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Application of global paleovegetation data for benchmarking paleoclimatic simulations

Kenji Izumi[†]; Patrick Bartlein; Sandy Harrison
[†] University of Oregon, USA
Leading author: izumi@uoregon.edu

Climate models provide the an opportunity to for testing hypotheses concerning the causes of past climatic variations, providing the consistent explanations of past climate changes, and simulating potential future climate changes. Here we compare paleovegetation syntheses from the Last Glacial Maximum and Mid Holocene with simulations performed as part of the PMIP 2 and 3 projects, with the aim of evaluating the ability of the simulations to reproduce the key regional and global patterns of climate recorded by the data. We apply two approaches using vegetation models in a data-model comparison framework: a forward-modeling approach that simulates vegetation using climate-model output, and inverse-modeling approach that uses the vegetation data to infer the past values of the specific climate values that control vegetation distributions. In the forward-modeling approach, we use the BIOME4 equilibrium-biogeochemistry model and comparisons with the latest palaeovegetation data (BIOME6000), which includes new regional pollen data sets from Australia, Southeast Asia, South America, and the Indian subcontinent, in order to evaluate the response of PMIP2 AOGCMs simulations of the Last Glacial Maximum and Mid-Holocene. For the inverse approach, we use BIOME4 to iteratively estimate the potential paleoclimate consistent with based on the BIOME6000 data using a Monte Carlo Markov Chain algorithm. BIOME 4 employs mechanistic descriptions of the relationship of vegetation on climate and also allows the direct effects of carbon dioxide concentration to be considered. Because the PMIP simulations employ a "preindustrial" control simulation, we have developed a compatible "control" climate data set, using the we use CRU TS 3.1 observed data (1901-2009) and the 20th Century Reanalysis v. 2 reanalysis data (1871-2008). In addition, because these approaches both use offline simulation models and are therefore highly dependent on the quality of the those models, we have used alternative process-based to validate the results. In addition to standard (i.e. map-comparison) approaches for comparing the simulated and observed vegetation and climate, we also show some diagnostics based the mapping of observed and simulated biomes in climatic spaces. These diagnoses can provide information about the specific climatological explanations for the mismatches between the simulations and observations.