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Climate of the Past Discussions

Interactive comment on "Assessing performance and seasonal bias of pollen-based climate reconstructions in a perfect model world" *by* K. Rehfeld et al.

Anonymous Referee #1

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Rehfeld et al. Assessing performance and seasonal bias of pollen-based climate reconstructions in a perfect model world

The authors use a vegetation model and climate model to simulate the process of reconstructing climate from pollen data, and in turn to assess the ability of pollen-based methods to accurately reconstruct seasonal Holocene climate change.

This is a interesting and novel approach, and although similar virtual experiments have been conducted with other proxies, this is the first time that I know of where it has been applied to pollen. Pollen-based climate reconstructions have been widely used in data-model comparisons, and large discrepancies have been found between these reconstructions and climate model simulations during the Holocene, particularly in terms

of seasonality. Investigation of potential seasonal bias in pollen-based reconstructions is therefore of particular interest and importance.

The study is generally well written and presented, but has a number of critical issues that I do not think can be easily resolved. The most obvious of these is the unrealistically low number of virtual taxa, or in this case PFTs, used in the transfer-function. To some extent the authors themselves acknowledge this (lines 550-554) "Furthermore, the methods we have tested are limited by the low number of plant functional types, as large-scale PFT-based pollen reconstructions use roughly 2-3 times the number of PFTs (as e.g. in Davis et al., 2003; Mauri et al., 2014)." This is actually an underestimate, since of the 8 PFT's used by Rehfeld et al, 3 are tropical (tropical evergreen trees, tropical deciduous trees and C4 grasses), leaving just 5 PFT's for the extratropics such as Europe. Davis et al. 2003 and Mauri et al. 2014 use 22 PFT's for Europe, which is more than 4 times the number used by the authors in their study. Taxa based pollen-climate transfer functions commonly use upwards of 50-60 taxa. These numbers are important because the individual behavior of the PFTs/Taxa and their climatic tolerances constitute the degrees of freedom necessary to reconstruct multiple climatic variables, and particularly those that may show close co-variance as cited as a potential problem by the authors. Furthermore, the PFT's used in the study by Rehfeld et al. have extremely broad climatic tolerances (deciduous trees, evergreen trees, grass..) that can be expected to have little diagnostic power. No pollen-climate transfer function should or would be based on such a low number of taxa/PFT's with such broad climatic sensitivity, and it is therefore disingenuous of the authors to compare their own over-simplified approach with the approach used in actual pollen-climate reconstructions. For instance the authors infer that because they were unable to reliably reconstruct winter temperatures, this should also be a problem for actual pollen-climate reconstructions. In reality, the problem with winter temperatures is just as likely to be a result of the authors over-simplified experimental design and the use of a limited number of PFT's with limited winter temperature sensitivity. This problem is likely to be compounded by the use of climate data for calibration from a climate model with

low spatial resolution, and where the spatial variability of climate is highly smoothed compared to the real world. On the one hand this reduces the variance of climate and vegetation in the training set and on the other, it greatly increases the propensity for spatial auto-correlation that the authors also highlight as a problem in their study. Whilst some simplification should be expected in a 'virtual' study like this, it is important not to over-simplify to the point where the study itself is so far removed from any actual application that the results are not comparable. The problem here is that the authors consistently conflate their results with those from actual pollen-climate reconstructions (as in the title), and therefore are at risk of presenting a fallacious argument that the average reader who is not so familiar with the topic will likely interpret at face value.

The subject of the paper is nevertheless interesting, and one that would otherwise be worthy of publication. I would therefore encourage the authors to collaborate with someone who has more experience in pollen-climate modeling, and to use a vegetation model such as LPJGUESS which can simulate a greater number of PFT's/Taxa so that the analysis can be more comparable with how pollen-climate transfer functions are actually applied.

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