Modelling Greenland's climate-ice-sheet interactions during the Last Interglacial

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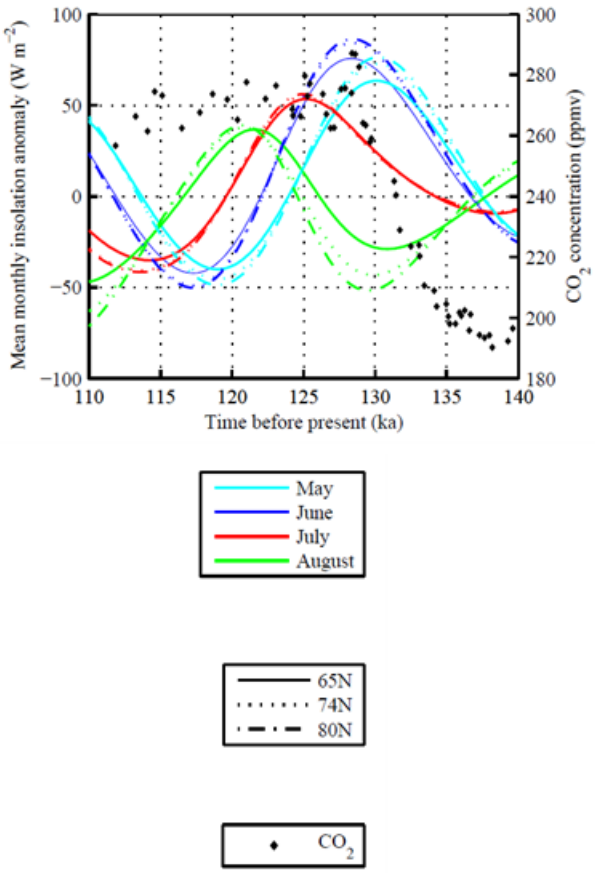
Outline

- Background and experimental design
- Greenland Ice Sheet (GrIS) evolution during the Last Interglacial (LIG)
- What is the likely contribution from the GrIS to LIG sea-level highstand
- Conclusions
- Past4Future WP1.1 snapshot simulations so far….

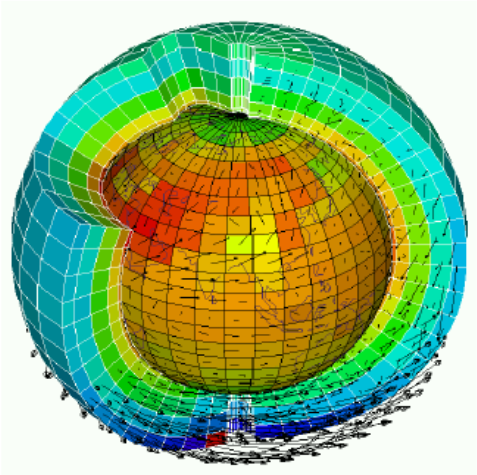
Background

Study	Method	Sea level (m)
Letreguilly *et al.* (1991)	Palaeothermometry & ice sheet model	~1.5
Cuffey & Marshall (2000)	Palaeothermometry & ice sheet model	4 - 5.5
Tarasov & Peltier (2003)	Palaeothermometry & ice sheet model	2 - 5.2
Lhomme *et al.* (2005)	Palaeothermometry & ice sheet model	3.5 - 4.5
Otto-Bliesner *et al.* (2006)	AOGCM output and ice sheet model	1.9 - 3.0
Robinson *et al.* (under review)	Coupled regional Energy-Moisture Balance Orographic model– ice sheet model	0.4 - 4.1

