

- 
- 1.Science:** Future Greenland surface mass balance variability change; anthropogenic SMB signal detection
 - 2.Development:** CESM/CISM atmosphere-topography coupling

Jeremy Fyke...

Miren Vizcaino

Bill Sacks

Bill Lipscomb

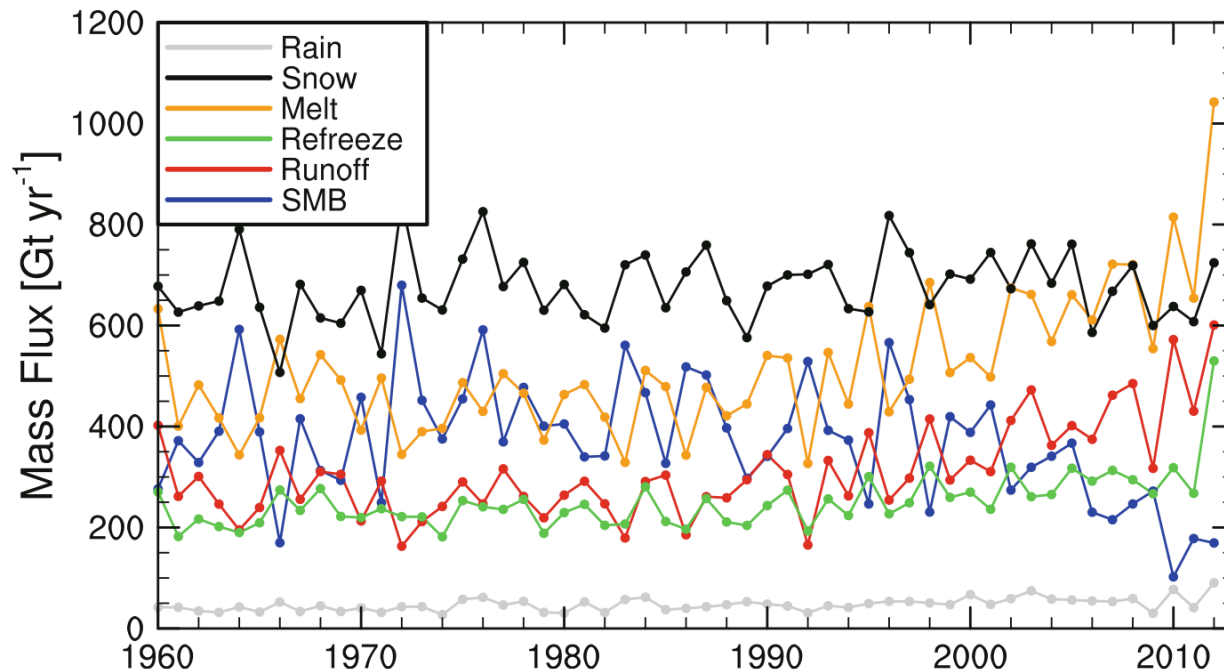
Peter Lauritzen

Steve Price

...

Greenland SMB variability

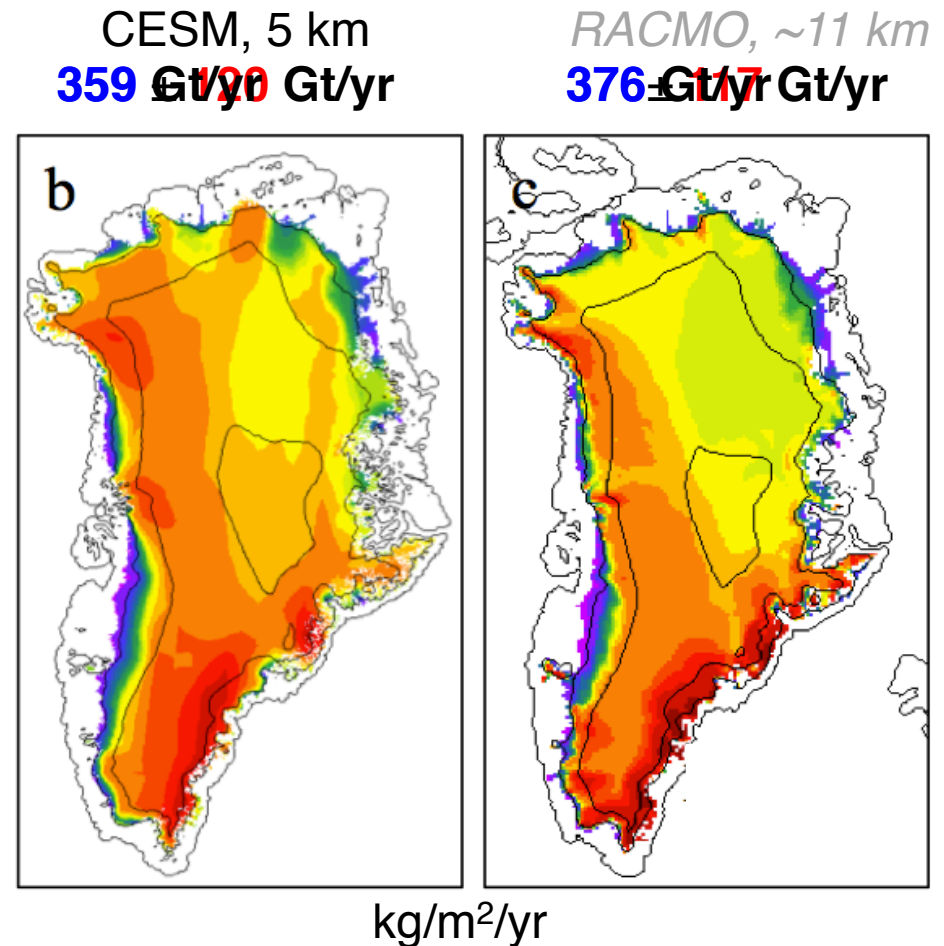
Greenland Ice Sheet (GrIS) surface mass balance (SMB) exhibits large interannual variability



How/why will this variability evolve under projected 21st century climate change?

