Reducing uncertainties in projections of global sea level rise

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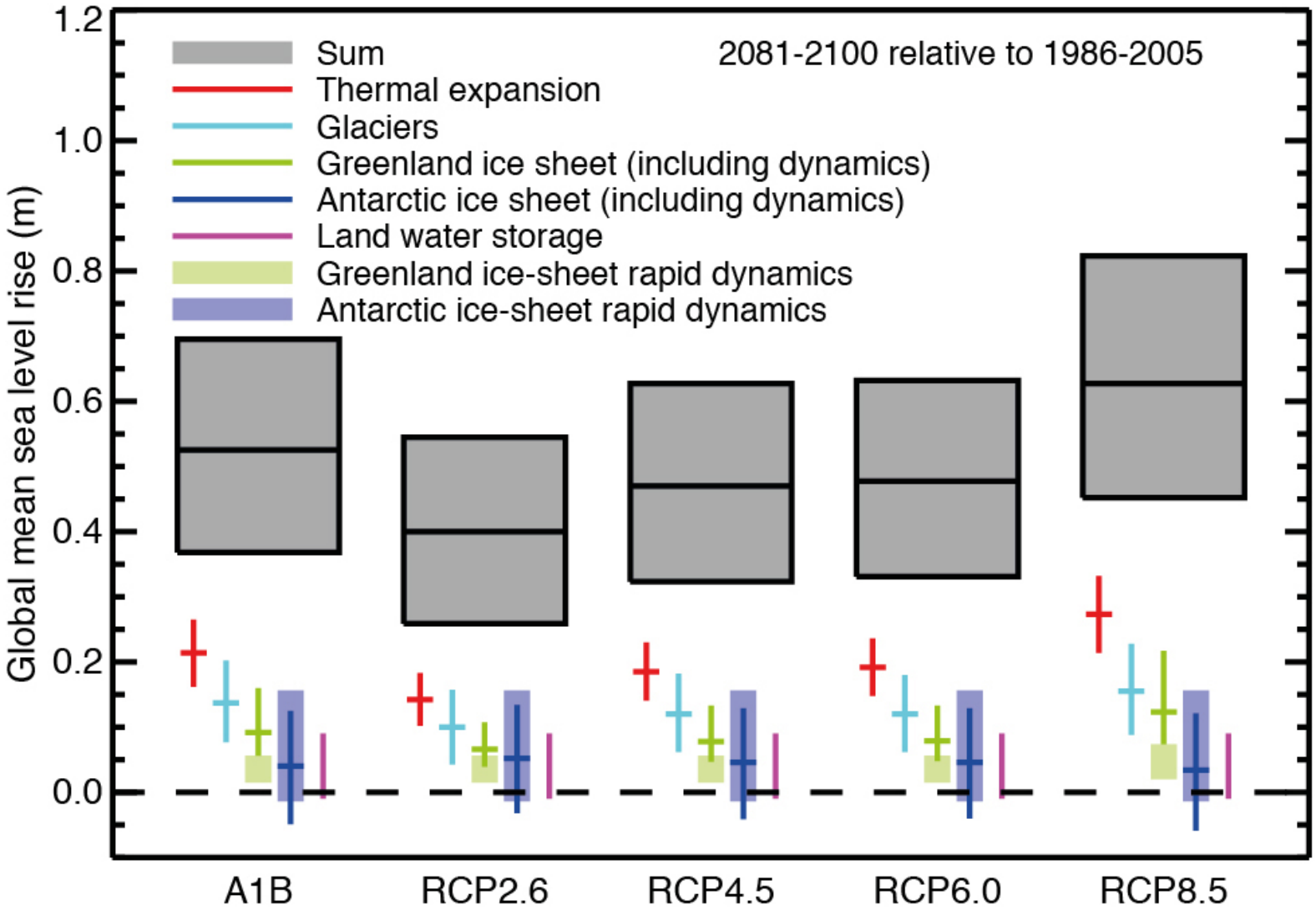
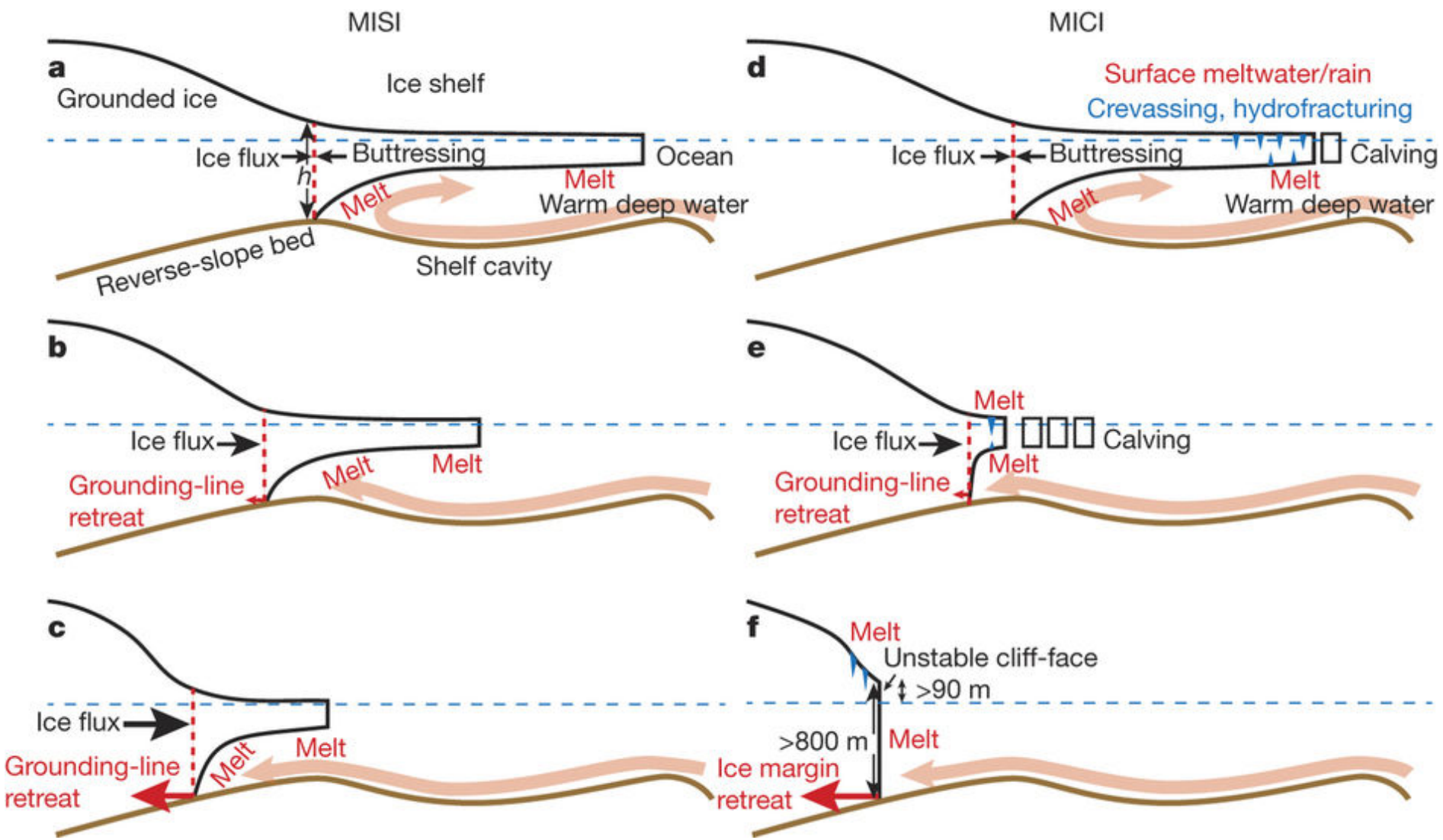
Likely changes in global sea level by 2081–2100



