ANTARCTIC GATEWAY PARTNERSHIP

Exploring the sensitivity of the Wilkes Basin to anthropogenic climate change

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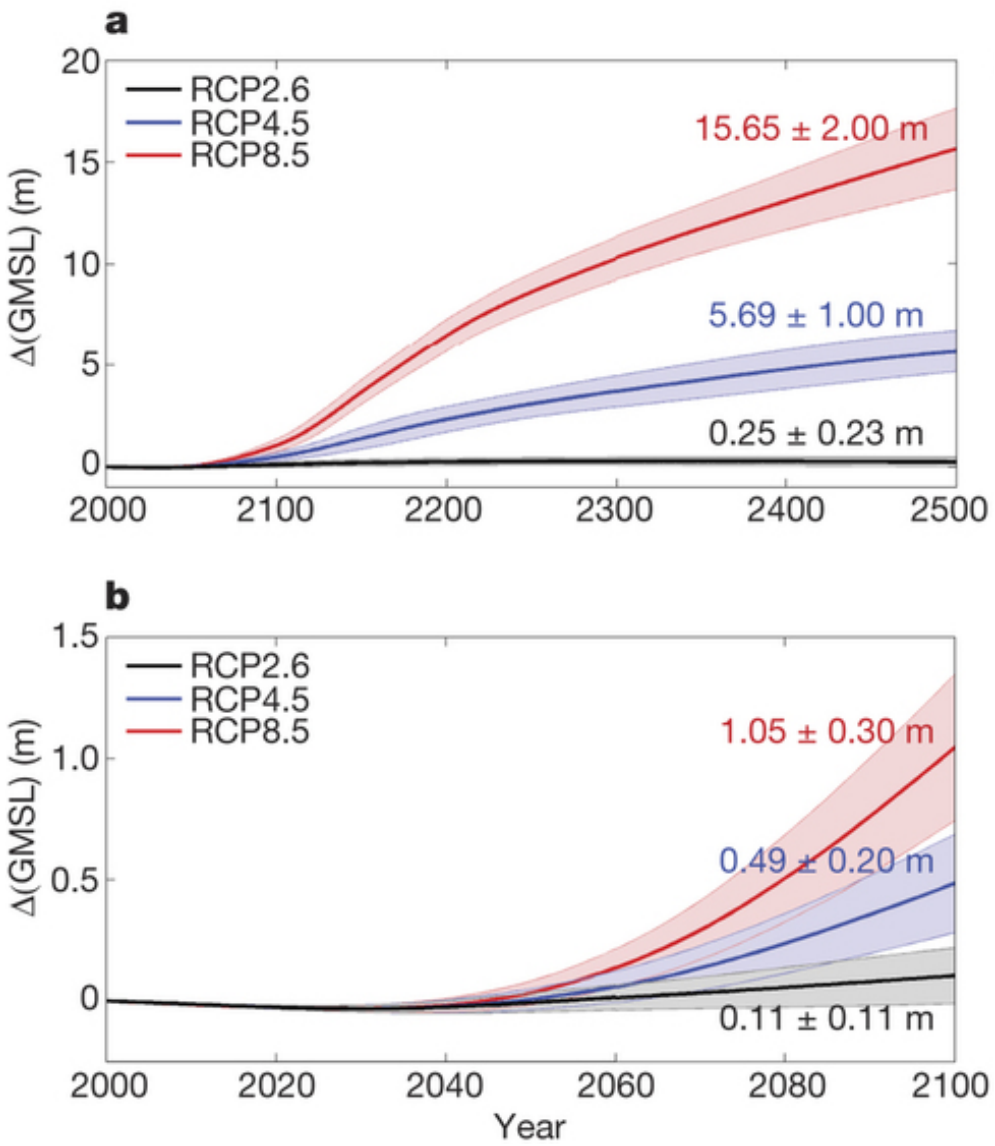
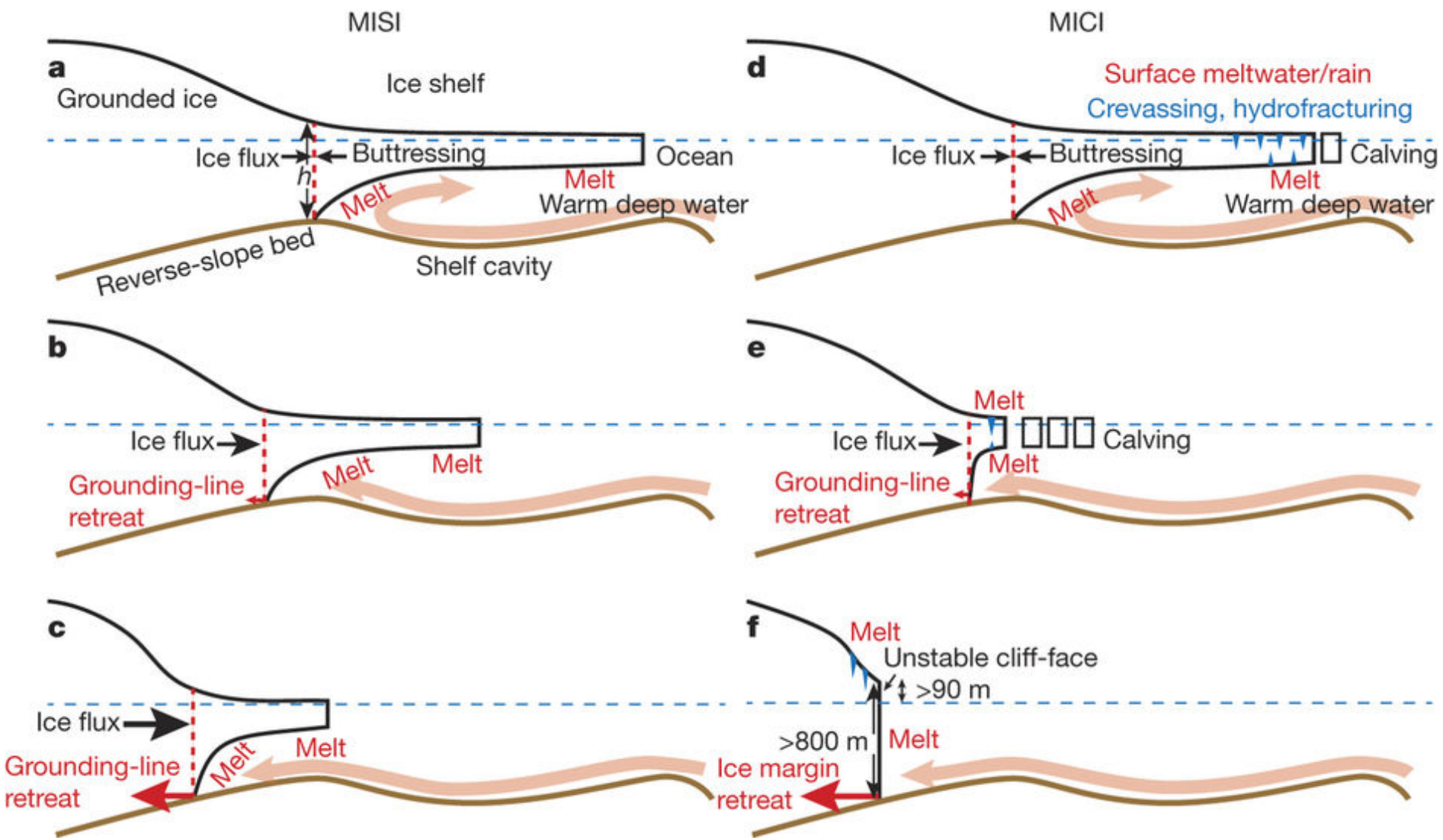
Antarctic contribution to global sea level (2000–2500)



