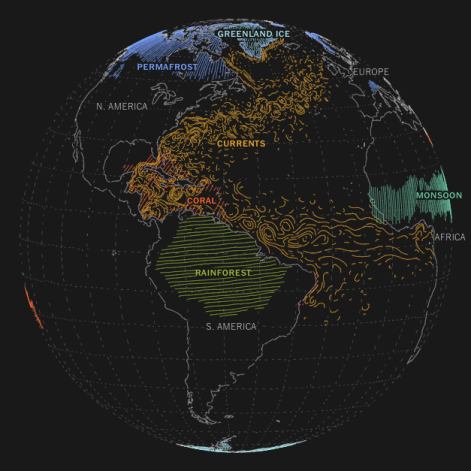
8/19/24, 9:38 AM How Close Are the Planet’s Climate Tipping Points? - The New York Times

HowCloseAre the Planet’s

ClimateTipping Points?

Earth’s warming could trigger sweeping changes in the natural world that would be hard, if not impossible, to reverse.

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8/19/24, 9:38 AM How Close Are the Planet’s Climate Tipping Points? - The New York Times

By Raymond Zhong and Mira Rojanasakul Aug. 11, 2024

Right now, every moment of every day, we humans are

reconfiguring Earth’s climate bit by bit. Hotter summers and

wetter storms. Higher seas and fiercer wildfires. The steady,

upward turn of the dial on a host of threats to our homes, our

societies and the environment around us.

We might also be changing the climate in an even bigger way.

For the past two decades, scientists have been raising alarms

about great systems in the natural world that warming, caused by carbon emissions, might be pushing toward collapse. These

systems are so vast that they can stay somewhat in balance even as temperatures rise. But only to a point.

Once we warm the planet beyond certain levels, this balance might be lost, scientists say. The effects would be sweeping and hard to reverse. Not like the turning of a dial, but the flipping of a switch. One that wouldn’t be easily flipped back.

Mass Death of Coral Reefs

Tipping point possible

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When corals go ghostly white, they aren’t necessarily dead, and their reefs aren’t necessarily gone forever. Too much heat in the water causes the corals to expel the symbiotic algae living inside their tissues. If conditions improve, they can survive this

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8/19/24, 9:38 AM How Close Are the Planet’s Climate Tipping Points? - The New York Times bleaching. In time, the reefs can bounce back. As the world gets warmer, though, occasional bleaching is becoming regular

bleaching. Mild bleaching is becoming severe bleaching.

Scientists’ latest predictions are grim. Even if humanity moves

swiftly to rein in global warming, 70 percent to 90 percent of

today’s reef-building corals could die in the coming decades. If we don’t, the toll could be 99 percent or more. A reef can look healthy right up until its corals start bleaching and dying. Eventually, it is a graveyard.

This doesn’t necessarily mean reef-building corals will go extinct. Hardier ones might endure in pockets. But the vibrant ecosystems these creatures support will be unrecognizable. There is no

bouncing back anytime soon, not in the places corals live today, not at any scale.

When it might happen: It could already be underway.

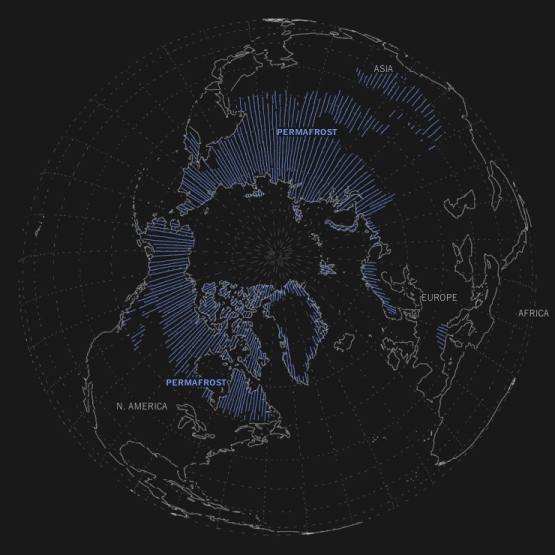
Abrupt Thawing of Permafrost

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In the ground beneath the world’s cold places, the accumulated remains of long-dead plants and animals contain a lot of carbon, roughly twice the amount that’s currently in the atmosphere. As heat, wildfires and rains thaw and destabilize the frozen ground,

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8/19/24, 9:38 AM How Close Are the Planet’s Climate Tipping Points? - The New York Times microbes get to work, converting this carbon into carbon dioxide and methane. These greenhouse gasses worsen the heat and the fire and the rain, which intensifies the thawing.

Like many of these vast, self-propelling shifts in our climate,

permafrost thaw is complicated to predict. Large areas have

already come unfrozen, in Western Canada, in Alaska, in Siberia. But how quickly the rest of it might defrost, how much that would add to global warming, how much of the carbon might stay trapped down there because the thawing causes new vegetation to sprout up on top of it — all of that is tricky to pin down.

