

Senate Standing Committee on Environment and Communications
Legislation Committee
Answers to questions on notice
Environment and Energy portfolio

Question No: 136
Hearing: Additional Estimates
Outcome: Outcome 3
Program: Australian Antarctic Division (AAD)
Topic: Data on sea level rise
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Senator Whish-Wilson asked:

Senator WHISH-WILSON: I suppose what I am most interested in is projections of sea level rise. We are not just talking about climate change per se here; we are talking about managing risk. This is a very serious issue for every council around the country that is facing the ocean and waterways. Could you take on notice if the department has any views on whether the data is substantial about changing those projections for sea level rise?

Answer:

The Australian Antarctic Division can comment on the Antarctic and Southern Ocean influences on global mean sea level and its projections. The issue of *local* sea level projections, while dependent on the global mean changes, involves a range of other factors, including weather and storm surges, vertical land motion and sea-surface variations. These issues lie outside of AAD research and are not discussed in this response.

Regarding whether Antarctic data are substantial about changing projections, it is valuable to first revisit the projections of the last Intergovernmental Panel on Climate Change Fifth Assessment Report (IPCC-AR5), as these typically constitute the basis for contemporary advice on future sea level; then secondly developments since then which might affect IPCC-AR5 conclusions may be considered.

IPCC AR5 Projections

IPCC AR5 predicted the following for sea level rise for four possible climate futures depending on greenhouse gas emissions. These are the representative concentration pathways (RCPs). The report states that global mean sea level rise for 2081–2100 relative to 1986–2005 will likely be in the ranges of “0.26 to 0.55 m for RCP2.6, 0.32 to 0.63 m for RCP4.5, 0.33 to 0.63 m for RCP6.0, and 0.45 to 0.82 m for RCP8.5. For RCP8.5, the rise by 2100 is 0.52 to 0.98 m with a rate during 2081–2100 of 8 to 16 mm yr⁻¹”, adding that they were unable to evaluate the probability of higher projections, but indicating:

“Based on current understanding, only the collapse of marine-based sectors of the Antarctic ice sheet, if initiated, could cause global mean sea level to rise substantially above the likely range during the 21st century. However, there is medium confidence that this additional contribution would not exceed several tenths of a meter of sea level rise during the 21st century.”

(IPCC Fifth Assessment Report, Ch. 13, p1140)

Developments since IPCC AR5

Since this report, the prospects of accelerated collapse of marine-based sectors has been a focus of research: particularly the Pine Island and Thwaites Glacier systems in West Antarctica. Recent studies suggest that retreat of marine based ice is underway in West Antarctica and that this may accelerate (Rignot *et al.*, 2014). The sea level potential of such retreat is around 3.3m (most likely over a timescale of centuries to millennia). The driver of ice retreat is relatively warm water from the ocean, which is intruding into the cooler waters on the continental shelf and enhancing the normal melt where ice meets ocean. This intrusion of warmer water is likely a result of climate change, due to wind-driven changes in ocean circulation, but this attribution is still debated.

New research since AR5 has raised the possibility of more rapid and early ice retreat than predicted in IPCC AR5. This work shows that Antarctica alone could deliver over a metre of sea-level rise by 2100. This is in contrast with IPCC AR5 upper-end estimate of around 12 cm (or a few tenths of a metre higher with a marine-based collapse). This new modelling includes additional physical processes. It is still relatively untested and results are debated, but it highlights the need for critical study of these regions and processes.

Research on past warm periods supports the view that sustained warming of around 2°C to 3°C above preindustrial is associated by multi-metre sea level rise which must come from melting of Antarctica and Greenland. The two periods mentioned are the mid-Pliocene Warm Period (MPWP, 3.3-3.0 million years ago) and the Last Interglacial Period (LIG, 125 thousand years ago).

There is no consensus on the ultimate thresholds for large scale retreat of marine based ice, however two studies support the view that RCP2.6 emissions pathway can avoid large losses. One study (DeConto and Pollard, 2016) indicates that RCP2.6 emissions pathway could contain total Antarctic sea level contributions to just 20 cm by 2500, whereas RCP4.5 emissions produce 32 cm this century rising to 5 metres contribution by 2500. Another study (Golledge *et al.*, 2015) using a completely different ice sheet model finds similarly that substantial Antarctic loss can only be prevented by limiting greenhouse emissions to RCP2.6 levels, with losses of 0.6 to 3 metres by 2300 for higher emissions pathways.

Work in East Antarctica, including from Australian collaborations has identified new areas of marine based ice sheet which may be vulnerable to unstable retreat, although it is not known whether current changes in this area are due to natural variations, or climate change.

The Totten Glacier is the largest (by volume of ice discharged) of East Antarctica's glaciers. It is also the most dynamic East Antarctic glacier. Substantial changes in surface height have been observed, with surface lowering by as much as 2 metres per year in the period up to 2007 (Pritchard *et al.*, 2012). Observations over the longer period 1994-2012, reveal this is part of a more dynamic pattern of height increases and decreases and without a significant overall trend (Paolo *et al.*, 2015).

The potential for large scale marine-based retreat of Totten Glacier is a focus of research within the Australian Antarctic Program (AAP). This work suggests potential for enhanced ocean-driven melting into the future with consequent retreat of the ice. It is consistent with geological evidence (Aitken *et al.*, 2016) showing that the Totten catchment has experienced large, rapid retreat in the past.

Survey work within the AAP has combined mapping of the outlet of the Totten Glacier by air (Greenbaum *et al.*, 2014) with ship-based oceanography measurements off the glacier front

(Rintoul *et al.*, 2016). This has revealed that the glacier has deep ocean floor channels underneath its floating portion which provide potential access for warm water under the glacier.

The prospects of revised projections

Much of the research since IPCC-AR5 is novel and developing. Precise mechanisms are subject to debate and refinement as the work matures. It is worth noting that nothing since IPCC-AR5 would suggest that its projections for Antarctica were too large, and some results point to them being conservative, while broadly consistent with the tenor of AR5 comments around marine instability.

These matters will no doubt be treated in the next IPCC report which will offer a revision in light of recent findings.

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