

development, spinup procedure,
and initial synchronous multi-
millennial simulations of a
coupled ice sheet /global climate
model

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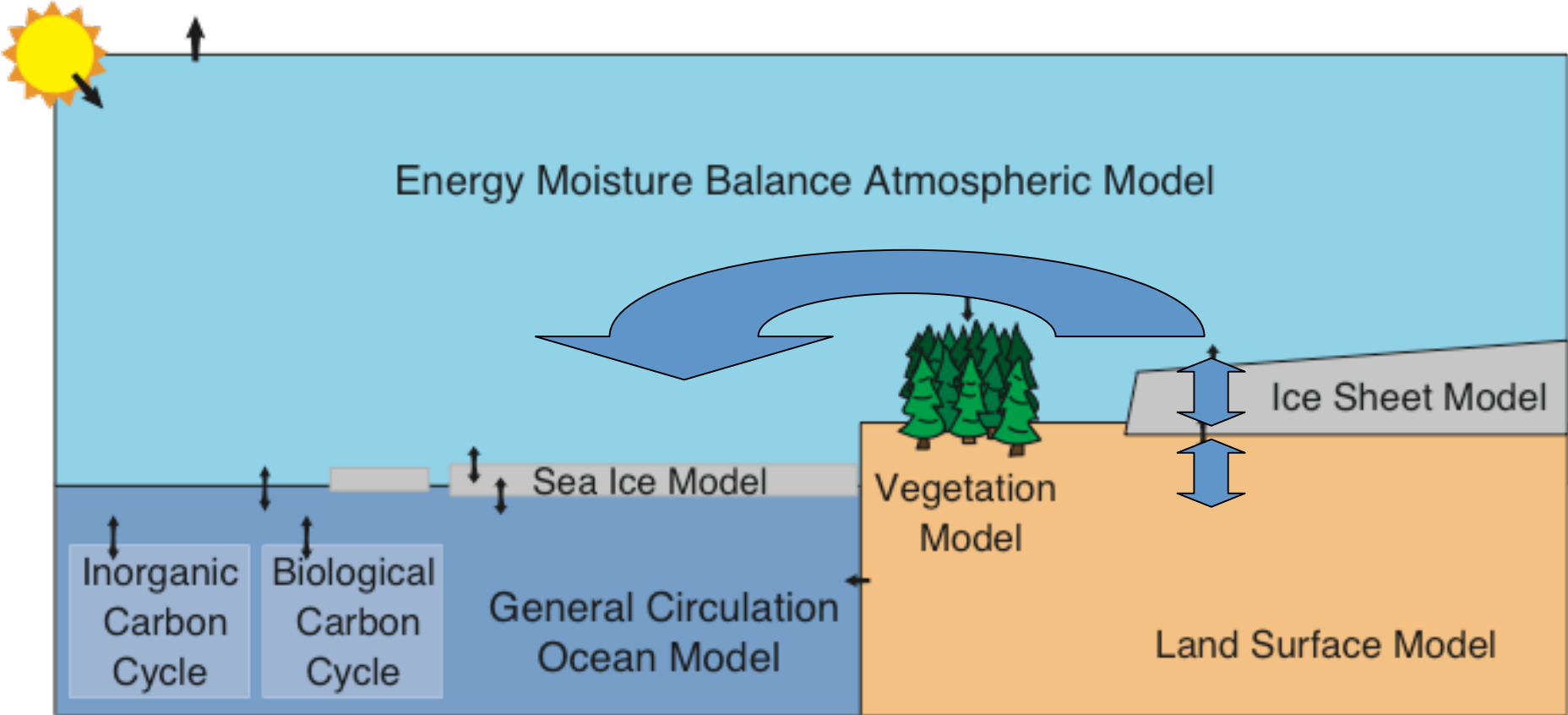
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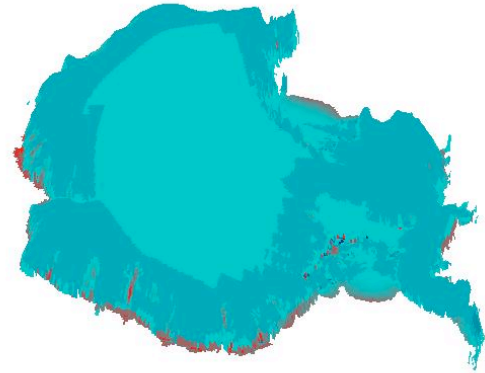
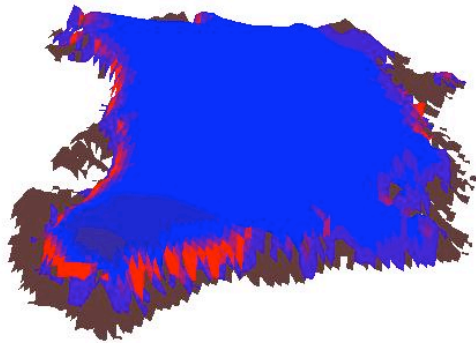
synopsis