“Because these things are very uncertain, there’s a bias toward not talking about it or dismissing the possibility, even,” said Tapio

Schneider, a climate scientist at the California Institute of

Technology. “That, I think, is a mistake,” he said. “It’s still

important to explore the risks, even if the probability of occurrence in the near future is relatively small.”

When it might happen: The timing will vary place to place. The effects on global warming could accumulate over a century or

more.

Collapse of Greenland Ice

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The colossal ice sheets that blanket Earth’s poles aren’t melting the way an ice cube melts. Because of their sheer bigness and

geometric complexity, a host of factors shapes how quickly the ice sheds its bulk and adds to the rising oceans. Among these factors,

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In Greenland, the issue is elevation. As the surface of the ice loses height, more of it sits at a balmier altitude, exposed to warmer air. That makes it melt even faster.

Scientists know, from geological evidence, that large parts of

Greenland have been ice-free before. They also know that the

consequences of another great melt could reverberate worldwide, affecting ocean currents and rainfall down into the tropics and

beyond.

When it might happen: Irreversible melting could begin this

century and unfold over hundreds, even thousands, of years.

Breakup of WestAntarctic Ice

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At the other end of the world from Greenland, the ice of western Antarctica is threatened less by warm air than by warm water.

Many West Antarctic glaciers flow out to sea, which means their undersides are exposed to constant bathing by ocean currents. As the water warms, these floating ice shelves melt and weaken from below, particularly where they sit on the seafloor. Like a dancer

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8/19/24, 9:38 AM How Close Are the Planet’s Climate Tipping Points? - The New York Times holding a difficult pose, the shelf starts to lose its footing. With less floating ice to hold it back, more ice from the continent’s interior would slide into the ocean. Eventually, the ice at the water’s edge might fail to support its own weight and crack into pieces.

The West Antarctic ice sheet has probably collapsed before, in

Earth’s deep past. How close today’s ice is to suffering the same fate is something scientists are still trying to figure out.

“If you think about the future of the world’s coastlines, 50 percent of the story is going to be the melt of Antarctica,” said David

Holland, a New York University scientist who studies polar

regions. And yet, he said, when it comes to understanding how the continent’s ice might break apart, “we are at Day Zero.”

When it might happen: As in Greenland, the ice sheet could begin to recede irreversibly in this century.

Sudden Shift in the

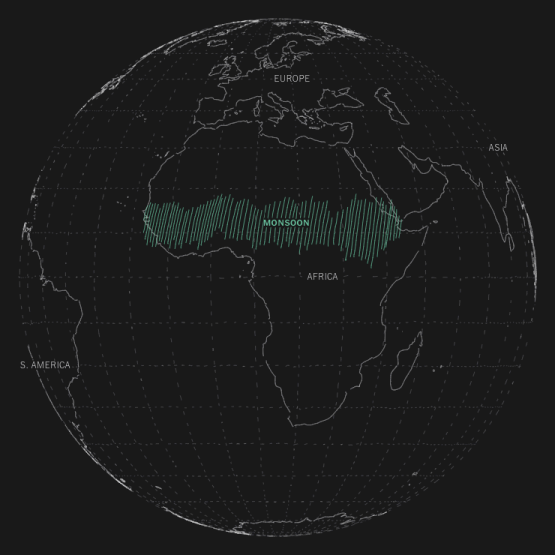
WestAfrican Monsoon

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Around 15,000 years ago, the Sahara started turning green. It

began when small shifts in Earth’s orbit caused North Africa to be sunnier each summer. This warmed the land, causing the winds to shift and draw in more moist air from over the Atlantic. The

moisture fell as monsoon rain, which fed grasses and filled lakes, some as large as the Caspian Sea. Animals flourished: elephants,

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8/19/24, 9:38 AM How Close Are the Planet’s Climate Tipping Points? - The New York Times giraffes, ancestral cattle. So did humans, as engravings and rock paintings from the era attest. Only about 5,000 years ago did the region transform back into the harsh desert we know today.

Scientists now understand that the Sahara has flipped several

times over the ages between arid and humid, between barren and temperate. They are less sure about how, and whether, the West African monsoon might shift or intensify in response to today’s

warming. (Despite its name, the region’s monsoon unleashes rain over parts of East Africa as well.)

Whatever happens will matter hugely to an area of the world

where many people’s nutrition and livelihoods depend on the skies. When it might happen: Hard to predict.

