Using the history of Antarctica to improve projections of sea level rise

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Australian Government
Australian Research Council
UNIVERSITY of TASMANIA AUSTRALIA
CSIRO
Australian Government
Department of the Environment
Australian Antarctic Division
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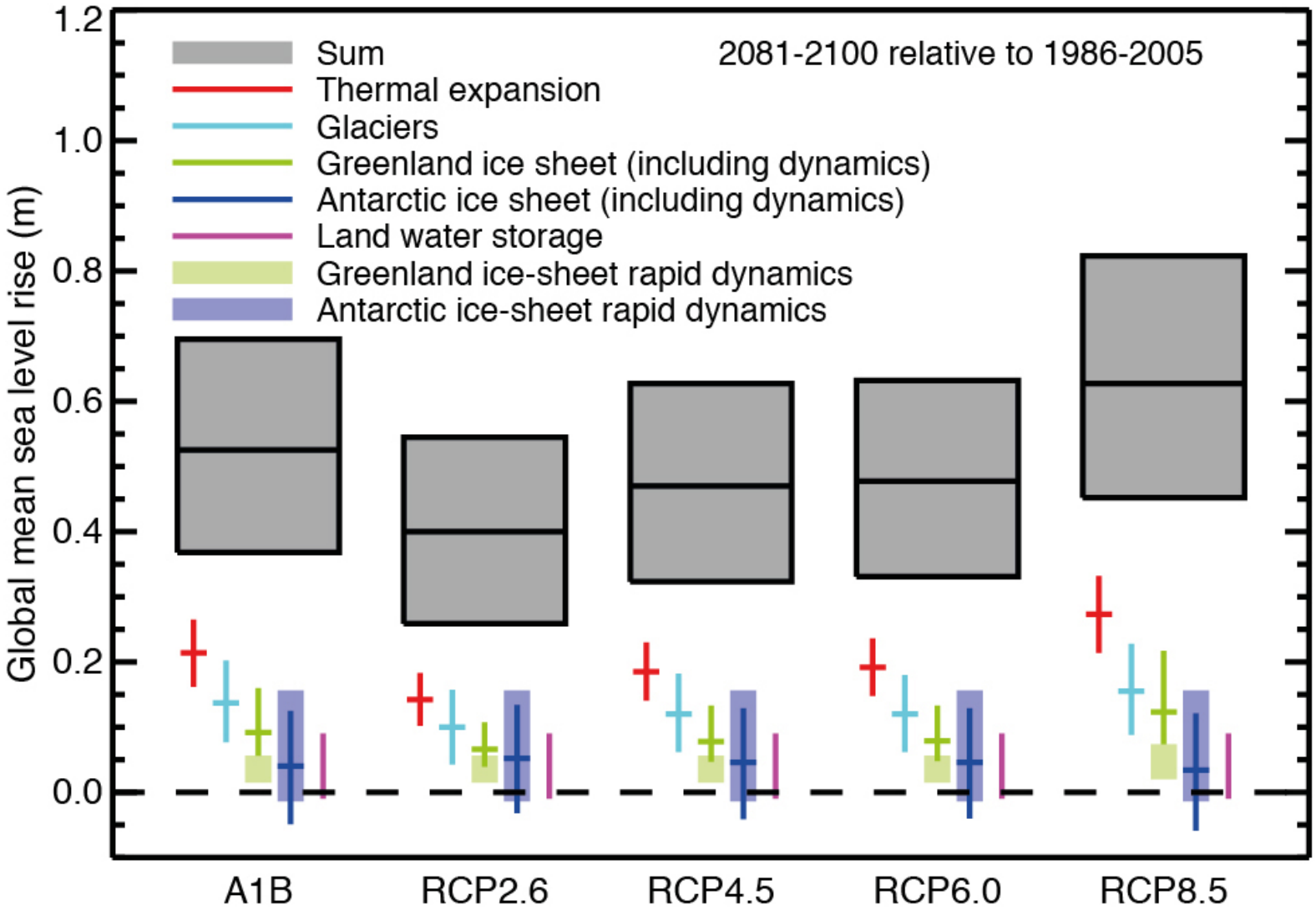
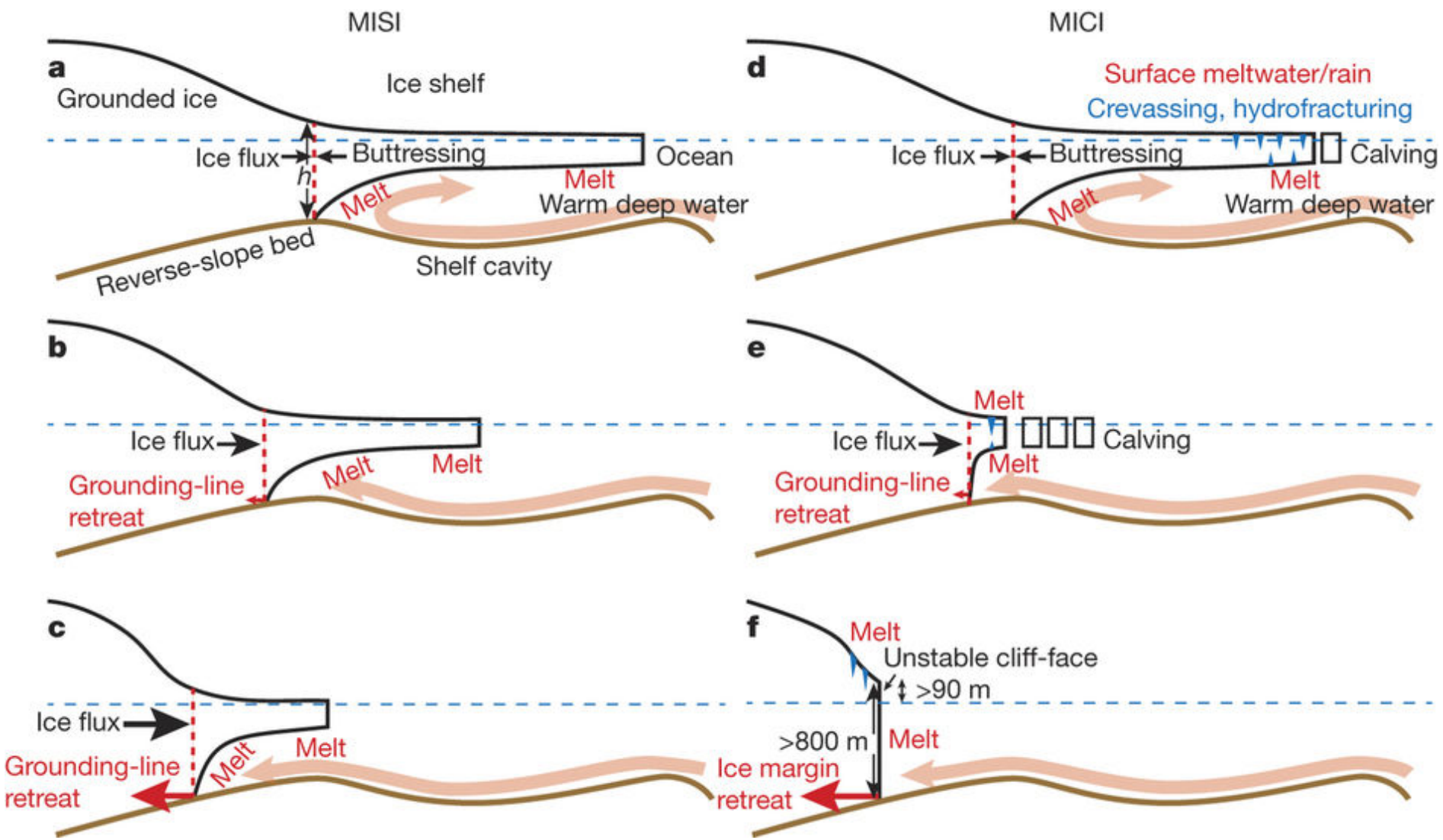
Likely changes in global sea level by 2081–2100



