ANTARCTIC GATEWAY PARTNERSHIP

Sensitivity of the Antarctic ice sheet to marine climate variability and change

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Australian Government
Australian Research Council
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CSIRO
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Department of the Environment
Australian Antarctic Division
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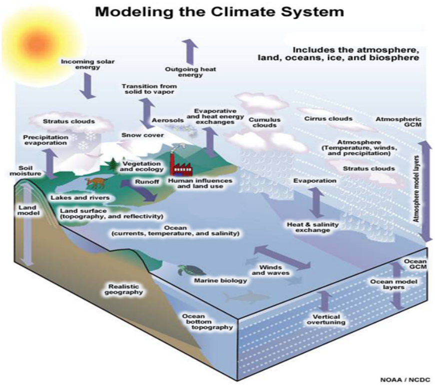
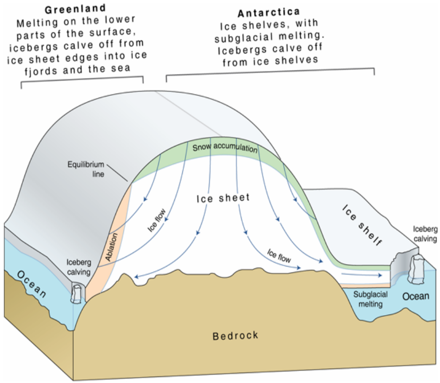
Climate and ice sheet modelling

Climate model



Ice sheet model



Images courtesy of NOAA/NCDC and NSIDC

Differing degrees of complexity

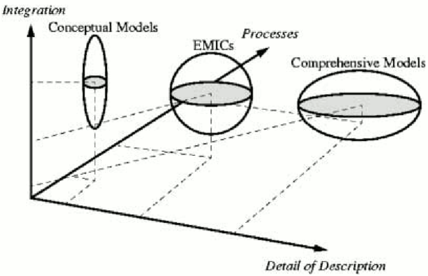


Fig. 1. Pictorial definition of EMICs. Adapted from Claussen (2000)

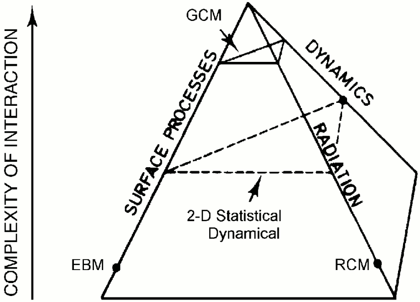
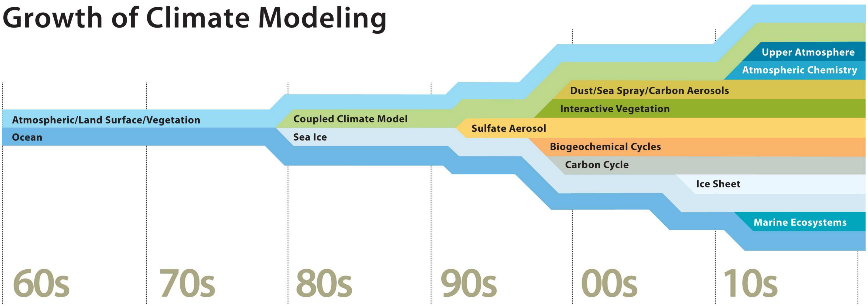


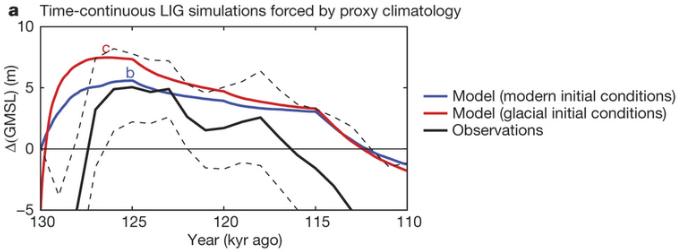
Fig. 2. The climate modeling pyramid. Adapted from Henderson-Sellers and McGuffie (1987)