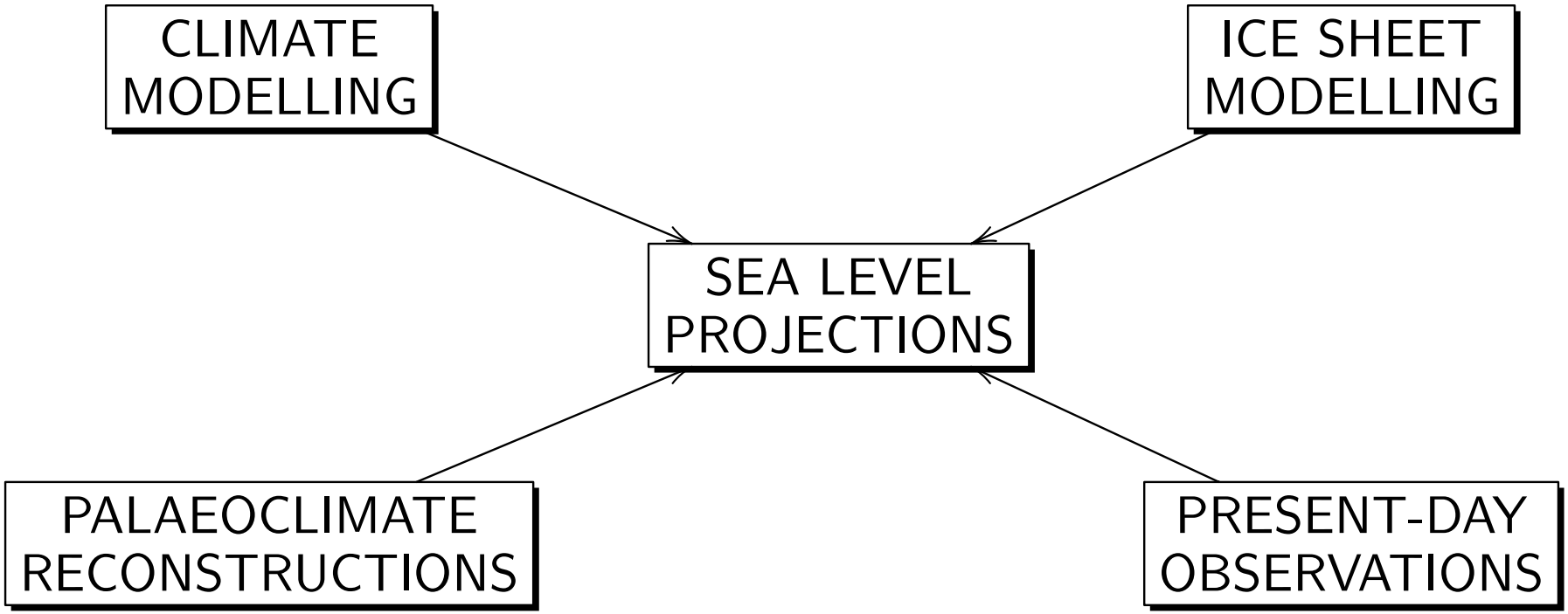
DeConto and Pollard (2016), *Nature*

Mechanisms of ice sheet instability



DeConto and Pollard (2016), *Nature*

An integrated approach to quantifying uncertainties



How do we project changes in global sea level?

