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The heterogeneity of temperature and vegetation change across Europe during the late Quaternary

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After the last glacial maximum (LGM; 18,000 years BP) global warming resulted in new ice sheet-free areas which allowed vegetation to recolonize. The pollen records of Europe document changes in ecosystem type, and are an important proxy for the reconstruction of climate parameters. Here, we quantify changes in January temperatures (Tjan) over the past 14,000 years using 216 European pollen records. In order to describe Tjan variability at the European scale using a reduced number of variables we have applied a multivariate analysis which gives the possibility of using information on the rates of change or derivatives of the Tjan time series.

Between 14 ka and 12 ka, Tjan records show comparable changes across Europe. After this time period, the NW and SE Europe experienced different trends in Tjan, which became pronounced by 9ka.

The heterogeneity of Tjan records are well-correlated with the overall change from steppe ecosystems, to increasingly diverse forest ecosystems. Particularly, differential incorporation of conifer vs. deciduous species into forest ecosystems based on differential colonization out of refugia, likely resulted in albedo heterogeneity that affected regional Tjan.

The significant differences between the NW and SE of Europe, in terms of the potential influence of different biomes on environment, may explain the dissimilarity in Tjan records between these regions during the Holocene.

To quantify and illustrate this claim, we computed correlation coefficients of the first component of the multivariate analysis on percentages of each biome type at 13 ka, 9 ka and 5 ka. Results revealed a significant relationship between vegetation types and Tjan records . Deciduous and conifer biomes are negatively and positively correlated with Tjan variability (that is expressed through the coefficient scores), respectively. In other words, the deciduous biome is located in areas where Tjan had a lower variability during the Holocene and a higher temperature than the European average. Conversely, the conifers occur in areas where Tjan recorded a higher variability but a lower temperature than the European average.

The spatial correlations we have obtained suggest strongly that the global warming during the postglacial period had triggered the forests dynamics and that the biome composition and distributions may have had also a feedback impact on climate. These data serve to further complicate discussions of anthropogenic climate and land-use change mechanisms.