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European BVOC emissions from the Last Glacial Maximum to present

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Terrestrial emissions of BVOC, such as isoprene and monoterpenes, affect climate by their atmospheric reactivity with OH and their ability to contribute to aerosol formation. Changes in vegetation types and climate have considerable effects on these emissions, and quantification of these emissions for the past will help our understanding of changes in atmospheric chemistry.

We performed simulations with the vegetation model LPJ-GUESS including BVOC emission algorithms for Europe, simulating the distribution and biogeochemistry of 20 dominant tree species. The simulations were driven with model climate data and proxy record CO_2 concentrations. We identified three main driving factors for changes in European emissions of isoprene and monoterpenes since the LGM: (1) changes in climate, most notably a change in temperature, (2) changes in the abundance and distribution of tree species, and (3) changes in CO_2 concentrations. On a European scale, emissions increase as a result of temperature rise since the Last Glacial Maximum, although the local emission patterns could vary due to vegetation shifts. The effect of changes in CO_2 concentration on BVOC emissions is not well-understood, but sensitivity tests with and without CO_2 effects showed that CO_2 effects cannot level out the increase caused by climate change.

In a comparison with a more common plant functional type (PFT) approach, the species simulations served as a test case to evaluate the temporal and spatial variability in emmission capacities of isoprene and monoterpenes. These simulations showed PFT emission capacities to be neither spatially constant, nor constant over longer periods of time, as a result of changes in the species distribution, which has important implications for the application of PFT emission capacities in regional and global BVOC modelling.