



Absence of interstadials at times of maximum ice volume during the penultimate glacial

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The last glacial period was punctuated by episodes of warm and humid climate. These rapid climate instabilities, called Dansgaard/Oeschger (D/O) events, lasted between a few hundred and a few thousand years. The triggering mechanism of these events is still not comprehensively decoded and various hypotheses are debated including oscillations of the Atlantic Meridional Overturning Circulation driven by changes in the freshwater budget, changes in the elevation of the Laurentide ice-sheet and its effect on wind stress and sea-ice cover, as well as ocean-sea ice interactions internal to the Nordic Seas. Moreover, two time periods during the last glacial show a distinctive reduction or even an absence of D/Os (~ 70 to 60 ka and ~ 26 to 16 ka). Those periods concur with minimum sea-level and are important constraints to test hypotheses for the D/O triggering mechanism as not all of them can explain this absence of D/O cyclicity. Knowledge about D/O cyclicity could be improved by extending the investigations to the penultimate glacial. However, existing records cover only parts of the interval between ~ 200 and 130 ka or are located far from the D/O event core location and may have missed some events. Especially marine records, which would be ideally located in the North Atlantic to detect D/O events, are often limited with respect to their age control during this period.

Here, we present a new, replicated and precisely dated speleothem record from the northern rim of the European Alps covering the penultimate glacial. This area has previously proven to be highly sensitive to rapid millennial-scale climate variations. Between ~ 202 and ~ 133 ka before present our new Alpine speleothem record reveals a similar number of D/O events as compared to the last glacial period. D/O events were notably absent during three ~ 8 ka-long intervals, which coincided with sea-level low-stands during the penultimate glacial. Hence, our results strongly support findings from the last glacial that D/O-events were precluded during intervals when the Northern Hemisphere ice sheets reached their maximum extent.