- model set-up
 - ice and climate model descriptions
 - mass balance generation and downscaling
 - surface air temperature bias correction
- spin-up procedure
- present model performance
- initial equilibrium-CO₂ simulations

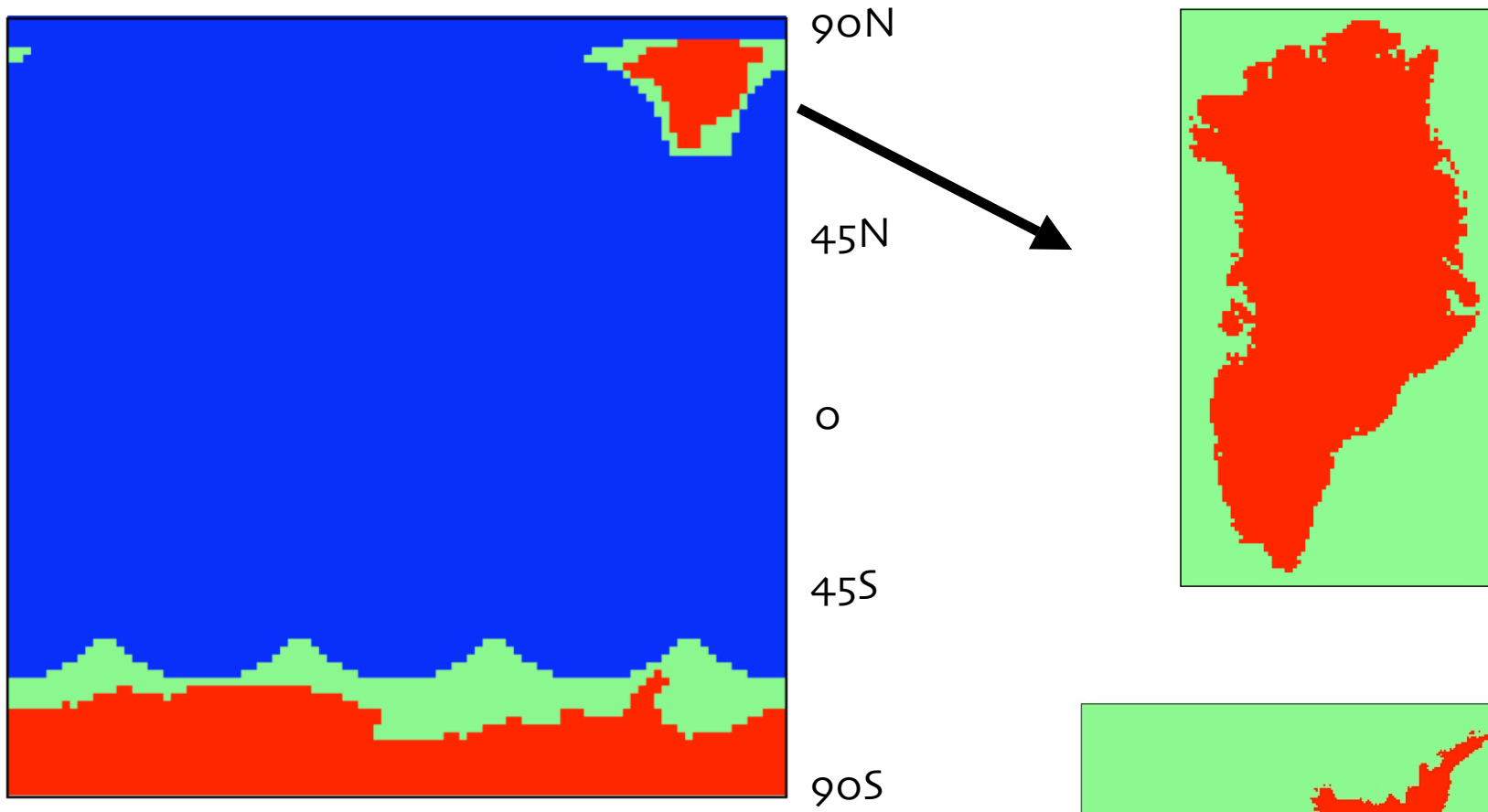
model description: UVic ESCM



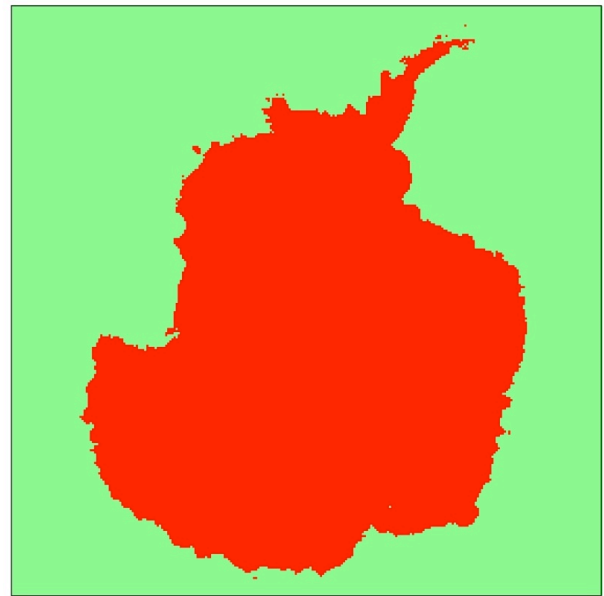
model description: PSU I



- 3D thermomechanical
- 'heuristic' combination of shallow ice approximation and vertically averaged shelfy-stream velocities
