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A simple conceptual model for Dansgaard-Oeschger oscillations derived from MIROC4m AOGCM experiments

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Dansgaard-Oeschger (DO) oscillations are most pronounced millennial-scale abrupt climate changes in glacial periods. Abe-Ouchi et al. have simulated DO oscillations with MIROC4m, a fully coupled atmosphere-ocean general circulation model (AOGCM). In that modelling study, it is elucidated that the bipolar seesaw and the Southern Ocean dynamics may play an important role for the occurrence of DO oscillations. In this poster, we present a simple conceptual model for DO oscillations based on the mechanism proposed by Abe-Ouchi et al. In this simple model, relaxation oscillations arise via Hopf bifurcations in a particular region of its parameter space, which is qualitatively consistent with the MIROC4m AOGCM experiments. In general, the period of oscillations does not grow drastically near Hopf bifurcation point in deterministic dynamical systems (Strogatz, "Nonlinear Dynamics and Chaos", 2014; Peltier and Vettoretti, GRL 2014). However, the oscillation periods (return times) increase near the bifurcation points in MIROC4m AOGCM. This gives a U-shape dependence of return times on the parameters in the AOGCM. We show that, in the simple model, such a U-shape dependence is achieved by an addition of noise into the system (which may represent fast "weather" forcings to slow climate) (cf. Mitsui and Crucifix, Clim. Dyn. 2017). We will also mention tipping point behavior found in this simple model.