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Just over 3 million years ago, in the Pliocene era, the Earth was a much warmer place. Global climate was about two degrees Celsius (35 degrees Fahrenheit) warmer than they are today, and sea levels were 85 to 100 feet higher. In the Arctic, there were hardly any ice sheets or glaciers to speak of.

Fast forward to the present. In the intervening years from the Pliocene to the familiar Holocene that we live in today, the Earth has gone through an overall cooling period that has allowed human civilization and life as we know it to thrive.

For more than a thousand years, atmospheric carbon dioxide remained at a steady and comfortable 270 to 280 parts per million, insulating the Earth's atmosphere and maintaining a climate that has, for the most part, steered clear of extreme weather patterns and heat waves. For most of human history, this has been the only climate and carbon concentration that human beings have ever lived in.

That all changed with the onset of the industrial revolution two centuries ago and the unprecedented and unstoppable fossil fuel bonfire it demanded to power factories and engines, homes and businesses, and later on, cars and planes the world over.

The rest is history. Or perhaps it might be more accurate to say that the future will look a lot like history.

Every step forward into the modern age was built on the decayed, fossilized carbon remains left in the Earth's crust over millions of years. Burned and released as an invisible but powerful greenhouse gas, that carbon is now concentrated in the Earth's atmospheres at levels not seen since the Pliocene.

Most of the discussion about man-made climate change takes place on a relatively small scale compared to the massive time scales that the planet and solar system operate on. The past two centuries of anthropogenic greenhouse gas emissions would be over in the blink of an eye in terms of Earth's 4.5 billion year history. But in that brief moment, human emissions have managed to overtake the driving force of climate change in Earth's past: the orbital patterns of the planet itself.

"Over the time scale of thousands of years, the dominant driver of changes in climate is changes in Earth's orbit," says Yarrow Axford, a professor of Earth sciences and paleoclimatology in Northwestern University's department of Earth and Planetary Sciences. "The geometry of the orbit and the tilt of the Earth on its axis—all these things affect how intense the seasons are and the way that solar radiation hits our planet."

The Earth's orbit isn't static. Its eccentricity, or elongated shape, changes in cycles ranging from 100,000 to 400,000 years. Coupled with a 40,000 year cycle in which the tilt of the Earth changes or "wobbles," Earth's seasons and overall climate can change drastically.

These cycles, called Milankovitch cycles, have shaped ice ages and warming periods overall in Earth's history since they lead to large variations in solar radiation reaching and warming the surface of the

Earth. “Small modulations can actually have pretty big impacts on climate,” says Allegra LeGrande, a scientist at NASA’s Goddard Institute for Space Studies and the Center for Climate Systems Research at Columbia University.

An initial cooling period can trigger positive feedback loops that gradually build up into massive ice ages, and a warming period can amplify the effects of the carbon cycle to induce an overall warming climate. These warmer periods in between ice ages—such as the one that the Earth has been in for several thousand years—are called interglacial periods.

“Our current orbital configuration would have led to a long interglacial period,” says Clay Tabor, a postdoctoral fellow at the National Center for Atmospheric Research. Tabor estimates that without anthropogenic greenhouse gas emissions, the next ice age might have occurred naturally in about 20,000 years.

“Adding our CO2 emission will probably prevent another glacial period for 50,000 years, if not more,” says Tabor. The extra 320 parts per million of carbon dioxide that humans have pumped into the atmosphere in two hundred years, in other words, has changed a pattern that’s been fairly consistent for the past 800,000 years.

“We’ve basically reversed that long term trend and overtaken orbital forcing as the dominant forcing of overall climate change,” says Axford. “It’s a pretty remarkable thing.”

For humans, future climate change trajectory in a warming world is an uncharted path. But the Earth has experienced this before, around 3 million years ago.

“A reason scientists are interested in the Pliocene as an analogy for today is that that greenhouse gases are really similar to where we are today,” says LeGrande. In May 2015, the National Oceanic and Atmospheric Administration announced that average monthly concentrations of carbon dioxide in the atmosphere had reached 400 parts per million—roughly the same concentration estimated in the Pliocene era.

If greenhouse gas emissions today mirror that of the Pliocene, the climate will soon catch up as well. “One question that’s not well answered is how long it takes to get to a Pliocene-like state,” says Axford. “We’re at Pliocene-like CO_2, but we’re nothing like Pliocene-like climate. There are a lot of aspects of Earth’s system that take a while to catch up to such a rapid change in greenhouse gas abundance.”

One of the hallmarks of the Pliocene is that sea levels were approximately 80 feet higher than they are today. Much of the change in sea level can be traced back to ice sheets: the Greenland ice sheet in the Arctic, and Antarctic ice in the Southern hemisphere.

Different factors, including sea level or snow fall and accumulation, can impact the rate of melt in a myriad of different ways. In the past, according to paleoclimate models, it may have taken hundreds or thousands of years for the ice to melt and sea levels to rise.