- implementation of Schoof (2007) grounding line parameterization



- climate model:
 $3.6^\circ(\text{lon}) \times 1.8^\circ(\text{lat})$
- ice models:
 20 km^2



coupling

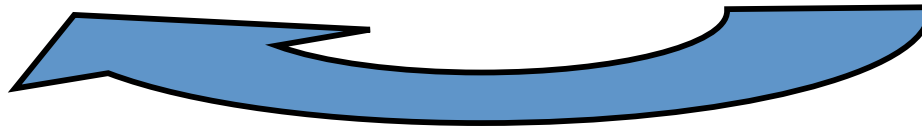


UVic ESCM passes:

- *surface mass balance*
- *sub-shelf melting rate*
(currently non-interactive)
- *boundary temperatures*

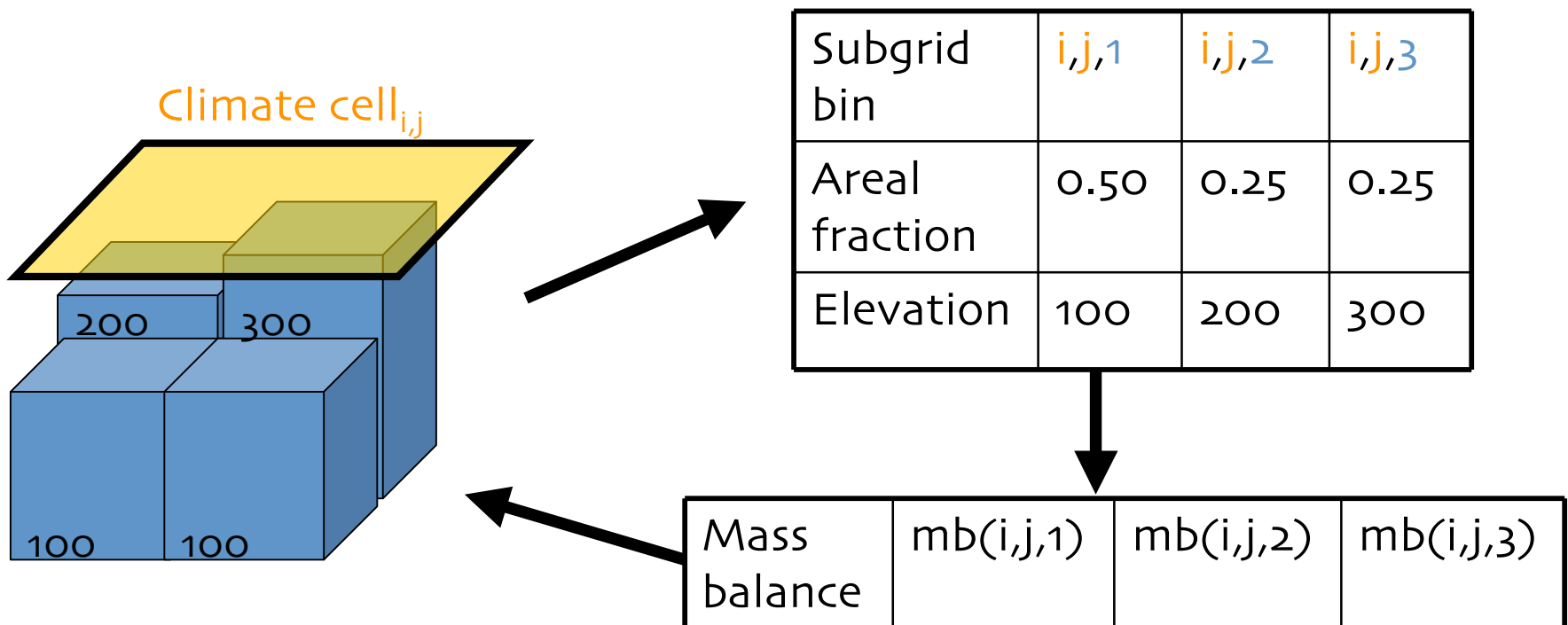
ice model returns:

- *revised elevation*
- *revised surface albedo*
- *ice sheet distribution*
- *oceanic heat/moisture fluxes*



surface mass balance

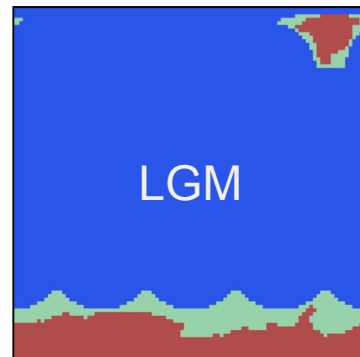
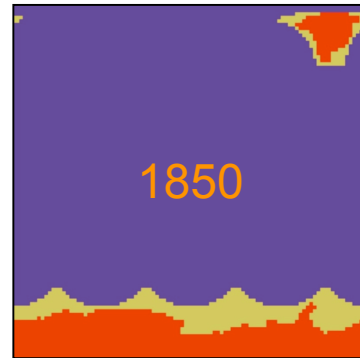
- surface mass balance generated by the climate model using **energy-moisture balance model** and a **dynamic sub-grid elevation binning scheme**

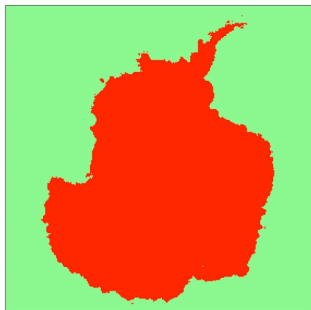
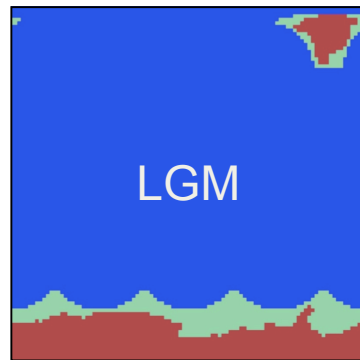
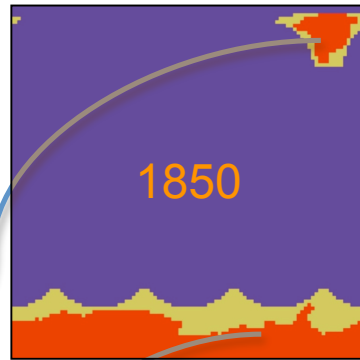


