

Coupled ice sheet/climate simulations of Greenland evolution in high-CO₂ conditions: sensitivity to modelled polar amplification

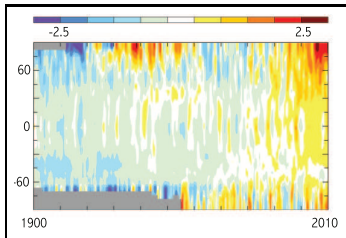
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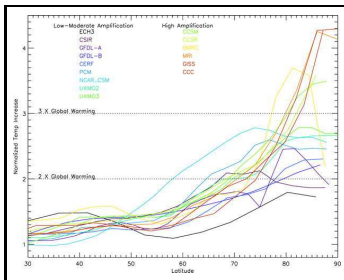
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2. Climate Modelling Group (University of Victoria)

overview

- ice sheet/climate model description
- Greenland Ice Sheet (GIS) deglaciation simulation sensitivity to model polar amplification (PA)



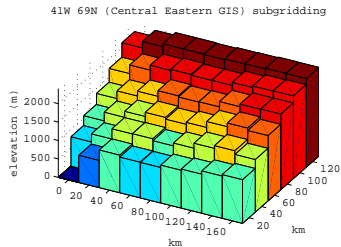
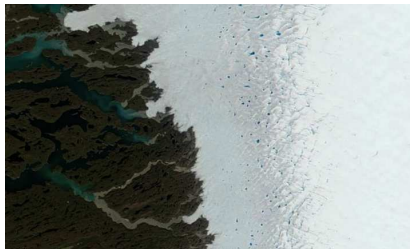
(a) Annual zonal mean SAT anomalies ($^{\circ}\text{C}$)
(NASA GISTEMP)



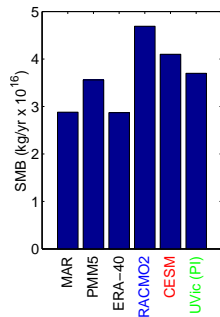
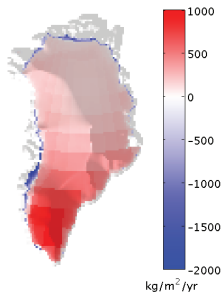
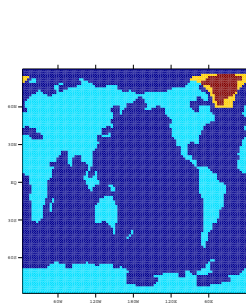
(b) AOGCM PAs (Holland and Bitz, 2003)

model design

- model couples UVic ESCM to PSUI (Fyke et al., 2011)
- accumulation from climate model snowfall
- melt/sublimation calculated by energy-moisture balance model on dynamic sub-gridded elevation bins
- model SAT bias corrected in calculations
- moisture/energy conserved across ice/climate coupling



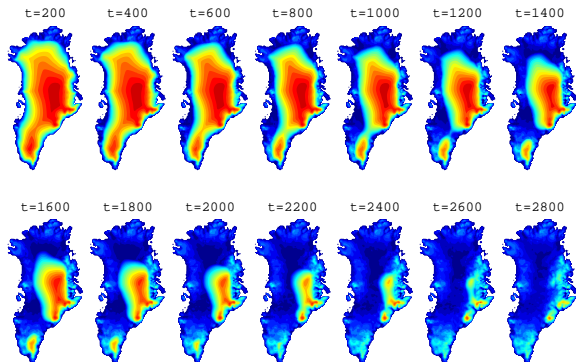
model layout, present day SMB/ice thickness