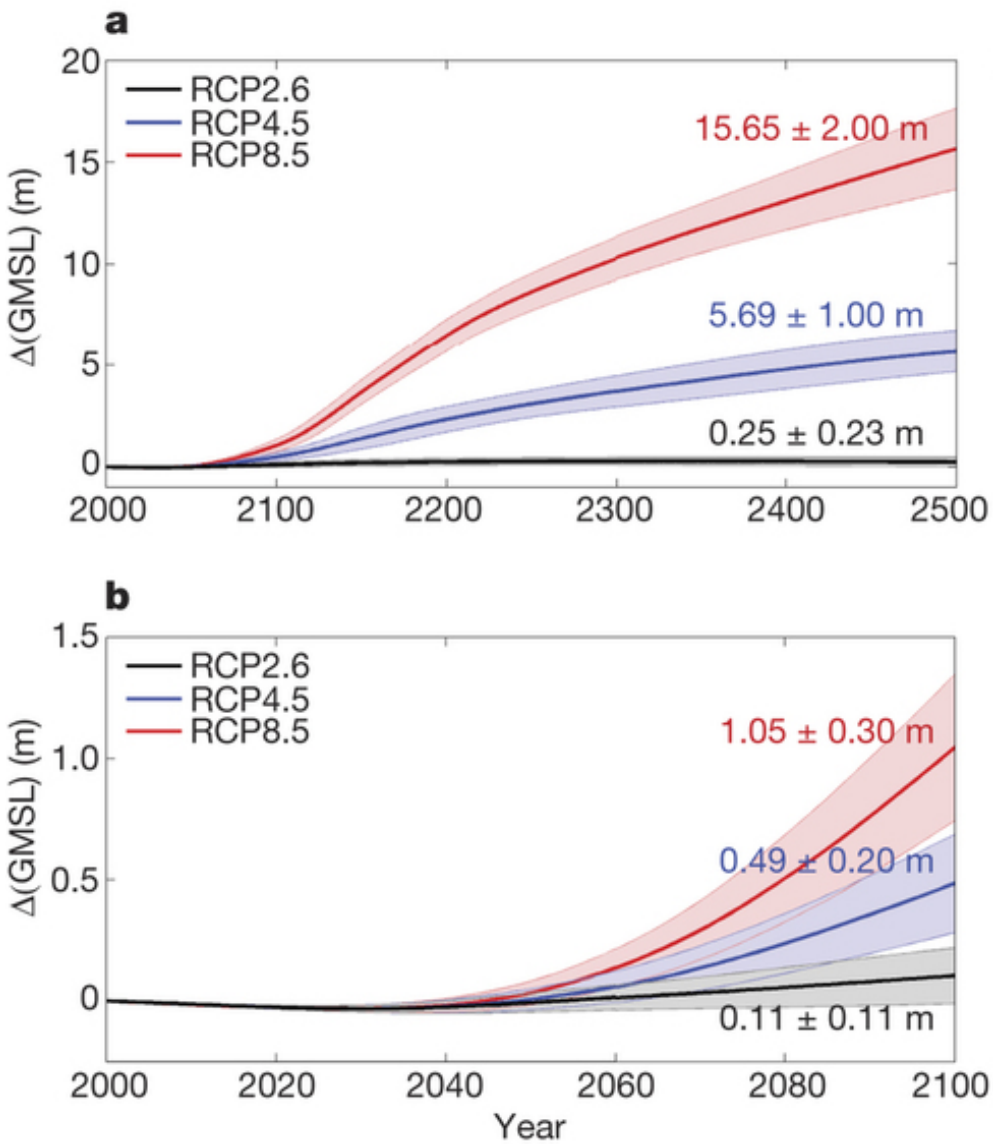
IPCC AR5 WG1 report (2013)

