Geophysical Research Abstracts
Vol. 13, EGU2011-907, 2011
EGU General Assembly 2011

Bayesian calibration of a 3D Glacial Systems Model for the past evolution of the Antarctic Ice Sheet

Rob Briggs (1), Dave Pollard (2), and Lev Tarasov (1)

(1) Department of Physics and Physical Oceanography, Memorial University of Newfoundland, St. John's, NF, Canada, (2) Earth and Environmental Systems Institute, Penn State, University Park, PA, United States

Understanding past Antarctica ice sheet behaviour, especially over the last glacial cycle, is essential both to interpret contemporary changes and to make predictions of ice sheet evolution. Previous model-based studies have relied either on geophysically constrained reconstructions that lack glaciological self-consistency, or on glaciological models that are hand-tuned to fit a limited set of constraint data. Glaciological models (especially those that operate on continental scales over glacial cycles) depend on numerous parameterisations to capture simplifications and uncertainties in the ice physics and the boundary conditions (climate forcing, mass balance, ice-ocean interactions, basal interactions etc.). Hand-tuning of these parameters does not allow the model to explore the potential phase space of such a highly non-linear and complex system. As such, no meaningful error bars can be determined for model predictions. This limits the confidence in any interpretations or predictions that are made.

In this study, following on from similar work for the Eurasian and the North American ice-sheets, we present initial results from an on-going Bayesian calibration of a Glacial Systems Model (GSM) for the Antarctic Ice Sheet. The core of the GSM is a 3-D thermo-mechanically coupled ice dynamics model, including hybrid coupling of sheet/stream/shelf flow, sub-grid grounding-line flux parameterisation, and non-local visco-elastic bedrock response. Uncertainties in the model system are captured through 26 model parameters that are varied between model runs. This allows a much larger exploration of the potential Antarctic model phase space than that of previous studies. We use a large ensemble Bayesian calibration methodology to generate a posterior distribution for the model parameters given model fits to observational constraints. The constraint set includes a comprehensive suite of data types including: relative sea level and paleo ice surface indicators, borehole temperature profiles and the present day ice sheet configuration. We therefore produce a probability distribution for the evolution of the Antarctic Ice Sheet. We also assess the relative impact of different types of constraints and identify key regions in need of further constraint.