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Climate of the Past Discussions

Interactive comment on "Quasi-100 ky glacial-interglacial cycles triggered by subglacial burial carbon release" *by* N. Zeng

Anonymous Referee #3

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1. General comments This paper applies the interesting idea that was presented in Zeng(2003)in a model to simulate the quasi-100ka glacial-interglacial cycle. Although a successful result is clearly shown, it is not clearly explained which process was responsible for the 100ka and how far it depends on parameters given in the non-machanistic atmosphere-ice sheet part. To convince the readers, it needs more explanation on the critical and key processes by describing the model performance and results especially related to the terrestrial carbon flux such as the basal process which transports the soil carbon,the speed of soil carbon decomposition and the feature of vegetation migration (ie. Boreal forest, tundra and ice sheet migration) which are treated in the mechanistic model. The non-mechanistic part plays also a critical role which needs more justification, since it may easily be tuned to get a 100ka cycle and it does not necessarily

correspond to the real world.Another point that I feel strange is that the model shows the amplitude of SST of 5 deg Celsius and Ice sheet size following the reconstruction (peltier's LGM vs modern) without Milankovitch forcing. With the Milankovitch forcing in the model the amplitude of temperature and ice sheet would apparently be over-estimated, which needs justification. I recommend, therefore, that the manuscript is submitted with major revision.

2. Specific comments I suggest that the manuscript is written with a structure that readers can easily find information on the processes that are critical for the result for each stage, such as switch to termination, deglaciation, interglacial, start of glacial period and the glacial maximum. Although there is a description on the result following every stage, more discussion and explanation is needed on how the assumptions or the key model processes are related to the critical result which drive the stages leading to 100 ka cycle. Also the model approach part should briefly mention the key model processes that are raised later in the result and discussion. I raise some points that should be described in detail.

(1) (p377 l24)What is the process responsible for the 60ppm CO2 drop from interglacial to glacial? It is written that CO2 is reduced partly because of the uptake by vegetation in the model, but is there no migration of tundra in the boreal region which is suggested as a positive (physical) feedback cooling mechanism during the inception in many previous studies or decrease in NPP which should be negative for the increase of uptake? If the tundra takes place of boreal, then the accumulation of carbon should not increase as in Fig.3d in the early glacial stage. More specifically, please explain the key process of the decrease of CO2 in the beginning of glacial up to 60 ppm (ex. From 338 ka to 350 ka as in Fig. 4) and discuss whether this result is robust or uncertain. The model description and the result description are not enough to see which process is included and what is important for the result in Fig.4, especially because the behavior of vegetation carbon is not the same as majority of carbon models which show lower carbon for glacial than interglacial (even without burial carbon hypothesis) and also

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because the 60ppm already in the beginning of glacial is huge compared to precious studies and even ice core data. Author should explain more and justify about the land and ocean carbon cycle model that leads to this result here. (2) Can the switch-on of basal flow which transports the burial carbon be justified? The termination of glacial is heavily dependent on this assumption. Ice sheet base is already wet under even present-day Greenland and Antarctica, but is there some support of observation to justify this process? It seems too artificial to switch on the basal melt at a critical ice sheet size. Does the base of ice sheet continue to be wet after the start of retreat of ice sheet? How long does the transport of burial carbon last? What would the result be if the transport stops (because the base is no more wet under smaller ice sheet) before the deglaciation ends. (3) Although the ice sheet model is non-mechanistic, some assumption which may be responsible for the 100ka mechanism should be justified. For example the assumption that the ice sheet cannot expand furthur than the LGM data of Peltier could be very much responsible for the termination. This assumption leads a quick expansion in size followed by a slow build up in height of ice sheet. (4) The explanation of ice sheet part in p386, section A4 should be guided more. Is the variable “Wi” dependent on grid? How is it interpolated with the Peltier ice data. Is the time scale of ice decay and growth of 4ka and 15 to40 ky responsible for the 100ka cycle? If so, how do you justify this number. How is the result dependent on this assumed time scale. (5) Equation of A10 should be explained in detail. What is the difference between the first term and second term in the rhs of eq.(A10)? What do you mean by the additional transport for the Vo and what is the physical meaning in the real world? How long does this transport by (A10) conitune to be switched on after the termination of the glacial? How does the result change if you change the A10.

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