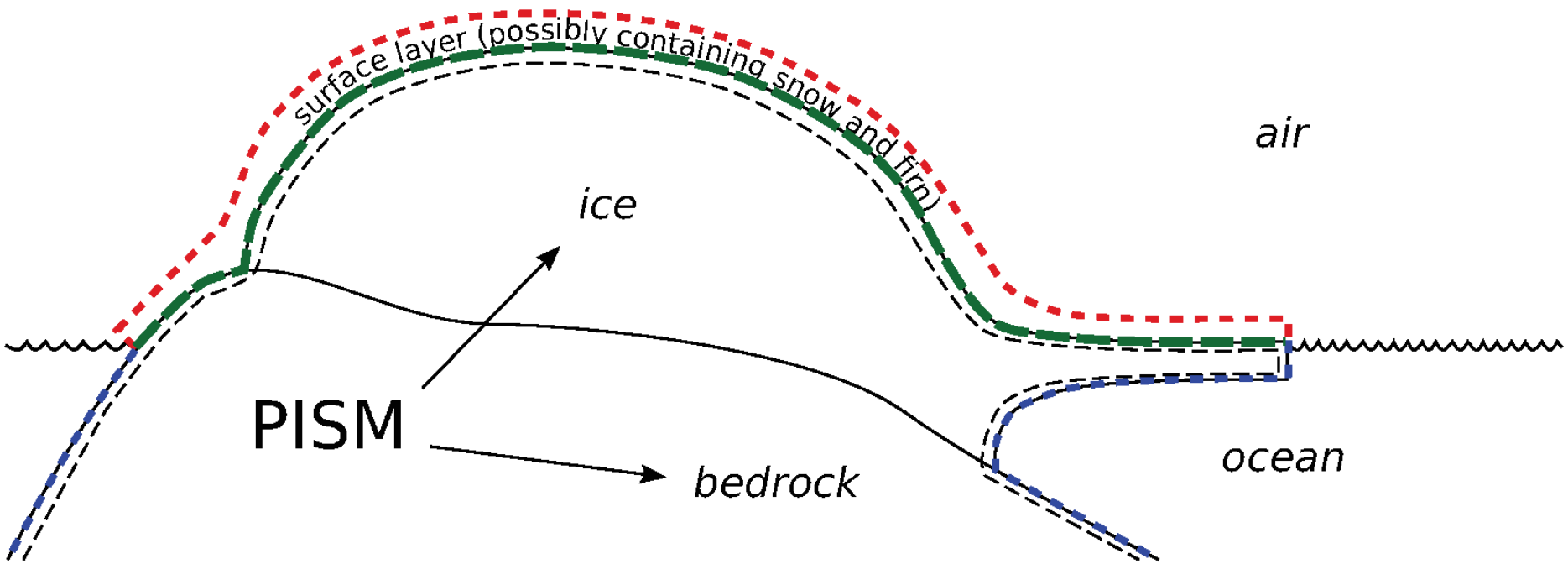
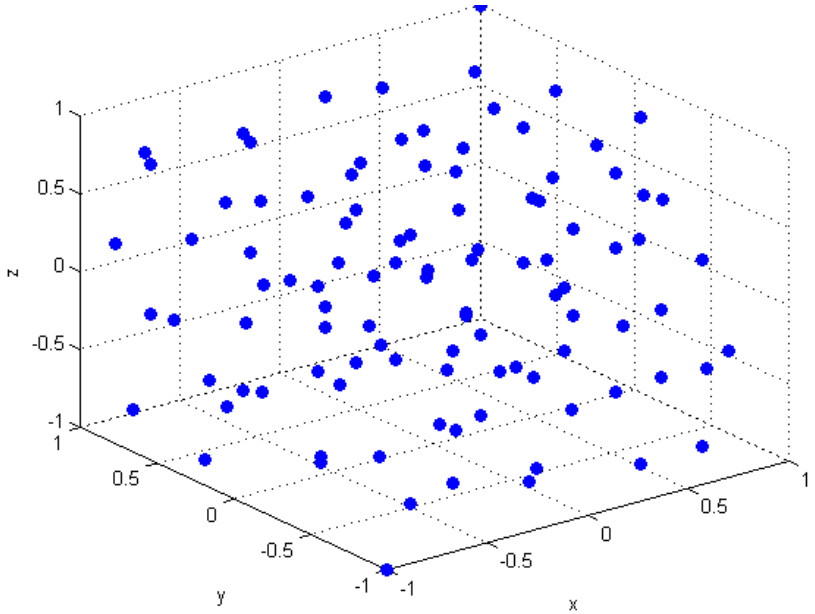


Figure 15: PISM's view of interfaces between an ice sheet and the outside world

Constraining ice sheet model parameterisations

- Problem:
  - Ice sheet model parameters are highly under-constrained.
- Solution:
  - Use PISM to simulate the present-day state 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 observations.