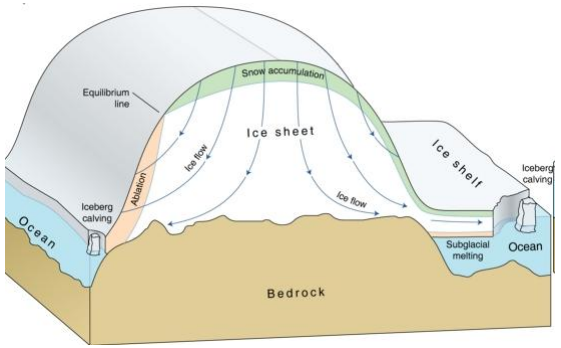


Methodology: the models

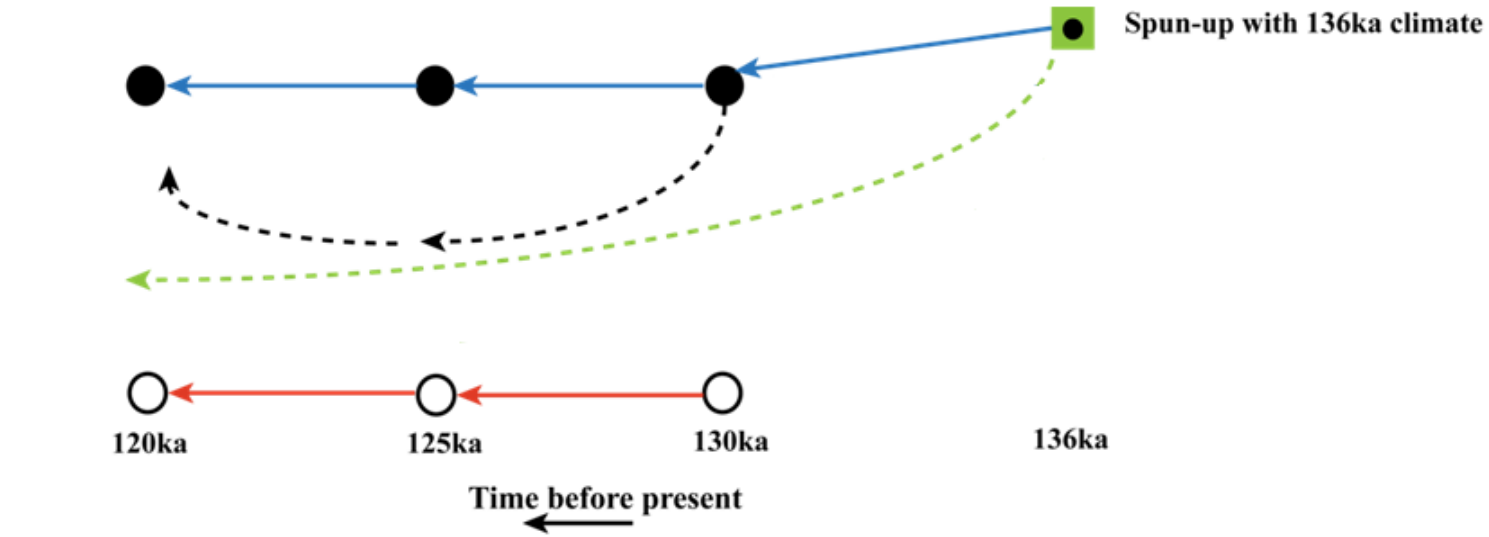
- **HadCM3 (UK Met Office Model)**
  - ➢Coupled atmosphere-ocean sea-ice models
  - ➢Ocean has a resolution of 1.25° x 1.25°
  - ➢Horizontal resolution 2.5° x 3.75°
  - ➢19 levels in the vertical



- **Glimmer**
  - ➢PDD Surface mass balance model
  - ➢Coupled ice flow
  - ➢Thermodynamics & ice-thickness evolution
  - ➢Isostatic readjustment