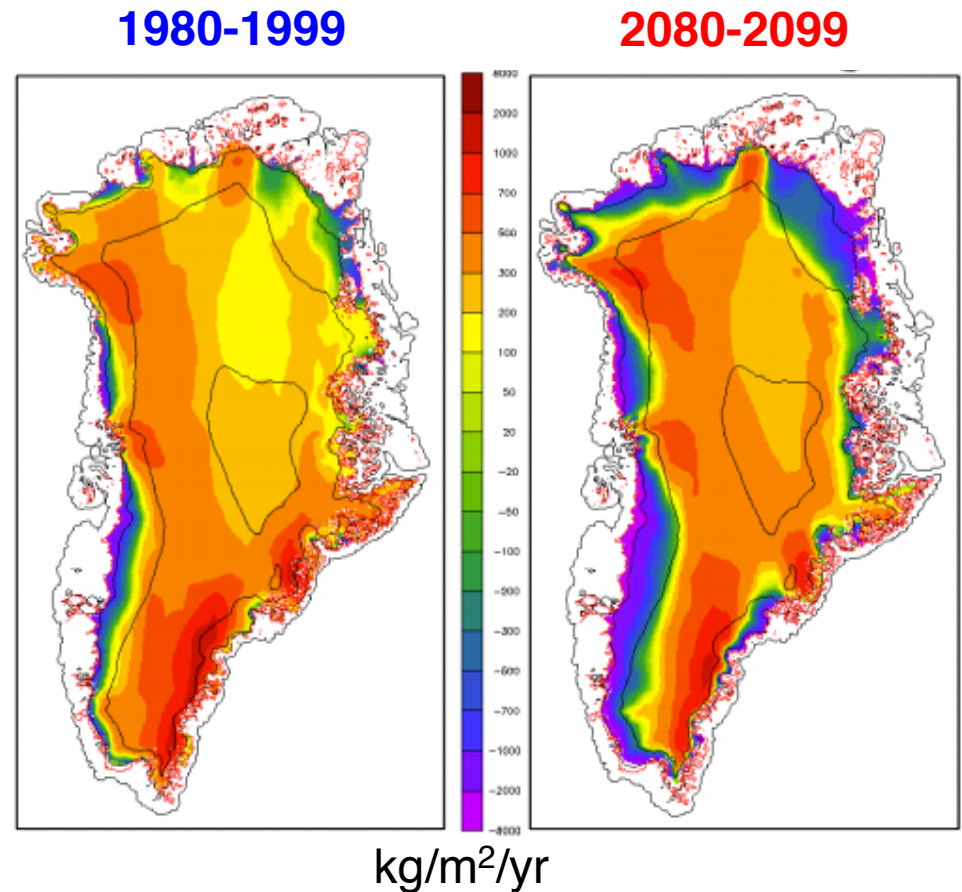
Evaluation

- CESM compared to RACMO2 regional model, in-situ/remote observations
- **Absolute CESM SMB and pattern of SMB** is similar to RACMO2 SMB (1960-2005) and in-situ and remote sensing observations
- **CESM SMB variability** is similar to RACMO2