The Greenland ice sheet alone, according to a study in the journal *Nature Climate Change,* could be responsible for seven meters of global mean sea level rise. The majority of Greenland’s ice will melt if carbon stays at or above 400 parts per million, simply because the ice sheet can’t survive the temperatures that this concentration of carbon dioxide will cause.

As the atmosphere continues to warm due to greenhouse gas emissions, the oceans will warm up, too, creating a positive feedback loop that has decidedly negative effects.

“Warm ocean water has a lot more heat capacity than the atmosphere,” LeGrande explains. “If you have one degree change in in the ocean, it has a lot more energy to warm the ice sheet up.” Since the Greenland ice sheet is essentially an island and its edges touch the ocean, as the ice melts and water levels rise, more of the ice sheet will become exposed to warmer ocean water. “If you have sea level rise a little bit, that can bring down the edges of the ice sheets,” LeGrande says.

The fact that the Greenland ice sheet will melt, at least partially, is not up for debate. Only the question of how and when remains. “We haven’t seen a huge ice sheet collapse,” LeGrande says. “We don’t know how it happens. We understand it in a larger sense but we don’t have satellite records.”

Greenland has been slowly melting for the last two decades. According to data from NASA, the current rate of sea level change is just over three millimeters per year—a seemingly miniscule rate. But over a thousand years, if the rate stays constant, that would add up to almost three meters (10 feet) of water. That’s enough water to submerge a one story house, and across the United States that much water could damage and destroy expensive coastal infrastructure.

“We’re talking about an ultimate magnitude of change that would severely change the current shape of the coastlines in the US and all over the globe,” says Jeremy Martinich, an environmental scientist with the EPA. “A meter of sea level rise will affect every part of the U.S. coastline.”

Roads, bridges, sea walls and other protective measures will have to be rebuilt or relocated to adapt to a warmer world that is full of uncertainties and constantly shifting norms.

“What we’re doing is entering a phase in which there is no longer any normal,” says Axford. “We’ve built huge cities on coastlines, but we wouldn’t have done that if when we built our big cities, it was in a world where seas were constantly rising.”

Whereas most of the infrastructure that stands today has been built to withstand historic norms and expected weather patterns, a warmer climate means more intense storms, flooding and erosion that will occur much more frequently and unpredictably.

Cities like New York and Miami, which are full of high-value development, will likely see vast investments in hard-protection measures, says Martinich. These protection measures include building new sea walls and restoring sand dunes that lessen the impacts of rising seas and stronger storm surges that feed off of the higher water levels.

But the fate of sparsely populated, undeveloped rural areas isn’t as clear. “There will be places in this country where at some point you can’t go on trying to hold back the sea,” Martinich says. Wetlands on the Gulf Coast are already disappearing, as are islands in the Chesapeake. “There’s a point where people just say, ‘It’s not worth it anymore.’ They’re losing land at something like a football field an hour in Louisiana.”

In the Pliocene, two degrees of extra warmth dramatically reshaped the Earth's surface. Rising sea levels and melting Arctic ice—it's all within the realm of possibility today, and the Earth could once again look like it did 3 million years ago.

"We would be really lucky if that's where we end up," says Axford. "We already have enough carbon dioxide in the atmosphere to achieve that and we're not going to stop emitting." If emissions aren't reduced, it's possible that future climate change will cause the Earth to return to an older, warmer and more unpredictable climate period.

Even though policy makers often advocate limiting emissions to ensure a two degree cut-off for overall global warming, the changes that will occur within that range could be devastating, if the Pliocene serves as a reliable marker.

"Two degrees is a number that gets thrown around a lot, but we don't know if that will really be safe," says LeGrande. Allowing anthropogenic emissions to exceed the two degree limit would undoubtedly be more dangerous. Not only would global temperatures become more intense, but so would overall weather patterns that influence stronger hurricanes, tropical floods and droughts.

"If we continue this trend, it's definitely something humans haven't experienced before," says Tabor, even if the Earth has experienced it before, many millions of years ago. "As far as most people are concerned, we're making changes that won't return to normal for thousands of years."

As ice sheets melt in Arctic latitudes, forests might take their place. Where forests once thrived, deserts may creep in. "50 million years ago, you coul find alligators in the Antarctic and palm trees in New Jersey," says LeGrande. If greenhouse gas emissions go unchecked, it's not an impossible scenario.

But at some point, greenhouse gas emission will have to peak. There is only a limited reserve of fossil fuels still buried in the Earth's surface, after all.

And then, perhaps, the slow cycles of the Earth will take over once again, restoring and repairing in tens of thousands of years the devastation that humans have unleashed in a mere two hundred. In thousands of years, carbon dioxide in the atmosphere will naturally break down and dissipate as it sinks into the oceans or is absorbed by weathering rocks.

As the carbon breaks down and atmospheric concentrations slowly fall to pre-industrial levels, the climate will slowly but surely follow suit, cooling down and returning to some semblance of the normal humans have known for millennia.

"Eventually," says Tabor, "if you look out millions of years, all of these things can be forgotten."