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Simulating the Northern Hemispheric Ice sheets throughout the Glacial and Interglacial cycles

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To explain the mechanism of ice age cycle by numerical simulation is a great challenge. Whether Milankovitch cycle or CO2 is the driver and why the dominant periodicity of ice age cycle switched from 40 ka cycle to 100ka cycle have been remained unsolved. Although gradual cooling due to CO2 decrease is raised as a plausible idea, recent proxy of pCO2 for the last 1.5 million years did not show a clear support of it. Here we simulate the glacial cycles and investigate the origin of saw-tooth shape 100ka cycle using a three dimensional ice sheet model with the input examined by GCM. The model is forced by the orbital parameters (Berger, 1978) and atmospheric CO2 content obtained by ice cores (Vostok, EPICA and DomeF), whose dating is partly given by a new method using the N2/ao2 ratio. The ice sheet model includes the thermo-mechanical coupling process of ice sheet with the process of delayed isostatic rebound with a typical time constant. In order to estimate the climate sensitivity to Milankovitch forcing and atmospheric CO2 indicated by ice core data we used an atmospheric GCM (part of MIROC GCM) coupled to a thermodynamical ocean. Within the range of possibilities of the model, ice age cycles with a saw-tooth shape 100 ka cycle, the major NH ice sheets [U+FF95] volume and the geographical distribution at the glacial maximum are successfully simulated. The role of the delayed response of viscoelastic earth mantle-crust system is confirmed to be important. Moreover the role of Atmospheric stationary wave feedback are found to be important to sharpen the termination and show the role of North American ice sheet. It is shown by sensitivity studies that this 100ka cycle is mainly obtained by the slowly acting ice sheet response to Milankovitch forcing, amplified by the CO2 change, which affects the global climate change. Concerning the switch from 40ka cycle to 100 ka cycle, mean CO2 decrease of only 20ppm is enough, which could be below the detection level of measurements.