Kyoto Protocol

international treaty, 1997

Also known as: Kyoto Protocol to the United Nations Framework Convention on Climate Change

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In full: Kyoto Protocol to the United Nations Framework Convention on Climate Change

Date: December 1997

Context: Paris Agreement

Key People: Jack Layton • Stéphane Dion

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Kyoto Protocol, international treaty, named for the Japanese city in which it was adopted in December 1997, that aimed to reduce the emission of gases that contribute to global warming. In force since 2005, the protocol called for reducing the emission of six greenhouse gases in 41 countries plus the European Union to 5.2 percent below 1990 levels during the “commitment period” 2008–12. It was widely hailed as the most significant environmental treaty ever negotiated, though some critics questioned its effectiveness.

Background and provisions

The Kyoto Protocol was adopted as the first addition to the United Nations Framework Convention on Climate Change (UNFCCC), an international treaty that committed its signatories to develop national programs to reduce their emissions of greenhouse gases. Greenhouse gases, such as carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), perfluorocarbons (PFCs), hydrofluorocarbons (HFCs), and sulfur hexafluoride (SF_6), affect the energy balance of the global atmosphere in ways expected to lead to an overall increase in global average temperature, known as global warming (*see also* greenhouse effect). According to the Intergovernmental Panel on Climate Change, established by the United Nations Environment Programme and the World Meteorological Organization in 1988, the long-term effects of global warming would include a general rise in sea level around the world, resulting in the inundation of low-lying coastal areas and the possible disappearance of some island states; the melting of glaciers, sea ice, and Arctic permafrost; an increase in the number of extreme climate-

related events, such as floods and droughts, and changes in their distribution; and an increased risk of extinction for 20 to 30 percent of all plant and animal species. The Kyoto Protocol committed most of the Annex I signatories to the UNFCCC (consisting of members of the Organisation for Economic Co-operation and Development and several countries with "economies in transition") to mandatory emission-reduction targets, which varied depending on the unique circumstances of each country. Other signatories to the UNFCCC and the protocol, consisting mostly of developing countries, were not required to restrict their emissions. The protocol entered into force in February 2005, 90 days after being ratified by at least 55 Annex I signatories that together accounted for at least 55 percent of total carbon dioxide emissions in 1990.

The protocol provided several means for countries to reach their targets. One approach was to make use of natural processes, called "sinks," that remove greenhouse gases from the atmosphere. The planting of trees, which take up carbon dioxide from the air, would be an example. Another approach was the international program called the Clean Development Mechanism (CDM), which encouraged developed countries to invest in technology and infrastructure in less-developed countries, where there were often significant opportunities to reduce emissions. Under the CDM, the investing country could claim the effective reduction in emissions as a credit toward meeting its obligations under the protocol. An example would be an investment in a clean-burning natural gas power plant to replace a proposed coal-fired plant. A third approach was emissions trading, which allowed participating countries to buy and sell emissions rights and thereby placed an economic value on greenhouse gas emissions. European countries initiated an emissions-trading market as a mechanism to work toward meeting their commitments under the Kyoto Protocol. Countries that failed to meet their emissions targets would be required to make up the difference between their targeted and actual emissions, plus a penalty amount of 30 percent, in the subsequent commitment period, beginning in 2012; they would also be prevented from engaging in emissions trading until they were judged to be in compliance with the protocol. The emission targets for commitment periods after 2012 were to be established in future protocols.

Challenges

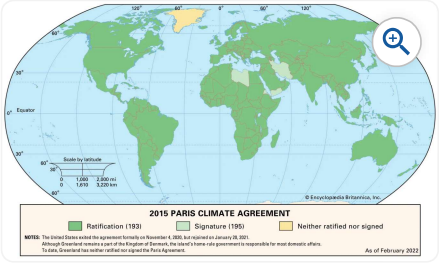
Although the Kyoto Protocol represented a landmark diplomatic accomplishment, its success was far from assured. Indeed, reports issued in the first two years after the treaty took effect indicated that most participants would fail to meet their emission targets. Even if the targets were met, however, the ultimate benefit to the environment would not be significant, according to some critics, since China, the world's leading emitter of greenhouse gases, and the United States, the world's second largest emitter, were not bound by the protocol (China because of its status as a developing country and the United States because it had not ratified the protocol). Other critics claimed that the emission reductions called for in the protocol were too modest to make a detectable difference in global temperatures in the subsequent several decades, even if fully achieved with U.S. participation. Meanwhile, some developing countries argued that improving adaptation to climate variability and change was just as important as reducing greenhouse gas emissions.

