Climate emergency: The new science showing it's make-or-break time

As climate talks ramp up ahead of the crucial COP26 meeting in Glasgow, new research on what our carbon emissions are doing to the planet paints a disturbing picture

Environment 21 April 2021

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SHALL we start with the good news or the bad news? The good news is that the world has made some progress in cutting the carbon emissions driving climate change. The bad news is that it is by no means enough, and emerging research suggests that the impact of the emissions we are pumping into the atmosphere could be even greater than we feared.

"The science, if anything, has become more pessimistic," says Stefan Rahmstorf, a climate scientist at the University of Potsdam, Germany. "The signs from the science are pointing towards more urgent climate action being needed."

To have a chance of averting catastrophe, we must get to "net-zero" emissions – where we are putting carbon dioxide into the atmosphere no more quickly than Earth's natural processes or yet-to-be-developed technologies can remove them – in less than three decades.

Most countries haven't yet got credible plans to produce the sort of emissions cuts needed, let alone to implement them. The question then becomes: how bad could it get if we fail to take the drastic action required now?

The fate of much life on the planet depends on three main factors. First, how much more CO_2 we add to the atmosphere. Second, how the planet changes in response to all that extra CO_2: how much it will warm the planet, and its impact on sea level rise and extreme weather. Third, how well we prepare for the coming changes.

Of these factors, by far the most important is how much CO_2 we are emitting. This is what is causing climate change and it is within our control. In 1988, climate scientist James Hansen gave the first high-profile warning that we needed to cut emissions. Decades of denial followed, but today that argument is largely won. "Everybody seems to realise that climate change is something that needs to be taken seriously," says Lisa Schipper at the Environmental Change Institute at the University of Oxford. "People are enraged and engaged."

Just about every country has now ratified the 2015 Paris Agreement on climate change, which aspires to limit warming to 1.5°C; the US formally rejoined the accord early this year. The few exceptions include Turkey, Iran and Iraq. The job of the UN COP26 climate conference later this year in Glasgow, UK, and the negotiations leading up to it, is to reach a credible plan to attain net-zero emissions by mid-century (see "Why is COP26 so important?").

"If all nations met existing net-zero targets, warming would be 2.6°C"

Such a plan is desperately needed. Carbon dioxide emissions are still rising, as they have more or less continuously from under 40 million tonnes of CO_2 per day in 1970 to more than 100 $MtCO_2$ today (see "Climate change: A status report"). There have been some declines when the global economy has faltered, such as after the 2007-08 financial crisis, but emissions growth has always resumed when the economy picked up. The coronavirus pandemic produced by far the biggest fall in emissions yet seen, with overall levels down by between 4 and 7 per cent. Yet this was short-lived. Emissions had bounced back to near pre-pandemic levels by around September 2020.

Challenges ahead

Atmospheric CO_2 levels continue to rise ever faster. In 2022, the average level over the year is set to exceed 417 parts per million, 50 per cent higher than its pre-industrial concentration. At the current rate, a doubling of the CO_2 levels from pre-industrial times will probably happen sometime between 2070 and 2080.

Today, the world has already warmed by 1°C over pre-industrial levels. It is on track to pass the Paris aspirational limit of 1.5°C between 2026 and 2042. The global average temperature is forecast to exceed 2°C above its pre-industrial level between the 2040s and 2070s. In theory, even if the world warms past 1.5°C, we can still meet the Paris target by 2100 through sucking enough CO_2 back from the atmosphere to cool the planet back down, but how we would do this remains debatable.

It could be worse. Emissions would be growing even faster now if nothing at all had been done. Many countries have managed to cut their overall emissions, typically by using less coal and more renewables to generate electricity. We aren't heading for the worst-case scenario, called RCP8.5, that climate researchers have been considering. That could have led to around 5 °C of warming by 2100.