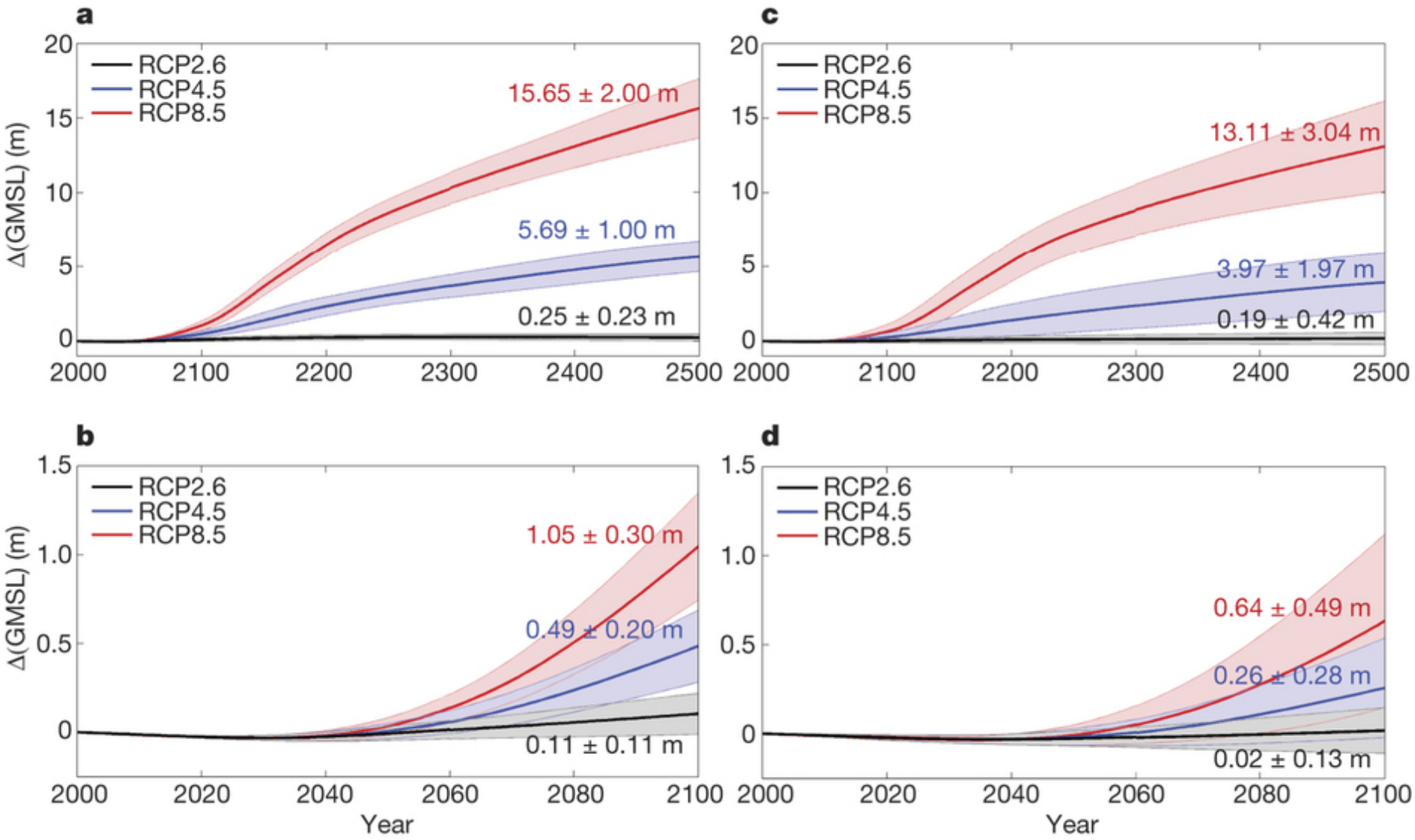
IPCC AR5 WG1 report (2013)