experimental design

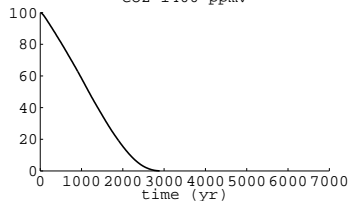
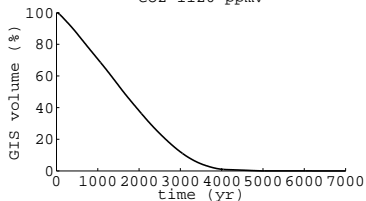
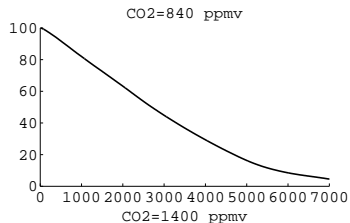
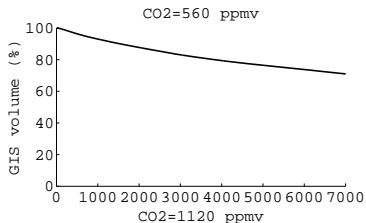
- **boundary conditions:** from late Holocene initial conditions, CO₂ elevated to multiples of 280 ppmv
- **PA sensitivity:** vary atmospheric diffusivity profile as a function of global average SAT anomaly (*M. Eby*)
 - HIGH: ↑ range of IPCC AR4 ensemble A2 Arctic amplification
 - LOW: ↓ range of IPCC AR4 ensemble A2 Arctic amplification
- **PA sensitivity contrasted against surface albedo sensitivity:** vary cold/warm snow, bare ice albedos by ± 0.05 about central values

distribution of ice loss

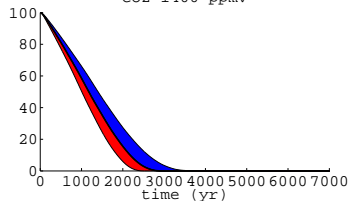
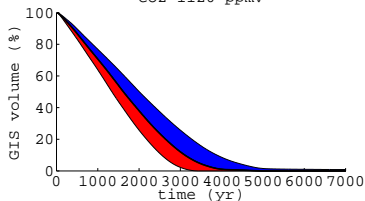
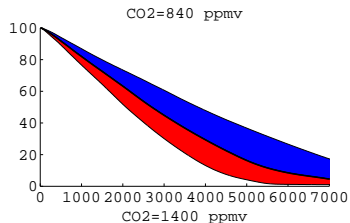
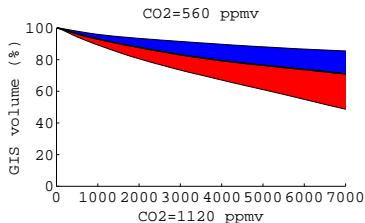


GIS deglaciation at 5x PAL CO₂

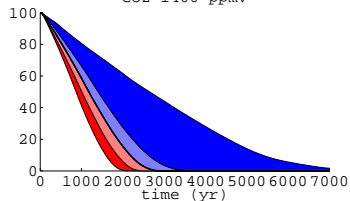
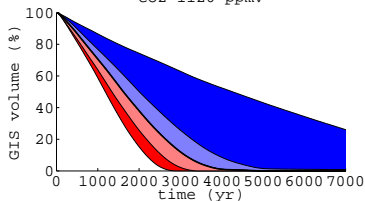
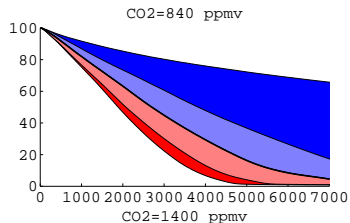
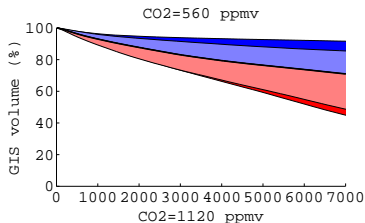
magnitude of ice loss



sensitivity to albedo



sensitivity to PA



summary

- **coupled ice sheet/climate model** used for suite of high-CO₂ sensitivity experiments
- near-total deglaciation in central simulations occurs **above 2x preindustrial concentrations of CO₂**
- PA sensitivity \geq albedo sensitivity
- **SLR predictions using AOGCMs coupled to ISMs will depend largely on model-specific Arctic amplification** (and present-day AOGCMs display large range of amplifications)
- **'correctly' modelling PA necessary** for robust 10²-10³ yr-scale predictions of GIS evolution and SLR
 - validation of model PA: comparisons of paleo-obs (Miller et al., 2010) to equivalent paleoclimate simulations
- will PA saturate?