

Global Climate Change

Q: What does “global warming” really mean?

A: People often refer to “global warming” to describe increasing temperatures caused by human activities such as fossil-fuel burning and deforestation. But, human interference with the Earth’s climate triggers many changes – from melting ice to rising sea levels, and from the frequency of wildfires to the intensity of hurricanes. These “global climate changes” affect floods and droughts, diseases such as malaria, flowering and breeding times, coral reefs, water quality, farming productivity, and more.

Q: Is global climate change real?

A: Yes. Today, the vast majority of scientists agree that the data shows the Earth is warming and will continue to warm as a result of human-produced greenhouse gas emissions. These emissions, produced in large quantities by the burning of fossil fuels and by deforestation, trap the Sun’s heat near the Earth’s surface, like a blanket.

Between 1990 and 2100, temperatures are expected to rise between 2.5 and 10.4 degrees Fahrenheit. Worldwide, temperatures have so far increased by about 1 degree Fahrenheit during this century, with the 1990s believed to be the hottest decade on record. In Alaska, the Alaska Climate Research Center has found that average temperatures there have increased by 3.5 degrees Fahrenheit over the last five decades, and 6.3 degrees Fahrenheit over the winters.

Q: Are humans causing global climate change?

A: Yes. Some 7.2 billion tons of carbon dioxide are being released into the atmosphere every year as a result of human activities. Cars, power plants, factories, and homes release about 5.5 billion tons of carbon dioxide every year as fossil fuels such as coal, oil, and natural gas are burned to produce energy. Another 1.6 billion tons of carbon dioxide are released by deforestation, especially in the tropics. Some of this carbon dioxide is absorbed by the ocean, plants, and other natural “sinks.” But about 3.2 billion tons of carbon dioxide is released into our atmosphere every year.

Q: Do natural climate fluctuations cause warmer weather?

A: Although the climate may change from age to age, the current trend is unprecedented in human history and clearly results from human activities. By studying ancient Antarctic ice cores, scientists have mapped temperatures and carbon dioxide levels over the past 400 thousand years. On a graph, it’s easy to see that temperatures on Earth have

corresponded very closely with atmospheric carbon dioxide levels for nearly 400 thousand years – up until the 1800s. Then, during the Industrial Revolution, carbon dioxide levels began to spike, jumping from 280 parts per million (ppm) to 381 ppm today. Temperatures on Earth also began to rise, surpassing even the so-called Medieval Warm Period (900 to 1300 AD), with the 1990s proving to be the hottest decade ever recorded.

Q: What climate-related changes can we expect in coming decades?

A: As of this writing, atmospheric carbon-dioxide levels stand at 381 parts per million (ppm). Atmospheric carbon dioxide levels are rising at a rate of about 2 ppm per year, and therefore could hit 400 ppm within the decade. As the trend continues, it could at some level trigger a disintegration of the Greenland ice sheet. And, a catastrophic collapse of the Greenland ice sheet could eventually, over hundreds of years, raise sea levels by up to 21.3 feet (or 6.5 meters), with dire consequences for many coastal cities, particularly for poor communities. Even now, Arctic coastal settlements such as the village of Shismaref, Alaska, are preparing to relocate as ice melts.

Montana's Glacier National Park, one of the world's most magnificent natural wonders, probably will have no remaining glaciers by mid-century. Similarly, Mount Kilimanjaro may have no ice fields at all by 2020. By comparison, this majestic peak was covered by 4.3 square miles of ice fields in 1912. Meanwhile, in North America and Europe, signs of spring such as animal breeding and the blooming of flowers have been happening, on average, 2.3 days earlier over the course of each decade for the past half-century. Already, it is clear that our children and grandchildren will inherit a dramatically different world.

Q: How else can global climate change affect us?

A: Global climate change affects the productivity of farms, forests, and fisheries; the livability of cities in summer; and damages from storms, wildfires, floods, and droughts. Recent research has linked a sharp increase in the number of wildfires in western U.S. forests since the mid-1980s with warming temperatures and earlier snow melts in the mountains. Other studies have shown an increase in the intensity of tropical storms – hurricanes and typhoons – in all ocean basins. Climate change affects the distribution and abundance of every species on Earth, including creatures that we value and depend upon, but also pests that carry diseases such as malaria. The World Health Organization has estimated that, in the year 2000, climate change claimed some 150,000 lives and sickened many others, especially elderly people and children. Continuing climate change is likely to kill or sicken many more.