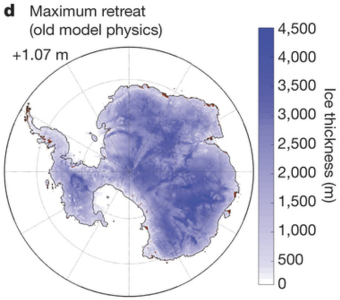
Claussen et al. (2002), *Climate Dynamics*

The development of coupled climate system models



Ice sheet modelling: The case of the ice that won't melt





DeConto and Pollard (2016), *Nature*

Ocean forcing: Changes in ocean circulation

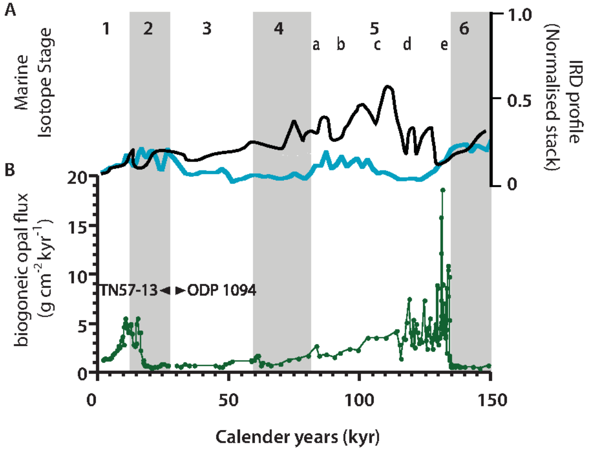
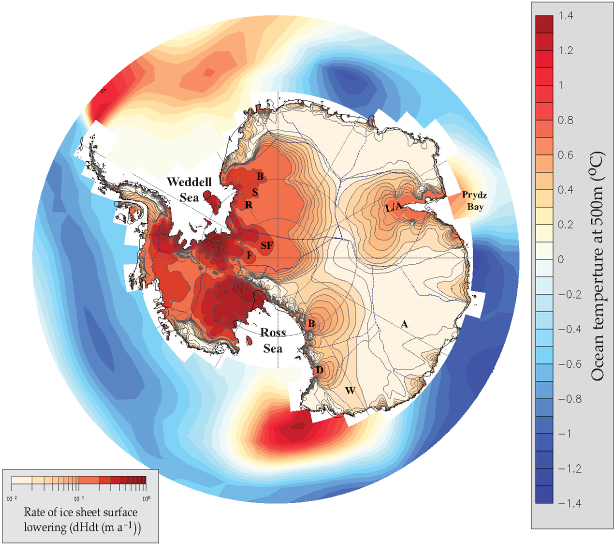


Figure 2. Proxy records of: (A) normalized stacked ice-rafted debris (IRD) profiles from the Weddell Sea (black line), and the Campbell Plateau (blue line). These composite records are based on datasets that were normalized to between zero and 1 (*x*-axis) by division of the maximum IRD concentration (Carter *et al.*, 2002). (B) Biogenic particle flux, reconstructed by ^{230}Th normalization for biogenic opal flux, a proxy for Southern Ocean upwelling triggered by SHW southward migration (Jaccard *et al.*, 2013), plotted against Marine Isotope Stages (MIS) over the past 150 ka. This figure is available in colour online at wileyonlinelibrary.com.