Climate-Ice-sheet coupling



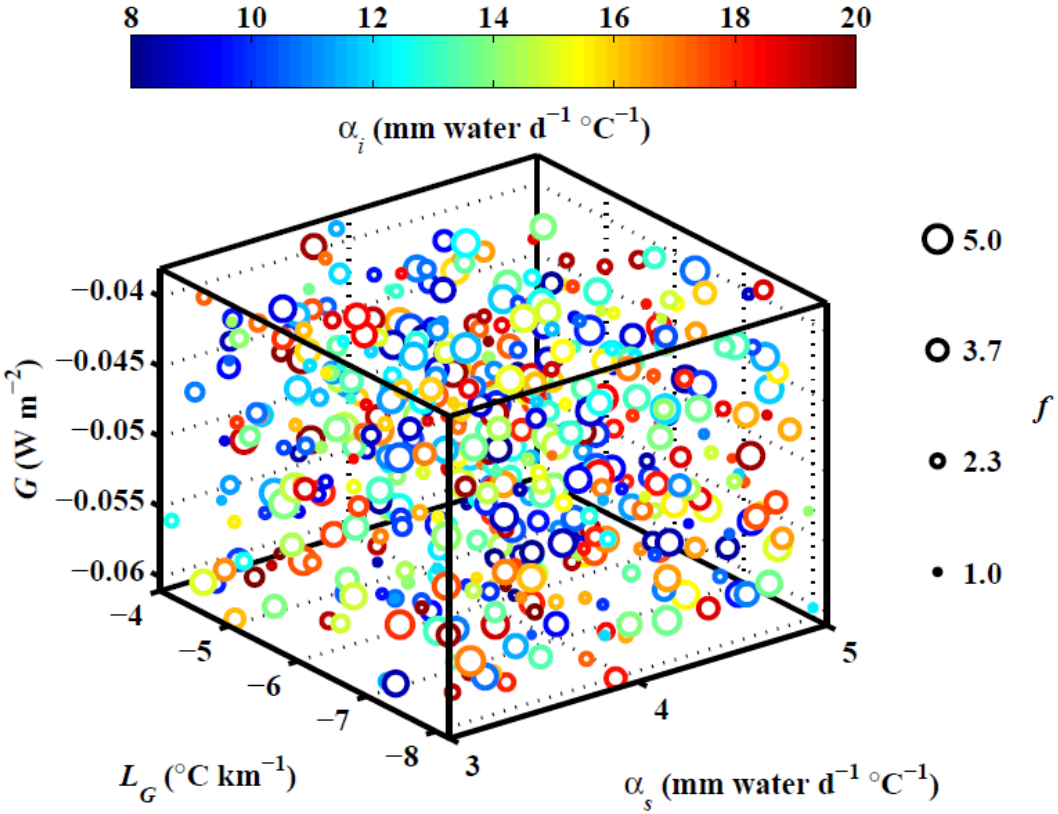
Based on the method used by Pollard & DeConto (2009)

Glimmer Latin-Hypercube Sampling

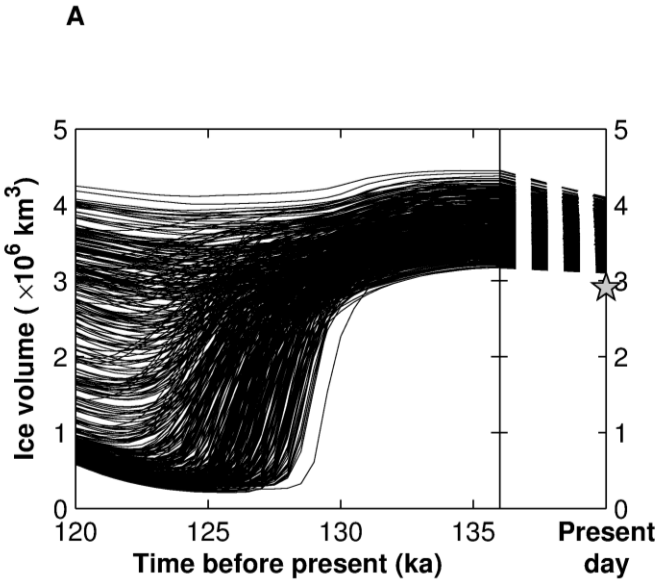
500 experiments

Parameters varied:

- Geothermal Heat flux
- Flow enhancing factor
- Lapse rate
- PDD factor for ice
- PDD factor for snow

