

Headline: Answers to climate change questions

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Temperature trend (1960-2014). SOURCE: NATIONAL GEOGRAPHIC Change in degrees Fahrenheit.

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Change in degrees Fahrenheit.

The issue can be overwhelming. The science is complicated. Predictions about the fate of the planet carry endless caveats and asterisks.

We get it.

And so, with the Paris climate talks now underway, we've provided quick answers to often-asked questions about climate change.

How much is the planet heating up?

1.7 degrees is actually a significant amount.

As of this October, the Earth had warmed by about 1.7 degrees Fahrenheit since 1880, when tracking began at a global scale. That figure includes the surface of the ocean. The warming is greater over land, and greater still in the Arctic and parts of Antarctica.

The number may sound low, but as an average over the surface of an entire planet, it is actually high, which explains why much of the land ice on the planet is starting to melt and the oceans are rising at an accelerating pace. The heat accumulating in the Earth because of human emissions is roughly equal to the heat that would be released by 400,000 Hiroshima atomic bombs exploding across the planet every day.

Scientists believe most and probably all of the warming since 1950 was caused by the human release of greenhouse gases. If emissions continue unchecked, they say the global warming could ultimately exceed 8 degrees Fahrenheit, which would transform the planet and undermine its capacity to support a large human population.

How much trouble are we in?

For future generations, big trouble.

The risks are much greater over the long run than over the next few decades, but the emissions that create those risks are happening now. Over the coming 25 or 30 years, scientists say, the climate is likely to resemble that of today, although gradually getting warmer.

Rainfall will be heavier in many parts of the world, but the periods between rains will most likely grow hotter and therefore drier. The number of hurricanes and typhoons may actually fall, but the

ones that do occur will draw energy from a hotter ocean surface and therefore may be more intense, on average, than those of the past. Coastal flooding will grow more frequent and damaging.

Longer term, if emissions continue to rise unchecked, the risks are profound. Scientists fear climate effects so severe that they might destabilize governments, produce waves of refugees, precipitate the sixth mass extinction of plants and animals in Earth's history, and melt the polar ice caps, causing the seas to rise high enough to flood most of the world's coastal cities.

All of this could take hundreds or even thousands of years to play out, conceivably providing a cushion of time for civilization to adjust, but experts cannot rule out abrupt changes, such as a collapse of agriculture, that would throw society into chaos much sooner. Bolder efforts to limit emissions would reduce these risks, or at least slow the effects, but it is already too late to eliminate the risks entirely.

Is there anything I can do?

Fly less, drive less, waste less.

There are lots of simple ways to reduce your own carbon footprint and most of them will save you money. You can plug leaks in your home insulation to save power, install a smart thermostat, switch to more efficient light bulbs, turn off the lights in any room where you are not using them, drive fewer kilometers by consolidating trips or taking public transit, waste less food and eat less meat.

Perhaps the biggest single thing individuals can do on their own is to take fewer airplane trips; just one or two fewer plane rides per year can save as much in emissions as all the other actions combined. If you want to be at the cutting edge, you can look at buying an electric or hybrid car, putting solar panels on your roof, or both.

If you want to offset your emissions, you can buy certificates, with the money going to projects that protect forests, capture greenhouse gases and so forth.

In the end, though, experts do not believe the needed transformation in the energy system can happen without strong state and national policies. So speaking up and exercising your rights as a citizen matters as much as anything else you can do.

What's the optimistic scenario?

Several things have to break our way.

In the best case that scientists can imagine, several things happen: Earth turns out to be less sensitive to greenhouse gases than currently believed; plants and animals manage to adapt to the changes that have already become inevitable; human society develops much greater political will to bring emissions under control; and major technological breakthroughs occur that help society both to limit emissions and to adjust to climate change.

The two human-influenced variables are not entirely independent, of course: Technological breakthroughs that make clean energy cheaper than fossil fuels would also make it easier to develop the political will for rapid action.

Scientists say the odds of all these things breaking our way are not very high, unfortunately. The Earth could just as easily turn out to be more sensitive to greenhouse gases than less. Global

warming seems to be causing chaos in parts of the natural world already and that seems likely to get worse, not better.

So in the view of the experts, simply banking on a rosy scenario without any real plan would be dangerous. They believe the only way to limit the risks is to limit emissions.

What's the worst-case scenario?

There are many.

That is actually hard to say, which is one reason scientists are urging that emissions be cut; they want to limit the possibility of any worst-case scenario coming to pass. Perhaps the single greatest fear is a collapse of food production, accompanied by spiraling prices and mass starvation.

Even with runaway emissions growth, it is unclear how likely this would be, as farmers are able to adjust their crops and farming techniques, to a degree, to adapt to climatic changes.

Another possibility would be a disintegration of the polar ice sheets, leading to fast-rising seas that would force people to abandon many of the world's great cities and the loss of trillions of dollars worth of property and other assets.

Scientists also worry about other wild-card scenarios like the predictable cycles of Asian monsoons becoming less reliable. Billions of people depend on the monsoons to supply them with water for crops. So any disruptions to monsoons would have catastrophic consequences to those populations.

Will a tech breakthrough help us?