Treaty extension and replacement

At the 18th Conference of the Parties (COP18), held in Doha, Qatar, in 2012, delegates agreed to extend the Kyoto Protocol until 2020. They also reaffirmed their pledge from COP17, which had been held in Durban, South Africa, in 2011, to create a new, comprehensive, legally binding climate treaty by 2015 that would require greenhouse-gas-producing countries—including major carbon emitters not abiding by the Kyoto Protocol (such

as China, India, and the United States)—to limit and reduce their emissions of carbon dioxide and other greenhouse gases. The new treaty, planned for implementation in 2020, would fully replace the Kyoto Protocol.

After a series of conferences mired in disagreements, delegates at the COP21, held in Paris, France, in 2015, signed a global but nonbinding agreement to limit the increase of the world's average temperature to no more than 2 °C (3.6 °F) above preindustrial levels while at the same time striving to keep this increase to 1.5 °C (2.7 °F) above preindustrial levels. The landmark accord, signed by all 196 signatories of the UNFCCC, effectively replaced the Kyoto Protocol. It also mandated a progress review every five years and the development of a fund containing $100 billion by 2020—which would be replenished annually—to help developing countries adopt non-greenhouse-gas-producing technologies.



Paris Agreement adoption status Each country's adoption status of the Paris Agreement. Convening in Paris in 201...(more)

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This article was most recently revised and updated by John P. Rafferty.

Politics, Law & Government › International Relations

Paris Agreement

international treaty [2015]

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Also known as: COP21, Paris Agreement under the United Nations Framework on Climate Change, Paris Climate Agreement

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Paris Agreement, international treaty, named for the city of Paris, France, in which it was adopted in December 2015, which aimed to reduce the emission of gases that contribute to global warming. The Paris Agreement set out to improve upon and replace the Kyoto Protocol, an earlier international treaty designed to curb the release of

Paris Agreement

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In full: Paris Agreement Under the United Nations Framework Convention on Climate Change

Also called: Paris Climate Agreement or COP21

Date: November 4, 2016

greenhouse gases. It entered into force on November 4, 2016, and has been signed by 195 countries and ratified by 190 as of January 2021.

Location: France • Paris

Context: climate • climate change • global warming

Key People: Barack Obama

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From November 30 to December 11, 2015, France hosted representatives from 196 countries at the United Nations (UN) climate change conference, one of the most important and most ambitious global climate meetings ever assembled. The objective was no less than a binding and universal agreement designed to limit greenhouse gas emissions to levels that would prevent global temperatures from increasing more than 2 °C (3.6 °F) above the temperature benchmark set before the beginning of the Industrial Revolution.

Background

The meeting was part of a process dating back to the 1992 Earth Summit in Rio de Janeiro, Brazil, when countries initially joined the international treaty called the United Nations Framework Convention on Climate Change. Seeing the need to strengthen emission reductions, in 1997, countries adopted the Kyoto Protocol. That protocol legally bound developed countries to emission reduction targets. However, the agreement was widely believed to be ineffective because the world's two top carbon dioxide-emitting countries, China and the United States, chose not to participate. China, a developing country, was not bound by the Kyoto Protocol, and many U.S. government officials used this fact to justify U.S. nonparticipation.

At the 18th Conference of the Parties (COP18), held in Doha, Qatar, in 2012, delegates agreed to extend the Kyoto Protocol until 2020. They also reaffirmed their pledge from COP17, which had been held in Durban, South Africa, in 2011, to create a new, comprehensive, legally binding climate treaty by 2015 that would require all countries—including major carbon emitters not abiding by the Kyoto Protocol—to limit and reduce their emissions of carbon dioxide and other greenhouse gases.

In the lead-up to the Paris meeting, the UN tasked countries to submit plans detailing how they intended to reduce greenhouse gas emissions. Those plans were technically referred to as intended nationally determined contributions (INDCs). By December 10, 2015, 185 countries had submitted measures to limit or reduce their greenhouse gas emissions by 2025 or 2030. The U.S. announced in 2014 its intention to reduce its emissions 26–28 percent below 2005 levels by 2025. To help accomplish that goal, the country's Clean Power Plan was to set limits on existing and planned power plant emissions. China, the country with the largest total greenhouse gas emissions, set its target for the peaking of its carbon dioxide emissions "around 2030 and making best efforts to peak early." Chinese officials also endeavoured to lower carbon dioxide emissions per unit of gross domestic product (GDP) by 60–65 percent from the 2005 level.