Q: Why are scientists so concerned about the Greenland ice sheet?

A: The Greenland ice sheet is rapidly thinning, and ice loss seems to be happening much more quickly than previously assumed. In fact, satellite measurements from 1996 to 2005 revealed a doubling of the amount of ice being dumped by Greenland's glaciers into the

Atlantic Ocean. It's important to note that scientists aren't certain yet how fast the ice is melting, and they also don't know how much atmospheric carbon dioxide might cause enough warming to trigger a sudden disintegration of the Greenland ice sheet. But, a number of respected, cautious scientists believe there is a "trigger point," which may lie somewhere between 400 ppm and 700 ppm atmospheric carbon dioxide. Currently, the atmospheric carbon dioxide level stands at 381 ppm. If the Greenland ice sheet collapses, sea levels could rise by up to 21.3 feet. Although this sea-level rise probably would happen relatively slowly, over hundreds of years, it would swamp coastal communities all over the planet and change human civilization forever.

Q: Is global climate change related to the "ozone hole" problem?

A: No. The "ozone hole" over Antarctica is different from global climate change, although both problems are caused by pollution. The ozone hole is not really a hole, or even a single trouble spot, but rather, several thinning regions of the Earth's protective layer of ozone molecules. High above the Earth, the ozone layer protects us from the Sun's ultra-violet rays. But, chlorine in chemicals such as chlorofluorocarbons, or CFCs, can interact with ozone molecules in a way that destroys the ozone layer. In the 1990s, the United States played a leading role in addressing the ozone problem, by taking decisive action to reduce the production and use of ozone-destroying chemicals.

Q: If climate change is real, why do some physical signs seem contradictory?

A: Some climate-change skeptics have noted that the middle of the Greenland ice sheet and the center of Antarctica are growing thicker, and therefore must be getting larger, rather than melting. In fact, a thickening around the middle of Greenland and Antarctica has been caused by increased precipitation linked to global warming, which affects a weather pattern known as the North Atlantic Oscillation. And, studies have found an overall reduction in both the Greenland ice sheet and Antarctica over the past several years. Global climate change disrupts the entire climate "envelope" on our planet and can cause extreme fluctuations in regional weather patterns, from snowfall to droughts. Global climate change is thus far more complex than global warming and melting ice.

Q: How can we fix the problem without ruining our economy?

A: The tools exist today to keep greenhouse-gas levels from rising any higher. AAAS and others have suggested approaching the problem from three directions – by combining efforts to reduce energy consumption and greenhouse-gas emissions with strategies for adapting to climate change, as well as technologies designed to mitigate impacts.

Human adaptation can include, for example, changing settlement patterns, or farming and flood-management practices. Ideas for mitigating global climate change now include such concepts as "geo-engineering" technologies to offset the effects of heat-trapping gases. Both approaches may show promise, but adaptive measures could be limited by economic and geographic forces, and certain geo-engineering ideas – such as using large mirrors to deflect the Sun's rays – may be impractical.

Improving the energy efficiency of cars, trucks, planes, buildings, appliances, and manufacturing processes, combined with next-generation energy solutions and innovative new technologies for capturing or “sequestering” carbon may also hold the key to our climate future. Increasingly, leading international corporations – including oil giants such as BP, Chevron, the Royal Dutch/Shell Group, and others – are setting the pace in embracing cutting-edge research to address global climate change.

Q: What can I do on a personal level?

A: Small steps can have big impacts. Plant trees, which absorb carbon dioxide. Consider more energy-efficient technologies, such as a hybrid car, or simply use less heat and air-conditioning. Become politically active, and vote for leaders who promise to work toward climate-change solutions. Calculate your own “carbon footprint,” then try to reduce it. For additional resources on climate change: <http://www.aaas.org/climate>.