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From the last interglacial to the future – new insights from modeling the last glacial-interglacial cycle in PalMod

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We present new insights from the project PalMod, which started in 2016 and is envisioned to run for a decade. The modelling initiative PalMod aims at filling the long-standing scientific gaps in our understanding of the dynamics and variability of the climate system during the last glacial-interglacial cycle. One of the grand challenges in this context is to quantify the processes that determine the spectrum of climate variability on timescales that range from seasons to millennia. Climatic processes are intimately coupled across these timescales. Understanding variability at any one timescale requires understanding of the whole spectrum. If we could successfully simulate the spectrum of climate variability during the last glacial cycle in Earth system models, would this enable us to more reliably assess the future climate change? Such simulations are necessary to deduce, for example, if a regime shift in climate variability could occur during the next centuries and millennia in response to global warming. PalMod is specifically designed to enhance our understanding of the Earth system dynamics and its variability on timescales up to the multimillennial with complex Earth System Models.

The following major goals were achieved up to now:

- Full coupling of atmosphere, ocean and ice-sheet models, enabling investigation of Heinrich Events and bi-stability of the AMOC, and millennial-scale transient climate-ice sheet simulations.
- Implementation of a coupled ocean and land biogeochemistry enabling simulations with prognostic atmospheric CO₂ concentrations and including improved representation of methane (CH₄) in transient deglaciation runs.
- Systematic comparison of newly compiled proxy data with model simulations.

The major goal for the next two years is to set up the fully coupled physical-biogeochemical model which will be tested for three time periods: deglaciation, glacial inception and Marine Isotope Stage 3 (MIS3). This fully coupled model will be eventually used to simulate the complete glacial cycle and project the climate over the next few millennia.