India's INDC noted the challenges of eradicating poverty while reducing greenhouse gas emissions. About 24 percent of the global population without access to electricity (304 million) resided in India. Nevertheless, the country planned to "reduce the emissions intensity of its GDP by 33 to 35 percent by 2030" versus the 2005 levels. The country also sought to derive about 40 percent of its electric power from renewable energy sources rather than from fossil fuels by 2030. The INDC noted that the implementation plans would not be affordable from domestic resources: it estimated that at least $2.5 trillion would be needed to accomplish climate-change actions through 2030. India would achieve that goal with the help of technology transfer (the movement of skills and equipment from more-developed countries to less-developed countries [LDCs]) and international

finance, including assistance from the Green Climate Fund (a program designed to assist, through investments in low-emission technologies and climate-resilient development, populations vulnerable to the effects of climate change).

Negotiations and agreement

One of the main sticking points of the negotiations was the issue of transferring funds from developed countries to LDCs, because developed countries did not want to be the only ones paying the costs. Moreover, even if the commitments of the countries were fulfilled, it was unlikely that temperatures would be limited to an increase of 2 °C (3.6 °F). Many countries, especially the island states threatened by rising sea levels, wanted to restrict warming to 1.5 °C (2.7 °F).

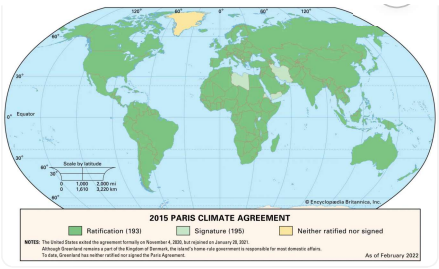
After nearly two weeks of difficult negotiations that sometimes lasted through the night, French Foreign Minister Laurent Fabius, who presided over the talks, announced on December 12 the adoption of the Paris Agreement. He noted that the accord aimed to hold the increase of global temperatures "to well below 2 °C above preindustrial levels and to pursue efforts to limit the temperature increase to 1.5 °C." To achieve this objective, he announced that the parties should "aim to reach global peaking of greenhouse gas emissions as soon as possible…and to undertake rapid reductions thereafter." The goal was to achieve a balance after 2050 between atmospheric inputs of greenhouse gases by emission sources (such as electrical power plants and engines that burn fossil fuels for energy) and removal into sinks (forests, oceans, and soil, which could be combined with technologies to extract and sequester carbon dioxide from power plants). The agreement also recognized the need of LDCs to improve their economies and reduce poverty, which made immediate reductions in greenhouse gas emissions difficult. As a result, it called on developing countries to enhance their mitigation efforts and move toward emission reduction or limitation targets, while it underscored the need for developed countries to continue to meet their emission reduction targets.

The Paris Agreement specified no new funding targets but noted that developed countries should provide financial resources to help LDCs "in continuation of their existing obligations under the Convention," such as the COP16 commitment of $100 billion per year from developed countries by 2020. (Approximately $10.3 billion had been raised by May 2018.) That funding was to support both mitigation and adaptation efforts. Funding from developed countries would come from a number of different mechanisms, presumably to include grants, equipment, and technical expertise.

The text of the Paris Agreement emphasized cooperation, transparency, flexibility, and regular reporting of progress in achieving the INDCs. There was no mechanism to enforce compliance with the accord's provisions, but there was to be one to "promote compliance." That aspect would be achieved via a committee that would function so as to be "transparent, non-adversarial and non-punitive." The committee would report annually to the COP, and each party was asked to update its INDC every five years. The Paris Agreement was open for signature at United Nations headquarters in New York City from April 22, 2016, to April 21, 2017, and entered into force on November 4, 2016, when 55 parties accounting for at least 55 percent of global greenhouse gas emissions had ratified it.

After ratification

By early 2017 the only sovereign countries that had not signed were Nicaragua and Syria, but that year changes in U.S. climate policy made by Pres. Donald Trump resulted in the country's formal exit from the agreement on November 4, 2020. The United States' absence was short-lived, however. On the first day of his term, on January 20, 2021, Pres. Joe Biden reentered the agreement on behalf of the United States, which opened the way for the country's formal reinstatement in February 2021. By January 2021, 195 countries had signed and 190 countries had ratified the agreement.



