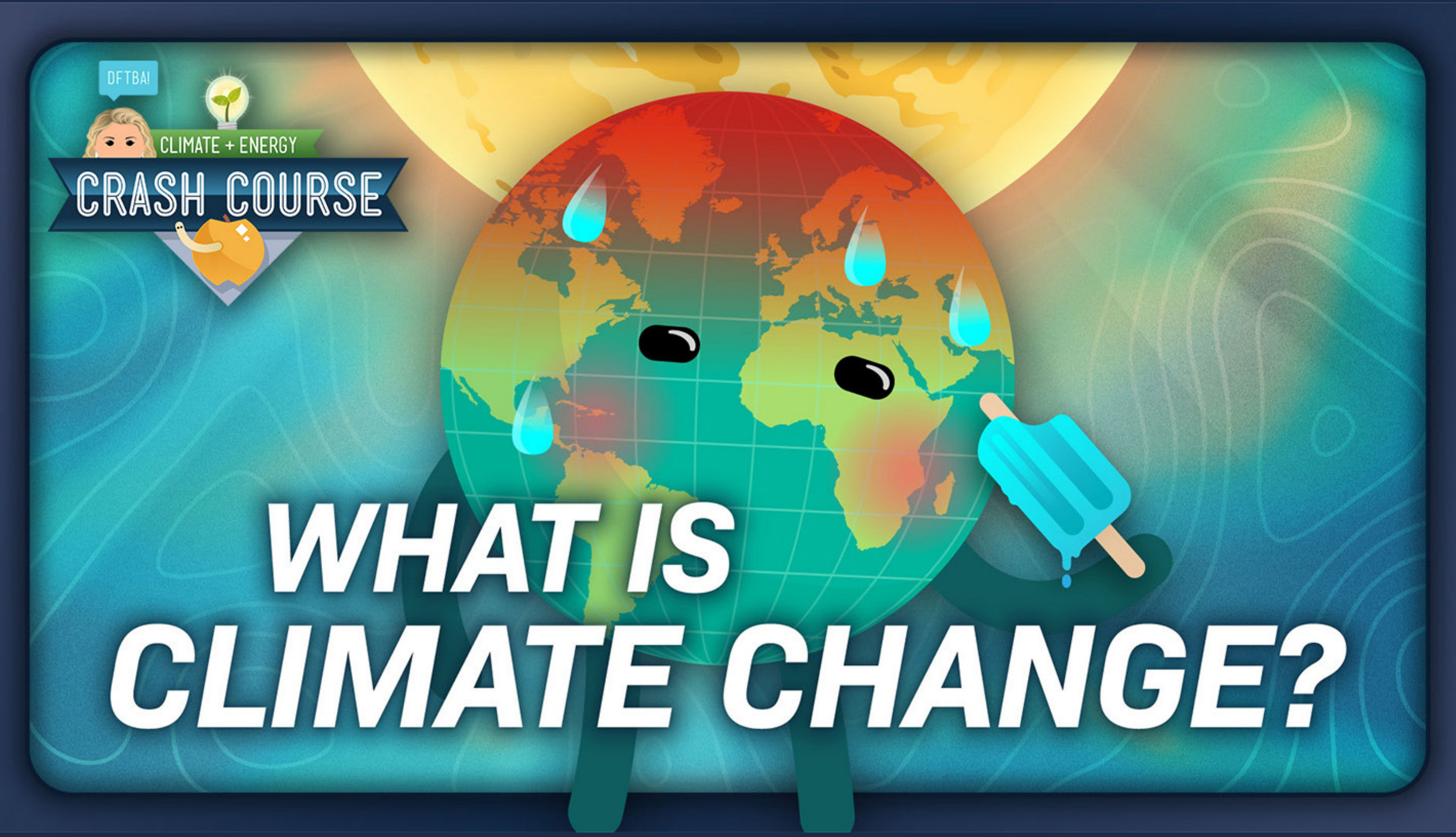

What is Climate Change?

