

Ice sheets in CESM: results and progress

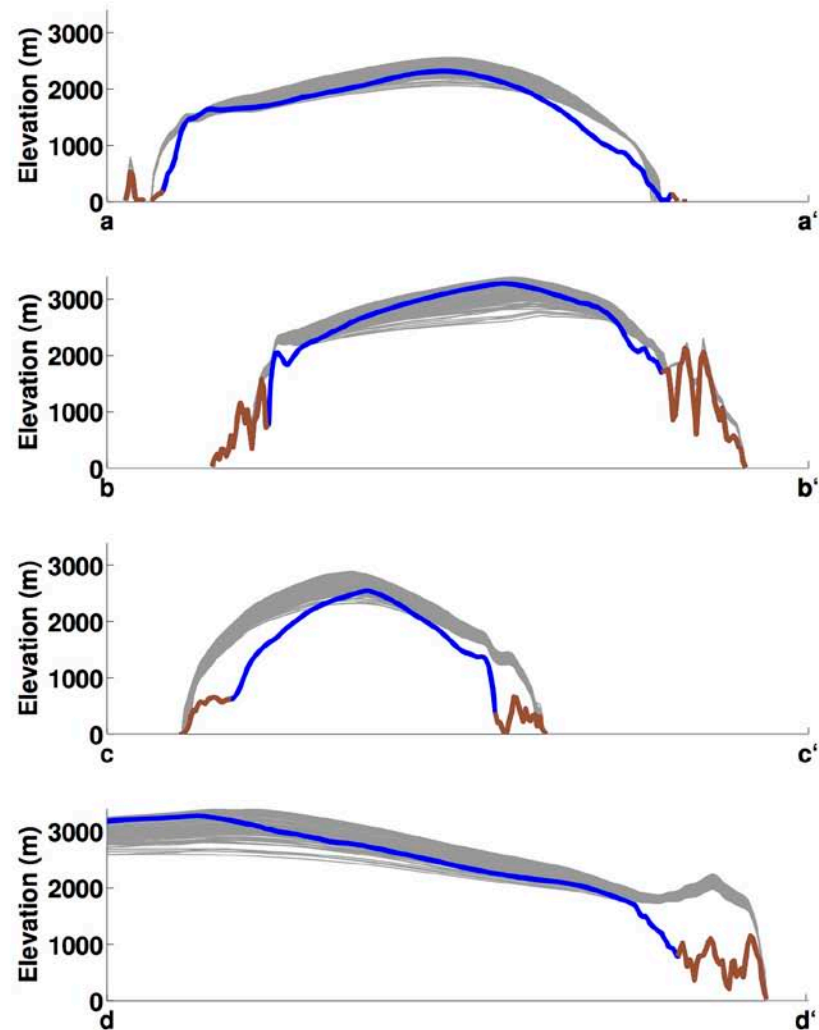
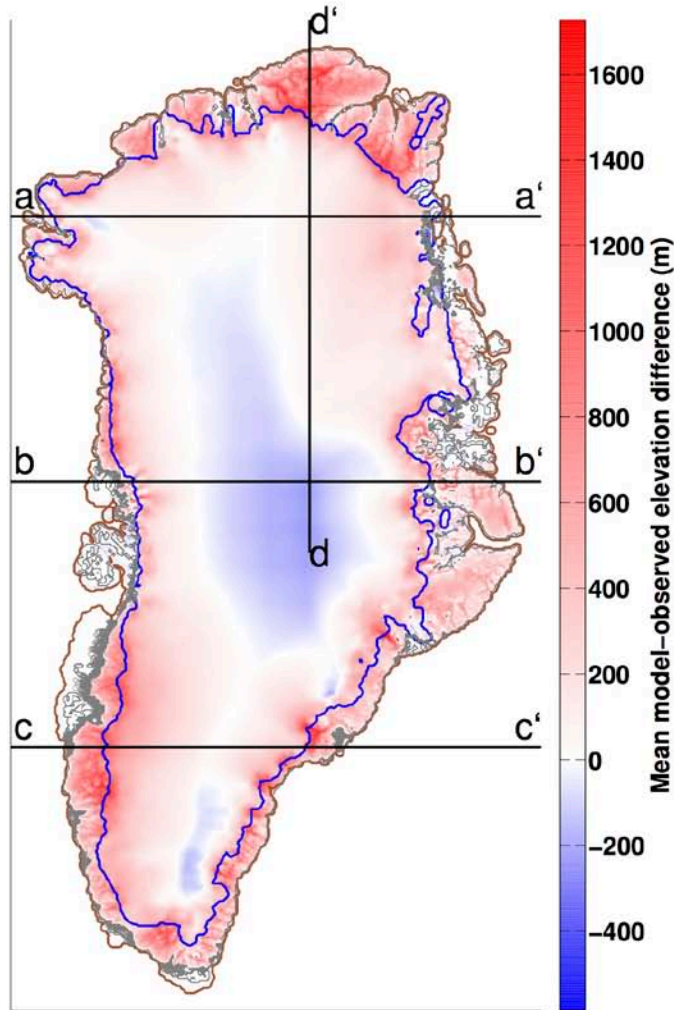
- Initial CESM-CISM sea level rise results from Greenland
- Transient, CESM-climate-consistent ice sheet spin-up
- CESM non-ice-sheet SMB evaluation
- Development and evaluation of CESM-CISM coupling

