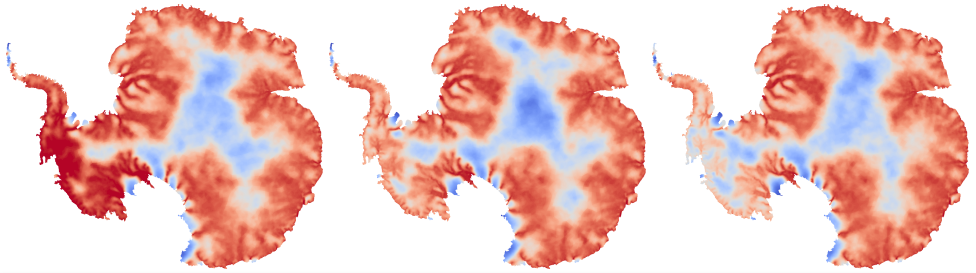
Inference & prediction for the Antarctic ice sheet using Gaussian approximations

Objective

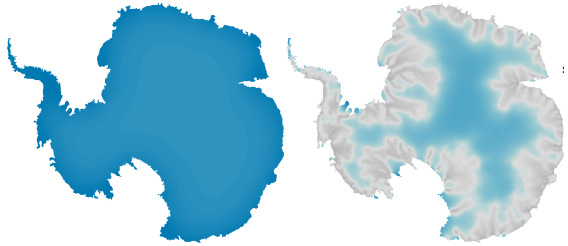
Development of algorithms for large-scale inference of basal sliding coefficient field with quantified uncertainties, and propagation of these uncertainties to a prediction quantity of interest



Samples from the Gaussian approximation to the posterior distribution of basal sliding coefficient fields; red (blue) areas correspond to areas with weak (strong) coupling between ice sheet and bedrock

Approach

- Find maximum a posteriori (MAP) basal sliding coefficient field using adjoint methods
- Make Gaussian approximation of posterior distribution for basal sliding coefficient by combining adjoint and low-rank methods
- Prediction of current mass loss of Antarctica based on Gaussian approximation of prediction quantity



Standard deviation of posterior (right) is significantly reduced compared to prior (left).

Impact

Large-scale, model-based inference with quantified uncertainties, and corresponding predictions is feasible. Results suggest that weak coupling between ice and bedrock extends far in the interior of the Antarctic ice sheet.

Isaac, T. , N. Petra, G. Stadler & O. Ghattas (2015). Scalable and efficient algorithms for the propagation of uncertainty from data through inference to prediction for large-scale problems, with application to flow of the Antarctic ice sheet. Journal of Computational Physics, 296, 348–368, doi:10.1016/j.jcp.2015.04.047