

Global Warming: The History of an International Scientific Consensus

Explore our timeline to discover the scientific evidence of global warming, and what is (or is not) being done about it

- 1896:** Svante Arrhenius, a Swedish chemist, advances the theory that carbon dioxide emissions from combustion of coal would enhance Earth's greenhouse effect and lead to global warming.
- 1924:** Based on 1920 coal use, Alfred Lotka, a U.S. physicist, speculates that industrial activity will double atmospheric CO₂ in 500 years.
- 1949:** Guy S. Callendar, a British scientist, speculatively links the estimated 10% increase of atmospheric CO₂ between 1850 and 1940 with the observed warming of northern Europe and North America which began in the 1880's.
- 1954:** G. Evelyn Hutchinson, a Yale biologist, first suggests that deforestation will increase atmospheric CO₂.
- 1957:** Roger Revelle and Hans Suess, scientists with the Scripps Institute of Oceanography, report for the first time that much of the CO₂ emitted to the atmosphere is not absorbed by the oceans (as some had argued), leaving significant amounts in the atmosphere which could eventually warm the Earth. They call carbon dioxide emissions "a large-scale geophysical experiment" with Earth's climate.
- 1958:** C.D. Keeling, a scientist with the Scripps Institute, begins the first reliable and continuous measurements of atmospheric carbon dioxide at Hawaii's Mauna Loa Observatory. Keeling finds CO₂ concentrations to be 315 parts per million and rising.
- 1967:** The first reliable computer simulation calculates that global average temperature may increase by more than 4 degrees Fahrenheit when the atmospheric CO₂ level doubles that of pre-industrial times.
- 1971:** Some scientists argue that cooling of the atmosphere by particulates from coal burning could be more significant than warming by greenhouse gases. Uncertainties are too large to be sure which effect will dominate.
- 1976:** Scientists at several research institutions identify chlorofluorocarbons (CFCs), methane, and nitrous oxide as greenhouse gases.
U.S. and Swedish scientists estimate that cooling by particulates from coal burning is a relatively small effect on a global average basis.
- 1979:** The report of a National Academy of Sciences (NAS) panel on climate change advises that "A wait-and-see policy may mean waiting until it is too late" to avoid significant climate changes.
- 1983:** An NAS report confirms that a doubling of CO₂ levels eventually would warm the Earth by 3 to 8 degrees Fahrenheit. The same year a U.S. Environmental Protection Agency (EPA) study called *Can We Delay A Greenhouse Warming?* states that as a result of warming, "agricultural conditions will be significantly altered, environmental and economic systems potentially disrupted, and political institutions stressed."
- 1985:** A conference sponsored by the United Nations Environment Program (UNEP), the World Meteorological Organization (WMO), and the International Council of Scientific Unions forges a consensus of the international scientific community on the issue of climate change. The conference report warns that some future warming appears inevitable due to past emissions regardless of future actions and recommends consideration of a global treaty to address climatic change. Atmospheric CO₂ concentrations recorded at Mauna Loa Observatory show steady increase averaging more than 1 ppm/year since Keeling's measurements began.
- 1987:** An ice core from Antarctica analyzed by French and Russian scientists reveals an extremely close correlation between CO₂ and temperature going back more than 100,000 years.
- 1988:** The Intergovernmental Panel on Climate Change (IPCC), made up of leading climate scientists from around the world, is established by UNEP and WMO to assess the scientific and economic basis of climate change policy in preparation for the 1992 Rio Earth Summit.
- 1990:** An appeal signed by 49 Nobel prize winners and 700 members of the NAS states, "There is broad agreement within the scientific community that amplification of the Earth's natural greenhouse effect by the buildup of various gases introduced by human activity has the potential to produce dramatic changes in climate ... Only by taking action now can we insure that future generations will not be put at risk."