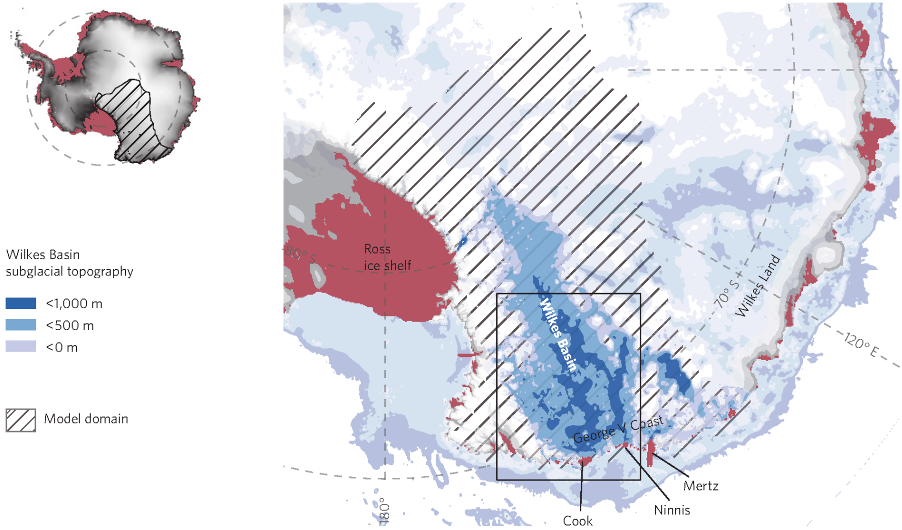
Fogwill et al. (2014), *Journal of Quaternary Science*

Ocean forcing: Changes in ocean circulation



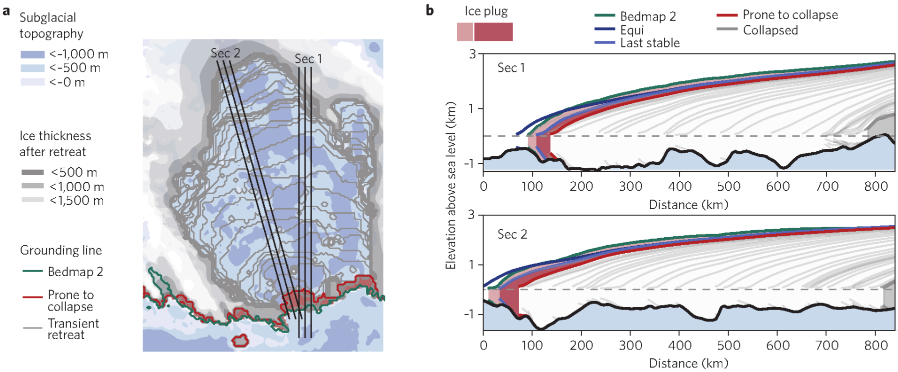
Fogwill et al. (2014), *Journal of Quaternary Science*

Ocean forcing: Marine ice sheet instability



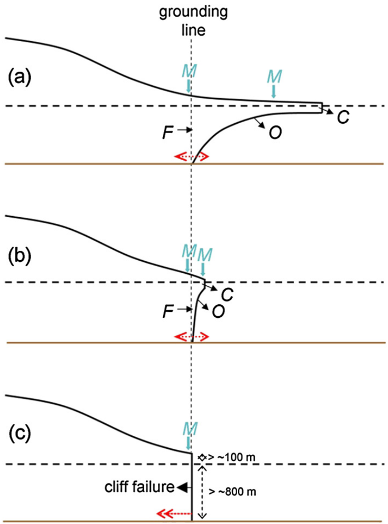
Mengel and Levermann (2014), *Nature Climate Change*

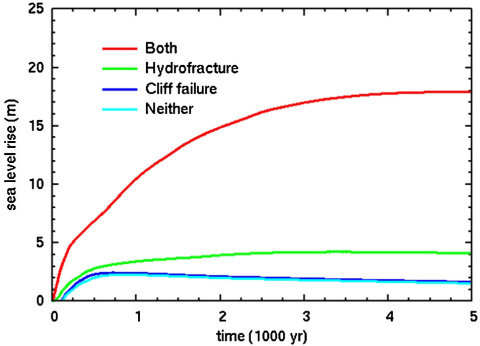
Ocean forcing: Marine ice sheet instability



