Global warming doesn't stop when the emissions stop

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Even if power plants are shut down it takes a long time for a positive effect on the climate to emerge. Credit: shutterstock

Our climate is out of balance: Increasing accumulation of CO2 in the atmosphere has caused the Earth's temperature to increase by 0.8° C since the beginning of the industrial revolution. According to a study by Thorsten Mauritsen from the Max Planck Institute for Meteorology in Hamburg and Robert Pincus of the University of Colorado, even if we

stopped all emissions from fossil fuels tomorrow, the Earth would still warm by a further 0.3° C. In this interview, Mauritsen explains why it will take millennia for the Earth to get back into balance.

Mr. Mauritsen, what inspired you to carry out this study?

I was a bit surprised that the 1.5° C target was even being discussed at the 2015 Paris talks. I was convinced that we were already past that point. So I wanted to show, using simple methods, that that goal was simply no longer achievable. But as I started to dig down into the literature and carried out more and more calculations, however, at some point I had to concede that this scenario is not entirely unrealistic. That's kind of a positive result.

You have determined that the Earth would warm by a total of 1.1° Celsius even if all emissions from fossil fuels stopped tomorrow. Why is that?

The Earth as a system is out of balance. More energy is flowing into the system than is flowing back out. This excess energy is mainly absorbed by the oceans. Water has a high heat capacity and consequently a long reaction time. As a result, at present the oceans are cooling the air. Over time, however, the deep ocean layers will also warm up, until finally, after thousands of years, the climate will settle down at a higher average ocean and atmospheric temperature. If there were no new emissions, the temperature at the end of this century would be 1.1° Celsius higher than before the industrial revolution.

What other factors are involved?

When we burn fossil fuels, in addition to CO2, we also pump aerosol particles into the atmosphere. These aerosol particles probably cool the Earth slightly, so working in opposition to the CO2. If we stopped

burning coal and oil, these aerosols would vanish within a few weeks, whilst the CO2 would remain in the atmosphere. There would therefore be a sudden spike in warming. Over a longer timescale, however, the deep oceans absorb some of the CO2. This means that the 'committed warming' by the end of this century is about 0.2 to 0.3° C less than it would be if the amount of CO2 were to remain constant. Nature gives us a bit of a helping hand.

What about the effect of other greenhouse gases, such as methane and nitrogen oxides?

These gases have a fairly short life span – maximum ten years. Of course, ten years doesn't sound like such a short period of time, but when you're looking at warming over hundreds of years, then it is. Emissions of these gases mean that the Earth is a bit warmer now. Their disappearance from the atmosphere would therefore slightly reduce global warming.

How did you determine the 'committed warming'?

To do that, we needed to know two things. Firstly, we needed to find out how sensitive the Earth's climate is, i.e. how sensitively it reacts to an increase in atmospheric CO2 over a timescale of a century (the transient climate sensitivity). This can be estimated from data on previous temperature rises and ocean warming. We also need to know how strong the effect of the disappearance of aerosols, methane and nitrogen oxides will be. From there, we can estimate warming through to the end of the century.

How does this differ from previous studies?

We used data from observations to estimate sensibilities. Previous studies were based on results from climate models which incorporated a

lot more assumptions. Our results broadly support the results from model-based studies, however.

What do the results teach us? In the real world, stopping emissions immediately is, unfortunately, impossible.

We can see how far we are from the climate targets set out in the Paris Agreement, which state that the Earth should not warm by more than 1.5–2° C. According to our study, there is a 13 percent probability that we have already exceeded the 1.5° C target. We have also shown that, based on current emissions, we still have 30 years until the probability of staying under the 1.5° C target falls to 50 percent.

How do you explain the amount of attention your study has received?

We've clearly hit a nerve. According to surveys, a great many people believe that global warming will stop if we stop emitting greenhouse gases. Many even assume that temperatures will fall back to pre-industrial levels within a couple of decades. But climate scientists have long known that that's not the case. CO2 has a much longer life span than that – it stays in the atmosphere for thousands of years. So, we need to state quite clearly: Global warming will not stop when emissions stop.

More information: Thorsten Mauritsen et al. Committed warming inferred from observations, *Nature Climate Change* (2017). DOI: 10.1038/nclimate3357

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