We know that temperatures on Earth have fluctuated dramatically in the past, but we also know that by burning fossil fuels we are causing temperatures to rise faster than ever. In this episode of Crash Course Climate and Energy, we'll introduce some core concepts that will help us throughout the series, like the difference between climate and weather, and take a look back through the Earth's history at other periods of significant climate change.

0:01

Video narrator M Jackson appears on screen; quick clips of people doing everyday tasks; NASA clips of the Universe

Climate change is intimate and personal. At this point, it affects you every time you go to the grocery store, or fill your gas tank, or vote, or flush the toilet, or put on your long underwear for a later-than-usual snowfall.

And every year, it will affect you more. At the same time, it's cosmically impersonal. It involves gases, and rocks, and chemicals that have been operating in relationship for billions of years before there were any persons…or underwear to contend with at all. In between these two levels — the sphere of your bedroom and the sheer vastness of the history of the universe — there are still other vantage points to look at climate change from.

Climate change is a collective and a systemic problem — dealing not just with individuals but with entire populations and global systems — like energy grids and international trade. So, we have to kind of zoom in and zoom out. Travel through time and space. And as centuries of mad scientists have taught us, that's not an easy task!

1:00

Crash Course Climate + Energy intro clip plays; animated timelines comparing human lifetime, future generations, and lifespan of the Earth; Nasa clips of the Earth from space

Hi hi! I'm M Jackson, and this is Crash Course Climate and Energy. [THEME MUSIC] Think about it. There's the human lifetime, where we all live — where there's weather and politics and hard choices and beautiful moments of collaboration. And then there's hundreds of years that contain full human lifetimes — the generations yet to come that will be impacted by the climate-related choices of today and yesterday. On top of that, there's the multi-billion-year timeline of Earth, which is entirely alien to our human perception.

But we won the planetary lottery with our habitable Earth — the only one out of the thousands of planets known in our galaxy where life like ours can survive. So, yes, truly understanding climate change across all these timelines is tough. Sometimes, it's downright mind blowing. But it's on us to grapple with what's happening not just to the Earth — but to all of its inhabitants — as the climate changes faster now than ever before. And I mean that…the Earth's climate has never changed this fast.

2:16

Animation of Eunice Foote in a science lab reading Scientific American; clip of a greenhouse; clip of tomato plants

Let's start at the human scale… a single human actually. A human named Eunice Foote. In the 1850s, she was reading an issue of Scientific American — and became curious. And like any good scientist, she nerded out about how the sun heats up the Earth. She wanted to see how density and the mixture of gases in the air affected how much heat the atmosphere could hold onto, and she tested that with a series of experiments.

In one of them, she noticed that high concentrations of so-called "carbonic acid gas" made the air heat up faster and stay warmer for longer. Based on her experiments, she concluded that, if the atmosphere ever contained more of this gas, then we might also expect the global temperature to be higher.

Today, we know carbonic acid gas as carbon dioxide. So, Foote became one of the first scientists to make the link between carbon dioxide and atmospheric heating. It was one of the first experiments demonstrating the greenhouse effect.

You know that wash of warm air you get when you go into a greenhouse? It happens because glass panels do a great job of trapping the sun's heat to nurture your tomato plants. Well, imagine scaling that up to the entire Earth, but instead of glass trapping heat, it's gas.

3:29

Animations of the Sun beaming soccer balls at the Earth; animation depicting the Greenhouse effect in space; cartoon image of the Sun crying

Specifically, gases like carbon dioxide, methane, and water vapor, which are known collectively as greenhouse gases.

You can think of the greenhouse effect like a giant volleyball game between the sun and the surface of the Earth, where the atmosphere is the net. And instead of one ball, there are trillions.

The sun serves these balls as different forms of radiation — what you and I might experience as visible light, UV light, or infrared radiation, which is another fancy way to say: heat.

Some of that radiation makes it over the metaphorical net. It passes through the atmosphere and hits the planet's surface. A lot of that energy is then absorbed by the land and the sea. Hey, where'd my ball go?