NEXT PAGE Apui, Brazil 11 August 2020

A firefighter holds a dead anteater retrieved from a burning rainforest tract near Apui, Amazonas state. Unusually dry conditions in the southern Amazon in 2020 contributed to a record wildfire season by some measures


REUTERS/Ueslei Marcelino

“We are in a better position than expected five or 10 years ago, but we are still taking baby steps,” says Glen Peters at the Center for International Climate Research in Norway.

According to the independent Climate Action Tracker, we are heading for warming of between 2.7°C and 3.1°C by 2100. If countries meet all existing pledges and targets, it would be around 2.6°C. And if all nations considering net-zero targets actually met them, warming could be limited to 2.1°C by the end of the century.

This suggests we are within sight of the 2°C target, which is very encouraging. However, even countries committed to a net-zero target will find it immensely challenging. The UK has cut emissions faster than most other large economies, for instance, but its climate watchdog has repeatedly warned that it isn’t on track to meet its long-term targets. While the UK has transformed its electricity generation system – the relatively easy part – it has done little to tackle emissions from trickier sources such as transport, heating and farming. Significantly reducing those will need new policies, as well as lifestyle changes (see “What I can do?”). That picture is broadly similar in many rich countries.

The longer emissions keep increasing, the bigger the cuts that will be required to limit warming to under 2°C, let alone 1.5°C. Achieving this now already requires drastic action: we need emissions reductions of the size caused by the coronavirus pandemic to happen every year, says Peters, but without any rebound.

That might actually be an underestimate when we bring into play the second crucial factor: how much all the extra CO_2 we are pumping into the atmosphere will actually warm the planet. This depends on a vast array of feedback effects. Some are relatively simple: for instance, warming increases the amount of water vapour in the atmosphere, and water vapour is a potent greenhouse gas. Others are extremely complex and still poorly understood. Clouds, for example, can have both warming and cooling effects depending on their location, height and thickness.

Some feedbacks, such as increases in water vapour, kick in quickly. Others, such as the melting of ice sheets, take centuries or millennia. How much warming these feedbacks cause is known as climate

sensitivity. If climate sensitivity is low, we have a chance of limiting warming to under 2°C, even if we don't quite get to net zero by mid-century. If it is high, warming could exceed 2°C even if we meet that target.

Porto Velho, Brazil 24 August 2019

Smoke rises from a recently deforested area of the Amazon rainforest. According to some calculations, ecosystem changes mean the Amazon basin is already flipping from a sink to a source of greenhouse gases

REUTERS/Ueslei Marcelino

When climate scientists talk about climate sensitivity, they usually mean how much warming would occur with a doubling of CO_2 levels, as is possible by 2070. There are three main ways to work out this "equilibrium" climate sensitivity: looking at how the climate has changed in the distant past, examining changes over the past centuries, and using computers to model key short-term feedbacks. These methods give a wide range of answers: pinning down a precise value has proved very hard. A 2013 report by the Intergovernmental Panel on Climate Change (IPCC), the UN-led body that summarises the scientific evidence, said it could be anywhere from 1.5°C to 4.5°C – the same as the first estimate in 1979 made by Hansen and his colleagues.

Recent studies suggest that climate sensitivity is towards the upper end of this range. One line of evidence comes from the latest generation of climate models, whose results will help inform the next set of IPCC reports. The first of these is due to be published in August. These models generally simulate things such as clouds more accurately than previous models, and many show higher sensitivity. According to the UK Met Office's model, sensitivity is a whopping 5.5°C.

Nothing ruled out

These results are still being studied and debated. Many climate scientists think such high sensitivities are unlikely, but they aren't ruling them out. "We can't say they are wrong," says Richard Betts at the Met

Office Hadley Centre in Exeter, UK. “It’s all about probabilities and likelihoods and so on. Unlikely things do happen sometimes.”

Last year, a major study concluded that equilibrium climate sensitivity is between 2.4°C and 4.6°C. “Their most confident conclusion was that we could rule out the low sensitivity, which is not good,” says Betts. “They also concluded with less confidence that the higher sensitivities are less likely, which is good news to some extent.”