Mechanisms of ice sheet instability



DeConto and Pollard (2016), *Nature*

Antarctic contribution to global sea level (2000–2500)



DeConto and Pollard (2016), *Nature*

How do we project changes in global sea level?

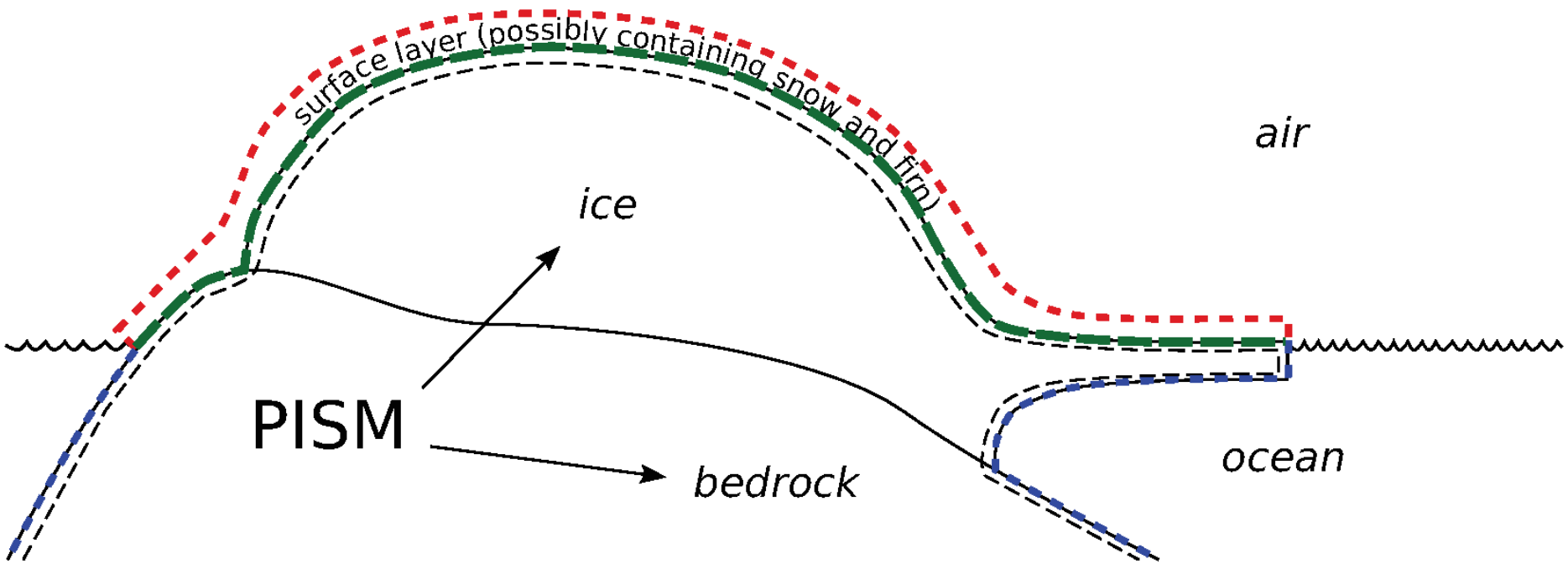


Figure 15: PISM's view of interfaces between an ice sheet and the outside world

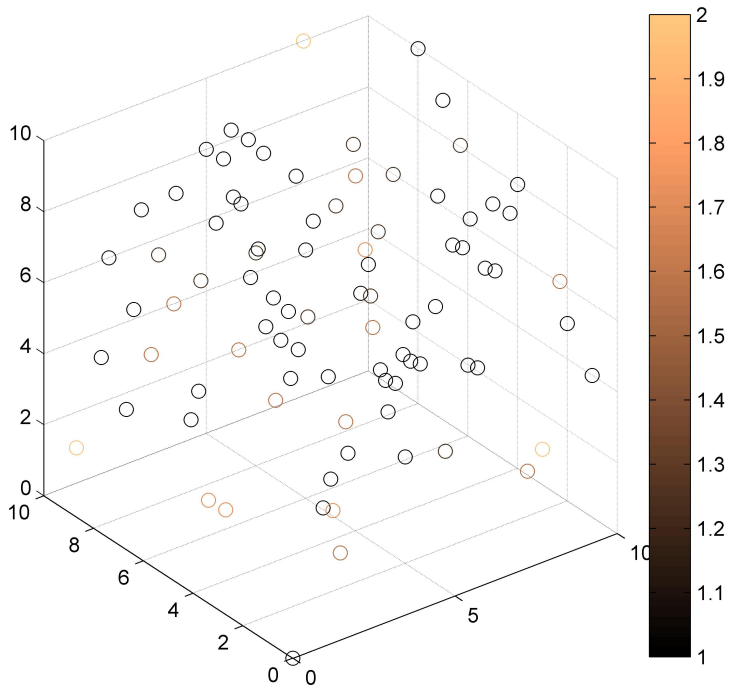
Challenge 1: Ice sheet models are under-constrained

```
mpiexec -n 4 pismr -skip -skip_max 10 -i nomass_20km.nc
-sia_e 3.0 -atmosphere given -atmosphere_given_file
pism_Antarctica_5km.nc -surface simple -ocean pik
-meltfactor_pik 5e-3 -ssa_method fd -ssa_e 0.6 -pik -calving