Jeremy Fyke

Bill Lipscomb

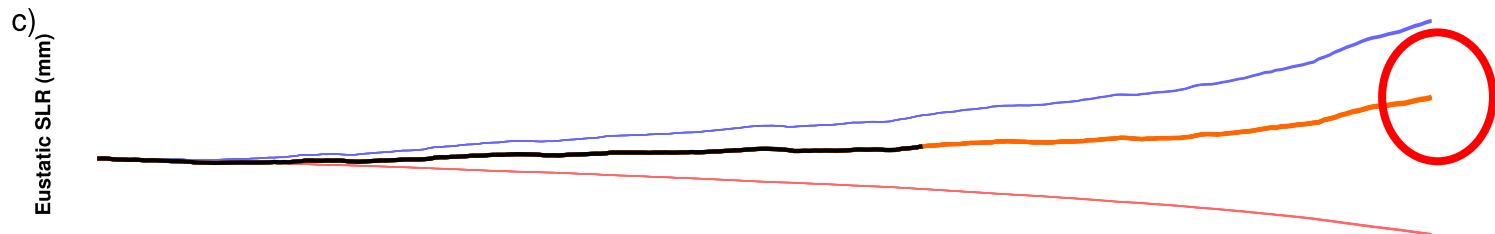
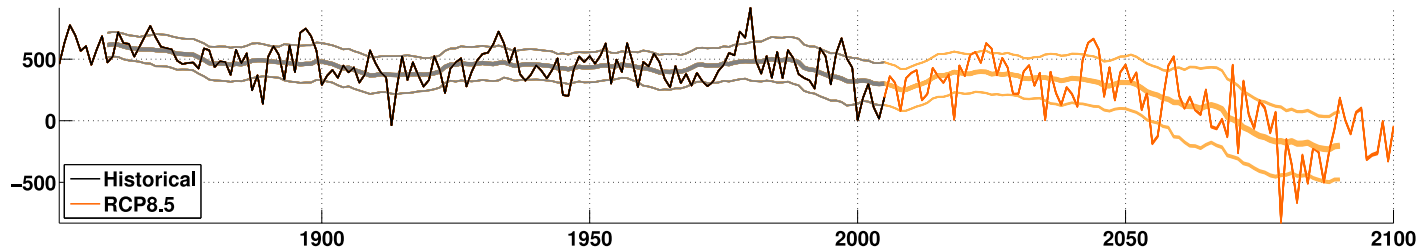
Bill Sacks

Preindustrial CISM Greenland steady-state perturbed-physics ensemble



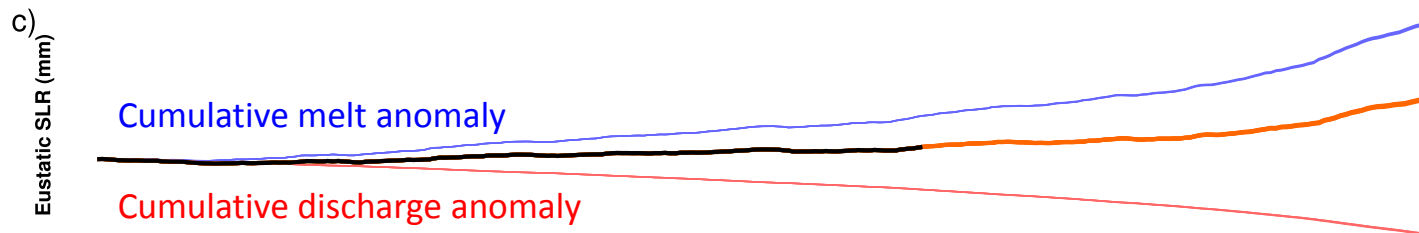
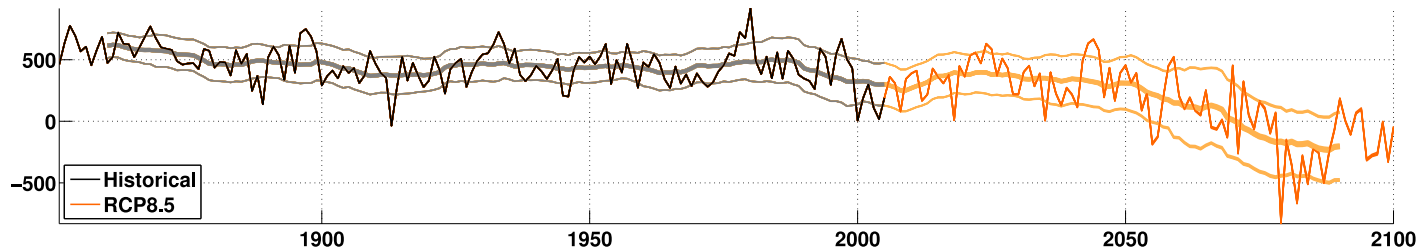
RCP8.5 GIS sea level rise contribution predictions (Lipscomb et al., submitted)

- Best initial GIS configurations generate 7.3 cm of eustatic sea level rise (SLR) 1850-2100