Mechanisms of ice sheet instability



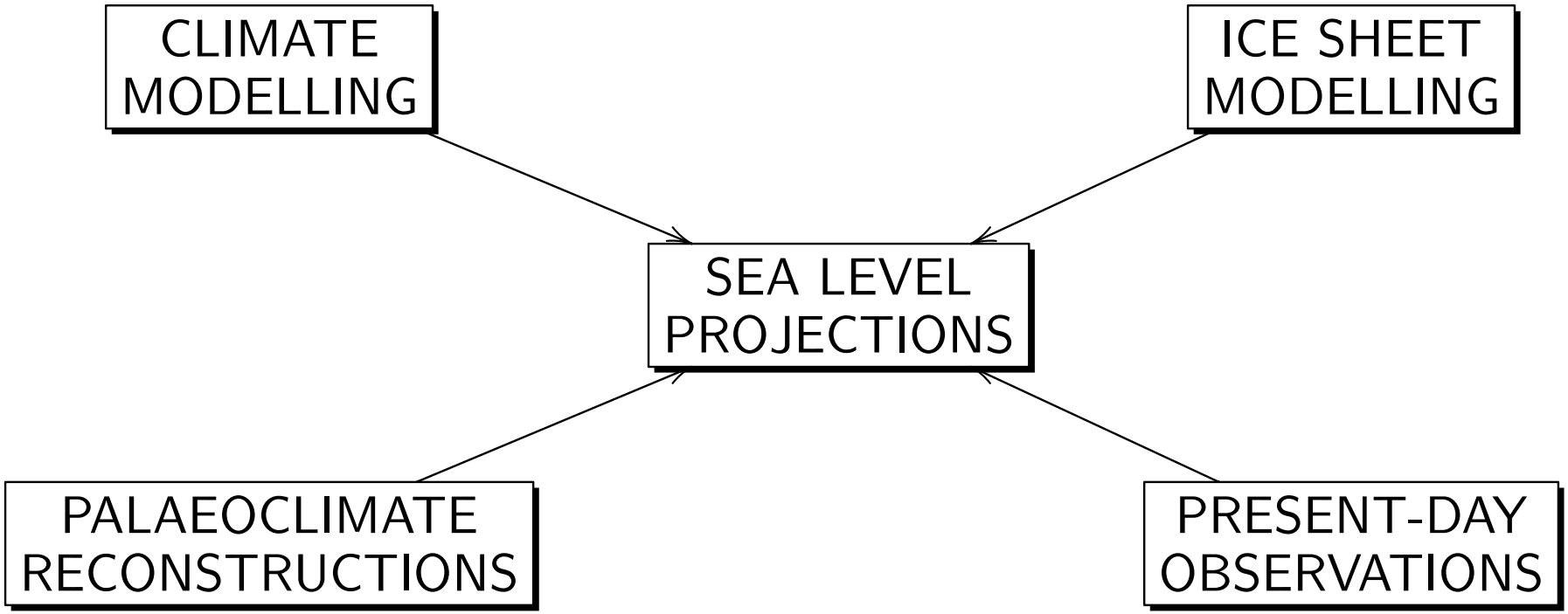
DeConto and Pollard (2016), *Nature*

Antarctic contribution to global sea level (2000–2500)



DeConto and Pollard (2016), *Nature*

An integrated approach to reducing uncertainties



How do we project changes in global sea level?

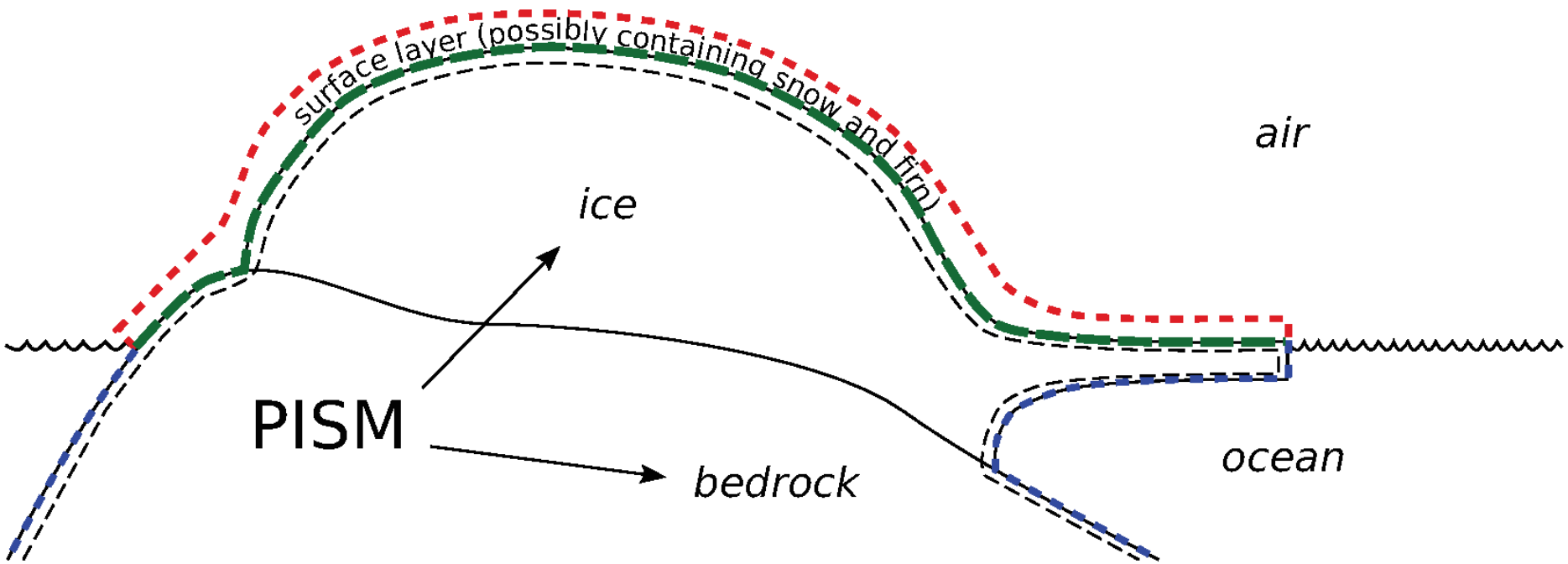
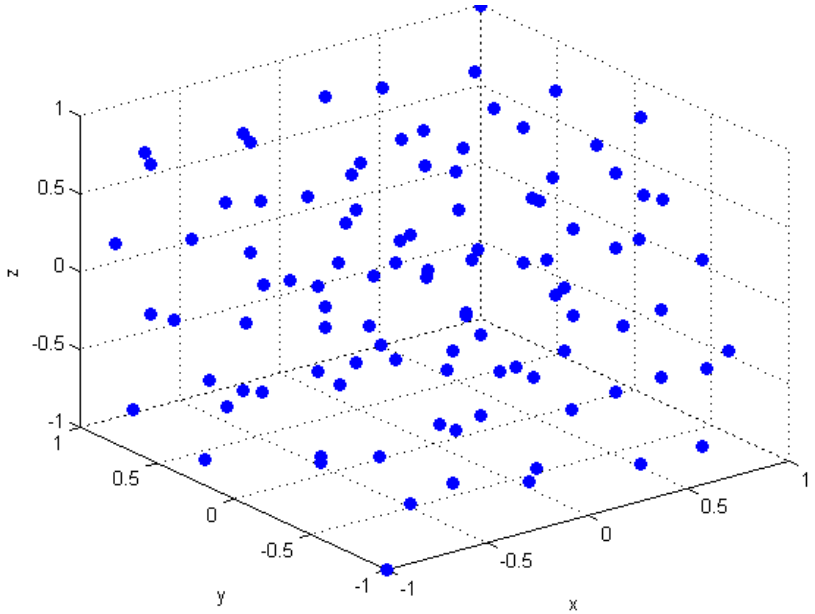


