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Underlying Dynamics of Glacial Millennial-Scale Climate Transitions Derived from Ice Core Data

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It has been argued that some abrupt paleoclimatic changes which occurred in the North Atlantic and the regions surrounding it might be related to a shift between two distinctly different states in a stochastically driven nonlinear dynamical system. Similar arguments have been made with regard to possible climate changes in the future. Here, we infer the underlying dynamics from ice core data using the unscented Kalman filter, a nonlinear extension of the conventional Kalman filter. The simple model of Brownian motion in a potential is adopted; its parameters (that is, the shape of the potential and the noise strength) are consistently estimated. The data reveal that during glacial times the system is degenerated: there is one cold stadial mode (stable state) and one warm interstadial mode (indifferently stable state) separated from each other by a potential barrier.