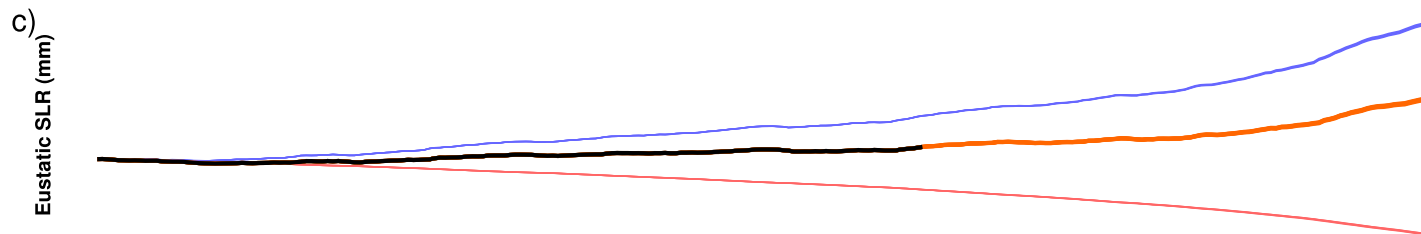
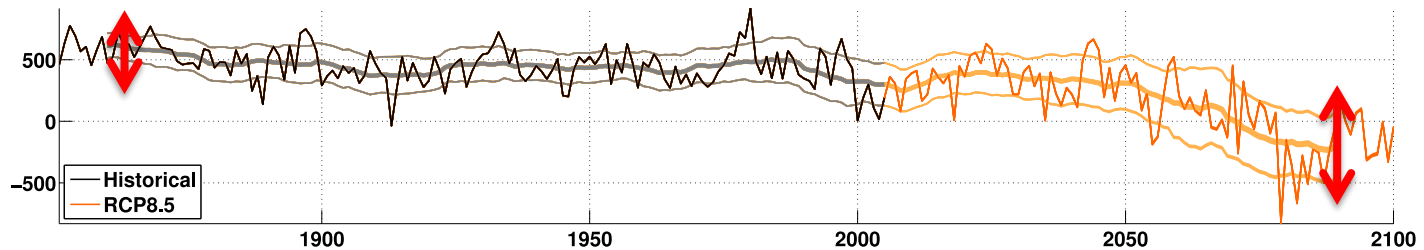
RCP8.5 GIS sea level rise contribution predictions

- Negative feedback between ice thickness and ice velocity: dampens GIS SLR contribution (also noted in w/ Elmer [Gillet-Chaulet et al., 2012] and others [Goelzer, AGU 2012])



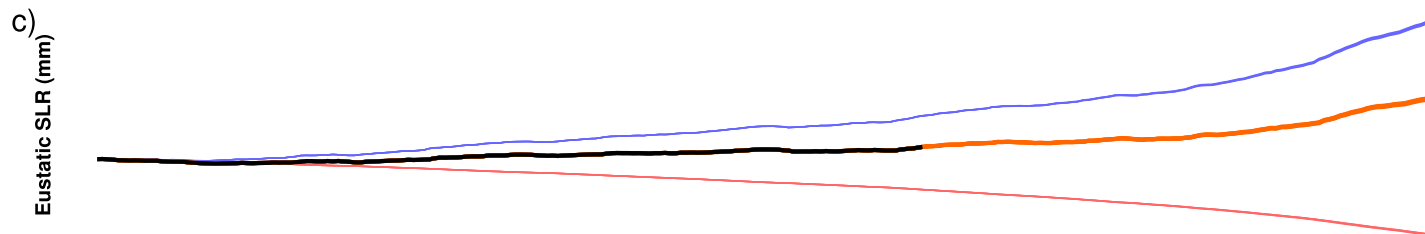
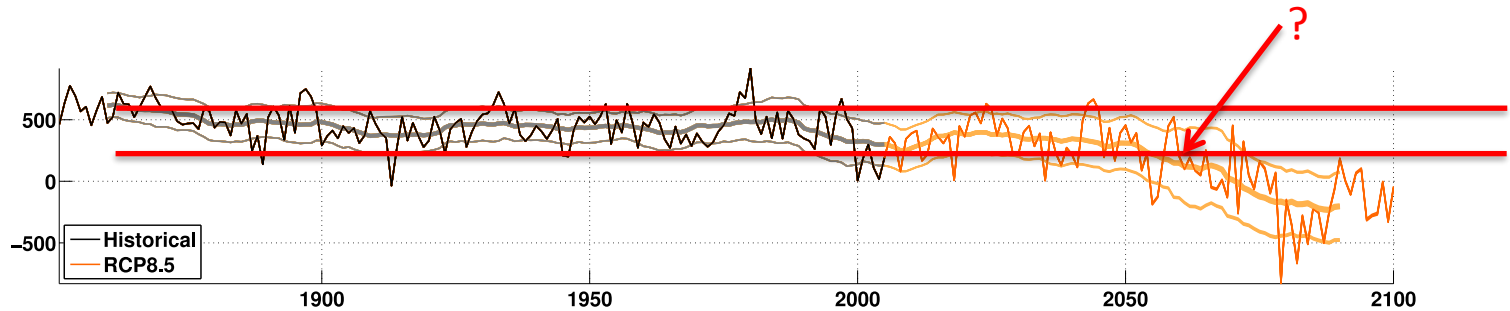
RCP8.5 GIS sea level rise contribution predictions

- Variability in ablation dominates overall SMB variability (+ increase in future variability?)