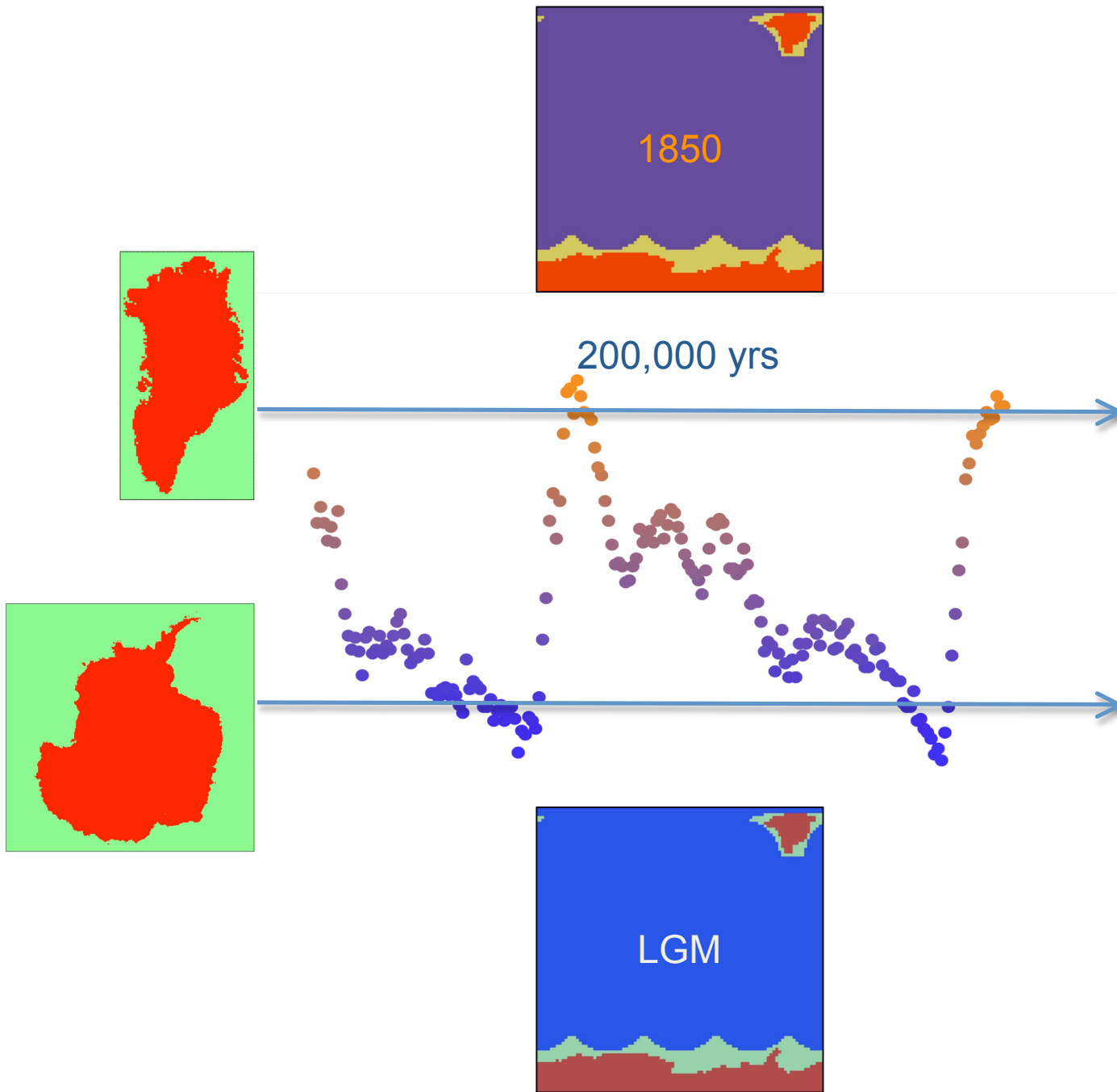
SAT bias correction

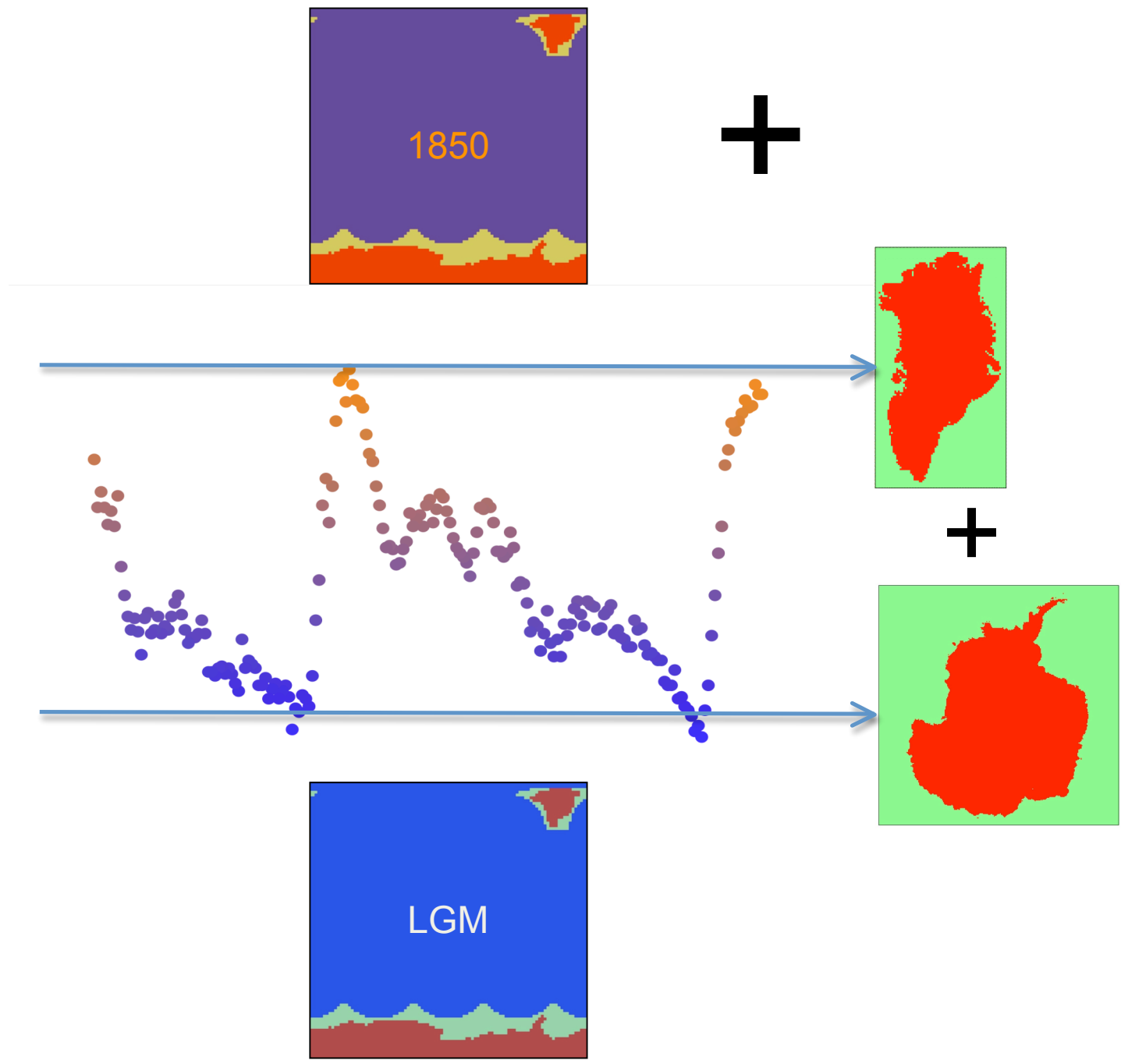
1. obtain monthly SAT bias from [NCEP/ERA40](#) & [UVic ESCM](#) long-term monthly mean SAT 1970-2001
2. within EMBM, remove monthly bias from
 - surface air temperature used to calculate sensible heat flux in EMBM
 - saturation specific humidity
 - snow/rain decision