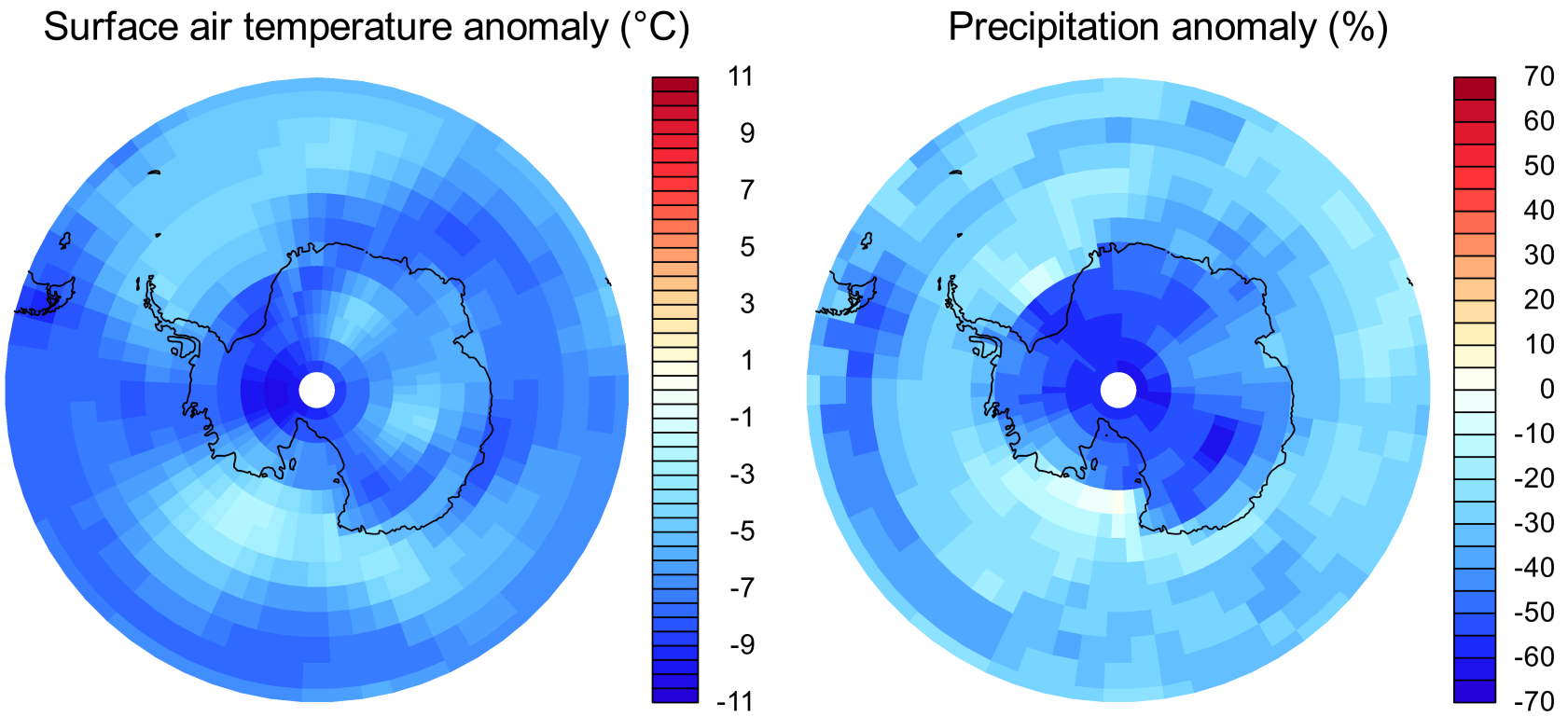
Figure 15: PISM's view of interfaces between an ice sheet and the outside world

Constraining ice sheet model parameterisations

- Problem:
  - Ice sheet model parameters are highly under-constrained.
- Solution:
  - 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.



