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Addressing glacial cycle uncertainty of the Greenland Ice Sheet: model, constraints, and initial results towards Bayesian calibration

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Given the ongoing challenge of missing LGM ice, there is a need to build confident bounds on paleo contributions from major ice sheets. For approaches based on glaciological models, such bounds require a model that adequately probes uncertainties in both climate and ice processes along with a methodology for using paleo-observations to constrain this probe. To date, paleo glaciological models of the Greenland ice sheet (GrIS) have low confidence in their derived bounds. This is due in good part to limited probes of model uncertainties and sole reliance on climate forcings based on glacial indices derived from GRIP or GISPII ice core records.

We describe the initial constraint data set (and welcome new data), error model for the data, and model setup in working towards a full Bayesian inversion of the last glacial cycle GrIS chronology. We use the 3D Glacial Systems Model with coupled glacial isostatic adjustment (including a first order gravitational correction) and subgrid hypsometric surface mass balance and ice flow modules. The climate component is distinguished by a weighting of climate representations, including a fully coupled "climate generator" 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 is currently against relative sea level observations, constraints on ice extent from cosmogenic dates, and borehole temperature records from the Greenland ice core sites. Comparison of initial ensemble results against calibration constraints will validate the extent to which the model system potentially "covers reality", a pre-requisite for confident Bayesian inversion.