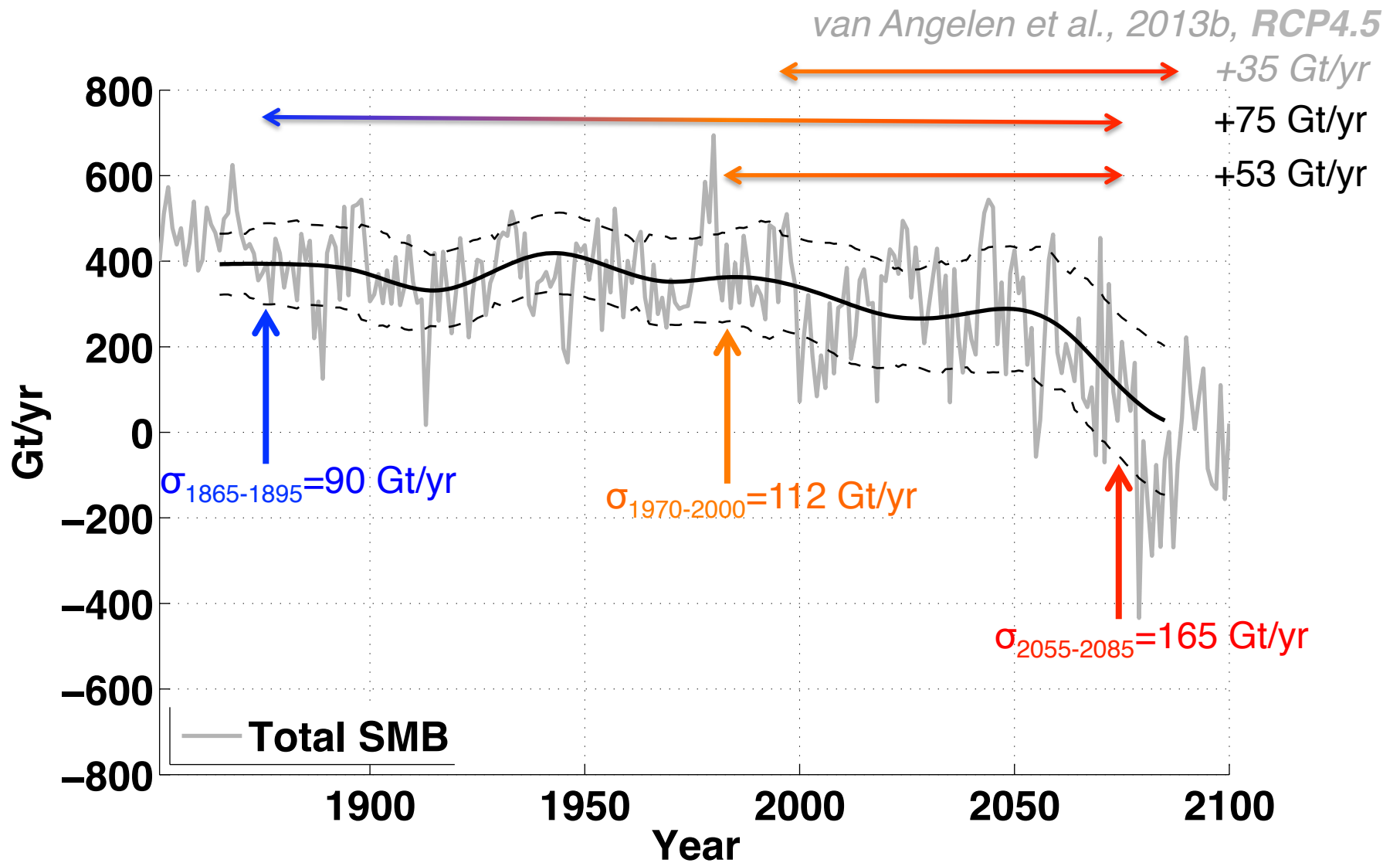


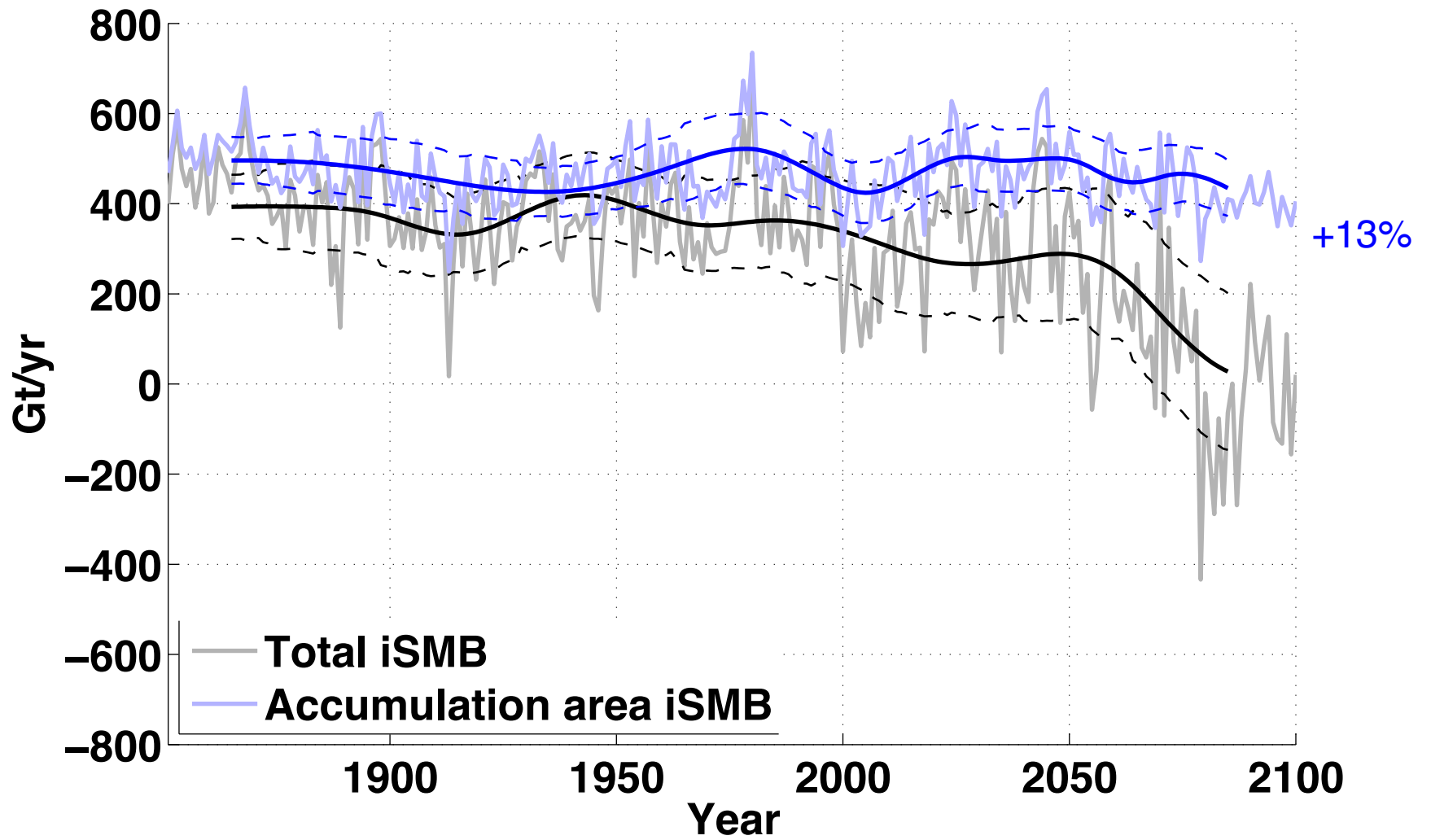
Projection

- Fully coupled CESM (fixed present-day GrIS geometry) forced with **RCP8.5 scenario to 2100**
- Interior snowfall, margin ablation both increase
- Net effect: simulated **SMB becomes negative** by end of 21st century