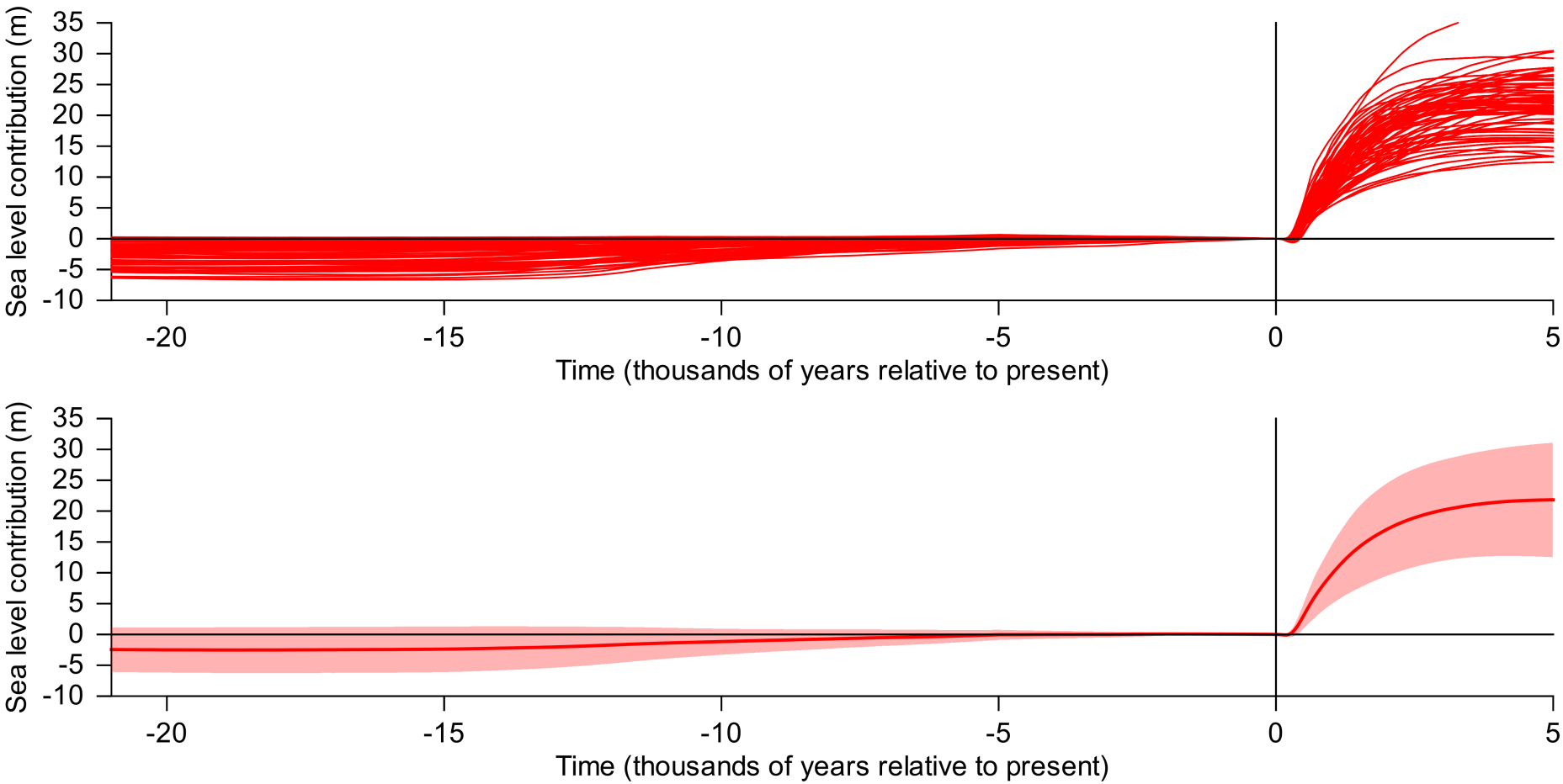
Constraining parameterisations: Boundary conditions



- Use the CSIRO Mk3L climate system model to simulate the period from the Last Glacial Maximum (~21,000 years ago) to present.
- Continue 5,000 years into the future under the RCP8.5 scenario.

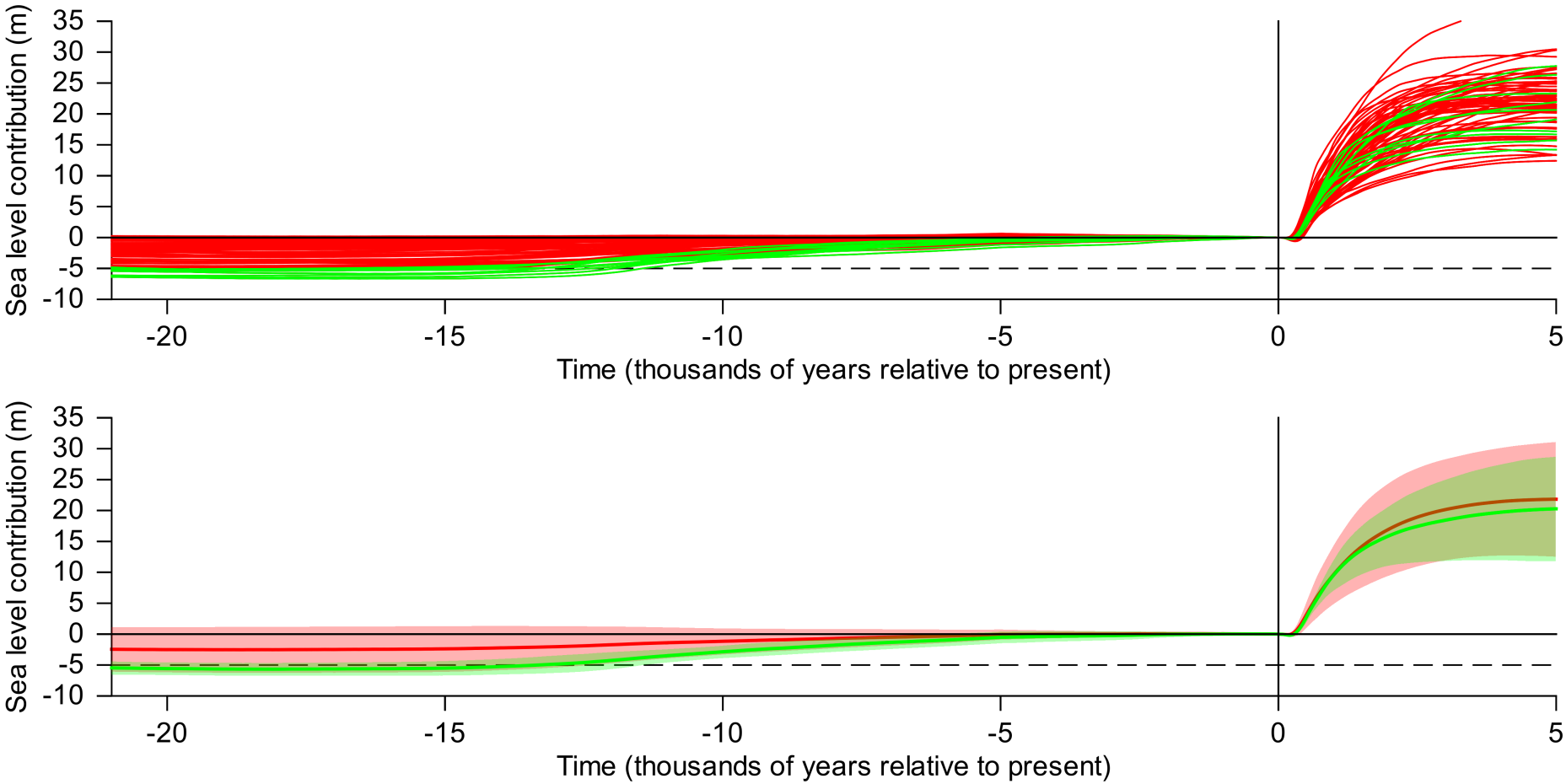
Simulated Antarctic contribution to global sea level

- Use the climate model output to drive 100 simulations using PISM.
- 69/100 simulations complete successfully, without crashing.

