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Investigating the mechanism of 100 ka ice age cycle by a three dimensional ice sheet model and GCM.

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One of the challenges of earth system modeling is to confirm the theories of ice age cycle by simulating it and to understand the uniqueness or necessity of the present state of climate and cryosphere and predict the future. Whether Milankovitch cycle or CO2 is the driver and what amplifies the forcing signal have been investigated by different hierarchy of models. Here we simulated the glacial cycles and investigate the origin of saw-tooth shape 100ka cycle using a three dimensional ice sheet model (IcIES) with the input obtained by a global climate model. The ice sheet model includes the thermo-mechanical coupling with the process of delayed isostatic rebound. In order to estimate the climate sensitivity to Milankovitch forcing and atmospheric CO2 indicated by ice core data we used an atmospheric GCM (CCSR/NIES) coupled to a slab ocean. Within the range of possibilities of the model, ice age cycles with a saw-tooth shape 100 ka cycle and the major NH ice sheet (Laurentide ice sheet and Fenno-Scandian ice sheet) volume and geographical distribution in the past 400,000 years are successfully simulated. It is shown that the contribution of Milankovitch forcing is necessary for the ice age cycle, although the CO2 change amplifies the cycle and affects the global climate change. The role forcings, response time of crustal rebound and the mean climate in obtaining the origin of 100 ka cycle and the geographical ice sheet pattern is investigated and the source of model uncertainty is discussed.