Even Bill Gates says don't count on it, unless we commit the cash.

As more companies, governments and researchers devote themselves to the problem, the chances of big technological advances are improving. But even many experts who are optimistic about technological solutions warn that current efforts are not enough.

For instance, spending on basic energy research is only a quarter to a third of the level that several in-depth reports have recommended. And public spending on agricultural research has stagnated even though climate change poses growing risks to the food supply.

People like Bill Gates have argued that crossing our fingers and hoping for technological miracles is not a strategy—we have to spend the money that would make these things more likely to happen.

How much will the seas rise?

The real question is not how high, but how fast.

The ocean is rising at a rate of about a foot per century. That causes severe effects on coastlines, forcing governments and property owners to spend tens of billions of dollars fighting erosion. But if that rate continued, it would probably be manageable, experts say.

The risk is that the rate will accelerate markedly. If emissions continue unchecked, then the temperature of the earth's surface could soon resemble a past epoch called the Pliocene, when a great deal of ice melted and the ocean rose something like 24 meters (80 feet) compared to today.

A recent study found that burning all the fossil fuels in the ground would fully melt the polar ice sheets, raising the sea level by more than 160 feet over an unknown period.

With all of that said, the crucial issue is probably not how much the oceans are going to rise, but how fast. And on that point, scientists are pretty much flying blind. Their best information comes from studying Earth's history and it suggests that the rate can on occasion hit a foot per decade, which can probably be thought of as the worst-case scenario.

A rate even half that would force rapid retreat from the coasts and, some experts think, throw human society into crisis. Even if the rise is much slower, many of the world's great cities will flood eventually. Studies suggest that big cuts in emissions could slow the rise, buying crucial time for society to adapt to an altered coastline.

Are the predictions reliable?

They're not perfect, but they're grounded in solid science.

The idea that Earth is sensitive to greenhouse gases is confirmed by many lines of scientific evidence. For instance, the basic physics suggesting that an increase of carbon dioxide traps more heat was discovered in the 19th century, and has been verified in thousands of laboratory experiments.

Climate science does contain uncertainties, of course. The biggest is the degree to which global warming sets off feedback loops, such as a melting of sea ice that will darken the surface and cause more heat to be absorbed, melting more ice and so forth.

It is not clear exactly how much the feedback will intensify the warming; some of them could even partially offset it. This uncertainty means that computer forecasts can give only a range of future climate possibilities, not absolute predictions.

But even if those computer forecasts did not exist, a huge amount of evidence suggests that scientists have the basic story right. The most important evidence comes from the study of past climate conditions, a field known as paleoclimate research.

The amount of carbon dioxide in the air has fluctuated naturally in the past and every time it rises, the Earth warms up, ice melts and the ocean rises.

A hundred kilometers inland from today's US East Coast, seashells can be dug from ancient beaches that are three million years old. These past conditions are not a perfect guide to the future, either, because humans are pumping carbon dioxide into the air far faster than nature has ever done.

Why do people question climate change?

Hint: Ideology.

Most of the attacks on climate science are coming from libertarians and other political conservatives who do not like the policies that have been proposed to fight global warming. Instead of negotiating over those policies and trying to make them more subject to free-market principles, they have taken the approach of blocking them by trying to undermine the science.

This ideological position has been propped up by money from fossil-fuel interests, which have paid to create organizations, fund conferences and the like. The scientific arguments made by these groups usually involve cherry-picking data, such as focusing on short-term blips in the temperature

record or in sea ice, while ignoring the long-term trends.

The most extreme version of climate denialism is to claim that scientists are engaged in a worldwide hoax to fool the public so that the government can gain greater control over people's lives.

As the arguments have become more strained, many oil and coal companies have begun to distance themselves publicly from climate denialism, but some are still helping to finance the campaigns of politicians who espouse such views.

Is crazy weather tied to climate change?

In some cases, yes.

Scientists have published strong evidence that the warming climate is making heat waves more frequent and intense. It is also causing heavier rainstorms and coastal flooding is getting worse as the oceans rise because of human emissions. Global warming has intensified droughts in regions like the Middle East and it may have strengthened the drought in California.

In many other cases, though, the linkage to global warming for particular trends is uncertain or disputed. That is partly from a lack of good historical weather data, but it is also scientifically unclear how certain types of events may be influenced by the changing climate.

Another factor: While the climate is changing, people's perceptions may be changing faster. The Internet has made us all more aware of weather disasters in distant places. On social media, people have a tendency to attribute virtually any disaster to climate change, but in many cases there is no scientific support for doing so.

Will anyone benefit from global warming?

In certain ways, yes.

Countries with huge, frozen hinterlands, including Canada and Russia, could see some economic benefits as global warming makes agriculture, mining and the like more possible in those places. It is perhaps no accident that the Russians have always been reluctant to make ambitious climate commitments and Russian President Vladimir V. Putin has publicly questioned the science of climate change.

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However, both of those countries could suffer enormous damage to their natural resources; escalating fires in Russia are already killing millions of acres of forests per year. Moreover, some experts believe countries that view themselves as likely winners from global warming will come to see the matter differently once they are swamped by millions of refugees from less fortunate lands.