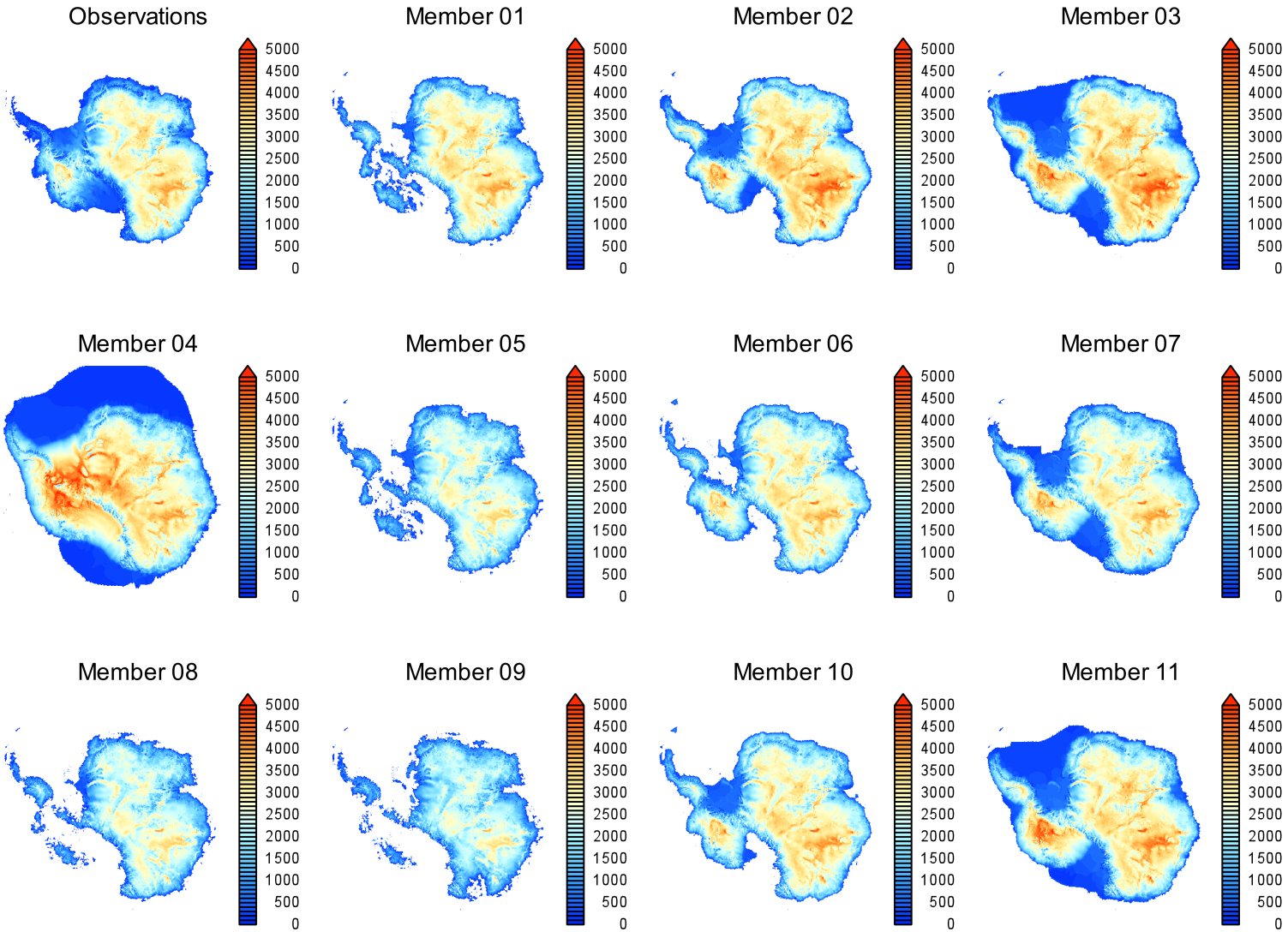


Constraining the model: Using the past

- LGM sea level contribution was at least 5 m (Noble et al., in prep.).
- 10/69 simulations satisfy this criterion.

