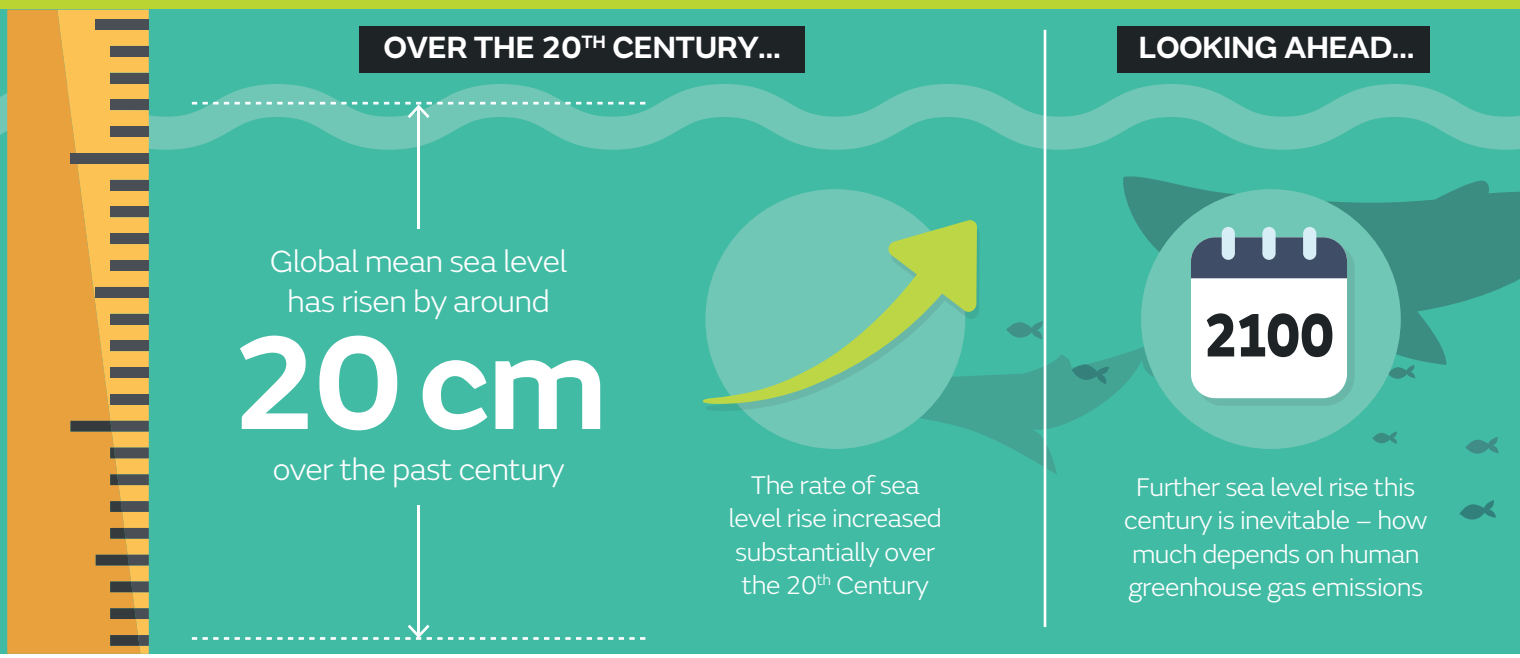
Met Office

Sea level rise



Rising sea levels increase the level of risk faced by hundreds of millions of people who are vulnerable to coastal flooding[1]. Warming caused by human activity is a major contributor to this, and the greenhouse gases we emit will play a key role in the amount of future sea level rise we see[2].

What have we seen?

Observations of global sea level rise show an acceleration over the 20th Century. The annual rate of rise over from 1993-2010 was about 3mm a year, considerably more than the rate for the preceding century[3].

Over the past century, global sea level has risen by about 20 cm, primarily as a result of ocean warming and melting of land-based ice.

Even this relatively modest rise has been linked to substantial increases in coastal flood risk. For example, one study looking at the severe flooding in New York caused by Hurricane Sandy found that recent sea level rise had made such extensive flooding up to three times more likely[4].

What do we expect up to the end of this century?

Intergovernmental Panel on Climate Change's (IPCC) Fifth Assessment Report (AR5) suggested further rise in sea level to the end of this century was likely to be between 26 cm under a low greenhouse gas emissions scenario, up to 98 cm for high emissions.