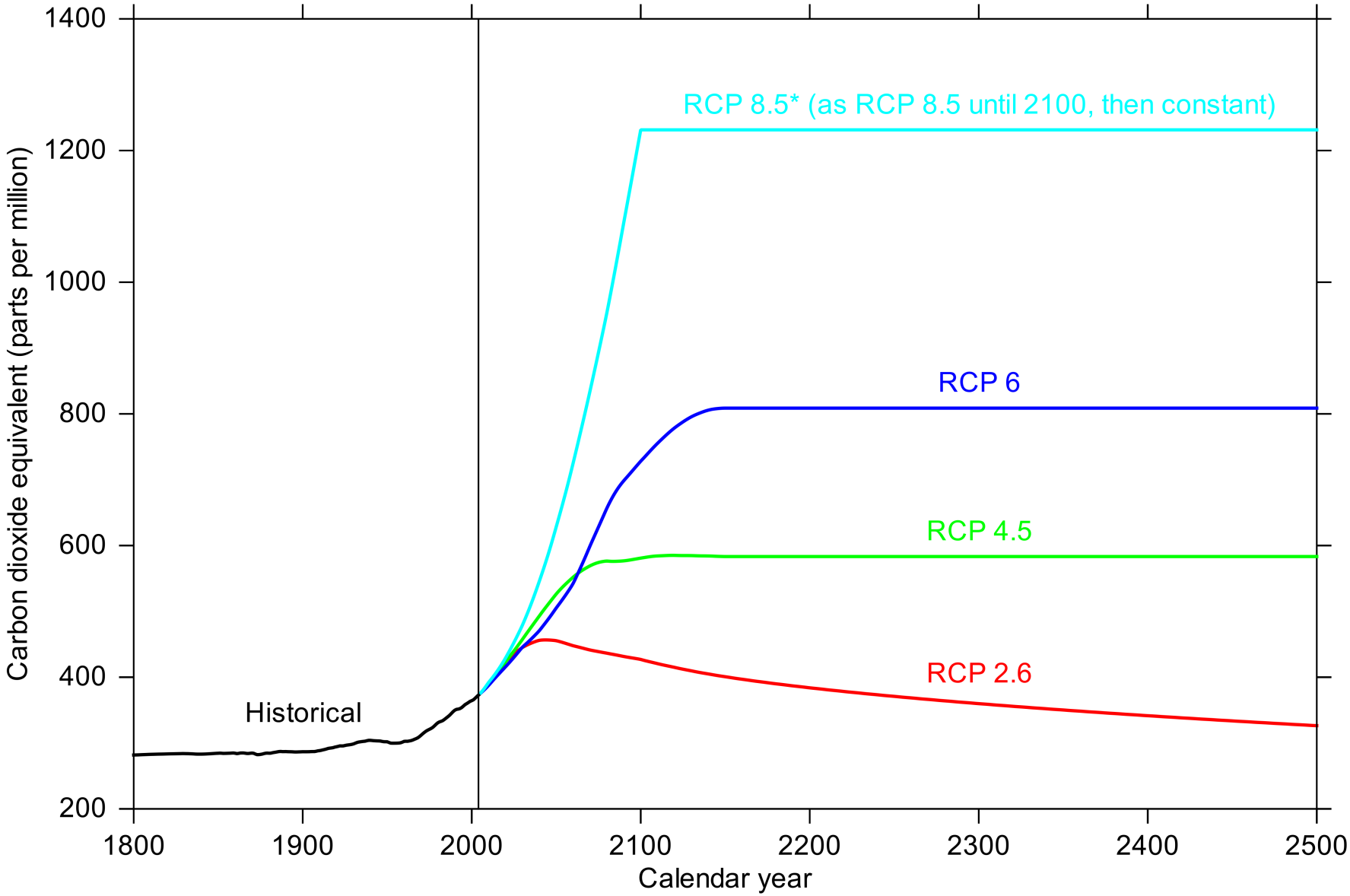


Constraining parameterisations: An iterative process

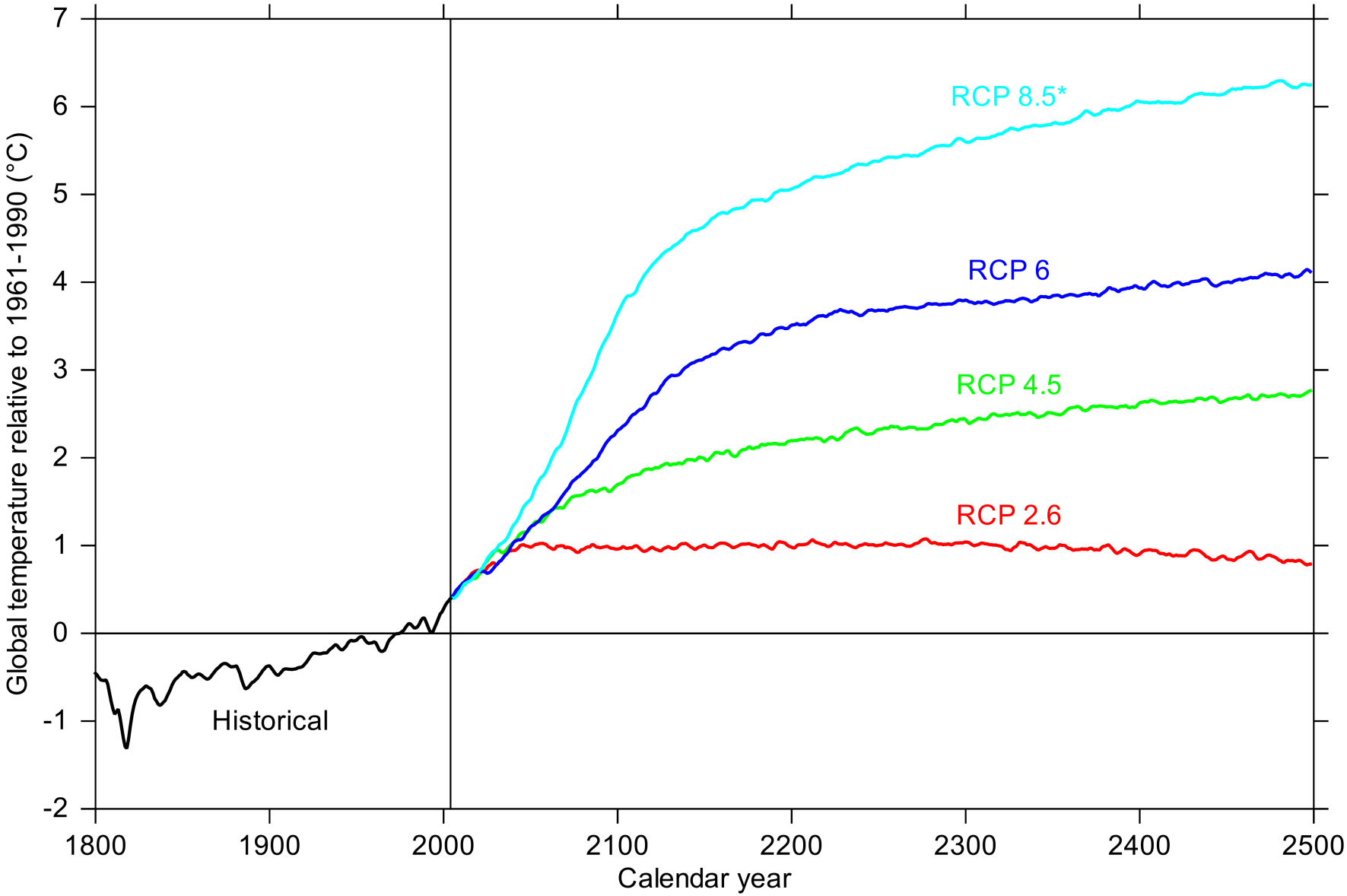
- A 100-member perturbed-physics ensemble is constructed, using a Latin hypercube approach to sample the range of uncertainty in the parameterisations of 10 key physical processes.
- An iterative process is used to determine the parameter ranges:
  - Initial values are selected, based on prior published work.
  - For each parameter, the range that gives a realistic simulation of the present-day AIS is determined. If this range differs from the previous iteration, according to a statistical test, then it is updated.
  - These steps are repeated until no further changes are required.

	Parameter	Iteration 1		Iteration 2		Iteration 3	
		Min.	Max.	Min.	Max.	Min.	Max.
1	Shallow ice enhancement factor	1.00	5.50	1.00	4.25	1.00	4.25
2	Shallow shelf enhancement factor	0.50	2.00	0.50	2.00	0.75	2.00
3	Exponent of basal resistance model	0.10	1.00	0.10	0.73	0.10	0.73
4	Effective till pressure scaling factor	0.0050	0.0400	0.0050	0.0400	0.0111	0.0400
5	Calving rate scaling factor	1.00e15	1.00e20	1.00e15	1.00e20	8.94e15	1.00e20
6	Minimum thickness of floating ice shelves	50.0	400.0	191.9	400.0	191.9	335.8
7	Minimum till friction angle	5.0	20.0	5.0	20.0	5.0	20.0
8	Maximum till friction angle	20.0	40.0	20.0	40.0	20.0	40.0
9	Elevation of minimum till friction angle	-1500.0	0.0	-1500.0	0.0	-1500.0	0.0
10	Elevation of maximum till friction angle	0.0	1500.0	0.0	942.5	0.0	942.5