Duchang county, China 7 August 2020

Rescue workers evacuate students from a school during catastrophic floods that were exacerbated by climate change

China Daily via REUTERS

It can take centuries for the full equilibrium climate sensitivity to kick in, so even if it is higher than previously thought, that will not necessarily make a big difference in our lifetimes. Matthew Gidden at Climate Analytics in Berlin, who works on the Climate Action Tracker, says he doesn’t expect its projections for 2100 to change much. “We expect the difference to be minimal,” he says – perhaps just a few per cent.

Unquantified risks

But even the improved models don’t tell the whole story. At the moment, half the CO_2 we emit is soaked up by the land and seas, for instance as vegetation grows. As the planet gets warmer, plants on land aren’t going to take up ever more CO_2. According to one study, the Amazon rainforest is already releasing more greenhouse gases than it absorbs, due to the combined effect of deforestation and climate change. Increasing amounts of carbon will also be released as permafrost thaws. Carbon dioxide is less soluble in warm water, so warming oceans may soak up less of it too.

Technically, these are just more feedbacks that help determine sensitivity, but most climate models don't model carbon-cycle feedbacks, because it involves adding many extra processes and requires more computing power. Instead, these models use best estimates of carbon-cycle feedbacks made by other teams.

Last year, Betts and Zeke Hausfather at the Breakthrough Institute in California calculated how these estimates being too high or low could alter projections of future warming. In a study yet to be published, they concluded that there might be anything from 10 per cent less warming to 25 per cent more warming than projected by models. "This means that we cannot fully rule out a small chance of close to 5°C warming in a current-policy world where our best estimate is 3°C, or close to 4°C warming in a pledges-targets world where our best estimate is 2.5°C," says Hausfather.

The picture is also grimmer when it comes to the impacts of warming. Take sea level. This has already risen 0.3 metres since the industrial age began, and the process is accelerating. According to a 2019 IPCC report, sea level could rise between another 0.3 and 1.1 metres by 2100 depending on how much the planet warms.

This is much higher than earlier IPCC estimates, but may still be on the low side. Estimates of sea level rise for a given temperature rise keep going up because studies suggest that the great ice sheets covering Greenland and Antarctica could disintegrate much faster than we thought. "The IPCC is still a conservative voice," says Rahmstorf. "The more advanced the ice sheet models are becoming, the more risky it looks." Some researchers think the rise could be more than 2 metres by 2100.

Yakutia, Russia 2 June 2020

A firefighter of the Aerial Forest Protection Service makes a controlled burn along a forest firebreak in Yakutia, eastern Siberia. Climate attribution studies have conclusively pinned the unprecedented 2020 Siberian heatwave, with a record Arctic high of 38°C recorded at Verkhoyansk, on the effects of global warming

Yevgeny SofroneyevTASS via Getty Images

Sea level rise is an unstoppable process that will continue for many centuries even after we stabilise temperatures. The only issues are how fast it will rise and how high. The IPCC estimate is for as much as 5 metres by 2300. Some scientists think we could see 8 metres by 2200.

“If we get to 4 degrees [of warming], there is not going to be a Greenland ice sheet,” says Peter Stott at the Met Office Hadley Centre.

Then there is the impact that global warming is having on the weather. Ever more extreme events are occurring around the world. Last year saw unprecedented fires in Australia and floods costing China at least $26 billion, to mention just two. The evidence that climate change is to blame is growing ever stronger, too. A heatwave in Siberia in 2020 was so extreme that it couldn’t have happened without global warming.

In general, what we are seeing is in line with model projections, says Stott. Basic physics says the amount of water vapour in the lower atmosphere rises by about 7 per cent for every 1°C of warming, exactly what is happening. More climate weather models are now allowing us to see what that means. “The dramatic effects are becoming much clearer,” says Stott.

For instance, recent model studies and radar observations suggest that the amount of rain falling in summer storms – the kind that cause flash floods – could increase about 14 per cent for every degree of warming. That would mean about a 60 per cent rise if the world warmed by 4°C. “That’s a very substantial increase in the amount of rain falling in heavy summer convective situations, which is well outside the envelope of what we’re adapted to,” says Stott.