eigen_calving,thickness_calving -eigen_calving_K 2.0e18
-thickness_calving_threshold 200.0 -stress_balance ssa+sia
-hydrology null -pseudo_plastic -pseudo_plastic_q 0.25
-till_effective_fraction_overburden 0.02
-tauc_slippery_grounding_lines -topg_to_phi 15.0,40.0,
-300.0,700.0 -ys 0 -y 100000 -ts_file ts_run_20km.nc
-ts_times 0:1:100000 -extra_file extra_run_20km.nc
-extra_times 0:1000:100000 -extra_vars thk,usurf,
velbase_mag,velbar_mag,mask,diffusivity,tauc,bmelt,
tillwat,temppabase,hardav,Href,gl_mask -o run_20km.nc
-o_size big
```

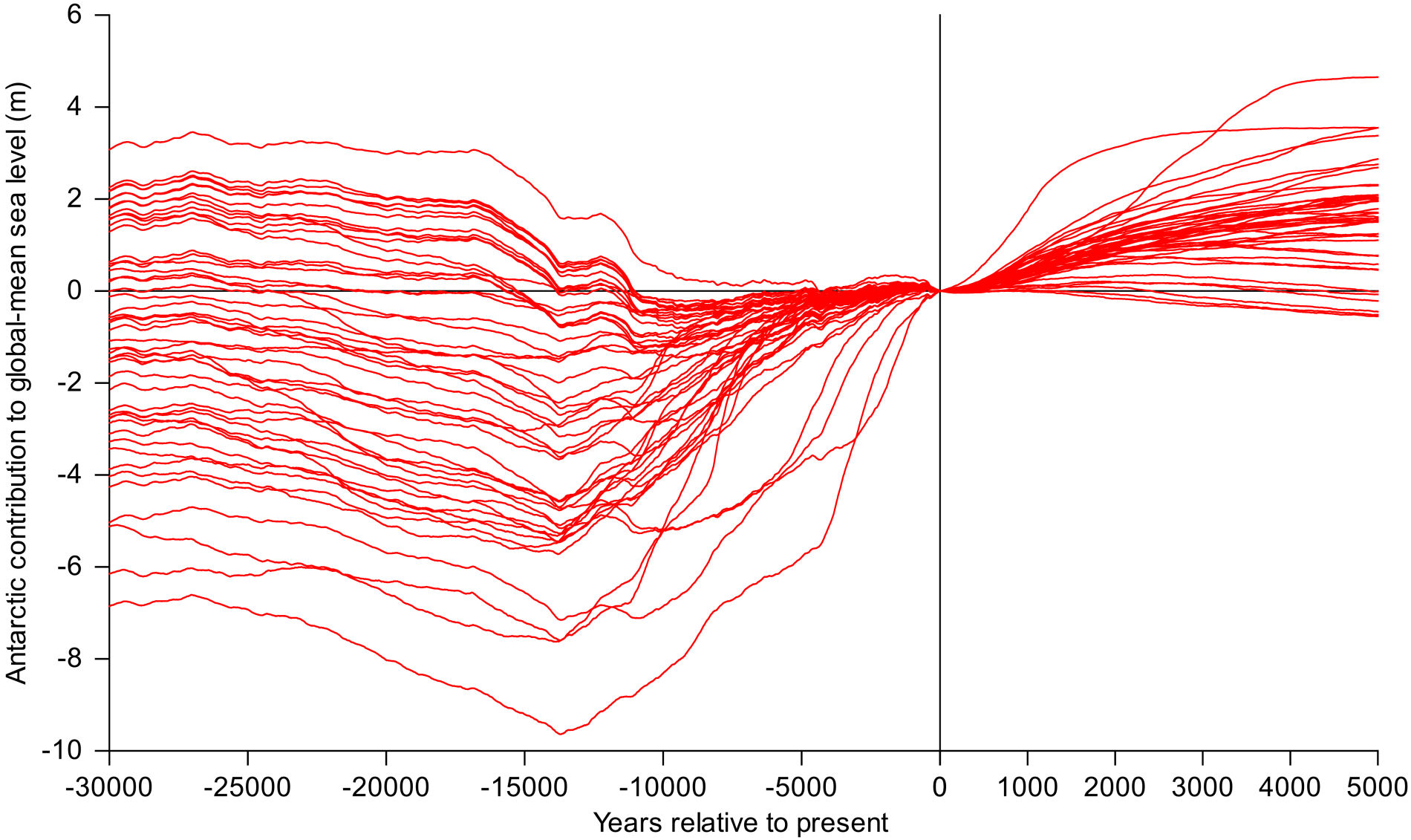
Challenge 1: Ice sheet models are under-constrained