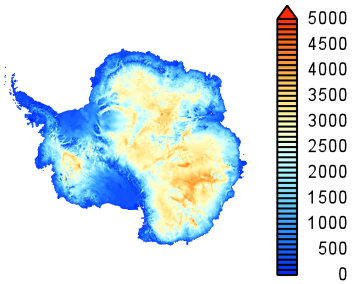


Constraining the model: Using the present

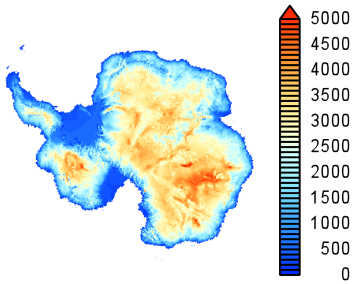


Constraining the model: Using the present

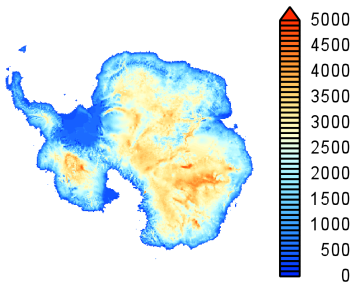
Observations



Member 02

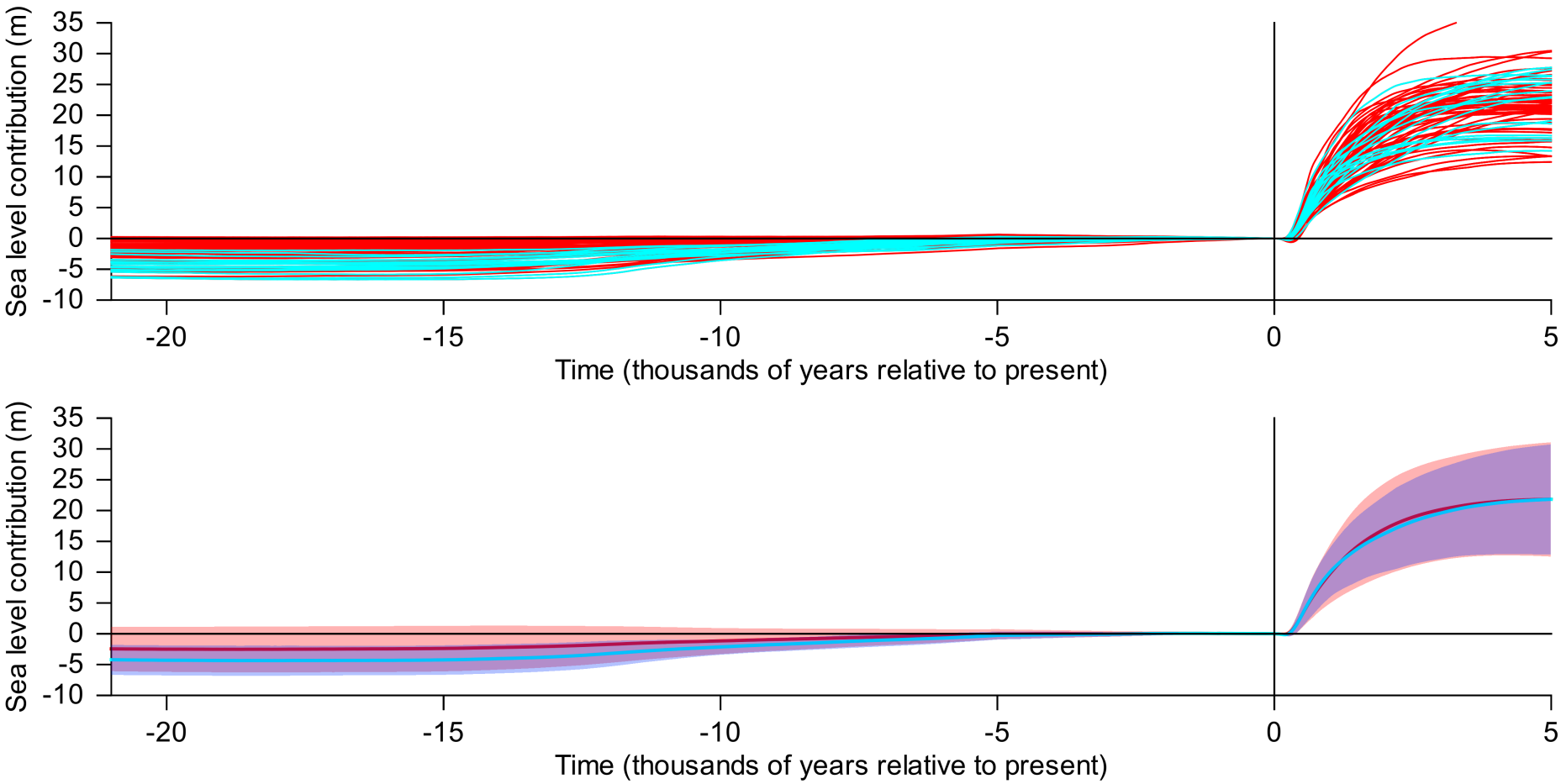


Member 10



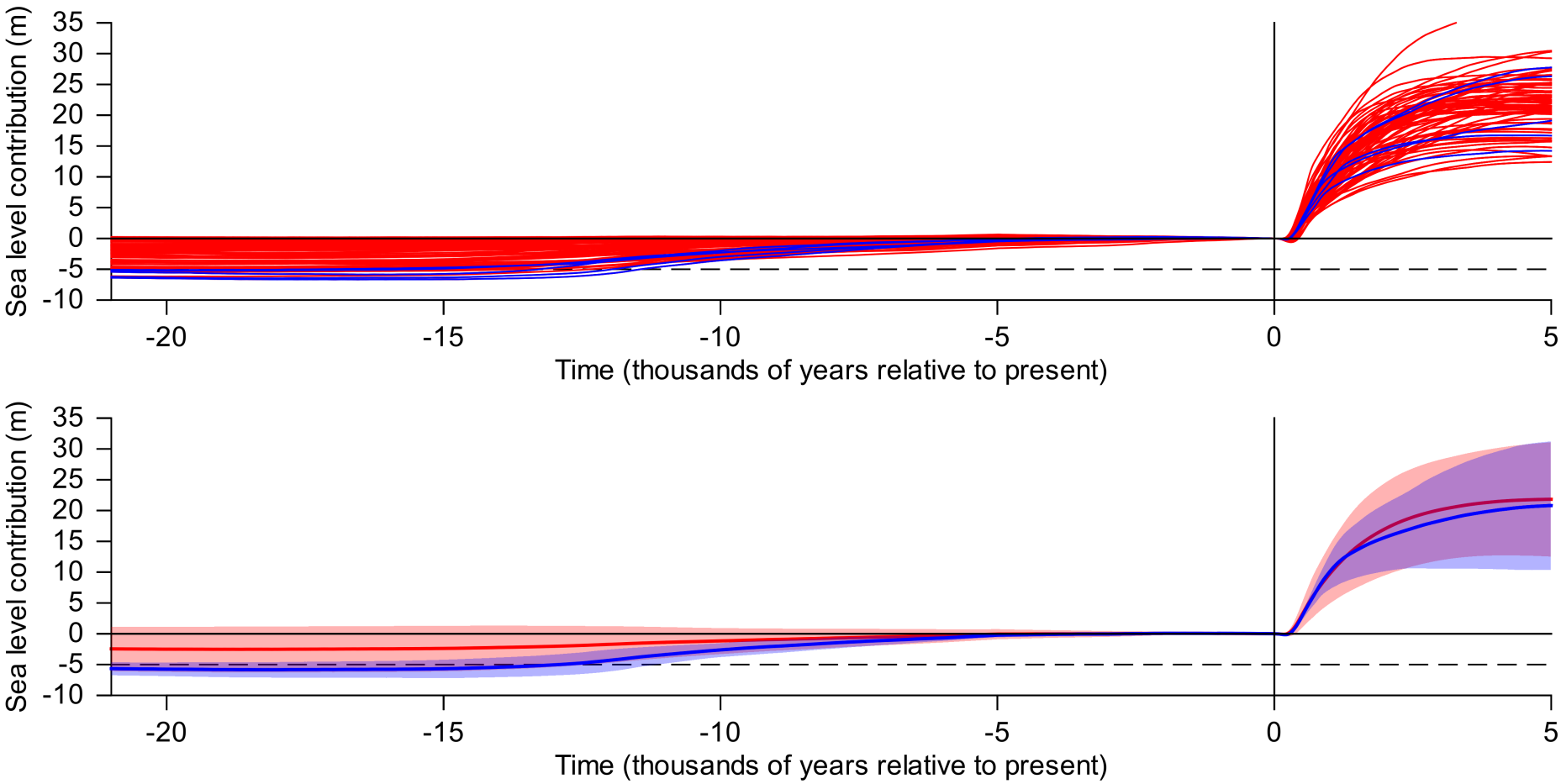
Constraining the model: Using the present