spinup procedure

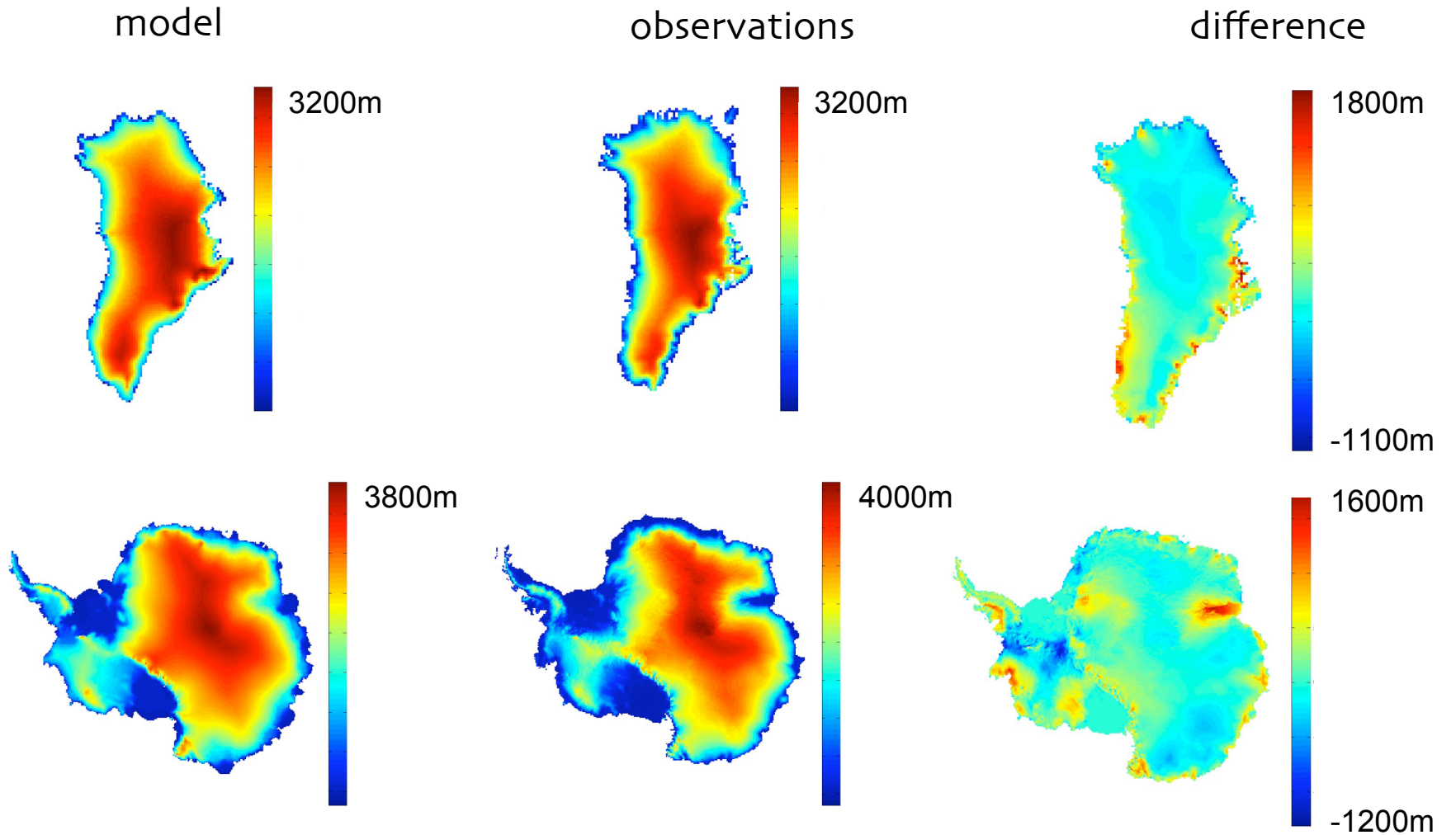




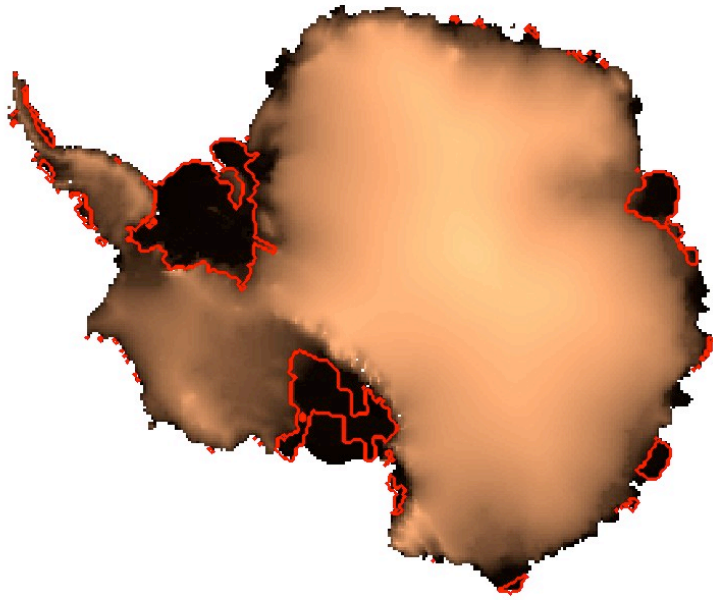




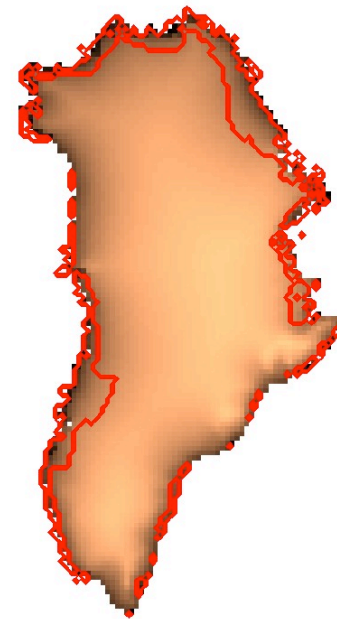
model performance, present-day equilibrium: geometry



model performance, present-day equilibrium: melt extent



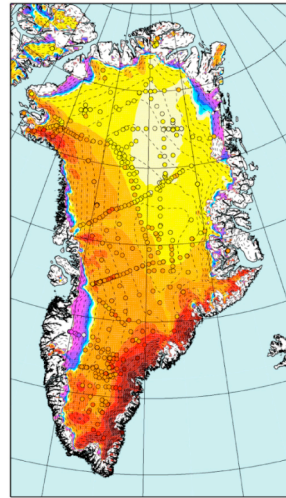
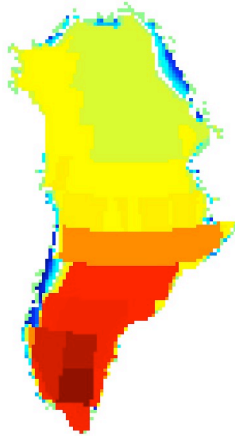