Mengel and Levermann (2014), *Nature Climate Change*

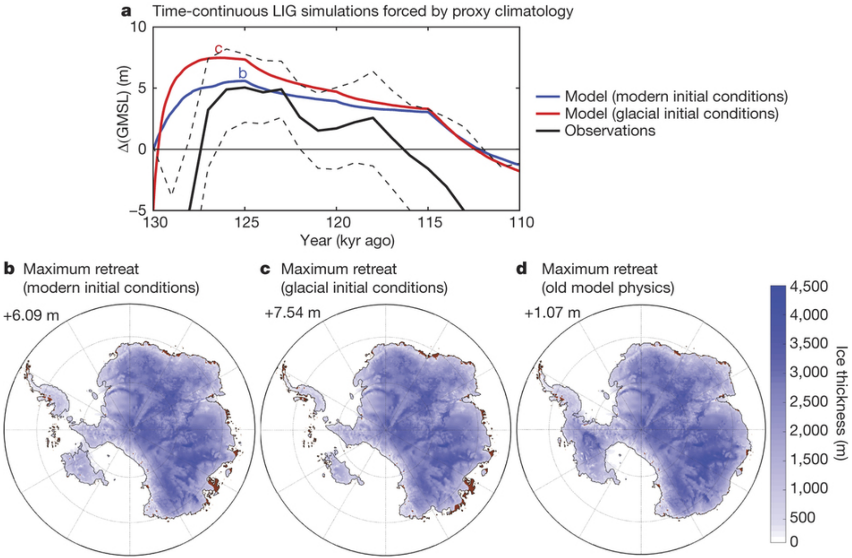
Ocean forcing: Hydrofracturing and ice cliff failure





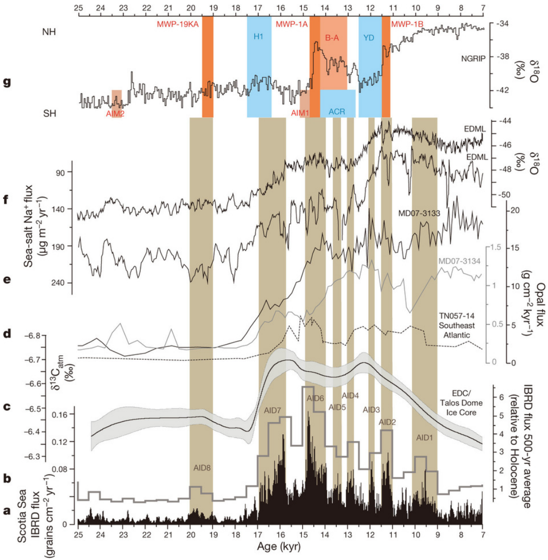
Pollard et al. (2015), *Earth and Planetary Science Letters*