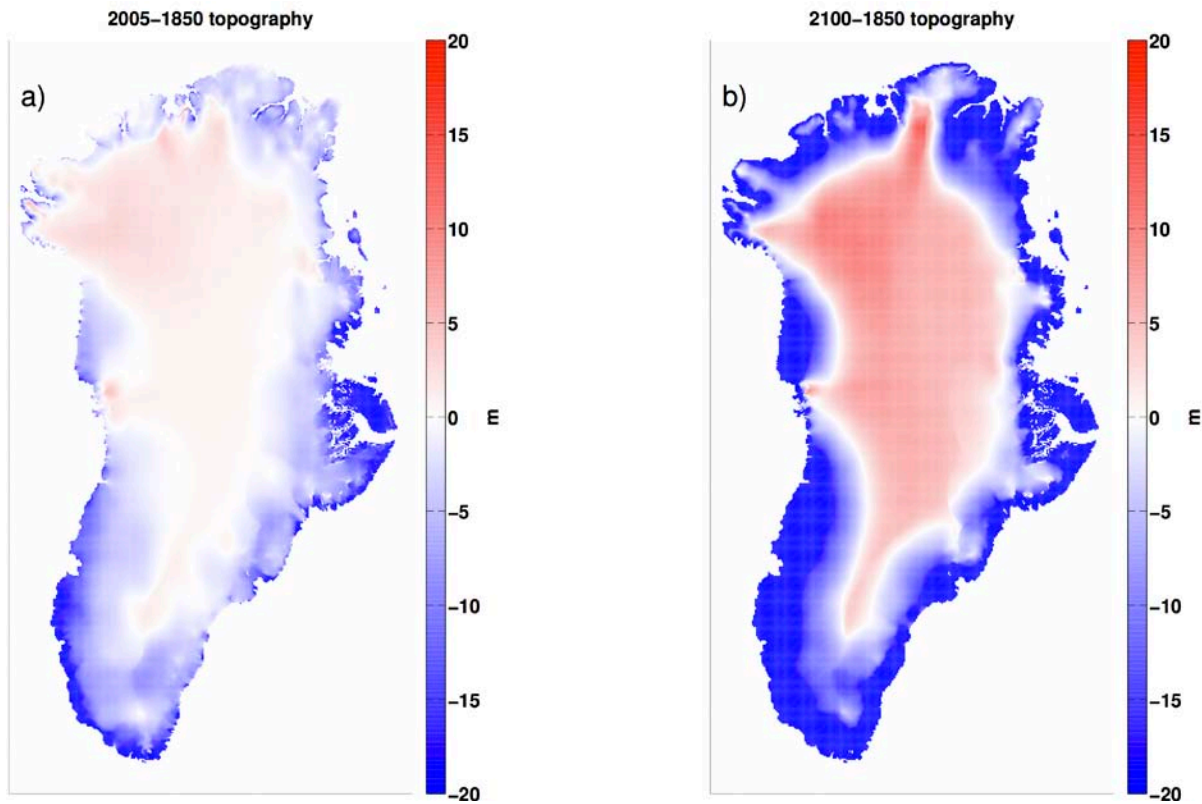


RCP8.5 GIS sea level rise contribution predictions

- Can we actually attempt to attribute CESM GIS SMB changes to anthropogenic forcing?