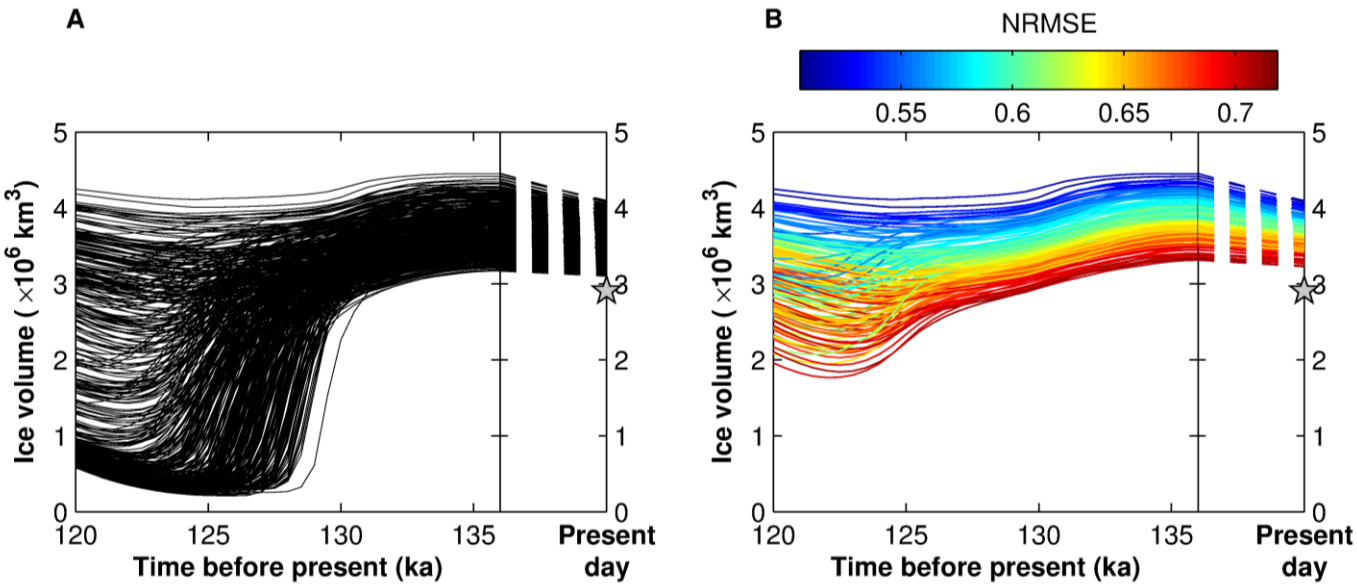


GrIS Evolution



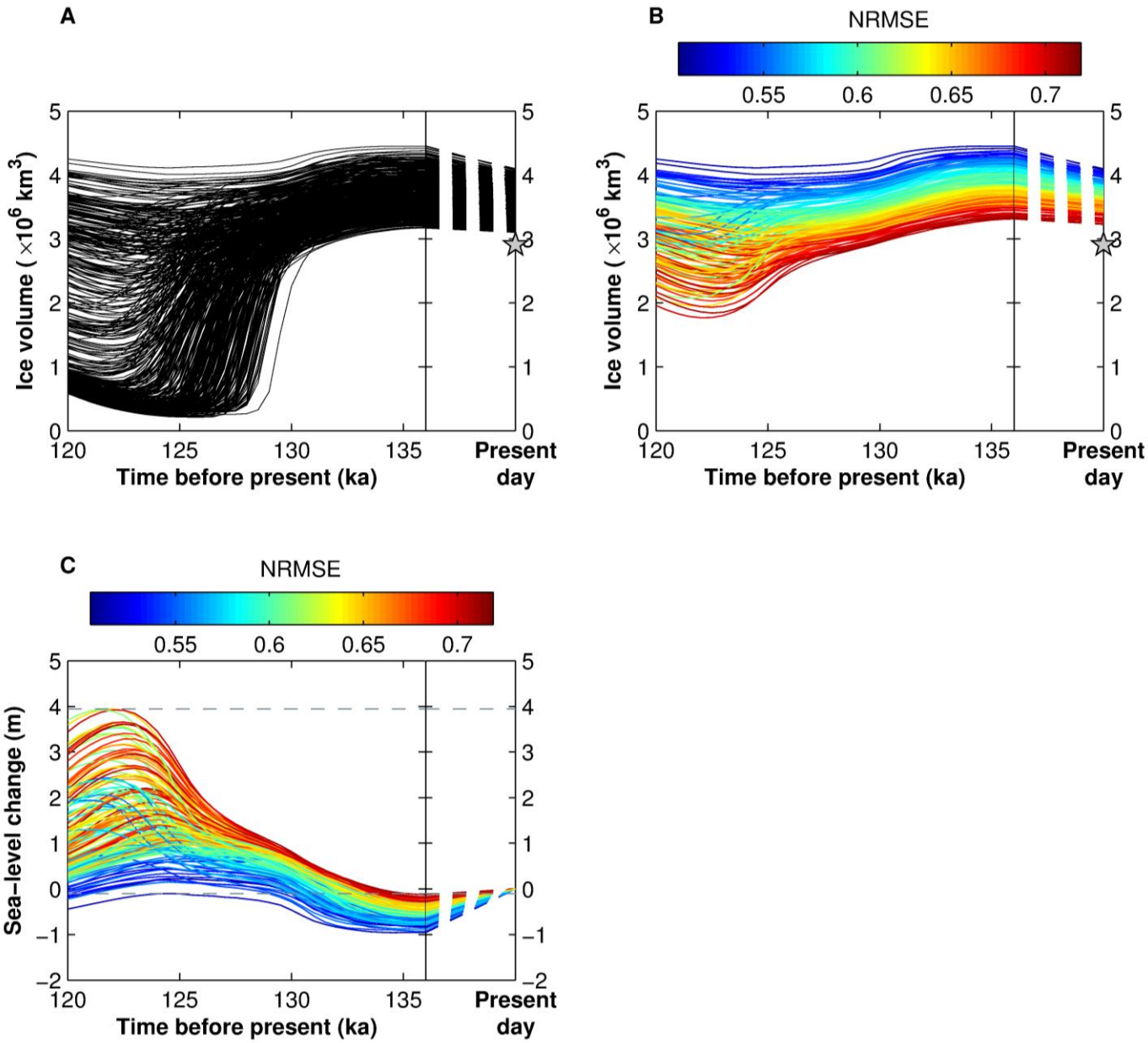
Reject simulations where there is no ice at NGRIP and Summit

