Geophysical Research Abstracts
Vol. 17, EGU2015-3769-2, 2015
EGU General Assembly 2015


# Influence of external forcings on the millennial-scale climate oscillations: an investigation based on simple skeleton models

Takahito Mitsui (1) and Michel Crucifix (2)

(1) Georges Lemaître Centre for Earth and Climate Research, Earth and Life Institute, Université catholique de Louvain, Louvain-la-Neuve, Belgium (takahito321@gmail.com), (2) Georges Lemaître Centre for Earth and Climate Research, Earth and Life Institute, Université catholique de Louvain, Louvain-la-Neuve, Belgium (michel.crucifix@uclouvain.be)

Ice core records as well as marine records reveal millennial-scale warming episodes in the Northern Hemisphere during the last glacial period, so-called Dansgaard-Oeschger (D-O) events. While the occurrence of D-O events is often explained by the changes of the Atlantic Meridional Overturning triggered by freshwater discharges into the North Atlantic, other several factors are considered to affect the occurrence of D-O events: the sea ice extent [Gildor and Tziperman, 2001], the height [Zhang et al., 2014] or the volume [Capron et al., 2010] of northern hemisphere ice sheets, as well as the Northern Hemisphere summer insolation change [Rial and Yang, 2007; Capron et al., 2010; Rial and Saha, 2011].
In this study, the influence of external forcings on D-O events is investigated based on simple skeleton models. We focus on the calcium concentration record of the NGRIP ice core [Rasmussen et al., 2014; Seierstad et al., 2014] because of its relatively clear bimodality [cf. Ditlevsen, 1999]. Following serial works by Kwasniok et al., we consider two skeleton models: a stochastic one-dimensional double-well potential model, and a stochastic relaxation oscillator model. Here, they are forced by the northern hemisphere summer insolation change and the global ice volume change (as suggested by Rial and Yang, 2007 as well as Capron et al. 2010). The parameter values of each model are estimated by the use of the augmented state-space method and the maximum likelihood method, where the state estimation from the potentially noisy record is performed with the unscented Kalman filter [Kwasniok and Lohmann, 2009]. The influence of the external forcings is detected in both models. Indeed, the frequency and the duration of D-O events are modulated by the northern hemisphere summer insolation change and the global ice volume change (though the physical mechanisms are not specified). However, the timings of abrupt warming and cooling are fairly stochastic (i.e. they depend on the realization of noise terms in the models). The precursor-type peak events and the rebound-type events [Capron et al., 2010] are interpreted as a property of the forced stochastic relaxation oscillator under the estimated parameter.

Selected references:
F. Kwasniok and G. Lohmann, Phys. Rev. E, Vol. 80, 066106 (2009).
F. Kwasniok, Phil. Trans. R. Soc. A, Vol. 371, 20110472 (2013).
J. A. Rial and R. Saha, Geophysical Monograph Series 193, 57 (2011).
E. Capron et al., Clim. Past, Vol. 6, 345 (2010).