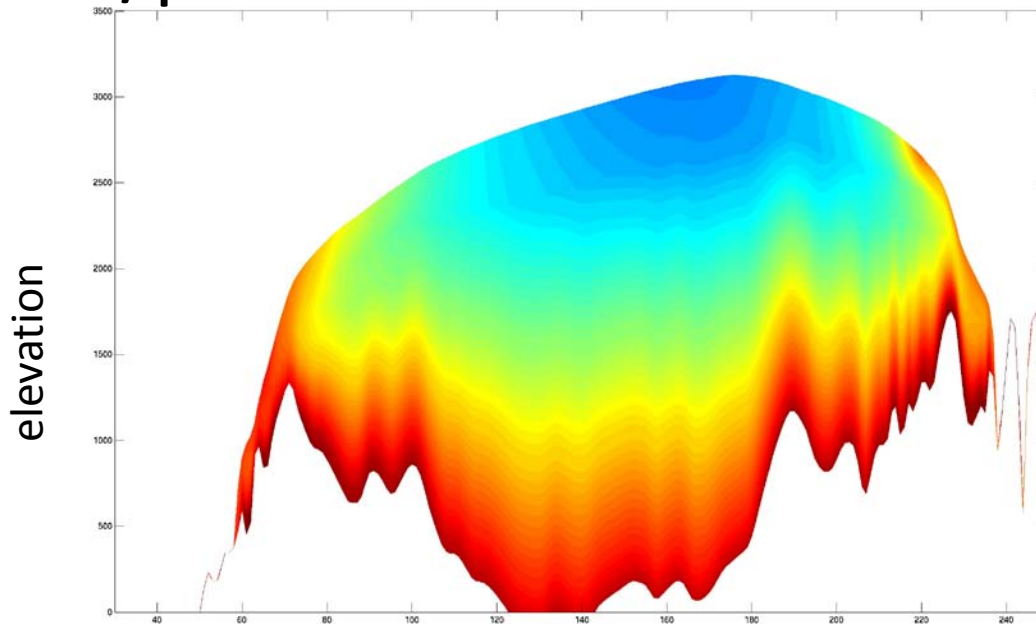


RCP8.5 GIS sea level rise contribution predictions

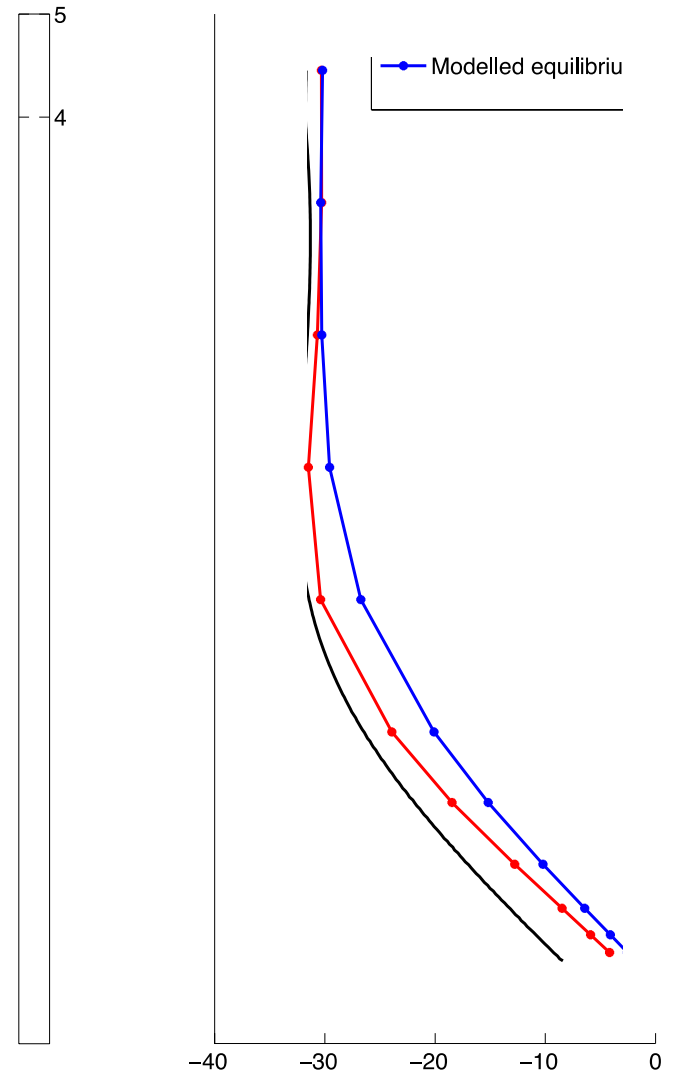


Ice sheet spin-up

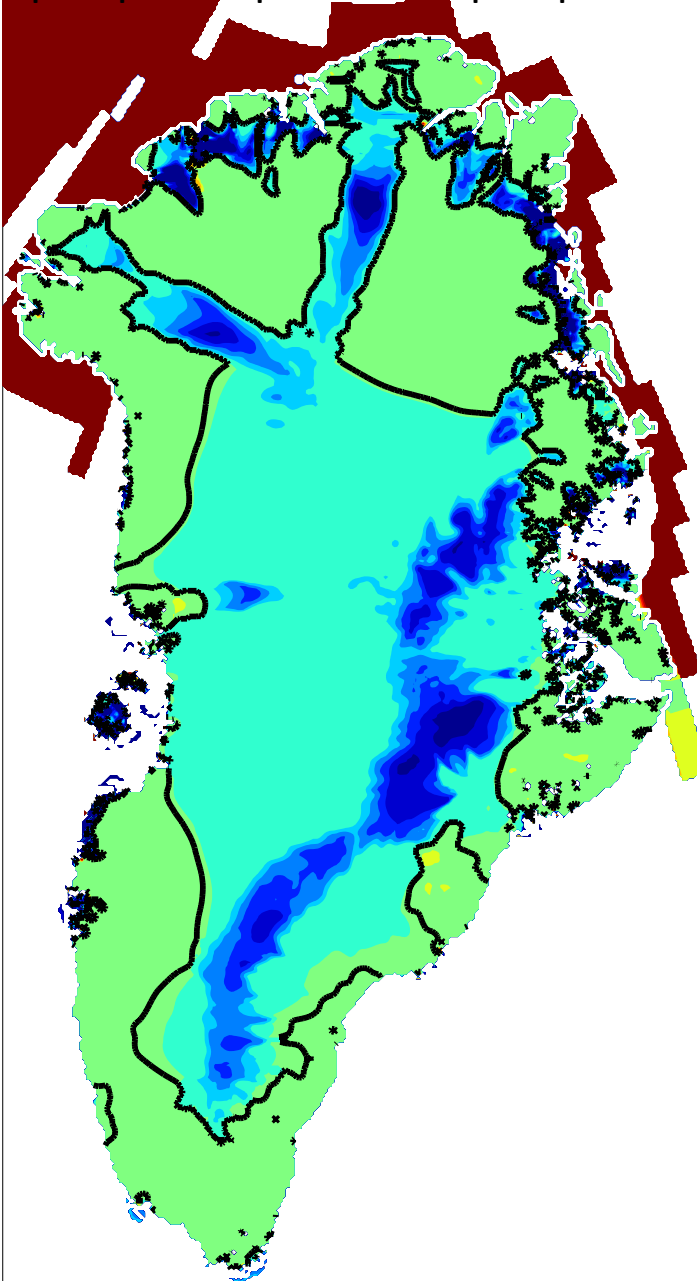
- CESM-and-climate-consistent 122,000 year spin up completed through last glacial cycle []
- Forced with GRIP $\delta^{18}\text{O}$ -interpolated SMB, end-members from CCSM4 LGM/mid-Holocene/preindustrial IG simulations



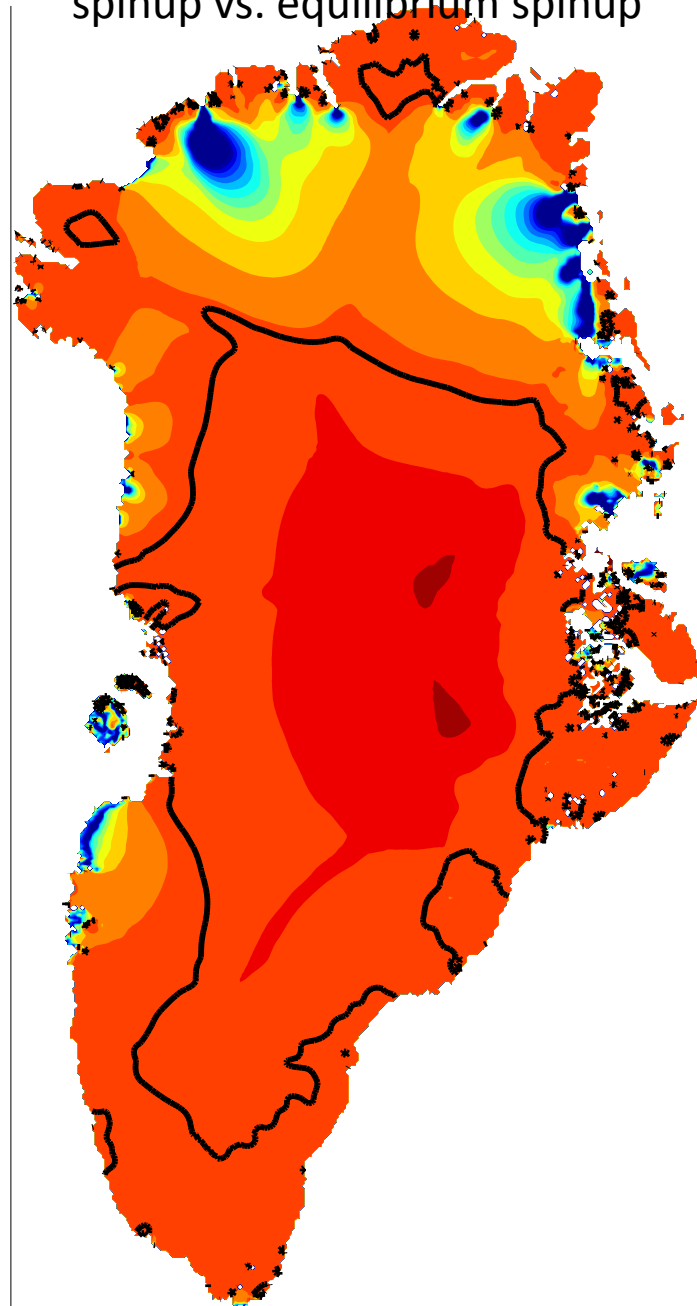
Comparison to observed GRIP temperature profile



