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The nature of MIS3 stadial-interstadial transitions in Europe: new insights from model-data comparisons

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15 abrupt warming transitions perturbed glacial climate in Greenland during Marine Isotope Stage 3 (MIS3, 60-27ka BP). One hypothesis states that the 8-16°C warming between Greenland Stadials (GS) and Interstadials (GI) was caused by enhanced heat transport to the North Atlantic region after a resumption of the Atlantic Meridional Overturning Circulation (AMOC) from a weak or shutdown stadial mode. This hypothesis also predicts warming over Europe, but so far this has been poorly constrained by data due to the paucity of well-dated quantitative temperature records. We therefore use new evidence from biotic proxies and a climate model simulation to study the characteristics of a GS-GI transition in continental Europe and the link to enhanced AMOC strength. We compare reconstructed climatic and vegetation changes between a stadial and subsequent interstadial – correlated to GS15 and GI14 (∼55ka BP) – with a simulated AMOC resumption using a three-dimensional earth system model set up with early-MIS3 boundary conditions. The simulated AMOC resumption results in the predicted warming in Greenland (∼10°C in annual mean) and the North Atlantic Ocean (∼7°C at the sea surface). Over western Europe (12°W-15°E), we simulate twice the annual precipitation, a 17°C warmer coldest month, a 8°C warmer warmest month, 1300°C-day more growing degree days with baseline 5°C (GDD5) and tree-cover potential vegetation after the transition. However, the combined effect of frequent killing frosts, <20mm summer precipitation and too few GDD5 after the transition suggest a northern tree limit lying at ∼50°N during GI14. With these 3 climatic limiting factors we provide a possible explanation for the absence of forests north of 48°N during MIS3 interstadials with mild summers. Finally, apart from a large model bias in warmest month surface air temperatures, our simulation is in reasonable agreement with reconstructed climatic and vegetation changes in Europe, thus further supporting the hypothesis.