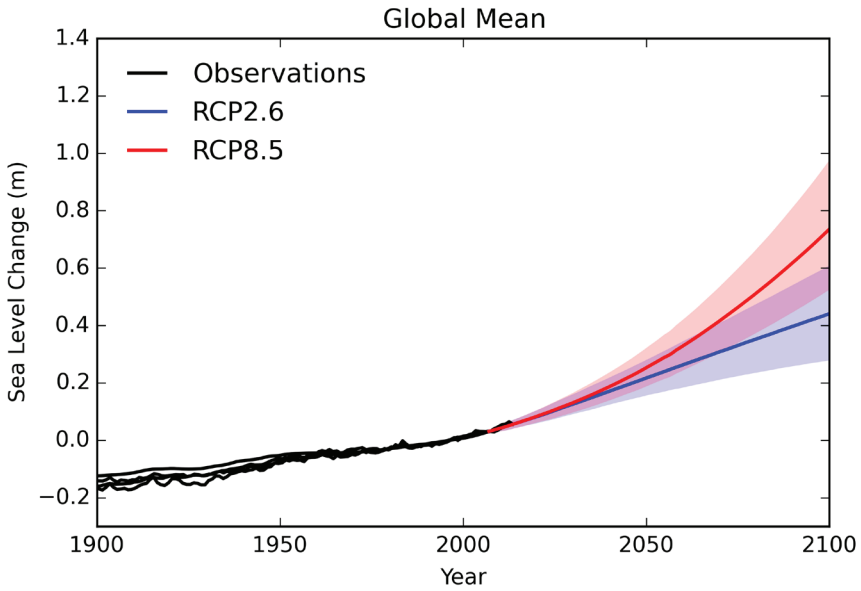


Figure 1 - Reconstructions[3,5,6,7] of historical sea level rise based on tide gauge observations (black) and projections for the RCP2.6 (blue) and RCP8.5 (red) scenario. All data are plotted relative to the 1986-2005 average. Shaded regions indicate the IPCC AR5 'likely' range.

[1]Neumann et al (2015), Future coastal population growth and exposure to sea-level rise and coastal flooding – a global assessment [2]Church et al, IPCC AR5: Chapter 13, Sea Level Change
[3]Hay et al (2015), Nature – Probabilistic reanalysis of twentieth-century sea level rise [4]Sweet et al (2013), Hurricane Sandy inundation probabilities today and tomorrow [5] Church and White (2011), Sea level rise from the late 19th to the early 21st Century [6]Ray and Douglas (2011), Experiments in reconstructing twentieth-century sea levels [7]Jevrejeva et al (2014), Trends and acceleration in global and regional sea levels since 1807

Since AR5, a substantive body of research has focussed on better understanding the potential for rapid loss of ice from the Antarctic Ice Sheet – a key uncertainty noted in the IPCC report of WG1.

While several studies[8,9,10] are largely consistent with the findings of IPCC AR5, a recent study[11] suggests the potential for a dramatic acceleration in the loss of Antarctic ice over the 21st Century and beyond under the RCP8.5 climate change scenario. This paper includes a representation of rapid, widespread and sustained collapse of coastal ice cliffs, triggered by the loss of ice shelves, which leads to very high projections of sea level contribution. However, modelling of ice sheets remains a challenging area of science and further work is needed to assess the robustness of this result.

