Spotlight on Climate

What does the past tell us about Abrupt Climate Change?

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(700 words)

We now know that human activities like fossil-fuel carbon emissions are currently causing our planet to go through an abrupt climate change. How much should we worry about the consequences of this rapid change?

My colleagues and I study past climate by looking closely at ice cores from deep in Antarctic glaciers. The layers of ice in Antarctica go back over 800,000 years and provide a very detailed record of past climate. These data tell us exactly when there were abrupt climate changes in the past, and we can look back at those times to learn some of the causes and consequences. What do these records tell us?

They tell us that past climate changes are not random. They all happen for specific reasons. They tell us that over the long-term, Earth's climate responds to changes in how the Earth orbits around the Sun. They show that our climate has changed in direct response to changes in the concentration of greenhouse gases in the Earth's atmosphere. They show that past climate has changed in response to major alterations of ocean currents, volcanic eruptions, and large meteor impacts. These records show that some climate changes of the past have taken place over long periods of time, while other climate changes have been much more abrupt.

One example of an abrupt climate change took place 12,800 years ago, when temperatures dropped as much as 10°C (18°F) in just a few decades. This happened because a large, freshwater lake the size of California drained suddenly into the North Atlantic, breaking the global conveyor belt of ocean currents. This abrupt shift resulted in an immediate decline of Clovis culture and other hunter-gatherer settlements of that time. It changed countless ecosystems and led to the die off of many species that were unable to adapt. As we peer back through Earth's climate history, we find numerous examples like this.

Here in Arizona, there is a rich history of cliff-dwelling ancestral Puebloans. At Walnut Canyon in Flagstaff, you can walk around the still-preserved dwellings and imagine what it would have been like for the people living between 600 and 1400 AD (now known as CE). During this time (800–1250 CE), Earth was going through the Medieval Warm Period. This period led to shifts in climate and persistent drought conditions in the Southwest (particularly up in the nearby Mesa Verde area), which ultimately drove many of the cliff-dwelling populations away.

Beyond the ice core data, preserved layers in limestone rock formations provide a climate record going even further back in time. From those records we've learned that

251 million years ago, a massive increase in the greenhouse gas, carbon dioxide (CO_2) warmed the Earth by over 10°C (18°F). This led to one of Earth's largest ever mass-extinctions, known as the "Great Dying". During that time, a series of massive volcanic eruptions in the area now known as Siberia, released an enormous amount of CO_2 into our atmosphere. As we see with current climate change, higher CO_2 in the atmosphere causes more CO_2 to be absorbed by the oceans, making the water more acidic. So, 251 million years ago, this led to widespread acidification and reduction of oxygen in the global oceans. As a result, over 90% of all species on the planet went extinct. Of course new species evolved, but the recovery of full ecosystem function took almost 50 million years.

Today, governments and peoples of the world are all interested in where our current climate is headed and what will happen as our oceans continue to acidify. Recent direct measurements show that average global temperatures have already risen by 1.2°C (2.2°F) in just the past few decades, and that greenhouse gas emissions are the primary cause of that change. Given our current emission rates, we can expect to reach 5°C (9°F) of warming by the end of this century. What we've learned from studies of the past is that climate changes, even small or subtle ones, can have enormous impacts on our planetary life support systems, and on human civilizations. If we are to avoid large, society-ending impacts, it is imperative that we work collectively to reduce our greenhouse gas emissions as quickly as possible.

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