- Present-day ice distribution should be consistent with observations.
- 17/69 simulations satisfy this criterion.

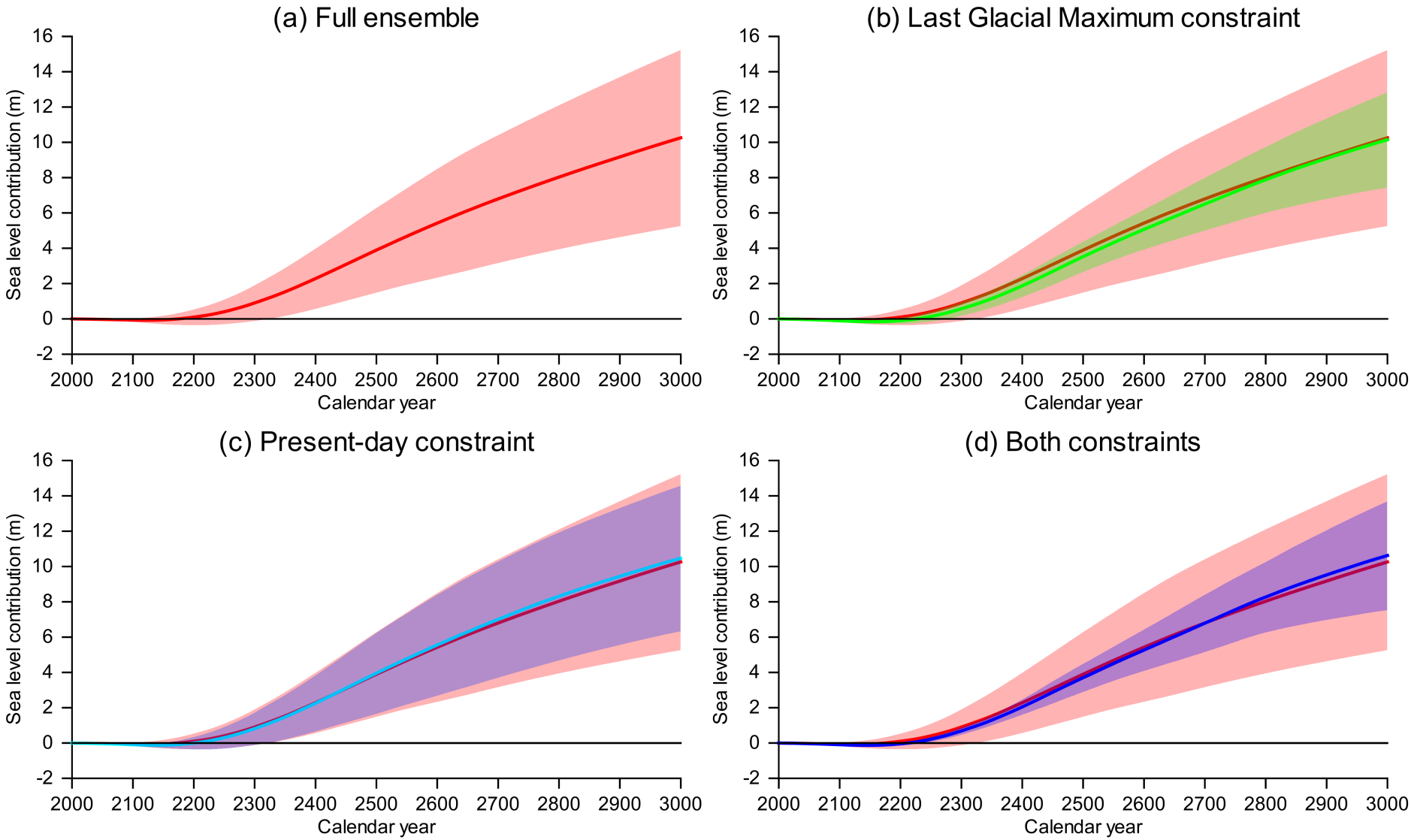


Bringing it together: Using the past and present

- Now we apply the LGM and present-day criteria simultaneously.
- 5/69 simulations satisfy both criteria.



Bringing it together: Using the past and present



Conclusions

- We have shown that information on the past and present states of the Antarctic Ice Sheet can be used to reduce uncertainty in future projections of global sea level.
- Reconstructions of past changes provide the greatest benefit, by eliminating unrealistic configurations of the ice sheet model.
- The primary benefit is to reduce *uncertainty* in the projections, rather than to revise the best estimates e.g. under the RCP8.5 scenario, the projected Antarctic contribution to global sea level by 2500 CE is refined from 3.90 ± 2.40 m to 3.70 ± 0.80 m.
- Our estimates are lower than those of DeConto and Pollard (2016), who project an Antarctic contribution to global sea level of 15.65 ± 2.00 m by 2500 CE.