Difference in basal temperature: transient spinup vs. equilibrium spinup

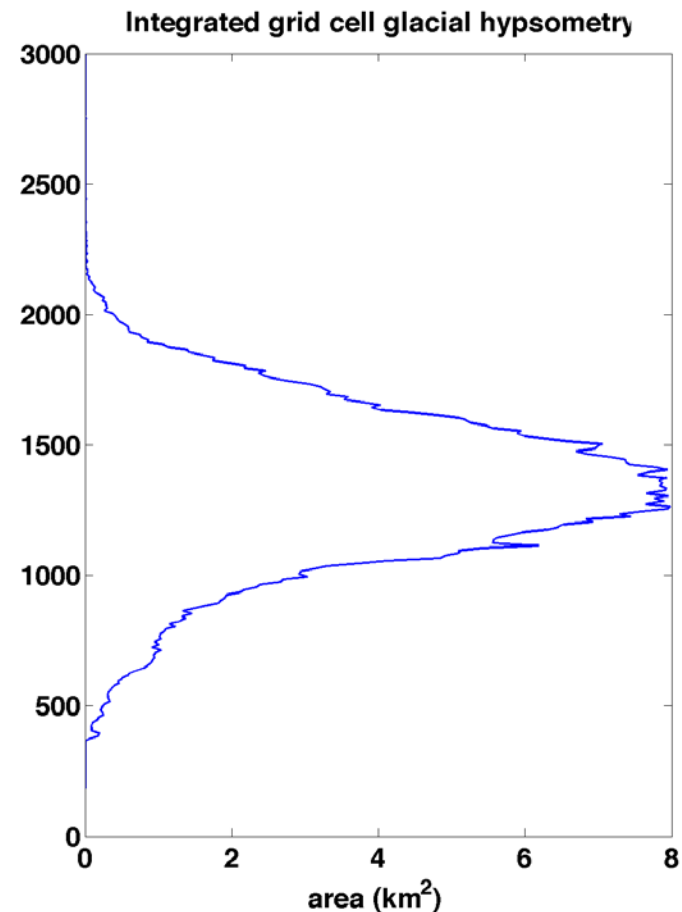
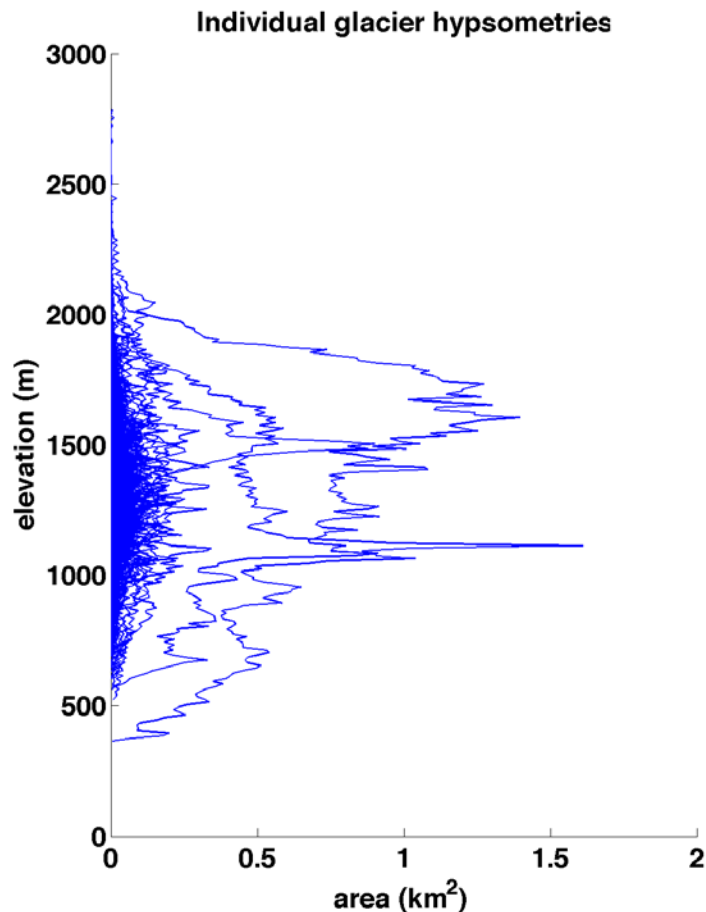


