Assimilating palaeoclimate reconstructions into GCM simulations for climates of the Mid-Holocene and Last Glacial Maximum

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General Circulation Models (GCMs) contain climate system theory in the form of dynamical equations describing physical processes, but are imperfect and computationally expensive. On the other hand, palaeoclimate reconstructions typically consider individual pieces of information independently, rather than accounting for correlations across space, time, and climate variables, and are thus at risk of being unphysical or at least implausible. These two sources of information are complementary, and a statistical synthesis can produce a best-estimate of the palaeoclimate state that combines them while not ignoring their limitations.

We combine perturbed parameter ensemble simulations of the Mid-Holocene and Last Glacial Maximum climates from the fully coupled GCM HadCM3 with continental climate reconstructions from pollen data. The resulting 'data assimilation' estimates of the two palaeoclimate states contain a full expression of climate uncertainty with spatial correlation structure. Such information is crucial for a full understanding of past climate states: for example, determining spatially extensive features such as isotherms, or the location of the tree-line.