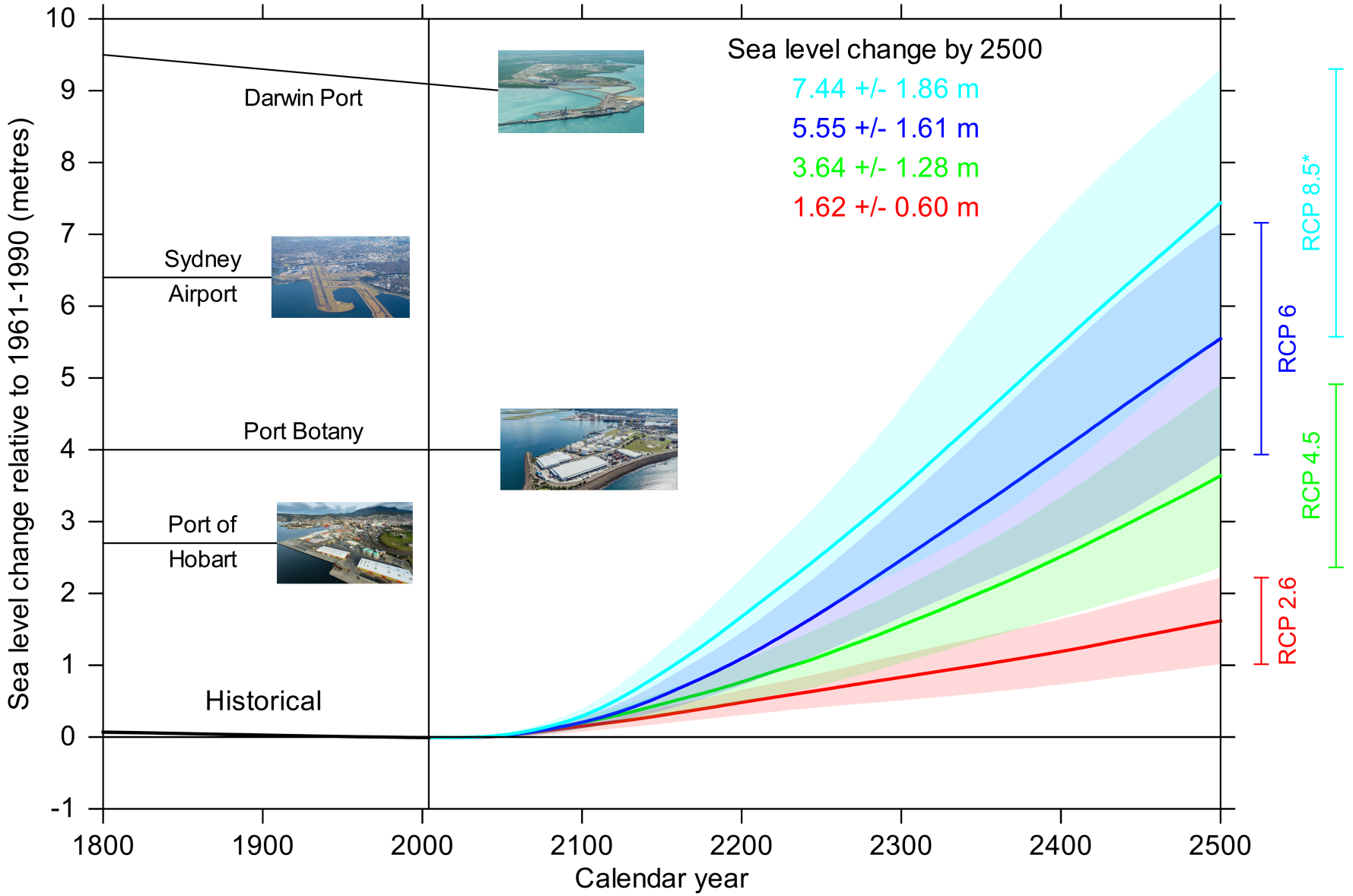
Future climate scenarios



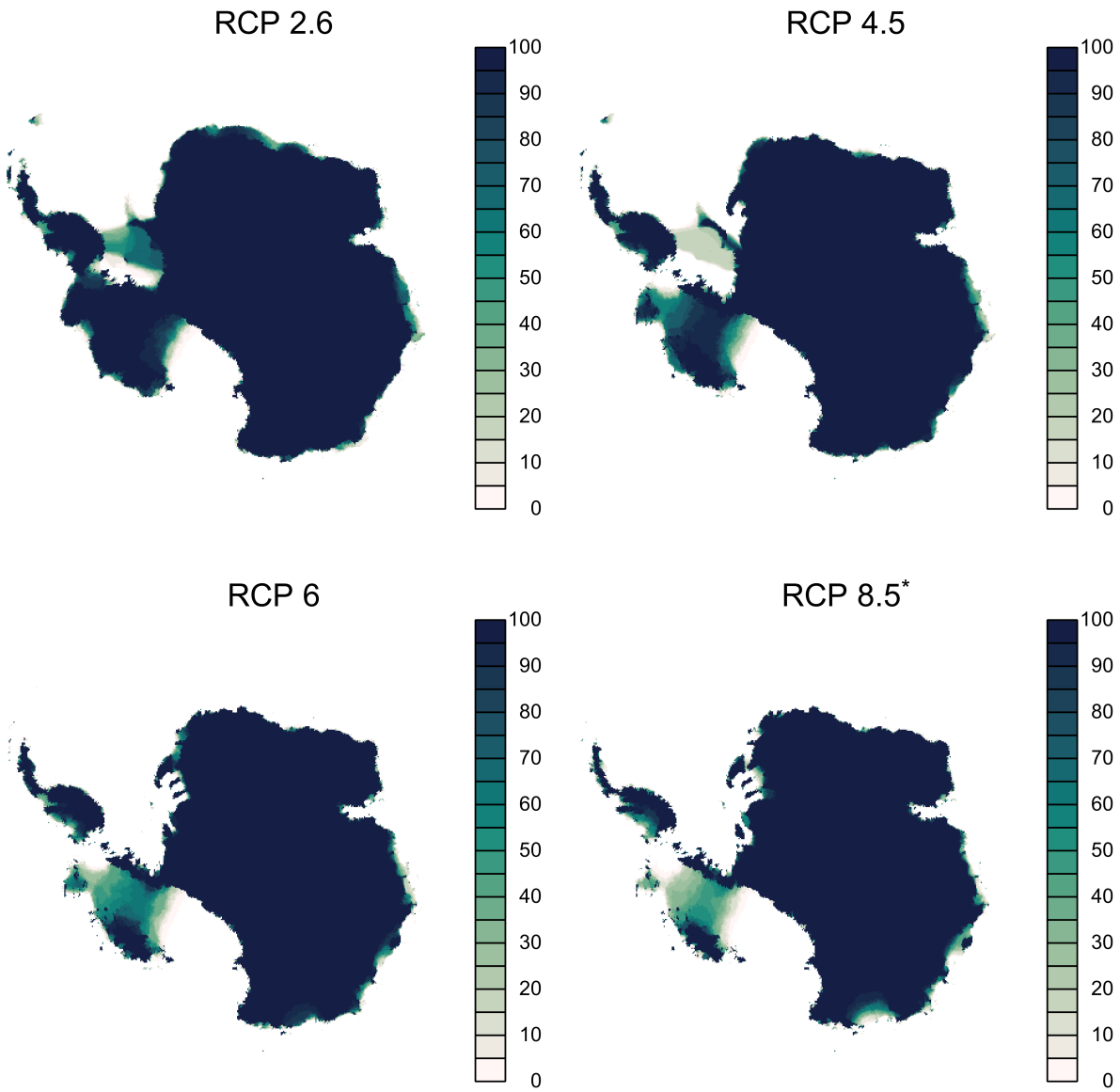
Simulated changes in global-mean surface temperature



