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Objective tuning of an EMIC using present-day observations and Last Glacial Maximum climate reconstructions

Muriel Racky[1], Felix Pollak[2,3], Elisa Ziegler[1], Nils Weitzel[1], and Kira Rehfeld[1]
[1]University of Tübingen, Geo- and Environmental Center (GUZ), Germany
[2]Institut des Géosciences de l'Environnement, Université Grenoble Alpes, Grenoble, France
[3]Institute for Marine and Antarctic Studies, University of Tasmania, Hobart, Australia

Climate models rely on parametrizations of unresolved Earth system processes. These often include uncertain parameters that are estimated in a procedure called tuning, where the model output is optimized with respect to selected climate observations. Most models are tuned against present-day observations. However, if the parametrizations robustly represent the underlying physics, a tuned set of model parameters should be valid independent of the simulated climate, including climate states very different from present-day such as the Last Glacial Maximum (LGM).

Here, we present the procedure for and the results of an iterative Bayesian tuning of PlaSim-LSG, an Earth system model of intermediate complexity (EMIC). Its low computational cost allows for long simulation periods and large ensembles. For a preliminary tuning restricted to observational information from recent decades, we find a less realistic LGM state of the Atlantic Meridional Overturning Circulation (AMOC) and sea ice distribution than in the default model version. This could imply that tuning based only on present-day observations might be insufficient to target significantly colder climates such as the LGM. However, prior sensitivity studies have shown that PlaSim-LSG is capable of simulating a wide range of AMOC states under varying ocean diffusivity parameters and handling of freshwater runoff. Therefore, we redefine tuning targets, combining present-day observations with LGM climate reconstructions. We investigate how the weighting of the different climate state metrics in the tuning target impacts the resulting present-day and LGM climates. The goal of this exploratory approach is to test parameter sensitivity and identify state-dependent parameters. This could be used in the future to inform model development decisions by focusing on improving parametrizations with highly state-dependent parameters.