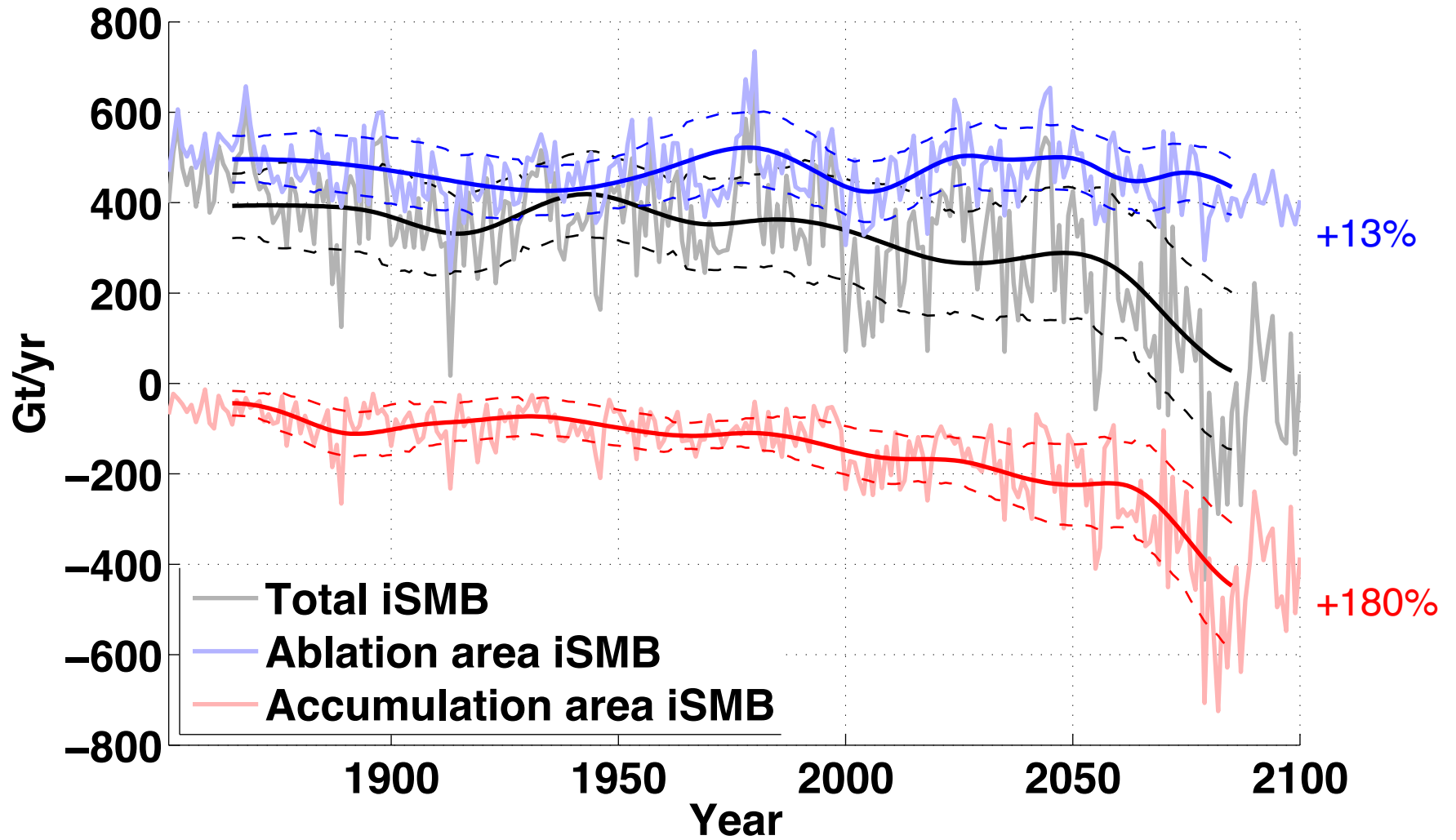


SMB variability change

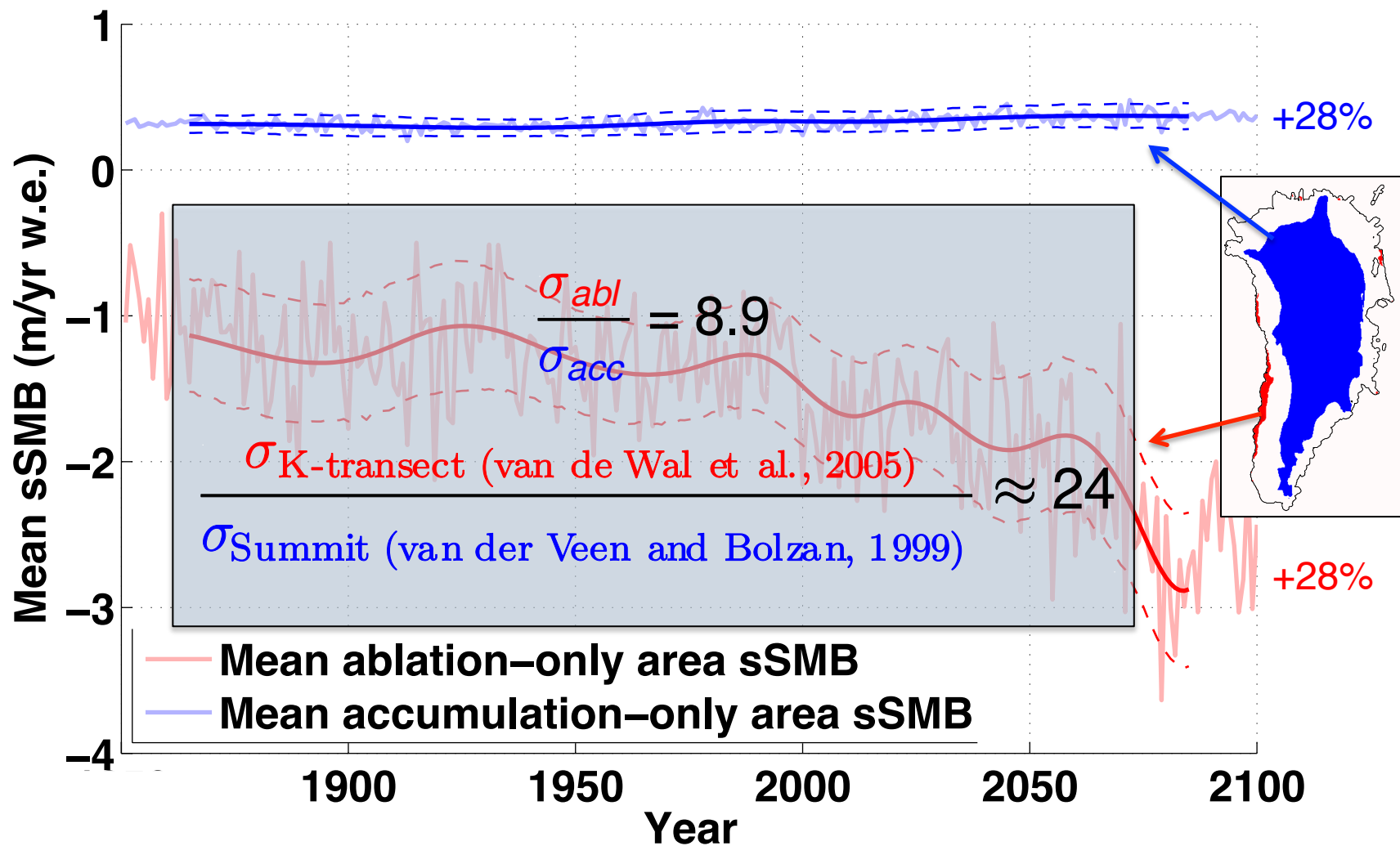




