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Bifurcation as a Criteria of Dynamical System Identification in Paleoclimate Time Series

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During the last 2.5 million years, there is a lot of evidences that a great part of the northern hemisphere was covered periodically by huge ice caps. These glacial cycles show a time-frequency variation: the signal firstly oscillated with a dominant nearby period of 40000 years, and since 800000 years, the major period is about 100000 years. The interval $[-1.2; -0.8]$ million years is characterized by a transition zone between these two dominant modes.
We focus here on qualitative time series comparison between proxy data and results from low-order dynamical systems, by means of the continuous wavelet transform (CWT), which is an adequate tool to study non-stationary signals.
Concerning the proxy data, we have used two records of benthic $\delta^{18}O$. The first one is the stack of 57 samples from Lisiecki and Raymo (2004), which is orbitally tuned. The second one comes from the DSDP site 607 core (Raymo and Ruddiman, 2002) for which the timescale is principally based on paleomagnetic evidences.
The low-order dynamical systems investigated for this work can be classified in two categories. On the one hand, the models describing the ice mass temporal evolution for the last 800000 years: Calder's model (1974), Imbrie & Imbrie's model (1980), Huybers' model (2009) and Paillard's model (1998). They are characterized by the insolation as input and by threshold functions that make the non-linearity and the desired output frequencies. On the other hand, two models of B. Saltzman and K.A. Maasch (1990 and 1991). They are characterized by the insolation as input and by non linear mechanisms represented in a non linear dynamical system of three equations governing the time evolution of the global ice volume, the global atmospheric carbon dioxide concentration and the global temperature of deep ocean. These two systems modelise the cycles of about 40000 years and those of about 100000 years and reproduce quite well the transition between the two modes as a result of a bifurcation. Moreover, a set of adequate parameters given in the two models was determined by a dynamical analysis.
The major result issued from this comparison is that the Saltzman & Maasch model of 1990 seems to be the nearest to the proxy time series in the framework of a time-frequency analysis with CWT, especially for the bifurcation zone. Other time series are currently under investigation in order to obtain a more complete comparison.