It keeps going: 1 meter sea-level rise by 2300 is now inevitable

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Climate change is often discussed in reference to where things will be in 2100, but the story obviously doesn’t end that year. Sea-level rise in particular has an impressive amount of inertia, and a very long time will pass before it has played out fully. What will our emissions have set in motion on longer time scales?

Projecting sea-level rise in the year 2100 is difficult enough, partly because the behavior of the world’s ice sheets and glaciers is varied and complex, and partly because it depends in a big way on how much greenhouse gasses we continue emitting. Take future emissions off the table, though, and it’s possible to think about what happens out to 2300.

The future is real

That’s what a team led by Alexander Nauels did in an analysis based on a combination of our past emissions and the current Paris Agreement pledges for emissions through 2030. Nauels and his colleagues used a simple mathematical model calibrated against the results published in the most recent IPCC report. Rather than running a massive global simulation on a

supercomputer, they calculated the relationship between emissions and sea-level rise in previous simulations—which projected out to the year 2300. This also allowed them to quickly process multiple variations of their question.

Considering only emissions through 2030 creates a hypothetical scenario in which warming peaks around 1.5°C above preindustrial temperatures and starts dropping before the end of this century. This results in about 43cm (17 inches) of sea level rise by 2100, and 105cm (41 inches) by 2300. That's what greenhouse gas emissions through 2030 commit us to, even if we emitted nothing after that.

By repeating the calculation with the emissions of individual countries/groups removed, the researchers also divvied up the sea-level rise that top emitters are responsible for. They did this for time periods starting from 1991, when the IPCC reports began and national emissions accounting became more reliable.

For emissions from 1991-2030, the estimated sea-level-rise contribution for each region in 2300 is: 10cm from China, 7cm from the United States, 5cm from European Union nations (here including the UK), and 2cm each from India and Russia.

To cover the higher end of the risk spectrum, the researchers also produced a 2300 projection based on a controversial ice-sheet model that simulates greater ice loss. The model included new processes, including one that allows cliffs of ice at the glacier front to collapse under their own weight if they exceed a certain height. The accuracy of this model has been studied and qualified since, but here it serves an illustrative purpose of representing worst-case scenarios.

In this case, it broadens the range of 2300 sea-level-rise numbers, which now go as high as 150cm.

Leaving a mark

Even in these simplified scenarios, there are factors that have to be more or less penciled in. Sea-level rise isn't *solely* due to the expansion of warming ocean water and the contributions of melting land ice. There is also a contribution from changing water use on land, which is not related to greenhouse gas emissions. Depletion of groundwater ultimately dumps that water into the ocean, while damming reservoirs increases the volume of water living on land.

These projections of sea level in 2300 can't ignore that factor, so the researchers extrapolate out current trends. The leads to about 20cm by 2300—or about 20% of the total projected number.

Regardless of the source of the water, the take-home point is a familiar one: our decisions now have long-lasting consequences. For example, the researchers repeated the calculation for just the period covered by the Paris Agreement pledges, from 2016 through 2030. Even if countries match their pledges, emissions over this short time alone will be enough to raise sea level 20cm (eight inches) by 2300—equivalent to the total amount we've experienced so far.

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