Bifurcation analysis of geophysical time series

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We propose a general synthetic framework, combining analytical and experimental techniques, for studying climatic bifurcations and transitions by means of the time series analysis. The method employs three major techniques: (i) derivation of potential from time series using unscented Kalman Filter (UKF); (ii) studying possible bifurcations and transitions of the obtained potential; (iii) projection of the time series according to the estimated perturbation. The method is tested on artificial data and then applied to observed records, in particular, a Greenland temperature proxy.

We correctly detect potential changes in artificial series with a varied number of potential wells. In the case of Greenland data, the technique detects a change of the number of system states from two to one (double-well potential transforming into single-well) at about 20 kyr BP.