The land and sea naturally reflect back some of their heat energy, but with the greenhouse effect, more and more heat energy is getting trapped by the net. Then, the energy gets absorbed by the atmosphere instead of escaping into space — the other side of the court. That causes the energy to bounce back down toward the surface of the Earth, warming it up.

The Earth is losing the cosmic volleyball game, returning fewer and fewer of the Sun's serves every year as the amount of greenhouse gases goes up.

4:40

Textbox: Without these gases, Earth's average temperature would be around -14 degrees Celsius, instead of the current 13.9 degree average; Textbox: Parts per Million, a unit representing the number of molecules of a substance present in a million total molecules; Clips showing the effects of climate change on Earth

Now, instead of having a constant number of balls on our side of the court… we have more each day.

Although greenhouse gases only make up a small portion of the atmosphere, they play a major role in controlling our planet's overall temperature, and its climate.

Even increasing the amount of carbon dioxide in the atmosphere by just a few parts per million, can lead to temperature changes that fuel severe weather, melt ice caps, and make life on Earth generally more difficult.

How do we know this? By studying the chemistry of rocks and fossils that are hundreds of millions of years old, scientists can piece together how ancient temperatures fluctuated, and how, in parallel, the composition of our atmosphere fluctuated. But if we want a more recent picture, we can get an even better record from —drumroll—glaciers.

Ice cores from Greenland and Antarctic ice caps have preserved tiny bubbles of our actual atmosphere from hundreds of thousands of years ago that today, scientists like me can study.

5:40

Animations of rocks floating in space amongst an orange Earth, volcano erupting, the earth turning blue with textbox showing "Snowball Earth", ice sheets and sea ice

What all of these records tell us is that, throughout Earth's four and half billion birthdays, at times, it's been a lot colder than today, and at other times, it's been a lot warmer.

And guess what is one of the most consistent variables that leads to that temperature fluctuation? You got it: the amount of greenhouse gases in the atmosphere. So, let's travel through time and space to see what things looked like when those bubbles were in their prime.

Let's go to the Thought Bubble. Back when Earth formed about 4.5 billion years ago, it was hot. And I don't mean "eating your bodyweight in popsicles" hot. I mean, "covered in an ocean of molten rock," hot. Earth was still being pummeled by debris from the formation of the solar system, and volcanoes were spewing out a whole lot of carbon dioxide, helping to trap all that heat.

Over millions and millions of years, the molten rock solidified, forming a solid surface on the Earth. And millions and millions of years after that, the primitive ocean formed. As a result, the Earth continued to gradually cool down. And then, a couple of times throughout its early history, before animals we'd recognize today even evolved, things got really cold.

So cold that researchers think ice sheets and sea ice extended all the way to the equator. These are called Snowball Earth periods. And scientists have a few ideas about why they happened, ranging from volcanic ash blocking out the sun, to a drop in carbon levels, which was possibly a result of things like early plants sucking in the gas for photosynthesis.

7:08

Animations of pre-historic birds, Santa Claus on a sunny beach in the North Pole, early humans hunting and gathering

After that, it got hot again a few times over the next half a billion years, most recently about 56 million years ago. Back then, average global temperatures were as high as 23 degrees Celsius.

There would have been no ice at the poles, and palm trees and crocodiles could be found at the Arctic. If humans had been around, we'd probably have been building tropical water parks at the North Pole. Because if there's one thing we know for certain about our species, it's that we love a twisty slide.

But maybe thankfully for everyone, modern humans wouldn't evolve for over 55 million years. We know our fragile civilizations, water parks and all, wouldn't have stood a chance through these dramatic shifts in Earth's climate. Thanks, Thought Bubble!

Now, luckily for the human species, the ice core record of the last 800,000 years reveals much gentler temperature fluctuations... at least, until we get to the last 200 years.

In just a couple of centuries, temperatures have gone up faster than ever seen before in recorded history, and the average temperature on Earth today is the highest it's been in 100,000 years.

