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On the global synchronicity of glacial vegetation changes

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Vegetation responds to local climate and carbon dioxide changes with response times ranging from decades to millennia, depending on location, spatial scale, and vegetation characteristic. Here, we focus on orbital timescales, for which all available estimates suggest an equilibrium of vegetation and climate. Over the course of the last glacial period, global mean temperature varied between minima during Marine Isotope Stage (MIS) 4 and MIS2, and a maximum in MIS3. If orbital-scale climate changes followed this global trend across most of the globe, we would expect vegetation changes to feature a similar temporal evolution.

Leveraging a global compilation of pollen records, we quantify the synchronicity of orbital-scale vegetation changes within and across regions during the last glacial period. We use the arboreal pollen fraction, statistical mode decompositions, and key taxa as indicators for forest cover changes. Our results suggest that a globally coherent forest cover minimum occurred during MIS2. However, we do not find evidence for other periods of coherent forest cover trends across the globe or either hemisphere. This indicates that vegetation changes were more regionally confined during earlier parts of the last glacial. As chronologies become more uncertain further back in time, we examine the likelihood of dating errors to explain the absence of globally coherent vegetation changes during MIS4 and MIS3. Finally, we compare our results with simulations of climate and vegetation to assess if models capture the diagnosed forest cover trends found in the pollen records. Moreover, this comparison allows us to infer the influence of temperature, moisture availability, and carbon dioxide on vegetation variations during the last glacial period.