The role of dynamic sea ice in a simplified general circulation model used for palaeoclimatic studies

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ABSTRACT

Observational records provide a strong basis for constraining sea ice models within a narrow range of climate conditions. Given current trends away from these conditions, models need to be tested over a wider range of climate states. The past provides many such examples based on paleoclimate data, including abrupt tipping points. However, the millennial-duration of typical paleoclimate simulations necessitates balancing the inclusion and sophistication of model processes against computational cost. We investigate the impact on climate mean states and variability of introducing sea ice dynamics into the simplified general circulation model PlaSim-LSG [1–3].

Considering the technical constraints of PlaSim-LSG, we choose to integrate a modified version of the MITgcm’s dynamical sea ice component [4, 5] into the model setup. We adapt the component to the structure and parallelization scheme of PlaSim-LSG, validate the physical consistency and stability of the component, and evaluate the impact of sea ice dynamics onto the simulated climate from decadal to millennial time scales. Specifically, we compare climatologies, variability and scaling of the extended model to control simulations of the preexisting setups, and quantify how additional sea ice dynamics affect well-known climatic biases of the PlaSim model family.

With our extended PlaSim-LSG model we aim at capturing the key small-scale sea ice processes that are important to past climate tipping points while maintaining model efficiency for millennial simulations. Sea ice is a key component of coupled atmosphere-ocean processes that led to large-amplitude, abrupt climate variability in the past [6–8]. Therefore, the extended model can be used to investigate the role of sea ice for such oscillations. This facilitates the understanding of processes that lead to current mismatches between palaeoclimatic data and simulations, and that impact the simulated surface climate variability [9].

REFERENCES