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# Using a Large Database of Pollen Assemblages to Quantify the Centennial to Multi-Millenial Vegetation and Climate Variabilities

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Multidecadal to millenial timescale climate variability has been investigated over the ocean using extensive proxy data and it was found to yield coherent interproxy estimates of global and regional sea-surface temperature (SST) climate variability (Laepple and Huybers, 2014). Global Climate Model (GCM) simulations on the other hand, were found to exhibit an increasingly large deficit of SST climate variability for increasingly longer timescales. Further investigation is needed to better quantify terrestrial climate variability for long timescales and validate climate models. Vegetation related proxies such as tree rings and pollen records are the most widespread types of archives available to investigate terrestrial climate variability. Tree ring records are particularly useful for short time scales estimates due to their annual resolution, but on the other hand they have been shown to underestimate variability at time scales above centuries. In the present work, we use a large database of pollen records covering the northern hemisphere in order to quantify vegetation and climate variability at centennial to multi-millenial timescales over the Holocene and the late Pleistocene. Using principal component analysis, we extract coherent regional signals of vegetation variability from the pollen assemblages and compare with an analogous analysis of plant functional type (PFT) proportions from GCM paleoclimate simulations which had a land surface scheme component implemented. The pollen assemblages indicate a strong scaling relationship of vegetation variability with timescales, which is found to be significantly higher than that of PFT proportions in GCMs. The climate to PFT link is also investigated in the GCMs and found to be well approximated by a linear response model. We thus found that while part of the discrepancy in vegetation variability between pollen assemblages and GCMs can be attributed to the vegetation response to climate, the input climate variability in the GCM simulations must be lacking at centennial time scales and above. When a climate signal with stronger variability is used to force the linear response model representation of the climate to vegetation link, the pollen to PFT discrepancy in vegetation variability at centennial to multi-millenial time scales is greatly reduced.