Constraining ice sheet model parameterisations

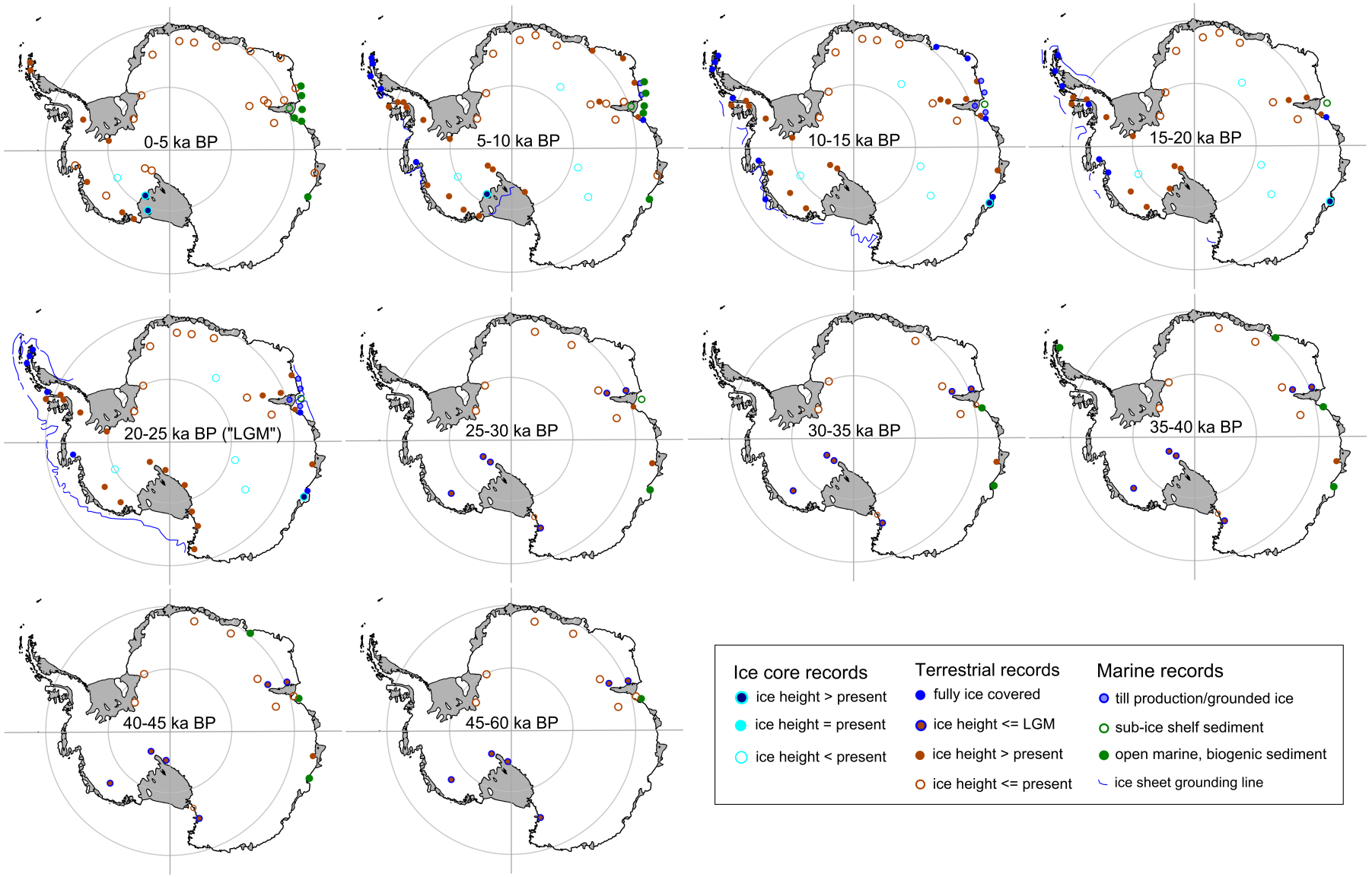
- Use PISM to simulate the past evolution of the Antarctic Ice Sheet.
- Run the model many times. Perturb the model physics each time, sampling as many different parameter combinations as possible.
- Identify the model configurations where the simulated evolution of the ice sheet agrees best with the known history.



