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Quantifying Last Glacial Maximum ocean circulation by state estimation

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The Last Glacial Maximum (LGM, ∼19,000- 23,000 years before present) cold period is ideally suited for evaluating the response of the climate system to large perturbations. For this period the best proxy-data coverage is available and forcing functions, boundary conditions and the climate response are "relatively well known". However, while IPCC-type coupled climate models are generally tuned to be consistent with historical and present-day data, they give ambiguous results for the LGM. For example, Atlantic meridional overturning rates are estimated as both stronger and weaker than and as strong as today by different models.

We present a new project which aims at reducing this uncertainty by combining proxy data with a numerical ocean model using systematic state estimation techniques.

In practice, models are often tuned to reproduce observations by adjusting individual parameters and repeating simulations in an ad-hoc iteration. We want to overcome this crude tuning procedure and use variational techniques (the so-called adjoint method) and sequential filtering as well as statistical methods (e.g., Monte Carlo methods). These techniques also take into account the large uncertainties associated with both model and data. Our goal is the best estimate of the LGM ocean circulation that is dynamically consistent (within prior error estimates) with model and data. We report on the current state of our efforts to produce and collect suitable data from the South Atlantic Ocean and worldwide and set up a global configuration of the MIT General Circulation Model (MITgcm), which is adapted for use with adjoint compilers to provide exact and efficient adjoint code.