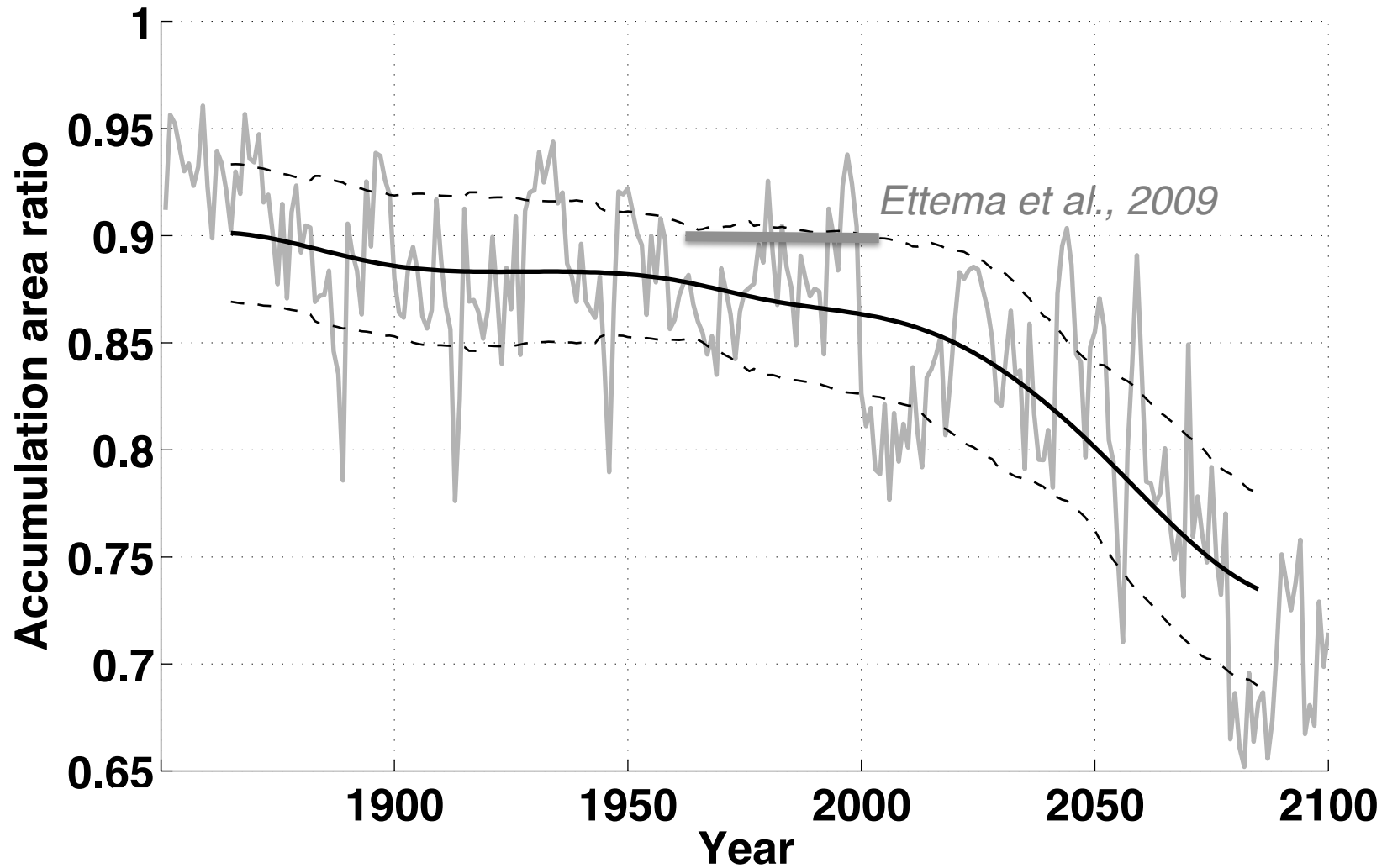
Increased variability in evolving ablation area → overall variability increase



