SAND2018-8115C

Simulation-based Bayesian Optimal Design for Ice Sheet Borehole Experiments

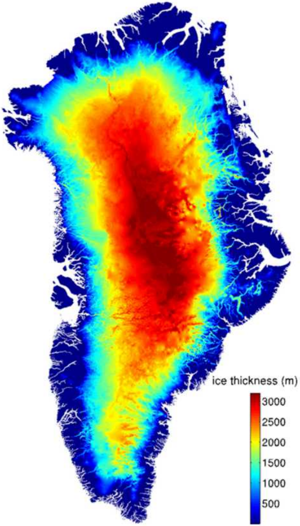
Andrew D. Davis, **Xun Huan**, Patrick Heimbach, Youssef M. Marzouk

Massachusetts Institute of Technology
Sandia National Laboratories

August 1, 2018

andia National Laboratories is a multimission laboratory managed and operated by National Technology & Engineering Solutions of Sandia, LLC, a wholly own subsidiary of Honeywell International Inc., for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA0003525.

Motivation





Source: (left) National Snow & Ice Data Center, (middle) earth-chronicles.com, (right) Andrew D. Davis

Motivation

Ice sheets impact future global mean sea level

- Greenland: $\approx$ 6 meters   Antarctica: $\approx$ 60 meters

Source: National Geographic

Physical model is nonlinear and complex

1. Stress and mass balance equations
2. Calving law
3. Temperature $T(x, z, t)$ via advection-diffusion

$$\dot{T} + \kappa \nabla^2 T + \mathbf{u} \cdot \nabla T = 0$$
$$T(x, h(x, t), t) = T_s(t; \theta)$$

Physical model is nonlinear and complex

1. Stress and mass balance equations
2. Calving law
3. Temperature $T(x, z, t)$ via advection-diffusion

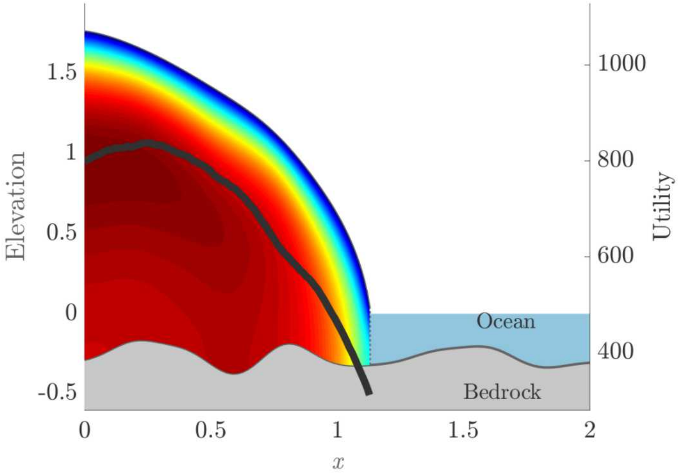
$$\dot{T} + \kappa \nabla^2 T + \mathbf{u} \cdot \nabla T = 0$$
$$T(x, h(x,t), t) = T_s(t; \theta)$$

Goal of Optimal Experimental Design:

Select borehole locations that maximize the expected information gain for inferring past surface temperature

$$\xi^* = \text{argmax} \left\{ U(\xi) = \mathbb{E}_{\delta|\xi} \left[D_{\mathsf{KL}}(\text{posterior}||\text{prior}) \right] \right\}$$

Expected information gain with inland hiking penalty



Today 11:35 AM, West Hall B, Poster #1

Acknowledgment

- Sandia National Laboratories[1]
- Massachusetts Institute of Technology
- U.S. Department of Energy
- National Science Foundation

[1] Sandia National Laboratories is a multimission laboratory managed and operated by National Technology and Engineering Solutions of Sandia, LLC, a wholly owned subsidiary of Honeywell International, Inc., for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA-0003525. The views expressed in the presentation do not necessarily represent the views of the U.S. Department of Energy or the United States Government.