The commitment to global sea level rise over the next 500 years

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Likely changes in global sea level by 2081–2100?

IPCC AR5 WG1 report (2013)
Antarctic contribution to global sea level (2000–2500)

DeConto and Pollard (2016), *Nature*
What are the potential economic impacts?

$226 billion worth of infrastructure & homes at risk from coastal inundation at a sea level rise of 1.1 metres.

CLOSE TO 250,000 HOMES AT RISK!

NATIONAL INFRASTRUCTURE WITHIN 200 M OF THE COASTLINE

- 120 ports
- 5 power stations
- 258 police, fire & ambulance stations
- 75 hospitals & health services
- 44 water and waste facilities

Data relates to infrastructure exposed to coastal inundation and shoreline recession at a sea level rise of 1.1 metres (high end scenario for 2100). The replacement values are drawn from Geoscience Australia’s National Exposure Information System (NEXIS) database. Source: DCC 2009, DCCCE 2011.

Climate Council of Australia (2014)
Generating robust projections of sea level rise

- **ICE SHEET MODELLING** → **SEA LEVEL PROJECTIONS** ← **PRESENT-DAY OBSERVATIONS**
- **CLIMATE MODELLING** → **SEA LEVEL PROJECTIONS** ← **PALAEOCLIMATE RECONSTRUCTIONS**
How do we project changes in global sea level?

PISM
Parallel Ice Sheet Model

- PISM
- ice
- bedrock
- surface layer (possibly containing snow and film)
- air
- ocean
Problem:
- There are gaps in our understanding of ice sheet dynamics.

Solution:
- Run the model many times, changing the model physics each time to sample as many different physical combinations as possible.
Use the CSIRO Mk3L climate system model to simulate the last glacial cycle, from 130,000 years ago to present.

During the Last Glacial Maximum (LGM; ~21,000 years ago), global sea level was around 120 m lower than today.
Climate modelling: Simulating the future

RCP 8.5* (as RCP 8.5 until 2100, then constant)

RCP 6

RCP 4.5

RCP 2.6

Historical

Carbon dioxide equivalent (parts per million)

Calendar year

1800 1900 2000 2100 2200 2300 2400 2500
Climate modelling: Simulating the future

The diagram illustrates the expected global temperature changes relative to 1850-1900°C for different Representative Concentration Pathways (RCPs) from 1800 to 2500. The RCPs include:

- **RCP 8.5**: The line shows a steep increase in global temperature, indicating the highest warming scenario.
- **RCP 6**: This pathway results in a moderate increase in global temperature.
- **RCP 4.5**: The line indicates a lower increase in global temperature compared to RCP 8.5 and RCP 6.
- **RCP 2.6**: The lowest warming scenario is represented by this pathway with the least increase in global temperature.

The Paris Agreement is also indicated on the graph, showing the temperature increase when the agreement is met. The graph also includes a historical line from 1800 to 2000.
Simulated Antarctic contribution to global sea level

- Use the climate model output to drive 100 simulations using PISM.
Using information from the past

- The Last Glacial Maximum sea level contribution was at least 5 m.
Using information from the present

- The present-day ice sheet should be consistent with observations.
Combining information from the past and present

Now we apply the LGM and present-day criteria simultaneously.
Combining information from the past and present

Sea level rise over the next 500 years

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Simulated Antarctic contribution to global sea level rise over the next 500 years

Sea level change by 2500:
- 6.09 +/- 0.86 m
- 4.38 +/- 0.59 m
- 2.78 +/- 0.29 m
- 1.20 +/- 0.15 m