Constraining ice sheet model parameterisations



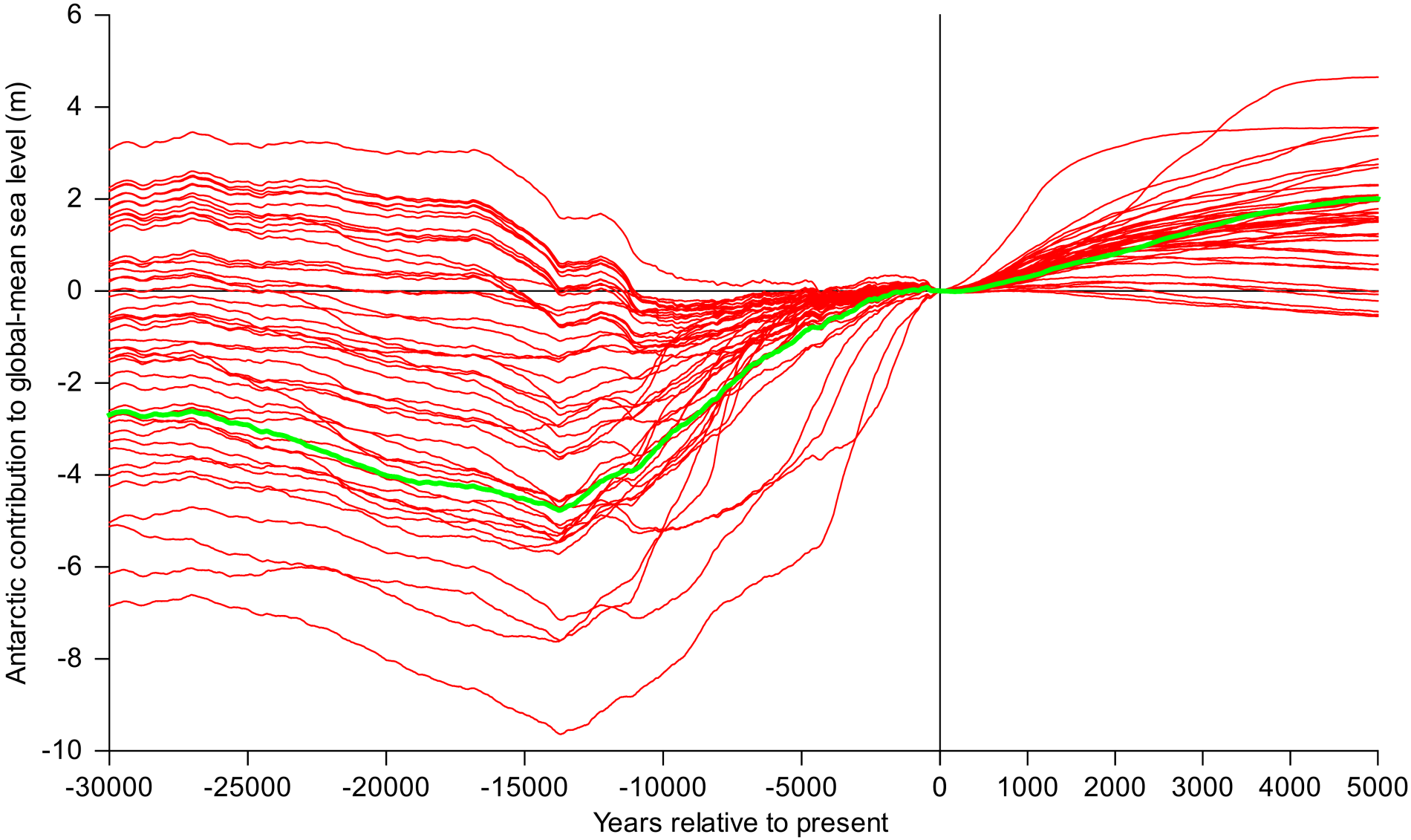
The history of the Antarctic ice sheet (60–0 ka)



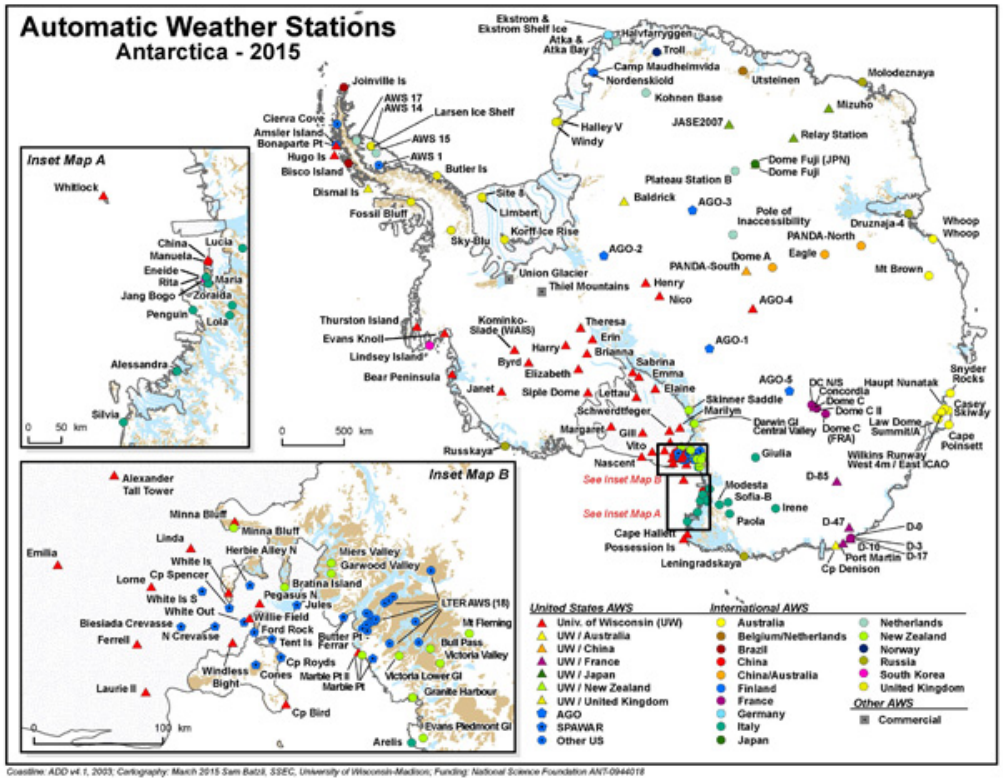
Duanne White/University of Canberra

We need more data!

