Clim. Past Discuss.,
https://doi.org/10.5194/cp-2018-79-AC3, 2018

Climate of the Past Discussions

Interactive comment on "Instability of Northeast Siberian ice sheet during glacials" *by* Zhongshi Zhang et al.

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Received and published: 8 September 2018

We are not surprised, but appreciate the tough review on challenging the methodology in our study.

Although the reviewer criticizes the method used to carry out ice sheet modelling, he/she admits the method is widely used.

More critically, the reviewer challenges the asynchronous coupling method with the equilibrated ice sheet simulations. We do not hide this weakness, but point it out in our paper. "In reality, climate forcings evolve alongside the ice sheet so, in an ideal world, fully coupled transient simulations (Ganopolski et al., 2010; Beghin et al., 2014) would most reliably mimic the interaction between climate and ice sheet. However

in a transient simulation, due to the complexity of a fully coupled system, it is quite difficult to distinguish the importance of orbital forcings, greenhouse gas levels and internal ice-vegetation-atmosphere-ocean feedbacks. With constant climate forcing, our asynchronous simulations provide a wealth of new and valuable information, which represents the first step in beginning to fully assess the question of the internal feedbacks and ice sheet configurations. Whilst climate and ice sheet interactions may influence the resulting ice sheet volume and shape, they are unlikely to change whether or not an ice sheet actually forms in NE Siberia or North America. Once developed, ice sheets tend to continue to grow during a full glacial, so the NE Siberian or Laurentide ice sheets should do exactly that, until they become large enough to trigger a swing to another ice sheet configuration. Seen in this way, before a fully coupled ocean-atmosphere-vegetation-ice sheet high complexity model (with a good ability to simulate atmospheric stationary waves) is really available for transient glacial-interglacial simulations, asynchronous coupled simulations remain a good choice to reveal the importance of atmosphere-ocean-vegetation-ice sheet feedbacks in the swings in ice sheet configurations. "

We have rerun asynchronous coupling experiments forced by variable orbital and greenhouse gas forcings, with the ice sheet model running for a few thousand years, during the past glacial-interglacial cycles. We do find the similar result that the NE Siberian ice sheet is unstable.

We know that the idea of gradual development of the Laurentide-Eurasian ice sheet configuration (without the NE Siberian ice sheet) during glacials has been established for more than three decades. However, several climate models can simulate ice sheets over NE Siberia. Our model can produce the numerical instability of the NE Siberian ice sheet. Together with some pieces of geological evidence supporting the NE Siberian ice sheet, it is important for our scientists to be open-minded, to reconsider the possibility of the NE Siberian ice sheet and rethink if the "well-established" idea is really right. It is clear that our study is the fundamental step to reassess this problem.