Difference in surface height: transient spinup vs. equilibrium spinup



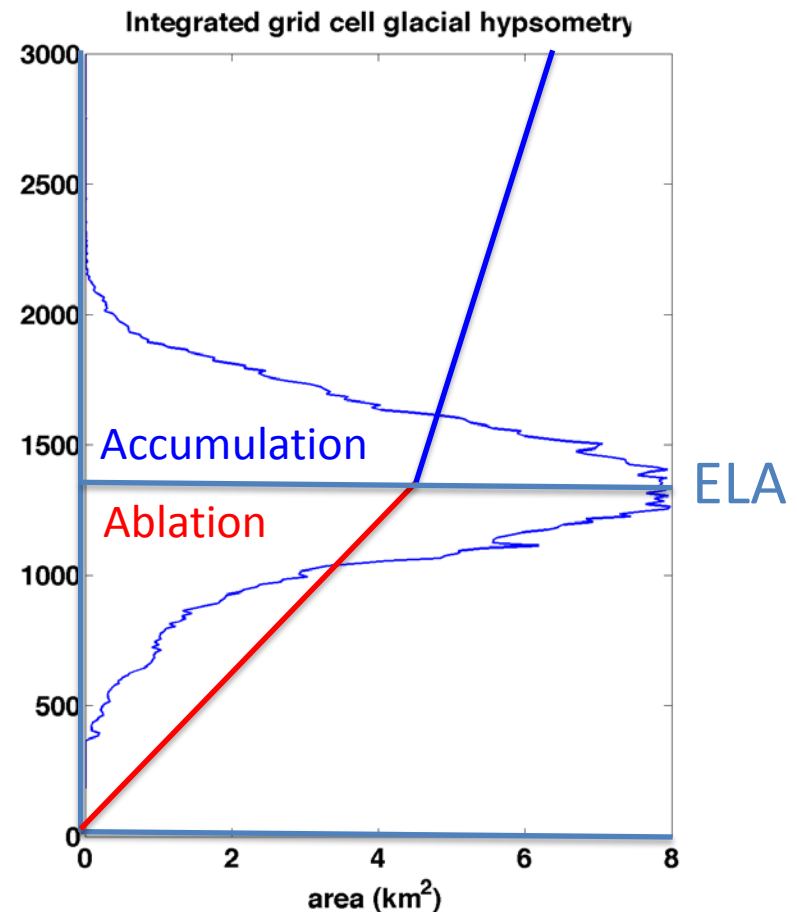
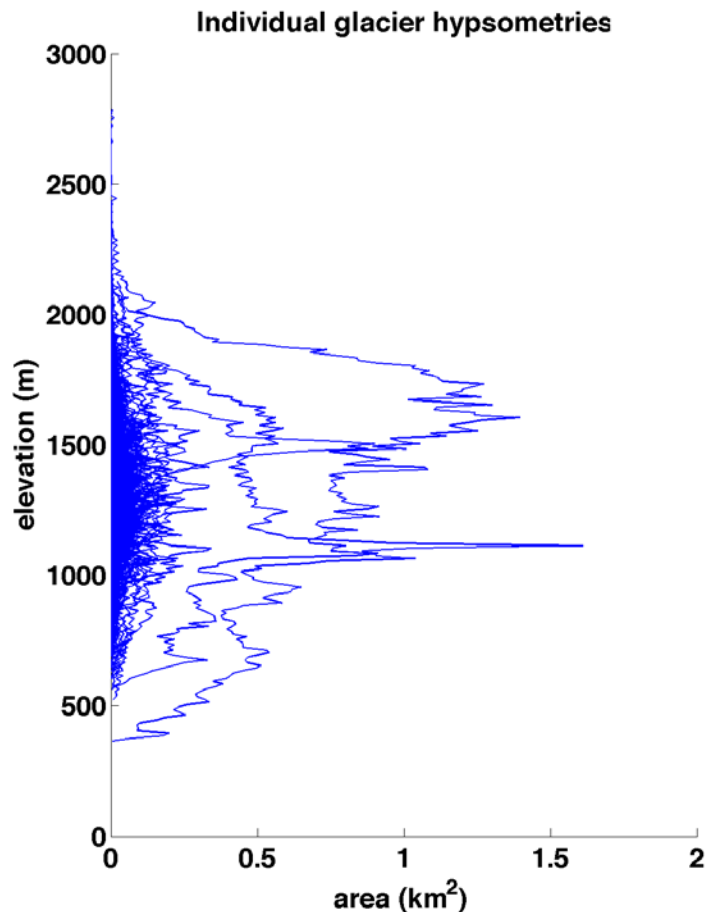
CESM non-GIS surface mass balance evaluation

- Issue: how to evaluate CESM non-ice-sheet SMB, given extreme sparsity of SMB observations?