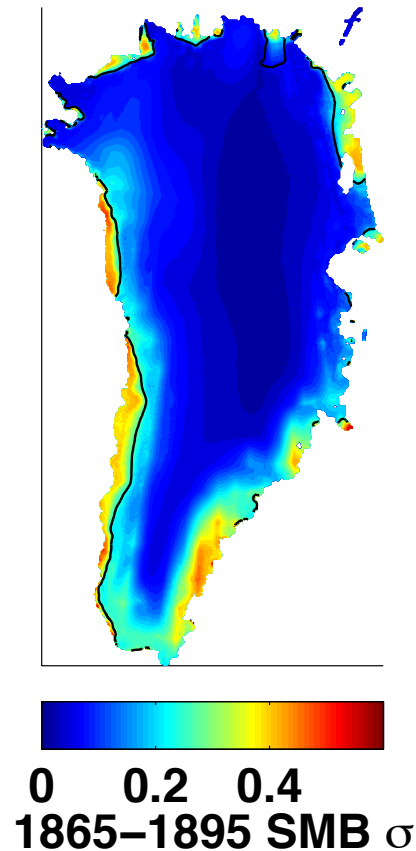
Increased ablation area integrated SMB variability not explained by increasing ablation area specific SMB variability alone



Accumulation area ratio decreases by ~20% during course of simulation due to expansion of ablation area



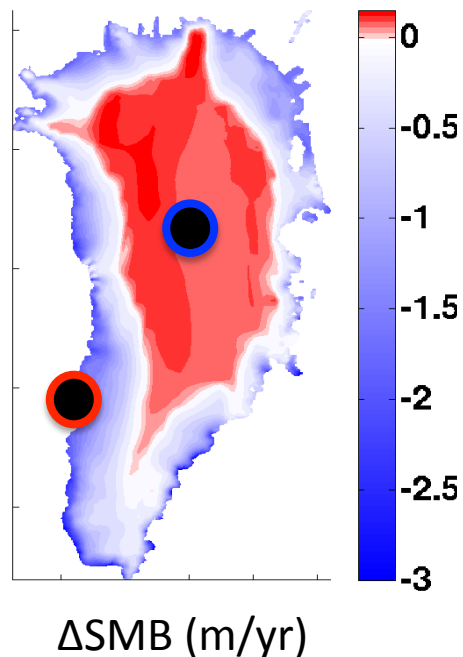
Increasing relatively low-variability accumulation area with high-variability ablation area should increase overall SMB variability, with a large fraction of variability increase occurring between initial and final ELAs...



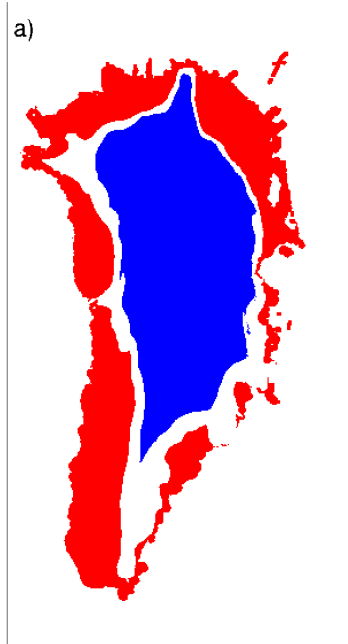
Increased GrIS SMB variability will be a robust consequence of future anthropogenic warming

Greenland Ice Sheet (GrIS) surface mass balance changes dramatically in the 21st century

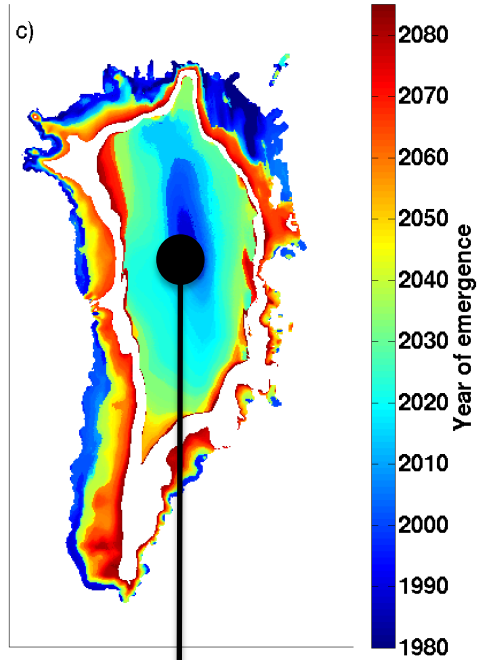
*Motivated by Mora et al. (2013), Hawkins and Sutton (2012), Mahlstein et al. (2011), we ask: **When will the signal of anthropogenic climate change emerge clearly in GrIS SMB?***