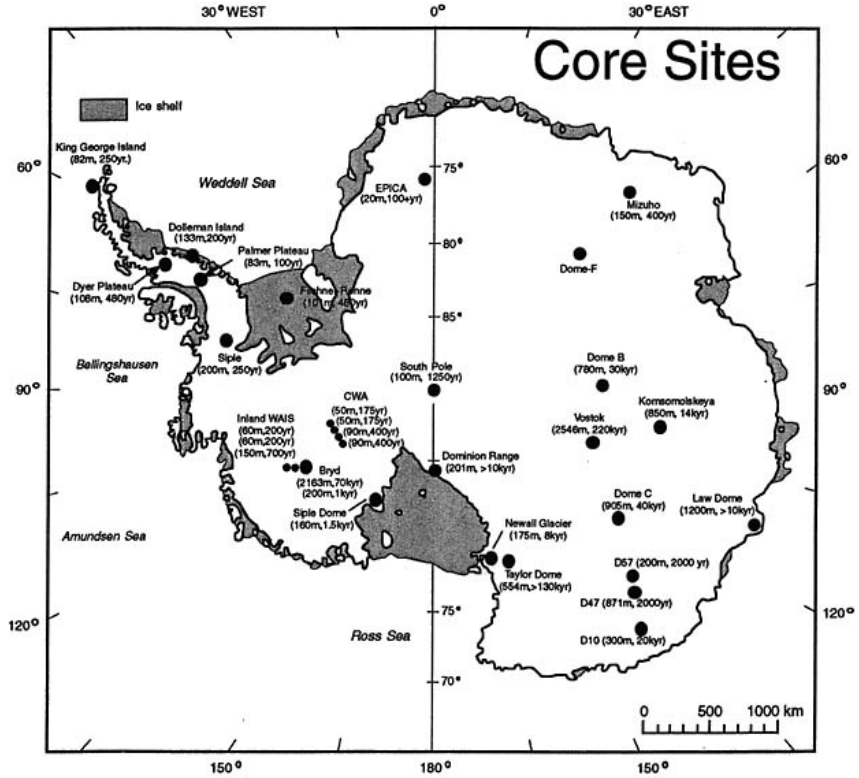
Constraining ice sheet model parameterisations