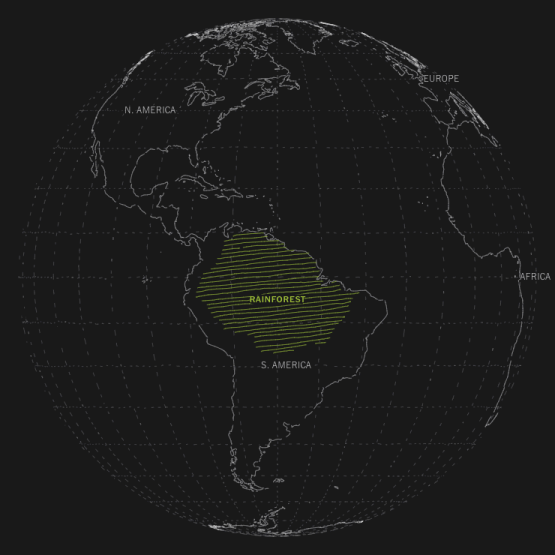
Loss ofAmazon Rainforest

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Besides being home to hundreds of Indigenous communities,

millions of animal and plant species and 400 billion trees; besides containing untold numbers of other living things that have yet to be discovered, named and described; and besides storing an

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8/19/24, 9:38 AM How Close Are the Planet’s Climate Tipping Points? - The New York Times abundance of carbon that might otherwise be warming the planet, the Amazon rainforest plays another big role. It is a living,

churning, breathing engine of weather.

The combined exhalations of all those trees give rise to clouds fat with moisture. When this moisture falls, it helps keep the region lush and forested.

Now, though, ranchers and farmers are clearing the trees, and

global warming is worsening wildfires and droughts. Scientists

worry that once too much more of the forest is gone, this rain

machine could break down, causing the rest of the forest to wither and degrade into grassy savanna.

By 2050, as much as half of today’s Amazon forest could be at risk of undergoing this kind of degradation, researchers recently

estimated.

When it might happen: Will depend on how rapidly people clear, or protect, the remaining forest.

Shutdown ofAtlantic Currents

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Sweeping across the Atlantic Ocean, from the western coasts of Africa, round through the Caribbean and up toward Europe before heading down again, a colossal loop of seawater sets temperatures and rainfall for a big part of the globe. Saltier, denser water sinks to the ocean depths while fresher, lighter water rises, keeping this conveyor belt turning.

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8/19/24, 9:38 AM How Close Are the Planet’s Climate Tipping Points? - The New York Times Now, though, Greenland’s melting ice is upsetting this balance by infusing the North Atlantic with immense new flows of freshwater. Scientists fear that if the motor slows too much, it could stall,

upending weather patterns for billions of people in Europe and the tropics.

Scientists have already seen signs of a slowdown in these currents, which go by an unwieldy name: the Atlantic Meridional

Overturning Circulation, or AMOC. The hard part is predicting

when a slowdown might become a shutdown. At the moment, our data and records are just too limited, said Niklas Boers, a climate scientist at the Technical University of Munich and the Potsdam Institute for Climate Impact Research.

Already, though, we know enough to be sure about one thing, Dr. Boers said. “With every gram of additional CO2 in the atmosphere, we are increasing the likelihood of tipping events,” he said. “The longer we wait” to slash emissions, he said, “the farther we go into dangerous territory.”

When it might happen: Very hard to predict.

Read More on Earth’s Tipping Points

Heat Raises Fears of ‘Demise’ for Great Barrier Reef 

Within a Generation

A new study found that temperatures in the Coral Sea have

reached their highest levels in at least four centuries.

By Catrin Einhorn

Aug. 7, 2024

A Collapse of the Amazon Could Be Coming ‘Faster

Than We Thought’

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8/19/24, 9:38 AM How Close Are the Planet’s Climate Tipping Points? - The New York Times A new study weighed a range of threats and variables in an 

effort to map out where the rainforest is most vulnerable.

By Manuela Andreoni

Feb. 14, 2024

In the Atlantic Ocean, Subtle Shifts Hint at 

Dramatic Dangers

A warming atmosphere is causing a branch of the ocean’s

powerful Gulf Stream to weaken, some scientists fear.

By Moises Velasquez-Manoff and Jeremy White

March 2, 2021

How Much Ice Is Greenland Losing? Researchers 

Found an Answer.

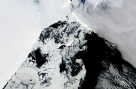
The island is shedding 20 percent more than previously

estimated, a study found, potentially threatening ocean

currents that help to regulate global temperatures.

By Delger Erdenesanaa

Jan. 17, 2024

Rapid Antarctic Melting Looks Certain, Even if 

Emissions Goals Are Met

It may be too late to halt the decline of the West Antarctic ice

shelves, a study found, but climate action could still forestall

the gravest sea level rise.

By Raymond Zhong

Oct. 23, 2023

Methodology

The range of warming levels at which each tipping point might potentially be triggered is from David I. Armstrong McKay et al., Science.

The shaded areas on the maps show the present-day extent of relevant areas for each natural system. They don’t necessarily indicate precisely where large-scale changes could occur if a tipping point is reached.

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