

Solar Forcing and Abrupt Climate Change over the Last 100,000 Years

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The prime example of abrupt climate change in paleoclimate records, the Dansgaard-Oeschger (DO) oscillations, provide clear evidence that sudden and substantial climate warming (as well as cooling) can happen on decadal timescales, so that understanding their natural causes is highly relevant to the assessment of plausible ranges of present and future climate variability. I present comparisons of ice core data of the last 100,000 years with climate models of low and intermediate complexity (e.g. ECbBilt/Clio) to suggest that the source of these oscillations is a form of convective instability of the thermo-haline circulation (THC), essentially controlled by density thresholds in the water column. These are free and self-sustained (nonlinear) oscillations of the THC between two stable states, one producing a cold North Atlantic and the other a warm one. We also suggest that the abruptness of the DO oscillations is controlled by the response of the sea ice, whose rapid advances and retreats, triggered by the switching THC, are accelerated by ice-albedo and greenhouse gas (GHGs) feedbacks. The modeling results further indicate that solar forcing organizes the free oscillations to form the (as yet unexplained) characteristic pattern of abrupt climate change over the last ice age. No North Atlantic fresh water balance perturbations were necessary to produce these model results; no external forcing other than the Milankovitch summer insolation was used.