What are the main factors determining the Northern Hemisphere Glaciation and ice age cycle?

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It is a big challenge using earth system modeling to investigate the sensitivity of our present state of climate and cryosphere and recent ice age cycle to external forcing such as CO2, solid earth configuration and insolation. Ice age cycle have been studied and simulated by different hierarchy of models. It is, however, difficult to distinguish the rival models and understand the mechanism only by analyzing the time series of ice volume instead of ice sheet extent (geography). Here we simulate the glacial cycles saw-tooth shape 100ka cycle using a three dimensional ice sheet model with the input obtained by a global climate model. The model is forced by Milankovitch forcing (orbital parameters, Berger, 1978) and atmospheric CO2 content (obtained by ice cores, Vostok and EPICA). The ice sheet model called ICIES includes the thermo-mechanical coupling 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, we used an atmospheric GCM (part of MIROC GCM) coupled to a slab 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' volume and the geographical distribution at the glacial maximum are successfully simulated. It is shown by sensitivity studies that this 100ka cycle is mainly obtained by the slowly acting ice sheet response to Milankovitch forcing even without the CO2 cycle. Both the geographical pattern of the ice sheet and the time series are shown to be highly dependent upon the temperature distribution determined by the continental configuration and mountains such as Tibet. Concerning the glaciation in Northern Hemisphere, we conclude that mean CO2 decrease is important, while the emergence of Tibet or the increase of precipitation in the North Atlantic region does not lead to shape the present ice age cycle.