Twenty thousand years ago,

the Earth was a frigid landscape where woolly mammoths roamed.

Huge ice sheets, several thousand meters thick,

encased parts of North America, Asia, and Europe.

We commonly know it as the "Ice Age."

But geologists call it the Last Glacial Maximum.

That’s because it’s the most recent time that ice reached such a huge extent,

and “ice age” is an informal term without a single agreed-upon definition.

Over the last million years,

there have actually been about 10 different glacial maxima.

Throughout Earth’s history, climate has varied greatly.

For hundreds of millions of years,

the planet had no polar ice caps.

Without this ice, the sea level was 70 meters higher.

At the other extreme, about 700 million years ago,

Earth became almost entirely covered in ice

during an event known as “Snowball Earth.”

So what causes these massive swings in the planet’s climate?

One of the main drivers is atmospheric carbon dioxide,

a greenhouse gas that traps heat.

Natural processes, such as volcanism,

chemical weathering of rocks,

and the burial of organic matter,

can cause huge changes in carbon dioxide when they continue for millions of years.

Over the past million years, carbon dioxide has been relatively low,

and repeated glacial maxima

have been caused by cycles in Earth’s movement around the sun.

As Earth rotates,

it wobbles on its axis and its tilt changes,

altering the amount of sunlight that strikes different parts of its surface.

These wobbles, combined with the planet’s elliptical orbit,

cause summer temperatures to vary

depending on whether the summer solstice happens when Earth is closer

or farther from the sun.

Approximately every 100,000 years,

these factors align to create dramatically colder conditions that last for millennia.

Cool summers that aren’t warm enough to melt the preceding winter’s snow

allow ice to accumulate year after year.

These ice sheets produce additional cooling

by reflecting more solar energy back into space.

Simultaneously, cooler conditions transfer carbon dioxide

from the atmosphere into the ocean,

causing even more cooling and glacier expansion.

About 20,000 years ago,

these trends reversed when changes in Earth’s orbit increased summer sunshine

over the giant ice sheets, and they began to melt.

The sea level rose 130 meters

and carbon dioxide was released from the ocean back into the atmosphere.

By analyzing pollen and marine fossils,

geologists can tell that temperatures peaked about 6,000 years ago,

before another shift in Earth’s orbit caused renewed cooling.

So what’s coming next?

Based on the repeated natural cycle seen in the climate record,

we’d normally expect the Earth to continue a trend of gradual cooling

for the next few thousand years.

However, this cooling abruptly reversed about 150 years ago.

Why?

Carbon dioxide levels in the atmosphere have been rising since the 19th century,

when fossil fuel use increased.

We know that from studying air bubbles trapped in Antarctic ice.

This surge in carbon dioxide also coincides

with a global temperature increase of nearly one degree Celsius.

Ice cores and atmospheric monitoring stations

show us that carbon dioxide levels are rising faster,

and to higher levels,

than at any point in the last 800,000 years.

Computer models forecast another one to four degrees Celsius of warming by 2100,

depending on how much additional fossil fuel we burn.

What does that mean for the ice currently on Greenland and Antarctica?

Past climate changes suggest that even a small warming shift

can begin a process of ice melt that continues for thousands of years.

By the end of this century,

ice melt is expected to raise the sea level by 30 to 100 centimeters,

enough to impact many coastal cities and island nations.

If a four-degree Celsius warming persisted for several millennia,

the sea level could rise by as much as 10 meters.

By studying past climates,

scientists learn more about what drives the shifts in ice

that have shaped our planet for millions of years.

Research suggests that by taking action now

to reduce carbon dioxide emissions quickly,

we still have the opportunity to curb ice loss and save our coastal communities.