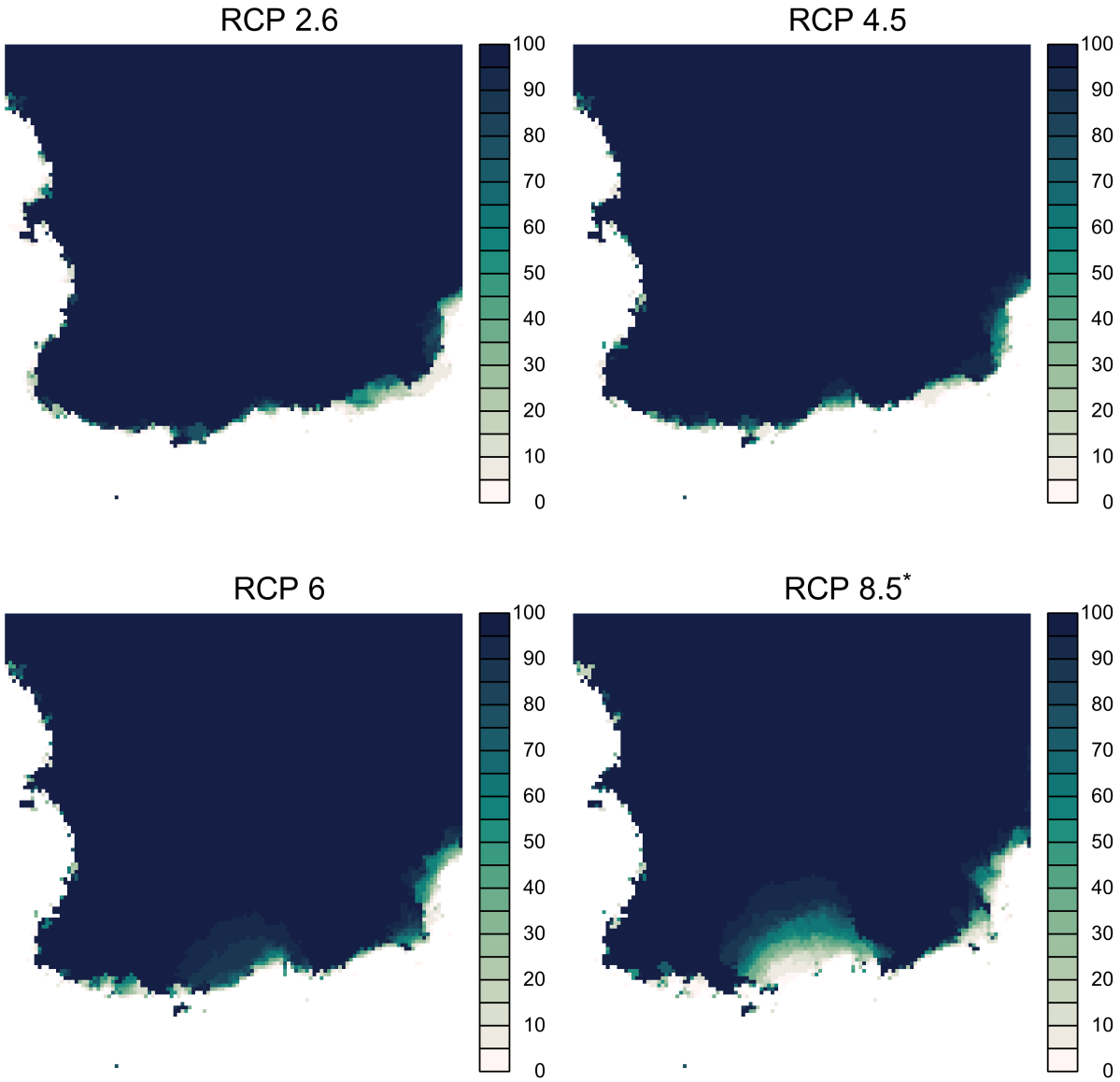
Simulated contribution of AIS to global sea level