GrIS Evolution

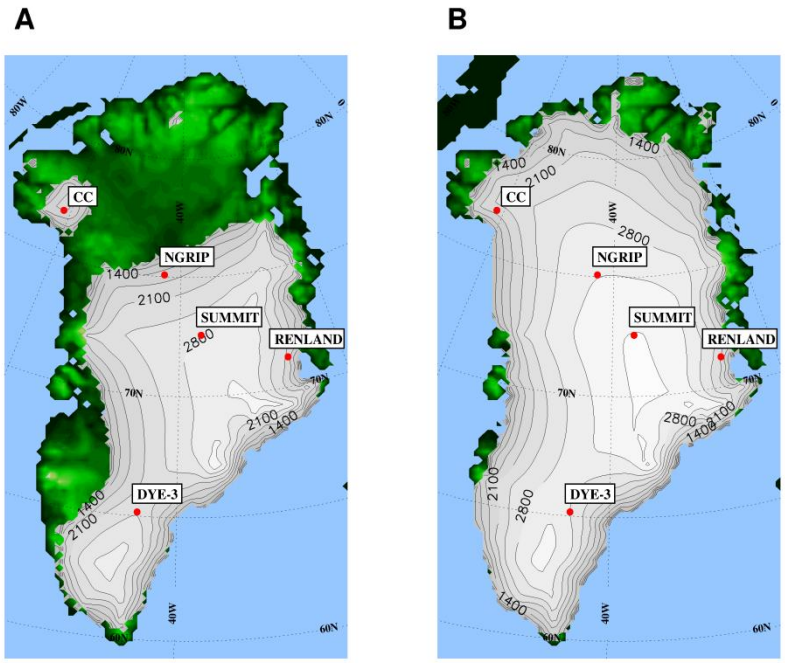


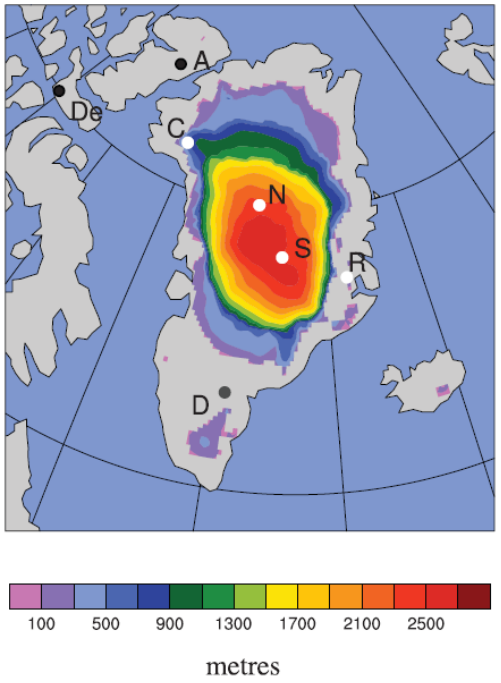
NRMSE skillscore for modern day GrIS thickness

GrIS Evolution



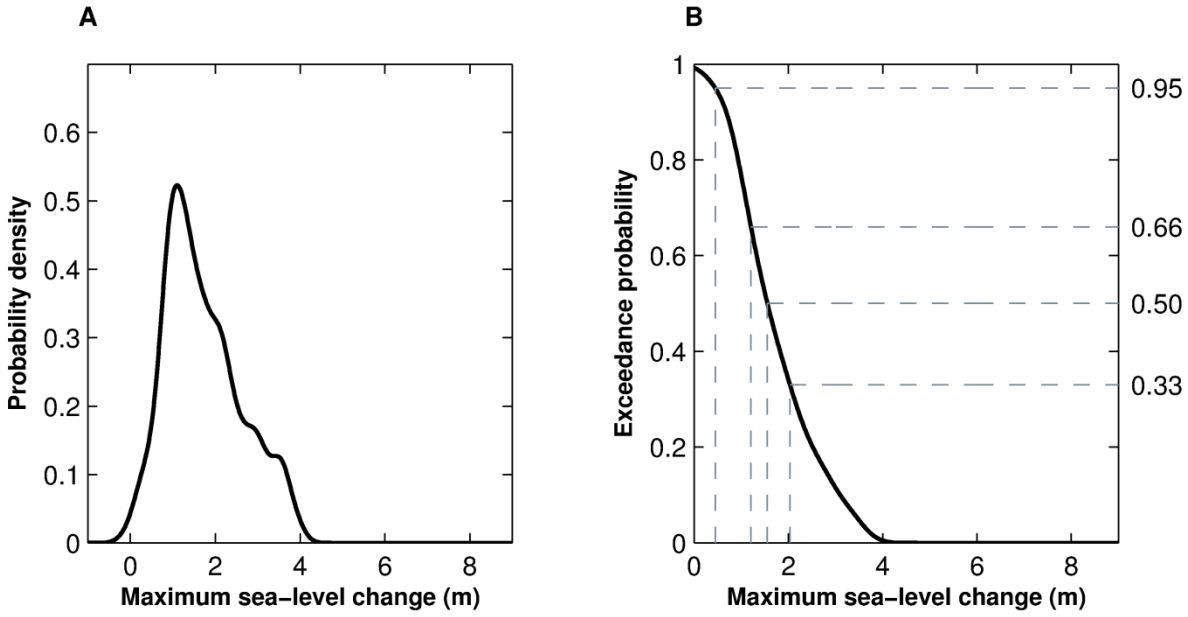
GrIS geometry





Minimum extent of GrIS (IPCC, 2007)

