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Using signal processing tools for analizing and comparing paleoclimatic time-series

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Determination of the timing and duration of paleoclimatic events is a challenging task. Classical techniques for time-series analysis rely too strongly on having a constant sampling rate, which poorly adapts to the uneven time recording of paleoclimatic variables; new, more flexible methods issued from Non-Linear Physics are hence required. We used two approaches to face this problem. In the first approach, we study time series of data (temperature proxy) extracted from the GRIP ice-core records and we relate it with the evolution of atmospheric CO_2 within the last glacial period. Our method is based in considering the warm periods known as Dansgaard-Oeschger (D/O) events and posterior returns to the cold stage as a climatic cycle. After the warming phase, D/O events relax to the initial cold state in three different ways, what gives rise to three classes of cycles. Also, the Younger/Dryas-Bolling/Allerod (Y/D-B/A) cycle corresponds to one of the classes obtained. We have found that all cycles start with identical warming phases which seem completely unrelated to variations in CO_2 concentration. In the second approach, we have used Huang's Empirical Mode Decomposition (EMD) for the analysis of paleoclimatic series. We have studied three different time series of temperature proxies (GRIP, Vostok and Epica), characterizing oscillation patterns by using EMD. To measure the degree of temporal correlation of two variables, we have developed a method that relates couples of modes from different series by calculating the instantaneous phase differences among the associated modes. We observed that when two modes exhibited a constant phase difference, their frequencies were nearly equal to that of Milankovich cycles. Our results show that EMD is a good methodology not only for synchronization of different records but also for determination of the different local frequencies in each time series. Some of the

obtained modes may be interpreted as the result of global forcing mechanisms.