Ocean forcing: Marine ice cliff instability



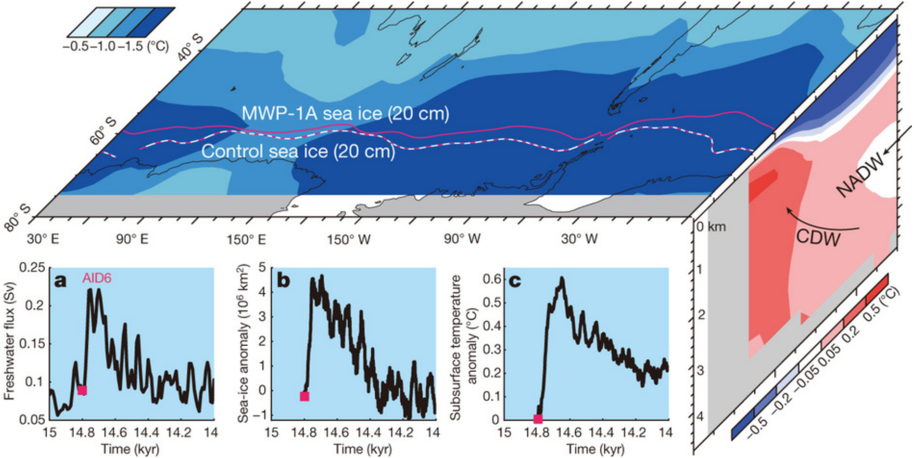
DeConto and Pollard (2016), *Nature*

Ocean forcing: Millennial-scale variability



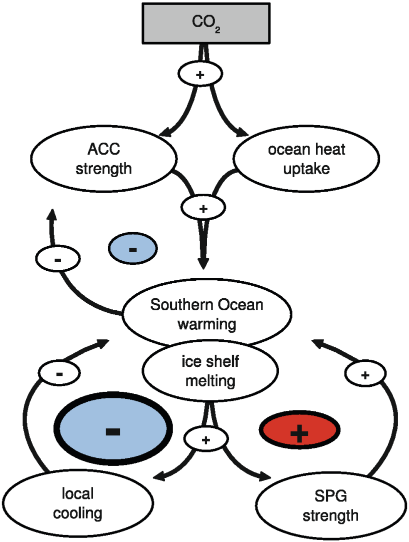
Weber et al. (2014), *Nature*

Ocean forcing: Millennial-scale variability



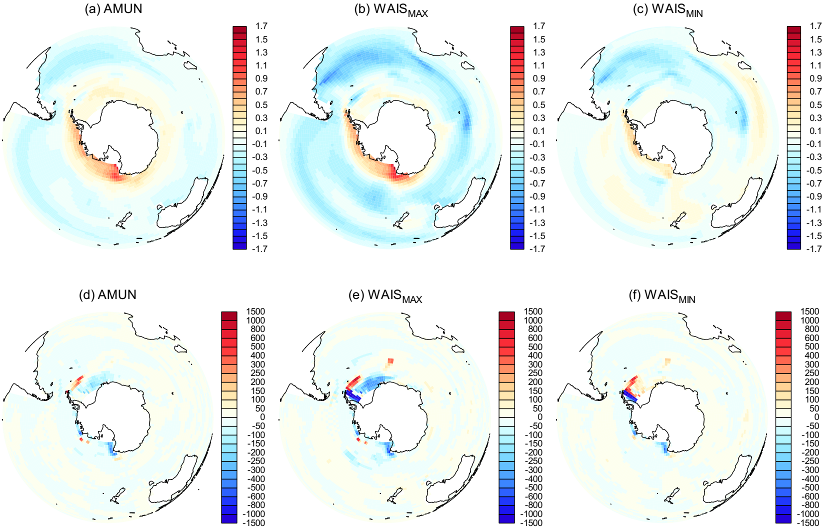
Weber et al. (2014), *Nature*

Ice sheet forcing: ice sheet–ocean feedback loops



Hattermann and Levermann (2010), *Climate Dynamics*

Ice sheet forcing: freshwater fluxes into the ocean



Fogwill et al. (2015), *Earth's Future*

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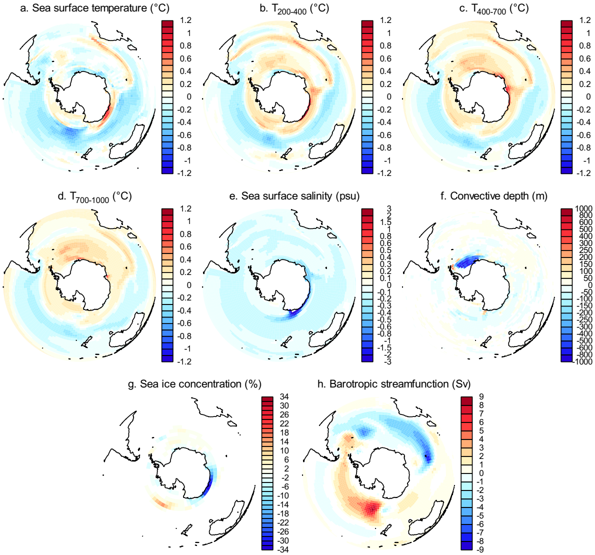
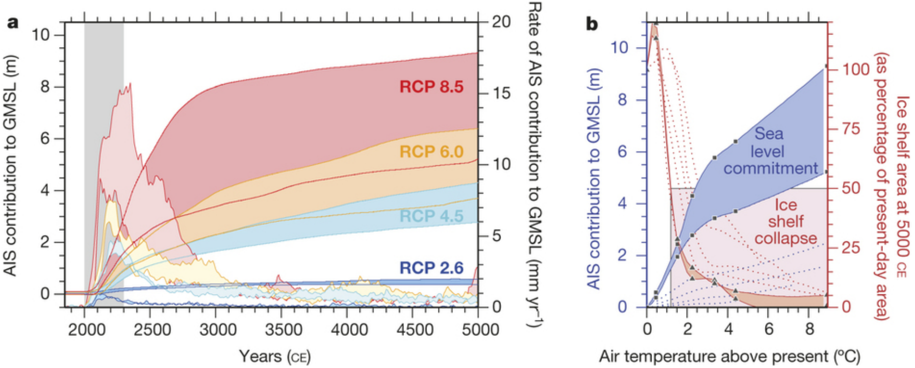


Phipps et al. (2016), *The Cryosphere*

Consequences for global sea level