Stockholm, Sweden 12 December 2020

Protests led by Swedish activist Greta Thunberg have turned up the heat for global climate action

Pontus Lundahl/TT News Agency/AFP Via Getty Images

Tropical cyclones are also growing stronger. While to a large extent this was predicted, recent evidence suggests they are moving more slowly as the world warms, due to slower tropical winds in summer. This means they dump more rain in one place, making them far more damaging. “What is becoming clear now is how dramatically much more intense they are becoming, and how much more rain is falling,” says Stott.

The issue is not just more of the same, in the sense of weather becoming more extreme. There could also be much bigger changes in weather patterns. An ocean current called the Atlantic meridional overturning circulation that shapes the climate of Europe and the east coast of North America is already slowing and could decline by half or more by 2100. “The impacts of such a major change in ocean circulation are hard to predict, but they will be major,” says Rahmstorf. “I think it will really disturb the weather patterns.”

Down the plughole

It will also affect sea level, he says. Sea level is lower in the area of the North Atlantic where water sinks, like the water above the plughole in an emptying bath. As the circulation slows, sea level will rise especially fast on nearby coastlines.

Many major impacts of warming are now unavoidable to some extent. “Realistically, the kind of changes we are going to be facing are pretty horrid,” says Schipper. She doesn’t think we will be able to limit warming to 1.5°C, although she thinks 2°C is still doable.

That brings us to the third factor that will determine how badly climate change affects us: how well we adapt to it. “Because we haven’t been able to mitigate greenhouse gas emissions properly, we now really have to look at adaptation,” says Schipper.

Some countries are doing just that. For instance, with Jakarta slowly sinking, Indonesia has announced plans to create a new city to become its capital. Unfortunately, a review by Schipper and her colleagues has found that, all too often, adaptation projects end up making matters worse. “It can backfire and make people more vulnerable,” says Schipper.

Perito Moreno glacier, Argentina 5 April 2019

A piece breaks off the Perito Moreno glacier, part of the Southern Patagonian ice field, one of the fastest melting areas of ice on the planet

David Silverman/Getty Images

In parts of the world, the building of sea walls and levees has encouraged more development in vulnerable areas, leading to bigger disasters when those defences are breached. Similarly, irrigation measures intended to help farmers cope with shifting climates has led to them carrying on growing the same crops when they really need to switch to something more suitable to the changing conditions. “It delays your actual response, your adaptation,” says Schipper.

So the future remains very much undecided. With swift and drastic action, and a bit of good fortune, we might still limit warming to around 2°C. But if we do too little, too late, and climate sensitivity and carbon-cycle feedbacks are on the high side, many children alive today might live to see 5°C of warming or more. Whether modern civilisation would survive in such a world, no one can say.

“Turning promises into action won’t be easy even if the will is there”

With the Paris Agreement in place, and more and more countries adopting net-zero targets, all the researchers *New Scientist* spoke to said they were more optimistic now than a decade ago. But they all stressed the importance of politicians turning these promises into action. That won’t be easy even where the will is there.

And many are worried that climate action won’t be a priority in a world reeling from the pandemic. “Given that coronavirus has knocked everyone off their feet, what worries me is that large parts of budgets are dedicated to other things and will derail and delay climate action,” says Schipper. As the latest science shows, that could be an extremely costly mistake in the long run.

Jakarta, Indonesia 18 January 2014

People walk through the flooded streets at Kampung Pulo in the Indonesian capital Jakarta during heavy rains that displaced more than 40,000 people throughout the north of the country. In 2019, the Indonesian government announced a plan to move the capital away from the fast-sinking, flood-prone coastal city

Oscar Siagian/Getty Images

Why is COP26 so important?

Thousands of delegates are expected to descend on Glasgow, UK, between 1 and 12 November this year for COP26, the 26th "conference of the parties" to the UN Framework Convention on Climate Change. This landmark treaty, signed at the Rio Earth Summit in 1992, committed countries to take steps to avoid dangerous global warming. The COP meetings have been held annually since 1995 to update on progress and thrash out next steps.

