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The deglacial forest conundrum

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The forest expansion in the Northern Hemispheric extra-tropics during the deglaciation, i.e. the last some 22,000 years, starts earlier and occurs much faster in our model simulation using the MPI-ESM 1.2 than in the recently published synthesis of biome reconstructions by Cao et al. (2019). As a result, the simulated Northern Hemisphere maximum in forest cover is reached at 11ka in the model, whereas the forest distribution peaks substantially later (at 7ka in the spatial mean) in the reconstructions. The model-data mismatch is largest in Asia, particularly in Siberia and the East Asian monsoon margin. The simulated temperature trend is in line with pollen-independent temperature reconstructions for Asia. Since the simulated vegetation adapt to the simulated climate within decades, the temporal model-data mismatch with respect to the forest cover may indicate that pollen records are not in equilibrium with climate on multi-millennial timescales.

Our study has some far-reaching consequences. Pollen-based vegetation and climate reconstructions are commonly used to evaluate Earth System Models against past climate states, but to what extent the reconstructed vegetation is in equilibrium with the climate at the reconstructed time slice is still a matter of discussion. Our results raise the question on which time-scales pollen-based reconstructions are reliable. Although, it is so far not possible to identify the causes of the mismatch between our simulations and the reconstruction, we suggest critical re-assessment of pollen-based climate reconstructions. Last, but not least, our results may also point to a much slower response of forest biomes to current and future ongoing climate changes than Earth System Models currently predict.

References:

Cao, X., Tian, F., Dallmeyer, A. and Herzschuh, U.: Northern Hemisphere biome changes (>30°N) since 40 cal ka BP and their driving factors inferred from model-data comparisons, Quat. Sci. Rev., 220, 291–309, doi:10.1016/j.quascirev.2019.07.034, 2019.