CESM non-GIS surface mass balance evaluation

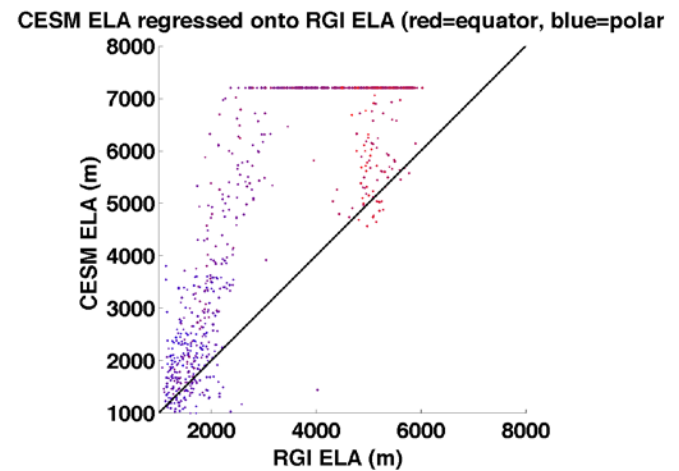
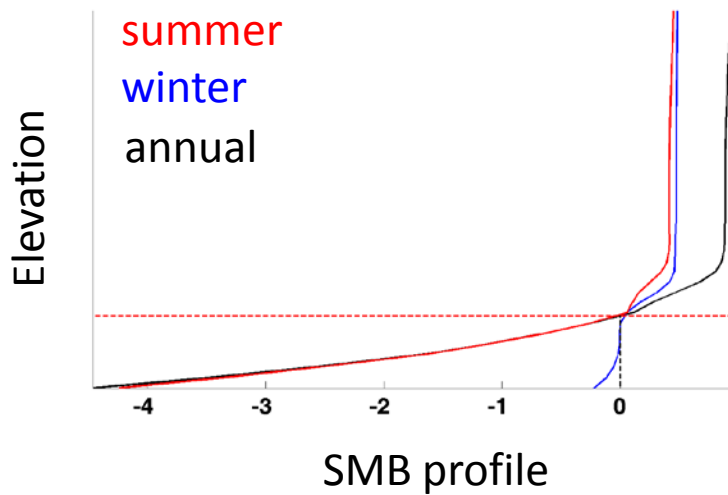
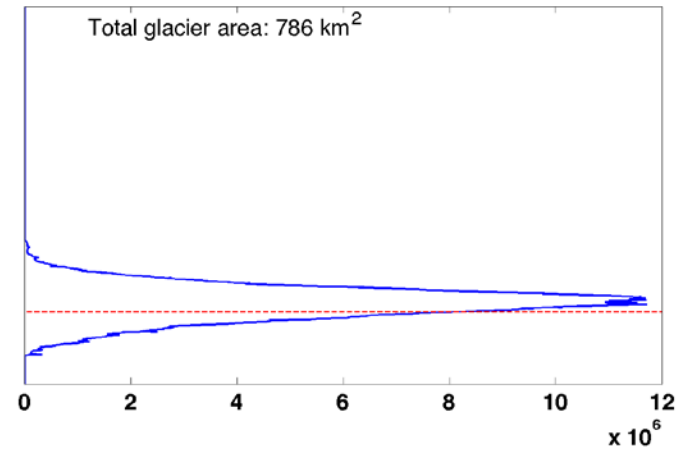
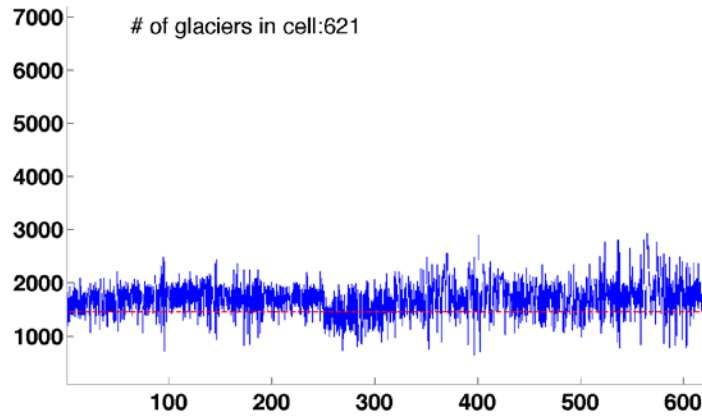
- Empirically, observed ELA occurs where accumulation area = $0.57 \times$ total area [Bahr et al., 2009]



CESM non-GIS surface mass balance evaluation

- Simulated SMB fields can be compared against against RGI-derived hypsometry
- ELA (line of net 0 ice **gain/loss**) useful as a composite indicator of T/P conditions: gives a glaciologically-relevant, global-coverage metric of climate model performance: **vertical ELA bias**

CESM non-GIS surface mass balance evaluation



Progress/upcoming work

- Ongoing/upcoming work broadly falls under:
 - Ice sheet-climate coupling development
 - Climate model surface mass balance validation



Coupling to-dos:

- **Dynamic landunits** (Bill Sacks, Jon Wolfe):
 - Necessary to grow tundra, etc., as Greenland Ice Sheet retreats
 - Complementary to other CESM requirements for dynamic land units
 - Summer 2013 completion?
- **Runoff routing to ocean:**
 - Necessary for linking ice volume changes to ocean freshwater forcing, isolating ocean-sea ice/ice sheet feedbacks
 - Summer 2013 completion?

Coupling to-dos, *continued*:

- **Dynamic atmosphere coupling** (Fyke, Lauritzen):
 - Necessary to allow dynamic atmospheric adjustment to ice sheet geometry changes
 - First coupling to be bash-scripted, based on DART
 - Fall 2013 completion?
- **Conservative downscaling to ice grid, multiple ice sheet instances** (Wolfe, Sacks, Lipscomb):
 - Current downscaling scheme non-conservative
 - Multiple ice instances needed to support simultaneous Antarctic, Laurentide, Fennoscandian (etc.) ice sheets
 - Fall 2013 completion?

Upcoming CESM-side evaluations

- CAM5-forced BG simulation (Fyke, Vizcaino):
 - Can we improve marginal Greenland + SMB bias
- SMB evaluation: Antarctic Ice Sheet (Vizcaino):
 - What does CESM AIS SMB look like?
- SMB evaluation: CLM4.5 (Fyke, Vizcaino):
 - How will SMB change with migration to CLM4.5?
- Diagnosis tools for evaluating land ice performance in CESM (Kate Evans, Jenn Kay)