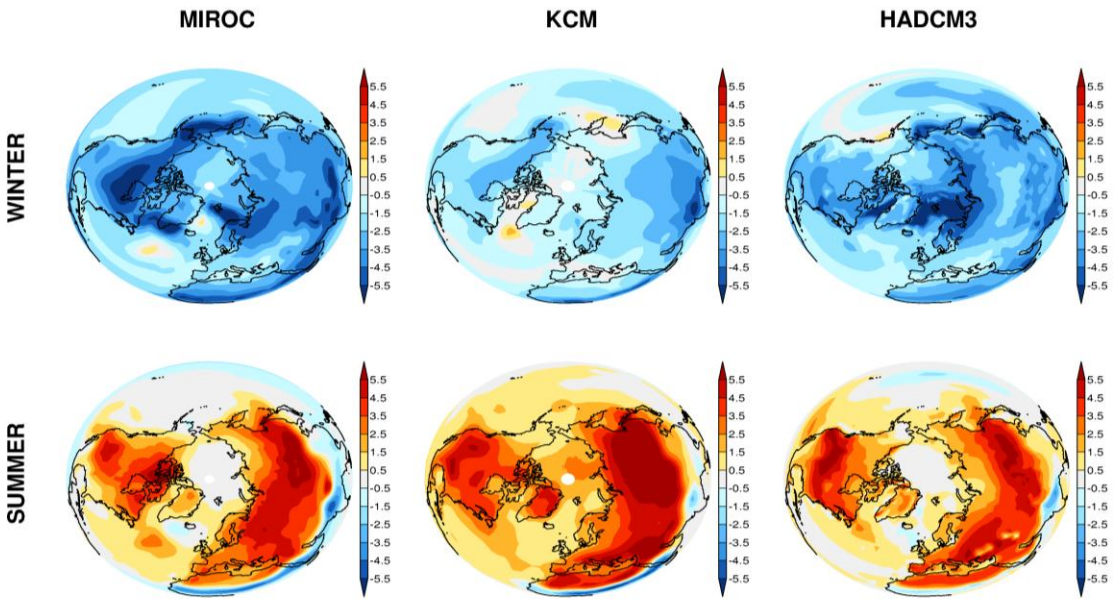
What is the likely contribution from the GrIS to LIG sea-level rise?