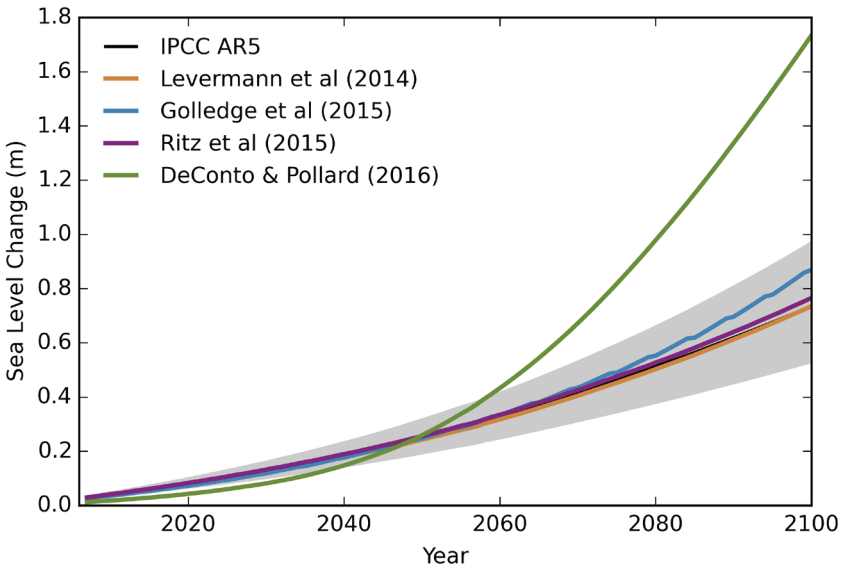


Figure 2 - Projections of global sea level rise for RCP8.5 presented in the IPCC AR5 (black). Shaded regions indicate the 'likely' range. Overlaid curves show the impact of substituting in more recent estimates of the contribution from Antarctica under RCP8.5 (except Ritz et al, who used the broadly similar A1B scenario). All data are plotted relative to the 1986-2005 average.

What about further into the future?

Air temperature responds relatively quickly to reductions in greenhouse gas emissions, but sea level responds much more slowly. This means our actions this century may commit us to sea level rise for hundreds, if not thousands, of years.

On even longer timescales and depending on our future greenhouse gas emissions, considerable further sea level rise may occur due to collapse of the world's ice sheets and their inability to recover. This implies a possible commitment over thousands of years to several metres of sea level rise, depending on mitigation efforts[2].

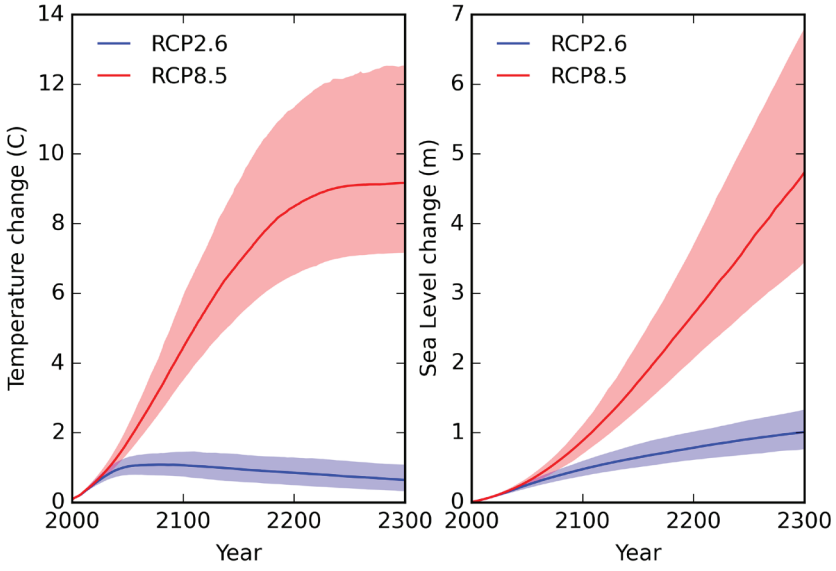


Figure 3 - Shows temperature and sea level projections based on data from Nauels et al (2017)[12]. A simple climate model is used to extend CMIP5 projections to 2300 for the RCP2.6 (blue) and RCP8.5 (red) scenarios. The shaded regions correspond to the IPCC AR5 'likely' range. Data are plotted relative to the 1986-2005 average. This is one published estimate of temperature and sea level rise out to 2300 and illustrates our expectation that sea level will continue to rise long after temperature has stabilised. What is less certain are the central estimates of sea level rise from this calculation and an active area of Met Office Hadley Centre research is attempting to better quantify the spread of sea level rise outcomes post-2100.

[8]Ritz et al (2015), Potential sea-level rise from Antarctic ice-sheet instability constrained by observations. [9]Golledge et al (2015), The multi-millennial Antarctic commitment to future sea-level rise [10]Levermann et al (2014), Projecting Antarctic ice discharge using response functions from SeaRISE ice-sheet models. [11]DeConto & Pollard (2016), Contribution of Antarctica to past and future sea-level rise. [12]Nauels et al (2017), Synthesizing long-term sea level rise projections – the MAGICC sea level model v2.

Produced by the Met Office, with contributions from Dr. Tamsin Edwards at the Open University.