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GLAC-GR2: a joint glaciological and earth rheology Bayesian calibration for the last glacial cycle of the Greenland ice sheet

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Paleo ice sheet reconstructions without confident uncertainty bounds have limited value. For approaches based on glaciological models, such bounds require a model that adequately probes uncertainties in both climate and ice processes along with a rigorous methodology for using paleo-observations to constrain this probe. To date, deglacial reconstructions of the Greenland ice sheet either do not specify uncertainty bounds or have low confidence in their derived bounds. This is due in good part to limited probing of model uncertainties and sole reliance on climate forcings based on glacial indices derived from GRIP or GISPII ice core records.

To rectify these limitations, we use the 3D Glacial Systems Model (GSM) with asynchronously coupled glacial isostatic adjustment (including a first order gravitational correction and accounting for ice load contributions from other ice sheets). Model grid resolution is about 25 km and model runs are over the last two glacial cycles. The climate component is distinguished by a calibrated weighting of diverse climate representations, including a two-way coupled 2D Energy Balance Climate model that has no dependence on Greenland ice core records. Calibrated model parameters also account for uncertainties in ice calving and submarine melt, basal drag, deep geothermal heat flux, and earth viscosity structure.

The calibration was against a large set of relative sea level observations, constraints on ice extent from cosmogenic dates, and borehole temperature records from the Greenland ice core sites. The inversion invokes Bayesian artificial neural network emulators of the GSM to enable effective multi-million point Markov Chain Monte Carlo sampling of chronologies. Calibration results will be presented for the whole last glacial cycle with a focus on max/min bounds, comparison against previous chronological inferences, and remaining data/model misfits.