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State estimation of Atlantic Ocean circulation at the Last Glacial Maximum

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Preliminary results are presented from application of state estimation techniques to Atlantic Ocean circulation at the Last Glacial Maximum (LGM). An extended North Atlantic (33S to 75N) is modeled using the MIT General Circulation Model. ICE-5G 21K bathymetry and first guess atmospheric forcing fields from fully coupled CCSM3 LGM simulations are used. The model is least-squares fit to the proxies using an algorithm based on the model adjoint. A one-degree resolution, basin-scale setup was chosen so that the adjointed model remains efficient and processes that influence circulation over decades and longer are accessible.

Estimates are sought of the ocean circulation that are dynamically consistent and within error bounds of available LGM proxy records. As compared to modern ocean state estimation, challenges include large and uncertain errors, data sparsity, and poorly known atmospheric circulation. The initial focus is on sea surface temperature and sea ice extent data compiled and unified by the Multiproxy Approach for the Reconstruction of the Glacial Ocean surface (MARGO) project. Estimates are made of the wind field and atmospheric heat flux adjustments required to obtain a consistent ocean circulation solution.