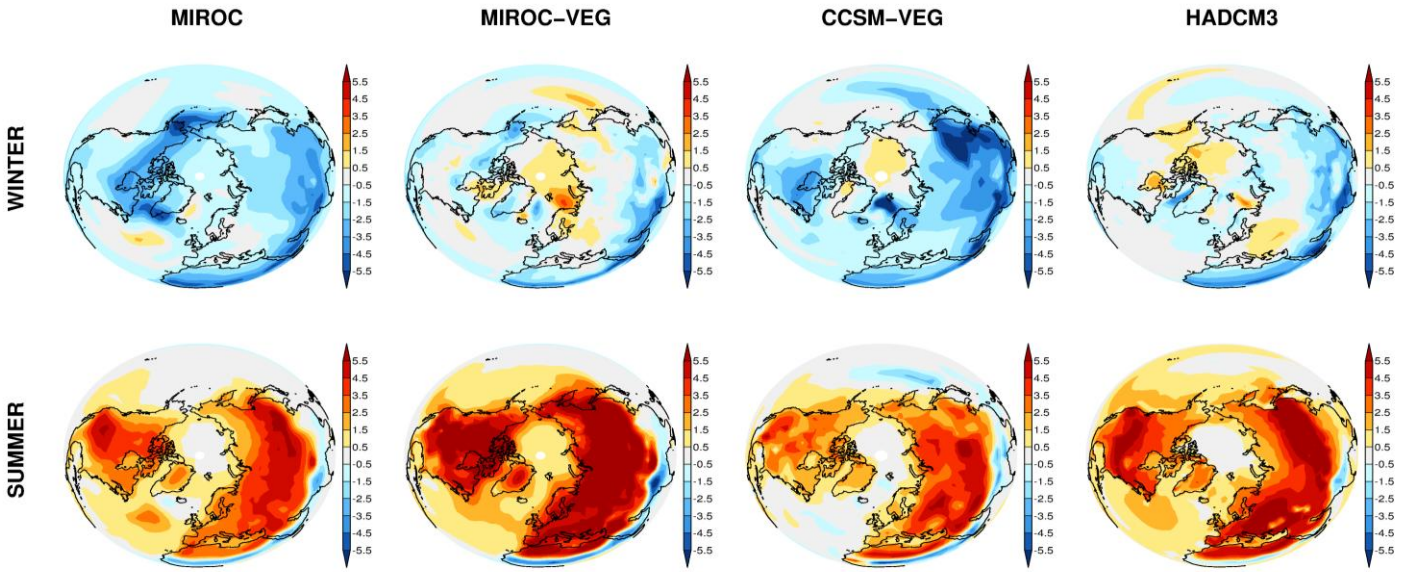
Conclusions

- 164 ice sheet model simulations from the ensemble of 500 agree with paleo-reconstructions of ice extent during the LIG
- Retreat of the ice sheet is from the north but insensitive in the south – an effect of the new bedrock topography?
- It is very likely the contribution from the GrIS exceeds 0.5 m but unlikely that its contribution was more than 2 m
- Less than half of the sea-level highstand (~4-6m) observed during the LIG comes from the GrIS indicating another source e.g. West Antarctic ice sheet
- Despite the different mechanisms for Arctic summer warming between LIG and predicted future warming mechanisms, this study emphasises the importance of including ice-sheet model parametric uncertainty when evaluating the impact of the Arctic on future climate change.

WP1.1 snapshot simulations: 130 ka

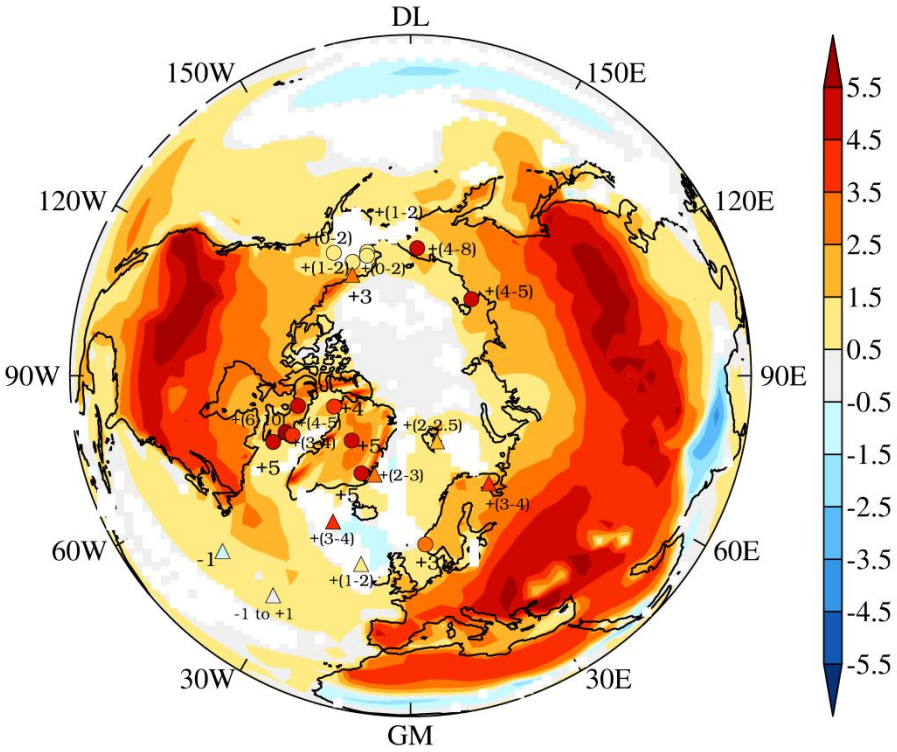


WP1.1 snapshot simulations: 125 ka



An initial data comparison

130 ka JJA temperature anomaly compared with maximum summer reconstructed proxy temperatures from the CAPE project, 2006.



Thank you

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