGVM influences the biome distribution, but is not necessarily correlated with the quality of the agreement between models and data. We hope that our results will contribute to the improvement of DGVMs by further incorporation of biological, physiological, and geophysical processes in these models.