melt extent: $25 \times 10^7 \text{ km}^2$:
orders of magnitude too high!



melt extent: $3 \times 10^5 \text{ km}^2$:
near bottom end of 1990-2009
melt extent range

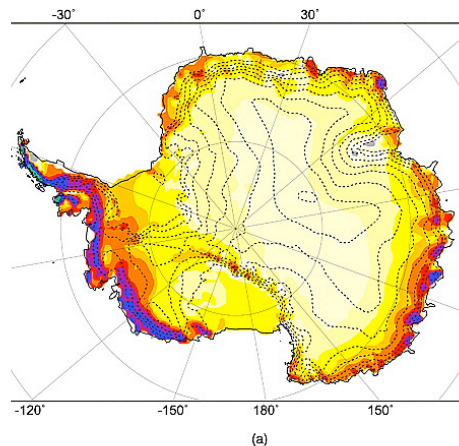
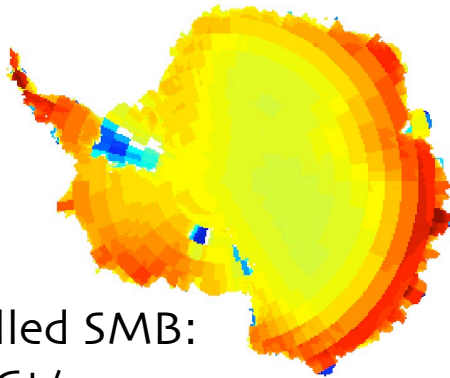
model performance, present-day equilibrium: surface mass balance

