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Deep-future climate change scenarios for site selection of nuclear waste disposal in Germany

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Abstract. Glacial cycles are primarily attributed to Earth's evolving orbital parameters, which change the amount of insolation received by the high latitudes in summer. Another significant aspect is how much of this solar energy is retained. Recent research (Ganopolski et al., 2016) has shown a connection between the maximum summer insolation at 65° N and CO_2 concentration needed for glacial inception. As available fossil fuel reserves have the capacity to impact the climate hundreds of thousands of years into the future (Archer and Ganopolski, 2005), there is a great deal of uncertainty regarding when (and how) glacial cycles will resume under different emission scenarios.

Using the newly developed Earth system model of intermediate complexity, CLIMBER-X (Willeit et al., 2022), in conjunction to a reduced complexity model of glacial cycles (Talento and Ganopolski, 2021), the Potsdam Institute for Climate Impact Research (PIK) will provide a set of deep-future climate change scenarios for Germany for the next 100 000 years (more detailed scenarios) and for the next 1 million years. These experiments will be evaluated in collaboration with other project partners and seek to quantify the degree of uncertainty in Earth's climate for the site selection planning of a deep geological repository.

The tuning of CLIMBER-X to current glacial conditions is displayed with regards to paleoclimatic data. Variables in the climate, such as temperature, precipitation, and sea level, are showcased for different emission scenarios. Conditions of the European ice sheet complex during future glacial cycles are presented. We argue that these results should be considered when discussing processes which effect the safety of a nuclear waste repository, including subterranean stress, permafrost, groundwater changes, chemical reactions, erosion, and subrosion. A detailed analysis and sensitivity study of the model simulations will be performed to assess the overall uncertainty associated with the climate response due to different cumulative anthropogenic CO_2 emissions and model parameters.

Competing interests. The research leading to these results has been done in collaboration with one of the session organizers of S08.

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