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- 1990:** The scientific working group of the IPCC, drawing on 170 scientists from 25 countries, publishes a report stating that human activity increasing greenhouse gas emissions "will enhance the greenhouse effect, resulting on average in an additional warming of the Earth's surface." It calculates that an immediate 60% reduction in CO₂ emissions would stop the buildup of carbon dioxide.
- 747 participants from 116 countries take part in the Second World Climate Conference. The conference statement reports that "a clear scientific consensus has emerged on estimates of the range of global warming which can be expected during the 21st century. If the increase of greenhouse gas concentrations is not limited, the predicted climate change would place stresses on natural and social systems unprecedented in the past 10,000 years."
- 1991:** Mt. Pinatubo, a Philippine volcano, erupts, temporarily interrupting the increase in surface temperatures.
- 1992:** The NAS publishes a study reporting that despite uncertainties, greenhouse warming poses a potential threat, "sufficient to merit prompt responses ... Investment in mitigation measures act as insurance protection against the great uncertainties and the possibility of dramatic surprises. In addition, the panel believes that substantial mitigation can be accomplished at modest cost. In other words, insurance is cheap."
- A supplementary IPCC report updating its 1990 study finds that new research confirms the general conclusions of its earlier study. However, the report notes that reflection of sunlight by particulates may be offsetting some greenhouse warming in the Northern hemisphere.
- The United Nations Framework Convention on Climate Change is signed by 155 nations at the Rio Earth Summit. The Framework Convention's stated objective is "stabilization of atmospheric concentrations of greenhouse gases at a level that would prevent dangerous anthropogenic interference with the climate system."
- 1993:** The United Nations Framework Convention on Climate Change is ratified by more than 50 nations, putting it into effect.
- 1994:** Mt. Pinatubo's cooling effect wanes, and Earth's temperature returns to high readings characteristic of the late 1980's; March through December 1994 are the warmest such period on record, according to the National Weather Service's Climate Analysis Center.
- 1995:** The Intergovernmental Panel on Climate Change, representing the consensus of climate scientists worldwide, concludes that "... the balance of evidence suggests that there is a discernible human influence on global climate." The year 1995 matches 1990 as the hottest year on record.
- 1997:** More than 160 nations, Parties to the Framework Convention on Climate Change, adopt the Kyoto Protocol, with legally binding obligations to limit emissions of industrialized nations for the years 2008-2012. The Protocol's emissions targets are hailed as important first steps toward the Framework Convention's objective of avoiding dangerous climate change, and as necessary if warming is to be limited to between 1°C-2°C (1.8°F-3.8°F).
- 1998:** The year is the warmest of the last century based on thermometer data and the warmest of the last millennium based on proxy temperature data.
- 1999:** New York City has its hottest July on record.
- 2000:** Nations meeting in The Hague, Netherlands fail to reach agreement on the implementation rules that are prerequisites for most industrialized nations' ratification of the Kyoto Protocol. Atmospheric concentrations of CO₂ measured at Mauna Loa reach 368.37 ppm, their highest level in 420,000 years.
- 2001:** The IPCC issues its Third Assessment Report stating that "There is new and stronger evidence that most of the warming observed over the last 50 years is attributable to human activities.". The IPCC points out a number of features of the climate system in addition to warming (like intensity of rainstorms) that have already changed, and estimates that warming of the coming century will reach 1.4°C-5.8°C (2.5°F-10.4°F) if emissions are not limited. IPCC finds that even warming of between 1°C-2°C (1.8°F-3.8°F) is likely to pose high risks to unique and threatened ecosystems, and to lead to increases in the risk of extreme climate events.
- The U.S. National Academy of Sciences, at the request of President George W. Bush, issues a report analyzing climate science. NAS finds that "temperatures are in fact rising. The changes observed over the last several decades are likely mostly due to human activities." NAS reports that IPCC's findings are "robust" and its work is "admirable."

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- 2001** The United States Global Change Research Program releases the findings of The National Assessment of the Potential Consequences of Climate Variability and Change. The assessment finds that temperatures in the U.S. will rise by 3-5°C (5-9°F) over the next century, and predicts increases in both very wet (flooding) and very dry (drought) conditions. Many ecosystems, including alpine, wetland, forests and coastal areas, are vulnerable to climate change. Water supply for human consumption and irrigation is at risk due to increased probability of drought, reduced snowpacks because of warmer temperatures, and increased risk of flooding. Human infrastructure along our nation's coast are at risk to increased damage from sea level rise and storm surges.
- President George W. Bush declares scientific uncertainty too great to justify Kyoto Protocol's targets.
- 2002:** 2002 is the second hottest year on record, following 1998.
- Heavy rains cause disastrous floods in Central Europe leading to over 100 deaths and more than \$30 billion in damage. Extreme drought in many parts of the world (including Africa, India, Australia and the U.S.) results in thousands of deaths and significant crop damage.
- The European Union, Canada and Japan ratify the Kyoto Protocol on climate change, bringing the agreement's total membership to over 100. The U.S. and Australia refuse to sign the Protocol, stating that it will harm their economies.
- President Bush calls for ten more years of research on climate change to clear up remaining uncertainties, and proposes only voluntary measures to mitigate climate change until 2012.
- 2003:** Senators John McCain and Joe Lieberman introduce a bipartisan bill to reduce emissions of greenhouse gases nationwide via a greenhouse gas emission cap and trade program.

More to come . . .

For more information go to www.environmentaldefense.org/go/globalwarming