Challenge 2: Boundary conditions

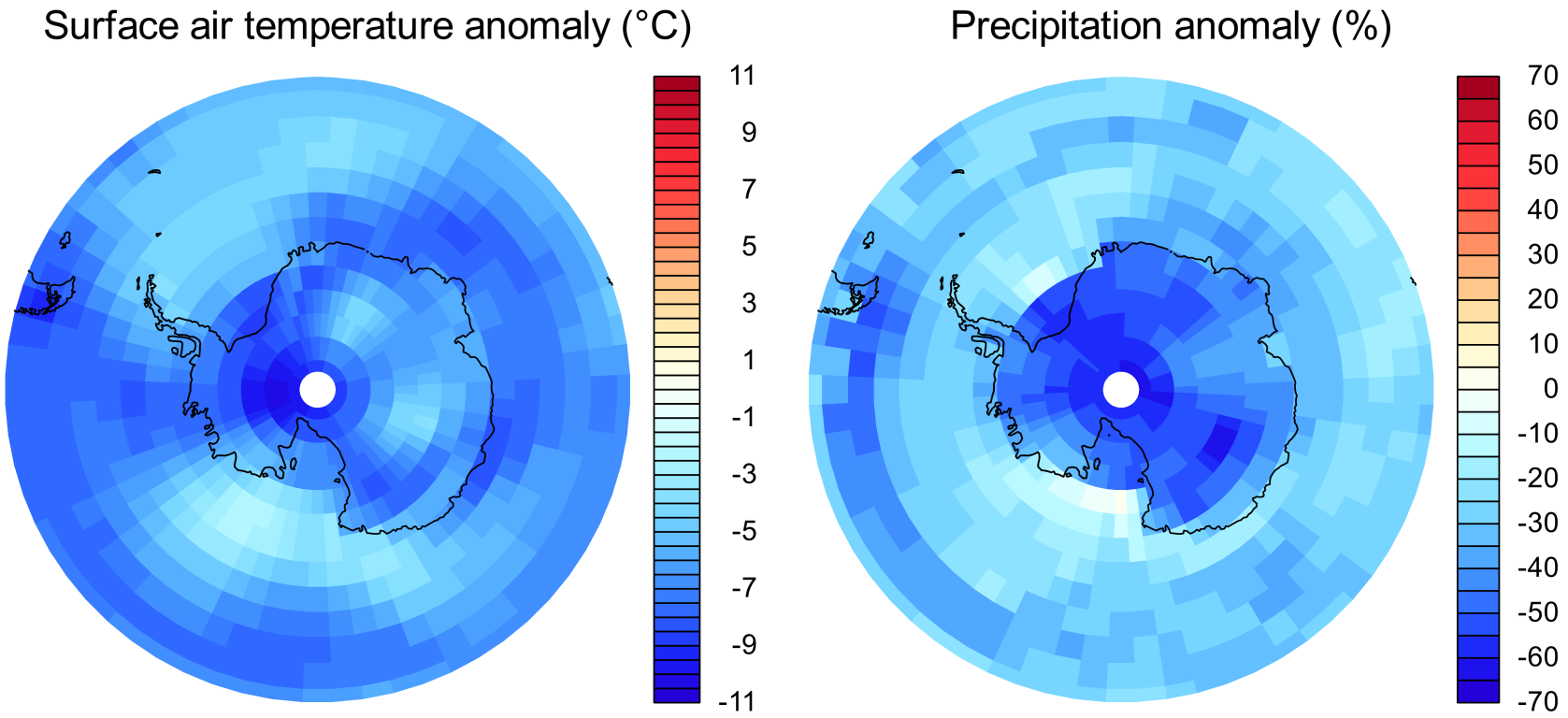


Present



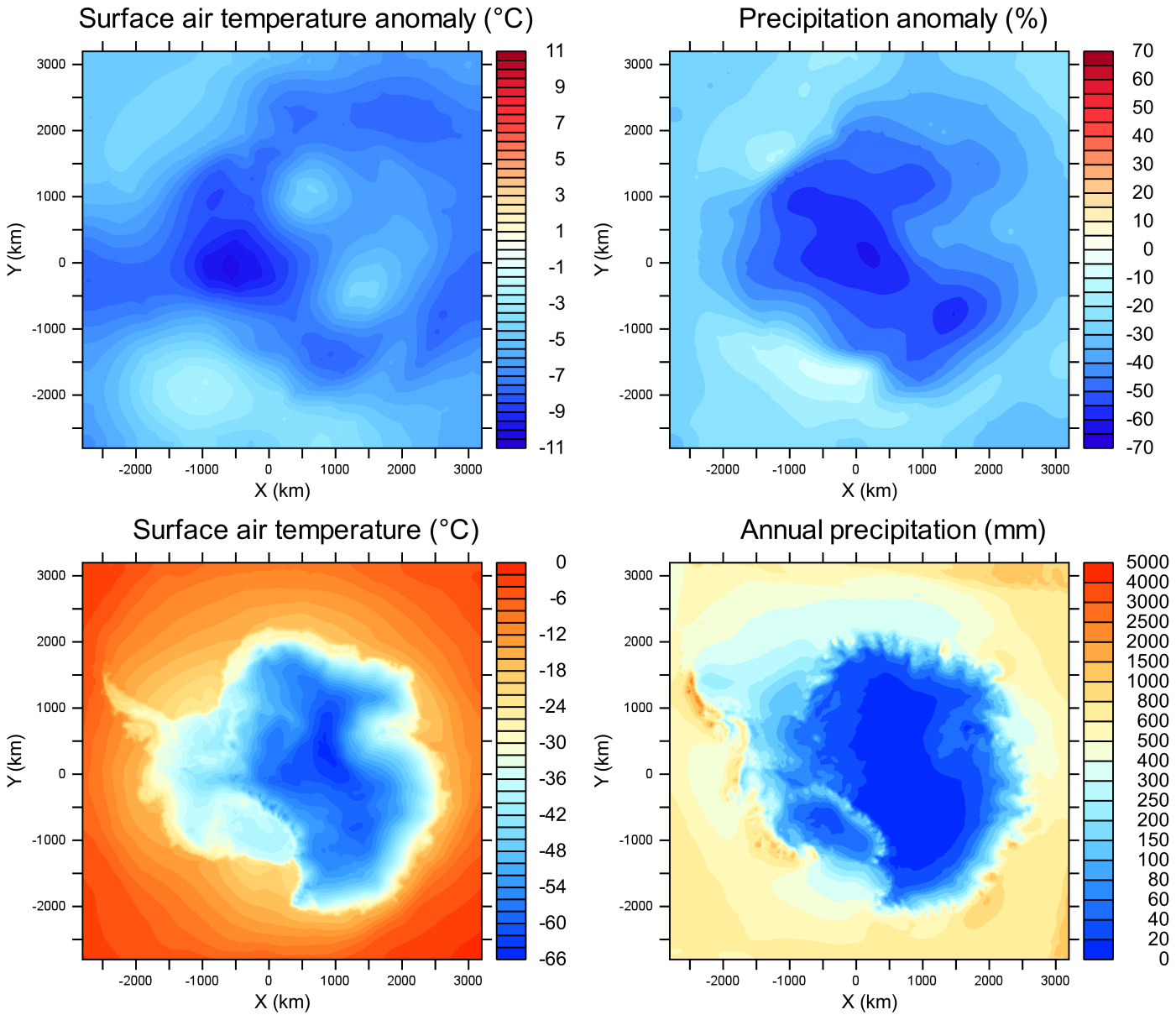
Past

Using climate modelling to generate boundary conditions



- Using the CSIRO Mk3L climate system model to simulate:
  - 26–0 ka, then 5,000 years into the future
  - 70–0 ka, then 5,000 years into the future
  - 120–0 ka, then 5,000 years into the future

Using climate modelling to generate boundary conditions



Why boundary conditions matter

Driving PISM with the geothermal heat flux datasets of:

- Shapiro and Ritzwoller (2004)
- An et al. (2015)