



# Spotlight on Climate

## Recent Warming is Different

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I was finishing my doctorate degree in Geoscience when the Intergovernmental Panel on Climate Change (IPCC) published its first assessment report in 1990. Global warming was emerging as a serious concern. Geoscientists like me had barely entered into the discussions of policy-relevant topics about climate change. Our research revealed rich details of natural climate fluctuations throughout Earth's history, but the fact that climate always changes seemed to be more of a talking point for those who distrusted the science of climate change than a fundamental contribution to the understanding of current change.

Thirty years later, as a lead author on the recently published IPCC's sixth assessment report, the value of the long-term perspective on climate change is clear. Climate records based on data from weather stations and satellites, as dramatic as some are, are too short to fully comprehend recent changes. As the climate now rushes to conditions uncharted by humans, we must look further back in time for climate records that can put the present into perspective and help us think more clearly about our future.

Take temperature: the average temperature of the Earth's surface is a key measure of global warming and is a focus of international agreements to limit future climate change. Global temperature has warmed by about 1.1°C (2°F) compared to the late 1800s, but it's difficult to gauge intuitively how much warming this really is. It might sound like a little or a lot. How does it compare to past natural fluctuations? When was the last time temperatures were this high?

Geoscientists use a number of tools to deduce what happened in the past, and they apply their techniques to some of Earth's most astonishing features. They retrieve ice from kilometers-thick polar icesheets to analyze the composition of ancient air trapped in bubbles. They extract microfossils from mud lifted from the deepest ocean to decode past ocean temperatures. They sample biological archives from tree rings, bogs, and packrat middens to reconstruct climate changes on land.

This rich variety of evidence shows that recent global warming is distinct from previous warm periods in four ways:

(1) **It's been a long time since it's been this warm.** We need to look back to the warm period prior to the last major ice age, around 125,000 years ago, to find evidence for global temperatures that were warmer.

(2) **Present warming reverses a long-term global cooling trend.** Global temperature was decreasing slightly for thousands of years prior to industrialization, driven by slow changes in Earth's orbit. Superposed on this cooling trend were centuries that were warmer or colder, but no changes were as prominent as the warming that began by the late 1800s.

(3) **Earth is now warming very rapidly.** At the end of the last major ice age, global temperature rose by about 5°C (9°F) between 17,000 and 12,000 years ago. The fastest warming rate averaged about 1.5°C per thousand years. This compares roughly to 1.1°C of global warming since the late 1800s. Higher-resolution records of global temperature show that the rate of global warming since 1970 has exceeded the rate during any other 50-year period over at least the past 2000 years.

(4) **It's warming almost everywhere.** During decades and centuries of the past 2000 years, some regions warmed more than the global average while, at the same time, other regions cooled. For example, between the 10th and 13th centuries, the North Atlantic region warmed more than other regions. In contrast, the pattern of recent warming is more globally uniform, meaning that every living ecosystem is affected.

Ancient temperature fluctuations were caused by well-known natural processes, while current warming is due to human causes. Studying past climate changes makes it clear that, when the climate system is pushed to change, it can change dramatically. We now know that current, human-caused climate change is different than the natural patterns of the past. Moreover, unlike previous climate changes, the effects of current warming are occurring on top of stresses that make humans and nature vulnerable in ways they have never before experienced. Every fraction of a degree of additional warming that we avoid will help to limit the negative consequences of global warming, which is already impacting every region of the planet.

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