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Variability, correlation and forcing of Dansgaard-Oeschger cycles constrain underlying mechanism

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The strongest mode of centennial to millennial climate variability in the paleoclimatic record are the Dansgaard-Oeschger events. Despite decades of research their dynamics and physical mechanism remain poorly understood.

Valuable insights can be obtained by studying high-resolution Greenland ice core proxies, such as the NGRIP δ^{18}O record. However, conventional statistical analysis is complicated by the high noise level, the cause of which is partly due to glaciological effects unrelated to climate, and which is furthermore changing over time. We remove the high-frequency noise and extract the most robust features of the DO cycles, such as rapid warming and interstadial cooling rates, by fitting a consistent piecewise-linear model to three Greenland ice core records. With statistical hypothesis tests we aim to obtain a mechanistic understanding of what controls the evolution of amplitudes and durations of the DO cycles. To this end, we investigate distributions, causalities in between different features, as well as modulations of them in time by external climate factors, such as CO_2 and insolation.

Our analysis suggests different mechanisms underlying warming and cooling transitions due to contrasting distributions and external influences of the stadial and interstadial durations, as well as the fact that the interstadial durations can be predicted to some degree by the linear interstadial cooling rates. From these empirical findings we propose a dynamical mechanism for DO cycles.