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Simulation of Quaternary glacial cycles with fully interactive carbon cycle

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Although it is generally accepted that, as postulated by the Milankovitch theory, Earth's orbital variations play an important role in Quaternary climate dynamics, the mechanism of glacial cycles still not fully understood. Among major scientific challenges remains the understanding of the nature of 100 kyr cycles that dominated climate variability over the late part of Quaternary and a strong link between ice volume and atmospheric CO_2 concentration. Here using the Earth system model of intermediate complexity CLIMBER-2 which includes all major components of the Earth system – atmosphere, ocean, land surface, northern hemisphere ice sheets, terrestrial biota and soil carbon, aeolian dust and marine biogeochemistry – we performed simulations of the Quaternary climate cycles using variations in the Earth's orbital parameters as the only prescribed climate forcing. Thanks to high computational efficiency of the CLIMBER-2 model we performed a large suite of model simulations aimed on better understanding the role of individual processes. We found that the main drivers of atmospheric CO_2 evolve with time: changes in sea surface temperature and volume of bottom water of southern origin exert CO_2 control during glacial inception and deglaciation, while changes in carbonate chemistry and marine biology are dominant during the first and second parts of the glacial cycles, respectively. Changes in terrestrial carbon pool play significant role during deglaciation. We also discus how paleoclimate records, such as atmospheric and deep oceanic d13C, can help to constrain model parameters and test hypotheses on the mechanism of glacial-interglacial CO_2 variations.