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Towards model-data comparison of the deglacial temperature evolution in space and time

Nils Weitzel[1], Heather Andres[2], Jean-Philippe Baudouin[1], Oliver Bothe[3], Andrew Dolman[4], Lukas Jonkers[5], Marie Kapsch[6], Thomas Kleinen[6], Maximilian May[1], Uwe Mikolajewicz[6], Andre Paul[5], and Kira Rehfeld[1]

[1]Institute of Environmental Physics, Heidelberg University, Heidelberg, Germany
[2]Department of Physics and Physical Oceanography, Memorial University of Newfoundland, St. John's, Canada
[3]Helmholtz-Zentrum Geesthacht Centre for Materials and Coastal Research, Geesthacht, Germany
[4]Alfred-Wegener-Institut, Helmholtz-Zentrum für Polar-und Meeresforschung, Potsdam, Germany
[5]MARUM, University of Bremen, Bremen, Germany
[6]Max Planck Institute for Meteorology, Hamburg, Germany

The increasing number of Earth system model simulations that try to simulate the climate during the last deglaciation (ca 20 to 10 thousand years ago) creates a demand for benchmarking against environmental proxy records synthesized for the same time period. Comparing these two data sources over a period with changing background conditions requires new methods for model-data comparison that incorporate multiple types and sources of uncertainty.

Natural archives of past reality are distributed sparsely and non-uniformly in space and time. Signals that can be obtained are in addition perturbed by uncertainties related to dating, the relationship between the proxy sensor and environmental fields, the archive build-up, and measurement. On the other hand, paleoclimate simulations are four-dimensional, complete, and physically consistent representations of the climate. However, they are subject to errors due to model inadequacies and sensitivity to the forcing protocol, and will not reproduce any particular history of unforced variability.

We present a method for probabilistic, multivariate quantification of the deviation between paleo-data and paleoclimate simulations that draws on the strengths of both sources of information and accounts for the aforementioned uncertainties. We compare the shape and magnitude of orbital- and millennial-scale temperature fluctuations during the last deglaciation and compute metrics of regional and global model-data mismatches. We test our algorithm with an ensemble of published simulations of the deglaciation and simulations from the ongoing PalMod project, which aims at the simulation of the last glacial cycle with comprehensive Earth system models. These are evaluated against a compilation of temperature reconstructions from multiple archives. Our work aims for a standardized model-data comparison workflow that will be used in PalMod. This

workflow can be extended subsequently with additional proxy data, new simulations, and improved representations of proxy uncertainties.