modelled SMB:
445 Gt/yr



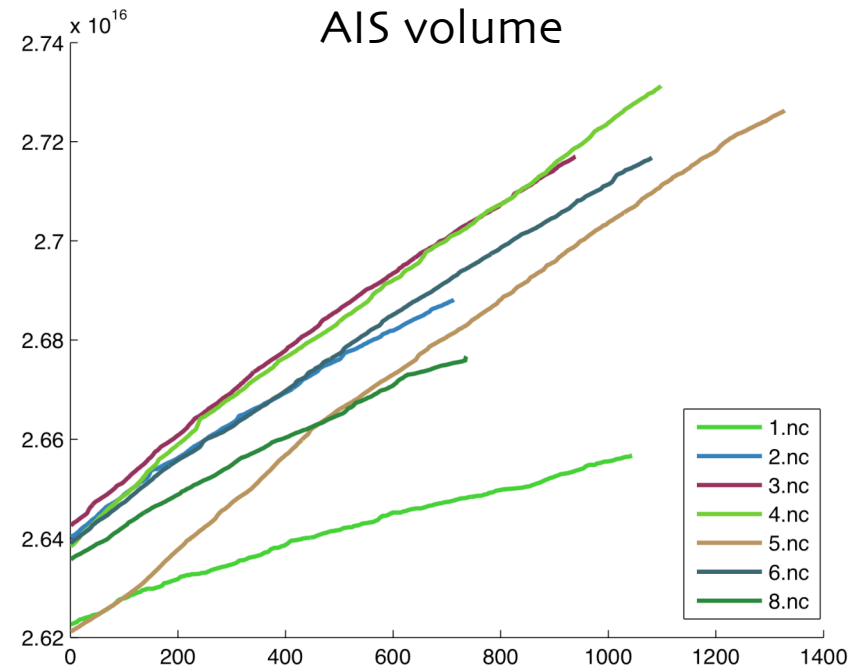
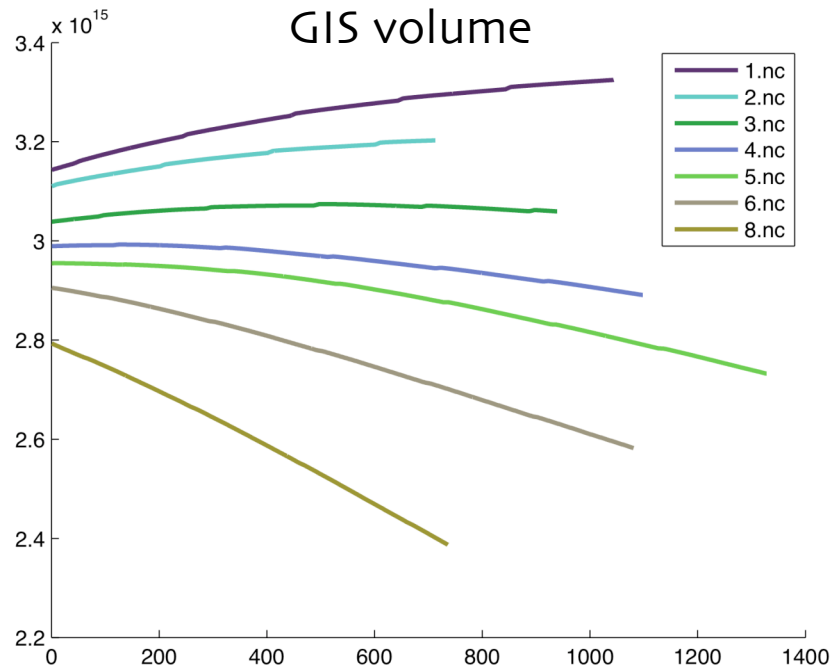
Ettema et al. (2009)
GIS SMB:
 469 ± 41 Gt/yr

modelled SMB:
2500 Gt/yr



Van den Berg et al. (2006)
AIS SMB:
 2520 ± 30 Gt/yr

elevated-CO₂ simulations



conclusions

- major ice sheet/climate model coupling complete
- monthly bias correction within EMBM a way to minimize (significant) spurious climate model-derived ice sheet evolution trends
- ice spinup with model-derived glacial/interglacial endmembers a way to minimize forcing discontinuity for 'future' simulations
- present model performance compares reasonably with previous modelling and observations
- initial simulations suggest threshold on GIS stability at 4xPAL, and a robust AIS, given constant basal melting