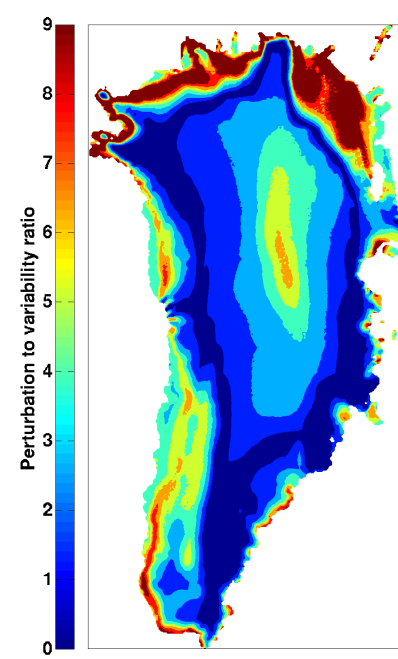
Emergence direction



Emergence year



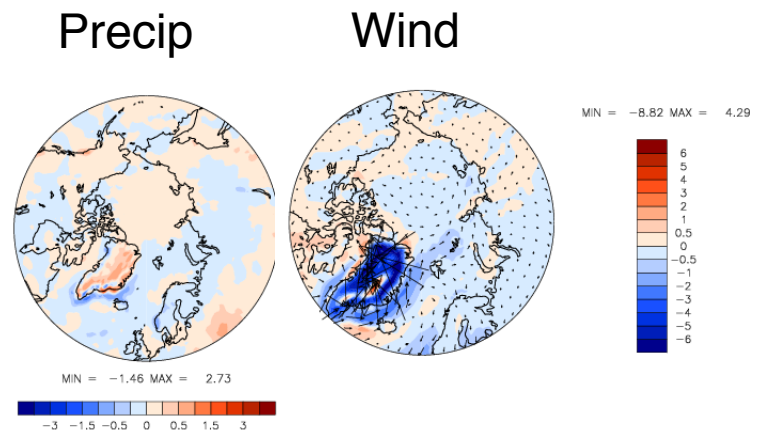
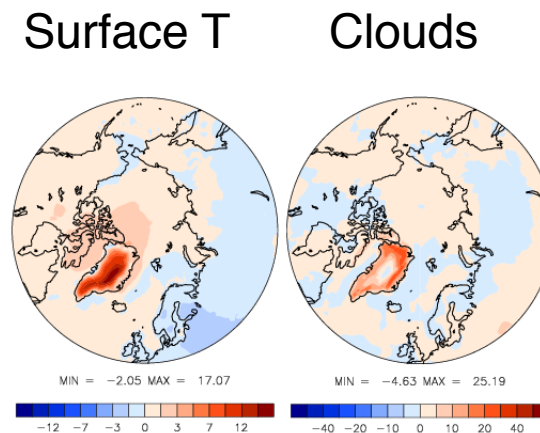
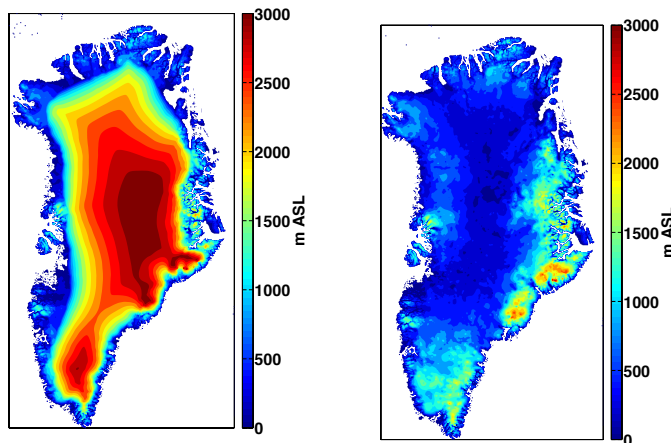
Perturbation:variability