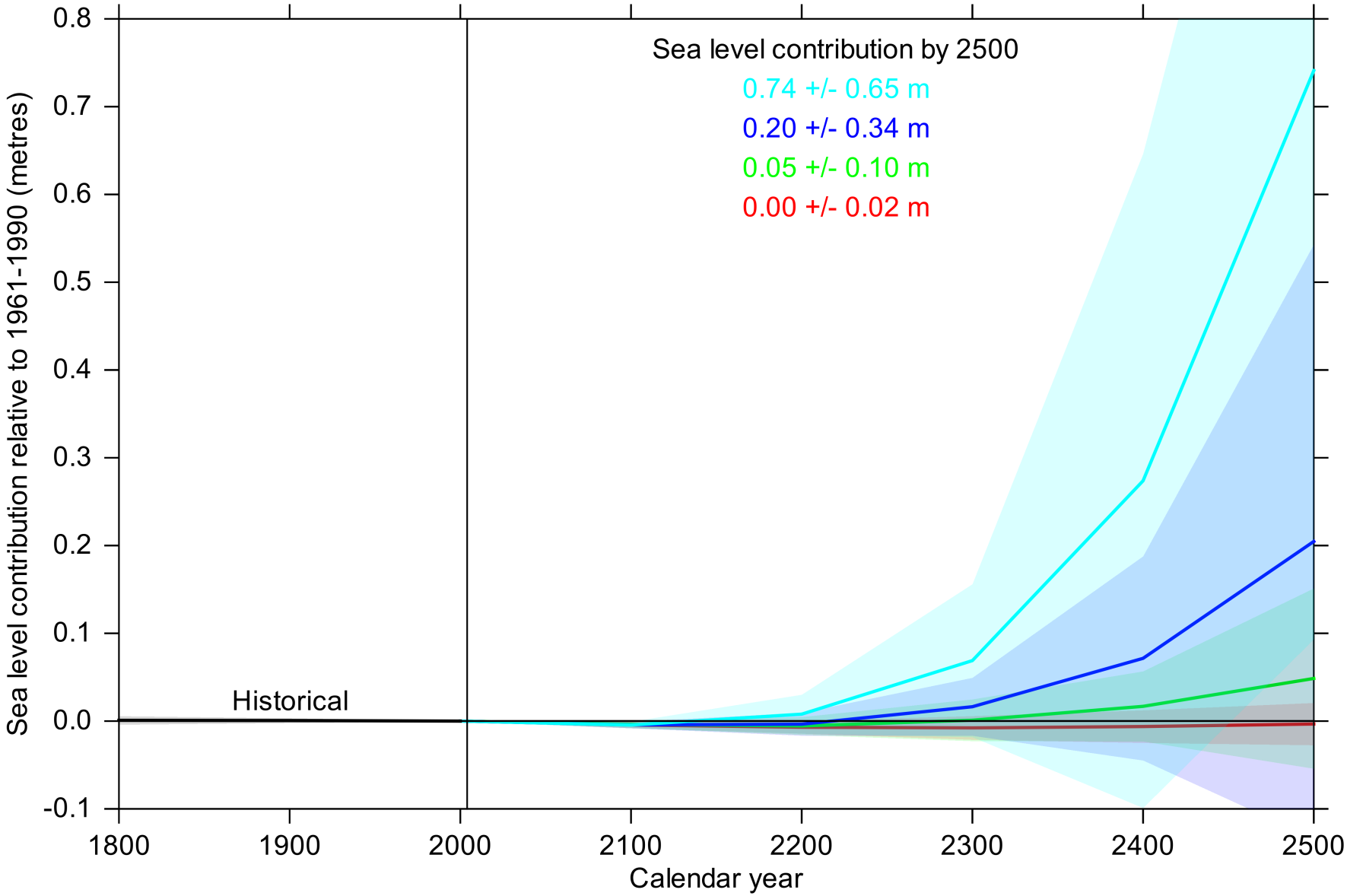
Probability of surviving ice cover by 2500 (percent)



Probability of surviving ice cover by 2500 (percent)



Simulated contribution of Wilkes Basin to global sea level



Conclusions

- Current ice sheet models may not be fit for purpose.
- The Wilkes Basin is the largest source of uncertainty in the projected response of the East Antarctic Ice Sheet to anthropogenic climate change.
- The Wilkes Basin is therefore the most promising target in East Antarctica for improving our understanding of the Antarctic Ice Sheet and our ability to model it.
- Quantifying and reducing uncertainty in projections of global sea level rise requires integrated research programs spanning climate modelling, ice sheet modelling, observations and palaeoclimate.