8:09

Graph showing global temperatures increasing since the last Ice Age; Greyscale graphics of the Industrial Revolution, coal miners working, and oil wells; Clip of a busy highway

We've never experienced this before. Even when Earth emerged from previous ice ages, the planet warmed up at a rate of only about one degree Celsius per 1,000 years.

But today, global temperatures have shot up by 0.7 degrees Celsius per 100 years. That's almost ten times faster! So what changed in the last 200 years?

Well, there was one big thing: the industrial revolution, when humans discovered we could do things a lot faster, and with a lot less effort, by burning fossil fuels.

Fossil fuels like coal, oil, and gas provided a reliable source of heat and electricity. So, when we went for them in a big way, they helped to shape our modern civilization. And that's how you ended up here, watching this video on an internet largely powered by fossil fuels.

8:58

Animations of a wind farm, and a woman looking out at a snowstorm from her window in Istanbul

But burning these fuels comes at a cost: It releases carbon dioxide. And as we've burned more of them to keep up with our growing population and energy needs, our emissions have gone up as well. And that volleyball match keeps getting harder to watch.

So, this is what we know. The average global temperature has gone up, and carbon dioxide emissions have gone up, and we know that carbon dioxide is a heat-trapping greenhouse gas.

As scientists have put those things together, it's led them to an inescapable conclusion: Human activity has caused the Earth to warm up at an unprecedented rate.

We can measure this warming with every passing month. But its global effects aren't as straightforward. There's a big difference between what scientists study as climate, and what you and I experience as weather.

Weather is where we live. So when you wake up in Istanbul in March, and see that it's weirdly cold and also snowing, that's weather. And although it may seem at odds with a warming planet, it's happening as a result of climate shifts elsewhere on Earth.

Climate deals with multi-decade, broad-scale trends in things like temperature and precipitation patterns across the globe.

10:09

Clips showing extreme weather events including a massive fire, dirty stream of water, heavy storm, melting ice caps, a village flooded with muddy water, dry lands

But since climate and weather are so closely linked, it can get complicated.

For instance, scientists agree that atypical, extreme weather events are more likely when the planet's climate is warmer, but that's only because there's more heat trapped in the oceans and atmosphere to power these weather events.

Meteorologists are constantly working to improve their forecasting models, for both short-term weather and long-term climate, based on how much energy is in the atmosphere.

By comparing and refining their models, scientists can now reliably predict some general outcomes if the current pace of climate change continues. And it might come as no surprise that it's not looking good.

We can expect — and are currently already seeing in some cases — melting ice caps, rising sea levels, shifts in agricultural productivity, more storms, more floods, more droughts.

10:58

Images of tomato plants, blue glacier, frill-necked lizard, blob fish, dancers in the Philippines, dancers in Ijebu Ode, Nigeria

Basically, climate change amplifies any weather you might typically experience.

And these effects can ultimately lead to global economic losses, displacement of vulnerable communities, and almost inevitably, geopolitical tensions.

Changing climate and changing weather patterns will have a significant impact on everyone, all over the globe. But not everyone will experience the same consequences of those impacts, or be able to adapt to them in the same way.

And those who have been and may continue to face some of the most severe consequences, are often in regions least responsible for the greenhouse gas emissions driving global climate change.

So the question becomes: what do we owe to each other, as roommates on this singularly lucky planet, where we live alongside tomato plants and vibrant blue glaciers and frill-necked lizards and blob fishes and incredible human creativity?

11:51

M Jackson appears on screen; video credits displayed

We know temperatures have fluctuated dramatically over Earth's long history, but by burning so many fossil fuels and flooding the atmosphere with gases like carbon dioxide, we also know we're causing temperatures to rise faster than ever.

And while this is a massive challenge that won't have easy solutions, there are lots of fascinating ideas for how humans might tackle climate change from a number of different directions.

We don't know all the answers and we can never return to the Earth of 250-years-ago.

But we'll explore the many cobblestones that might make a pathway forward towards a new way of living together on our Earth. Even if it's a bit bumpy.

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