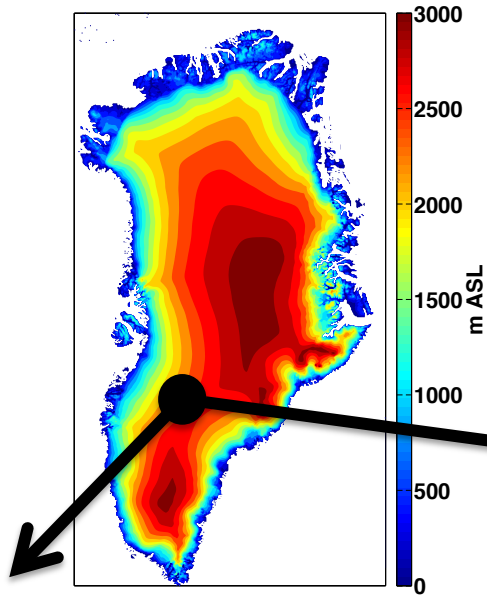


Development

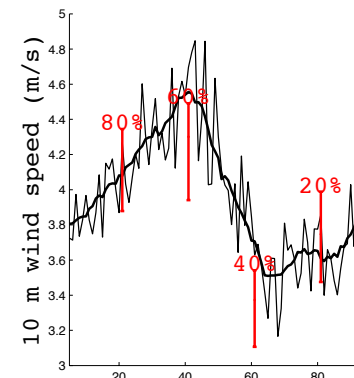
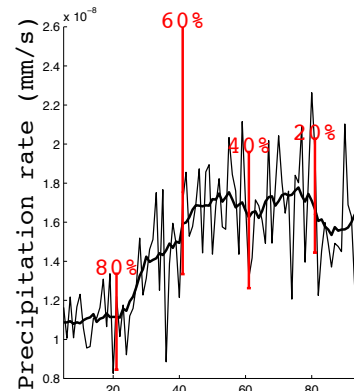
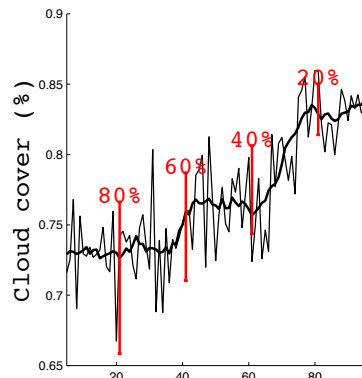
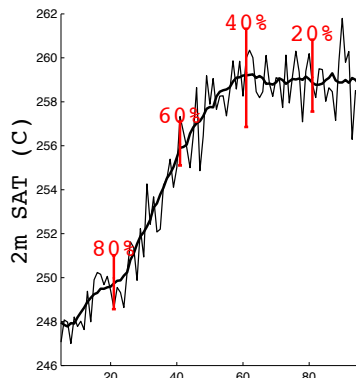
dynamic atmosphere-topography coupling

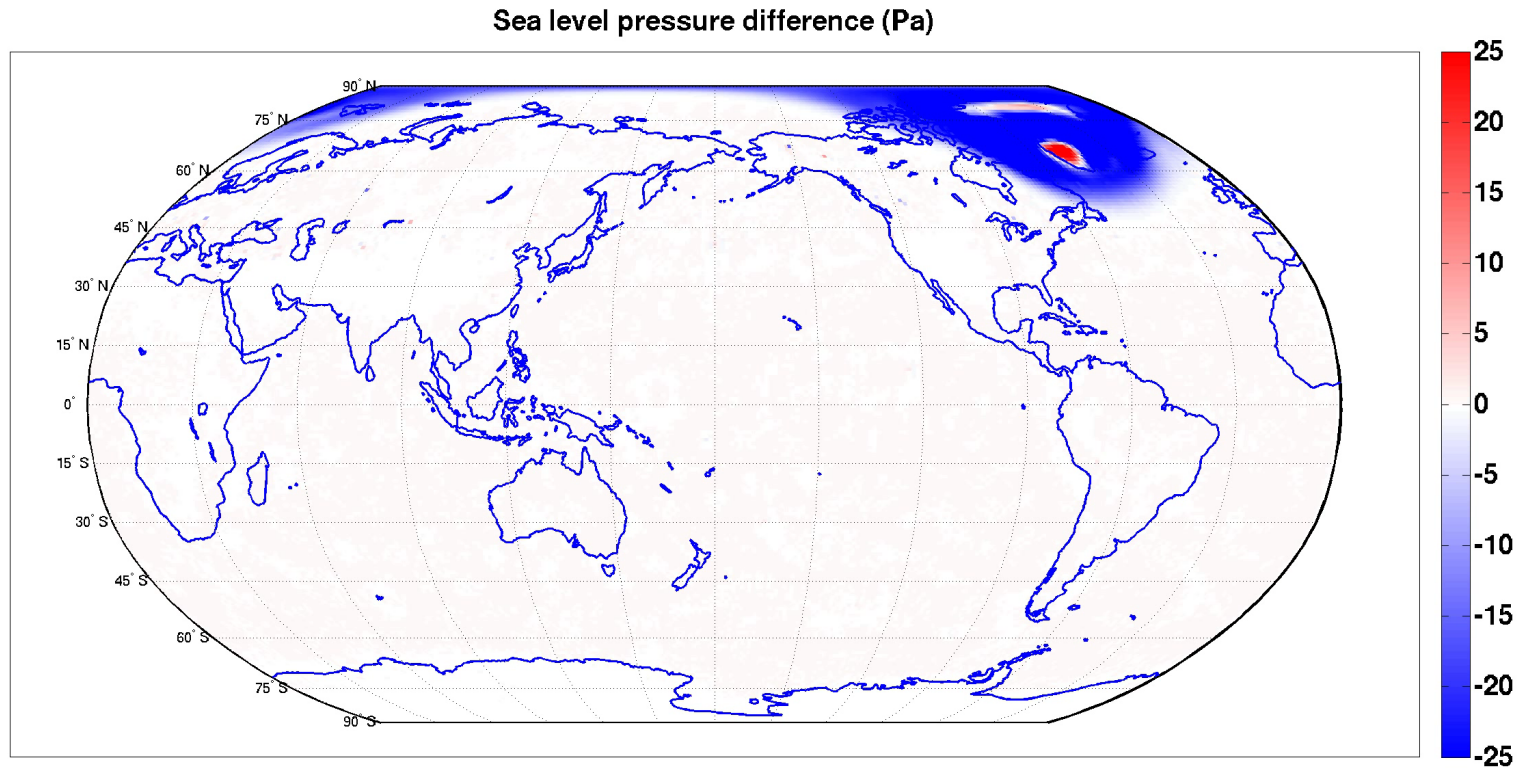
- Coupling approach merges evolving high-resolution ice sheet model topography into CAM topography annually.
- Procedure tested using **AGCM simulations with CAM5-FV 1°**.





- Transient deglacial simulation with coupling procedure moves through **snapshot climatological states**





- Pressure shock from (unrealistically large!) topography change dissipates to levels below atmospheric model noise in ~ 3 days

Upcoming work

1. Development:

1. Continue coupling developments
2. Merge coupling developments into one model, perform extended testing
3. Document coupled model

2. Science:

1. Climate/SMB feedback analysis
2. Fully 2-way-coupled simulations