COP26, delayed for a year by the covid-1 9 pandemic, is the most important in the series since COP21, held in Paris, France, in December 2015. Back then, nearly 200 countries signed the Paris Agreement committing themselves to take action to hold future temperature rises to 1.5°C. The aim of COP26, and the negotiations leading up to it, is to elicit much bolder action to bring down greenhouse gas emissions in line with that goal.

The UK government, which is co-hosting the summit with Italy, has laid out four objectives for the summit. It wants every country to: commit to hit net zero by 2050, as the UK did in 2019; ensure protection for the people most vulnerable to a warming world; deliver a $100 billion a year climate finance pledge from richer nations; and increase collaboration across business, civil society and nations.

Key to the success or failure of the summit are the national emissions-reducing plans known as nationally determined contributions (NDCs). Countries were originally supposed to submit new NDCs by the end of 2020, but the pandemic, plus heel-dragging by the world's biggest emitters, derailed that timeline. By the time of a UN assessment in February, only 74 countries, representing 30 per cent of global emissions, had submitted a new climate plan.

Worse still, despite the EU, UK and others having put forward stronger plans, a UN report calculated that current pledges would cut emissions by just 0.5 per cent compared with 2010 levels by 2030, a far cry from the 45 per cent by 2030 that the Intergovernmental Panel on Climate Change says is needed to limit warming to 1.5°C.

The UN has called on countries who submitted national climate plans before the end of 2020 to review them. Plans from China, India and the US, expected in the coming months, will be crucial to setting the tone for COP26. Along with the fourth big emitter, the EU, these three countries will be the key players. But other groupings of nations will be crucial too, including the alliance of small island states most affected by sea level rise and the G77 grouping of developing countries.

Perhaps the biggest issue at COP26 will be finance. The $100 billion a year to help lower-income countries adapt to and fight climate change was originally pledged at COP15 in Copenhagen, Denmark, in 2009, to be delivered by 2020. Only about $80 billion is currently on the table. This matters because international climate negotiations rely on consensus decision-making and goodwill, and also because some actions to cut emissions in national climate plans are conditional on financing.

Countries' negotiators at COP26 must also do the prosaic yet important job of tidying up outstanding issues from the Paris Agreement around the so-called "rulebook". Chief among those is a row over "Article 6", about how to create an effective global carbon-offsetting market, a key bone of contention left over from 2019's COP25 in Madrid, Spain. **Adam Vaughan**

WHAT CAN I DO?

In 2020, the average emissions per person were around 5 tonnes of carbon dioxide in the UK and 13 tonnes in the US. That is a lot lower than it used to be now that less electricity comes from coal and more from renewable sources.

That fall has happened without most people doing anything different, but to have any chance of getting close to net-zero carbon emissions by mid-century – what's needed to limit global warming to a "safe" level – we all need to make changes to our lifestyles and homes. Here's what you can do.

If you must drive go electric

A third of the CO_2 emissions from an average household in the UK come from road transport. If you can live without a car of any sort, do. If you can't, switching to an electric car can largely eliminate the emissions associated with running one. If you cannot go electric, get a smaller, more fuel-efficient car. Avoid diesel because of the air pollution it produces.

Switch to a heat pump

Another third of household emissions are from heating. Installing a heat pump could halve heating emissions and may save you money in the long run. But be aware that heat pumps are only suitable for well-insulated properties.

Don't go back to flying as often

Before the pandemic, around a tenth of household emissions in the UK were from flying. Frequent flyers can have huge carbon footprints. Flying from London to New York and back produces about a tonne of CO_2, while a return trip between London and Australia generates at least 3 tonnes.

Consume FEWER meat and animal products

Worldwide, ever more land is being cleared for new farms, which is disastrous for wildlife as well as releasing lots of carbon from, say, deforestation. Contrary to popular belief, what you eat matters far more than where it comes from. The emissions per kilogram of red meat and cheese can be around 100 times higher than those for nuts, fruits and vegetables.

New Scientist 24th April 2021