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Antarctic ice losses tracking high

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Satellite observations show that ice losses from Antarctica have accelerated over the past 25 years[1]. Since 1992, the continent has contributed 7.6 mm to global sea levels, with 40% of this occurring in the past 5 years. Glaciers draining West Antarctica have retreated, thinned, and accelerated, due to ocean driven melting at their termini, and the collapse of ice shelves at the Antarctic Peninsula has led to reduced buttressing and increased ice discharge[2]. Of the 3.2 mm yr^{-1} sea level rise (SLR) measured during the satellite era[3], Antarctica has contributed 0.27 mm yr^{-1}. The extent of SLR from Antarctica is the largest source of uncertainty in global sea level projections, information key to appropriate climate change policy.

Projections of the global sea level budget in the IPCC's fifth assessment report (AR5[3]) are driven by emission scenarios accounting for permutations of the physical, socioeconomic and legislative factors which will shape the century-scale increase in global temperature. These representative concentration pathways (RCPs) allow for unabated (RCP8.5), stabilising (RCP6.0, RCP4.5) and decreasing (RCP2.6) emissions, plus the special report on emissions scenarios (SRES) used in the IPCC's fourth assessment[4]. The scenarios predict between 280 and 980 mm of global mean SLR by 2100, within a central estimate of 570 mm. The contribution from Antarctica is uncertain, due to challenges in simulating the regional meteorology and the ice sheet's dynamical response, and falls within -75 and +160 mm.

The accuracy of sea level predictions is important because there are consequences associated with under- or overestimating the societal response required. Recent advances in ice sheet model capability have improved the skill of simulations when compared to historical trends[5]. In AR5, the Antarctic regional meteorology was determined from an ensemble of global coupled atmosphere-ocean models[6], and the ice sheet models incorporated full numerical descriptions of ice flow and grounding line migration[3]. The expected range of dynamical ice loss was assessed through depth-averaged ice flow simulations[7]. When combined, these contributions produce the lower, central and upper estimates of sea level change due to Antarctica reported in AR5 (Figure 1).

Because the satellite record of Antarctic ice sheet mass balance[1] now overlaps with a decade of the AR5 projections[3], we can perform a meaningful comparison between the measured and predicted change (Figure 1). Between 2007 and 2017, satellite observations show that Antarctica lost 1883 Gt of ice, equivalent to a 0.55 mm yr^{-1} contribution to global SLR. This value is around 30 times greater than the IPCC's lower estimates, which predicted an average contribution of just 0.02 mm yr^{-1}, and is now at odds with the satellite record. The rate of ice loss is also 80% higher than the AR5 central projections (0.36 mm yr^{-1}) as a consequence of the observed acceleration, and is in fact closest to the upper range (0.68 mm yr^{-1}).

If Antarctic ice losses continue to track the upper range of the AR5 projections, the continent will contribute 151 mm, on average, to global sea levels by 2100. When compared to the central estimate (50 mm), this amounts to an extra 101 mm of SLR. An even greater contribution is possible, because the AR5 projections did not account for the effects of increasing emission concentrations on ice sheet dynamics, or for the possible impacts of processes such as ice cliff instabilities. Additional ice losses from Antarctica are of particular concern for cities in the northern hemisphere where, owing to gravitational redistribution of ocean mass, SLR will be around 30% higher than the eustatic mean[8].

Evaluating predictions of ice sheet losses gives a clearer picture of how reliable climate models are, raising confidence in the forecasts on which policy can be based. A higher than expected Antarctic contribution to future SLR has significant implications for coastal communities; it has been estimated, for example, that 10 cm of additional SLR will more than double the frequency of storm flooding in the Tropics[9]. And without adaptation, economic losses in coastal cities caused by such flooding could reach US$1 trillion by 2050[10]. As the upper range of Antarctic sea level projections predict an additional contribution of this scale, these risks should be considered when developing strategies to prepare for future climate change.

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Data availability

Mass balance datasets generated in the IMBIE study are freely available at http://imbie.org/data-downloads/, and IPCC sea level projections are also freely available at http://www.climatechange2013.org/report/full-report/.

Competing interests

The authors declare no competing interests.

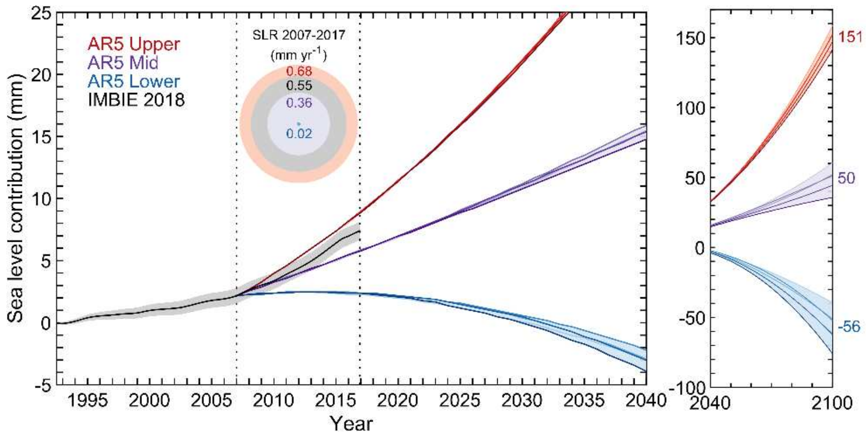

Figure 1. Observed and predicted sea level rise due to Antarctica. Global sea level contribution from Antarctica according to the IMBIE satellite record (black, shaded 1σ uncertainty) and IPCC AR5 upper (red), mid (purple), and lower (blue) projections from (left) 1992-2040 and (right) 2040-2100, with values indicating the average sea level contribution predicted at 2100. Darker coloured lines represent pathways from the five scenarios used in AR5 in order of increasing emissions: RCP2.6, RCP4.5, RCP6.0, SRES A1B and RCP8.5. Solid circles indicate the rate of sea level rise (SLR) in mm yr^{-1} during the overlap period 2007-2017 (dashed lines). All AR5 projections have been offset by 0.66 ± 0.21 mm (range is one standard deviation) on average, so as to equal the observational record at their start date (2007).