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Transient Pleistocene simulations with a new coupled climate-ice-sheet model

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Orbital and CO_2 variations over glacial timescales are widely held responsible as drivers of the ice-age cycles of the Pleistocene. Alongside these glacial cycles, our paleoclimate history is marked with abrupt changes and millennium scale variabilities. However, the relative contributions of these forcings over glacial transitions and mechanisms of abrupt changes are not very well understood. Here, using the recently developed three-dimensional coupled climate – ice-sheet model (LOVECLIM – Penn State University ice-sheet model), we simulate the glacial inception over the period of MIS7 to MIS6 (240-170ka). This period is the coldest interglacial post the Mid-Brunhes Event and includes one of the fastest glaciation/deglaciation events of the Late Pleistocene, over MIS7e-7d-7c (236-218ka); which we use here to benchmark our transient coupled model runs. Our results suggest that glacial inceptions are more sensitive to orbital variations, whereas terminations need both forcings to work in tandem over a tiny ablation zone at the southern margins of ice sheets. And abrupt changes may result from a critical interplay between the climate and the cryosphere systems. Using multiple ensembles in combination with conceptual dynamical systems' models, we test the sensitivity of ice-sheets to various physical factors and discuss the presence of multiple equilibrium states and runaway effects. Additionally, our simulations show that regional scale variations at the southern end of Laurentide can lead to a bifurcation of the system and play a role even in orbital-scale ice-sheet growth/decay.