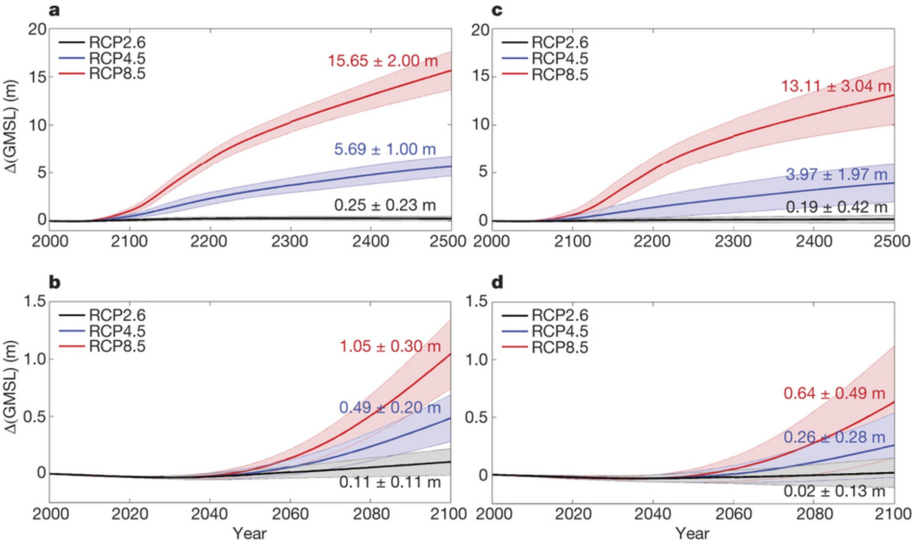
Golledge et al. (2015), *Nature*

Consequences for global sea level



Golledge et al. (2015), *Nature*

Consequences for global sea level



DeConto and Pollard (2016), *Nature*

Conclusions

- Ice sheet models can be used to explore the mechanisms that have driven past changes in the Antarctic ice sheet.
- Ice sheet models are the *only* physically-based tool that we have to predict future changes in the Antarctic ice sheet.
- Comparison with palaeoclimate data can be used to refine the models and identify potential missing physics.

Future research priorities:

- Continue to use palaeoclimate data to identify missing processes and incorporate them into ice sheet models.
- Couple, couple, couple...