Paris Agreement adoption status Each country's adoption status of the Paris Agreement. Convening in Paris in 201...(more)

Since the agreement entered into force, progress toward emission targets has been mixed. Chinese authorities announced that they were making great strides in reducing greenhouse gas emissions, noting that China had met its 2020 commitments in 2017. In contrast, European Union officials announced in 2018 that all member states had fallen behind on reaching their targets; Sweden, Portugal, and France had made the most progress, reaching 77 percent, 66 percent, and 65 percent of their 2020 targets by 2018, respectively. U.S. progress was less clear. Some reports noted that changes in U.S. climate policy were keeping the country from meeting its climate goals, whereas others argued that many individual U.S. cities and states had enacted more stringent greenhouse gas regulations that allowed the country as a whole to remain on track.

Despite such reports, a number of international research organizations noted that carbon emissions continued to increase. The Rhodium Group noted that U.S. emissions had increased 3.4 percent in 2018. The Global Carbon Project (GCP) reported that carbon emissions worldwide, which were largely flat from 2014 to 2016, had increased by 1.6 percent and by 2.7 percent in 2017 and 2018, respectively. The Rhodium Group and the GCP also recorded a decline in carbon emissions by nearly 5 percent in 2020 during the COVID-19 pandemic as industrial activity slowed; however, emissions increased by roughly the same amount in 2021 with the pandemic's subsidence and the pace of industrial activity returned to pre-pandemic levels.

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This article was most recently revised and updated by John P. Rafferty

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greenhouse gas

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Also known as: GHG

Written by Michael E. Mann

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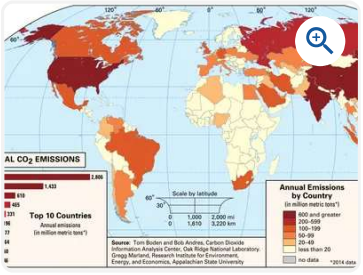

carbon dioxide emissions

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Greenhouse gas, any gas that has the property of absorbing infrared radiation (net heat energy) emitted from Earth's surface and reradiating it back to Earth's surface, thus contributing to the greenhouse effect. Carbon dioxide, methane, and water vapour are the most important greenhouse gases. (To a lesser extent, surface-level ozone, nitrous oxides, and fluorinated gases also trap infrared radiation.) Greenhouse gases have a profound effect on the energy budget of the Earth system despite making up only a fraction of all atmospheric gases. Concentrations of greenhouse gases have varied substantially during Earth's history, and these variations have driven substantial climate changes at a wide range of timescales. In general, greenhouse gas concentrations have been particularly high during warm periods and low during cold periods.

A number of processes influence greenhouse gas concentrations. Some, such as tectonic activities, operate at timescales of millions of years, whereas others, such as vegetation, soil, wetland, and ocean sources and sinks, operate at timescales of hundreds to thousands of years. Human activities—especially fossil-fuel combustion since the Industrial Revolution—are responsible for steady increases in atmospheric concentrations of various greenhouse gases, especially carbon dioxide, methane, ozone, and chlorofluorocarbons (CFCs).

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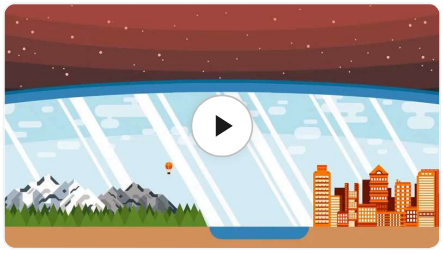
The effect of each greenhouse gas on Earth's climate depends on its chemical nature and its relative concentration in the atmosphere. Some gases have a high capacity for absorbing infrared radiation or occur in significant quantities, whereas others have considerably lower capacities for absorption or occur only in trace amounts. Radiative forcing, as defined by the Intergovernmental Panel on Climate Change (IPCC), is a measure of the influence a given greenhouse gas or other climatic factor (such as solar irradiance or albedo) has on the amount of radiant energy impinging upon Earth's surface. To understand the relative influence of each greenhouse gas, so-called forcing values (given in watts per square metre) calculated for the time period between 1750 and the present day are given below.



Understand how the presence of gas molecules, including greenhouse gases, protect the earth by shielding and.....(more)

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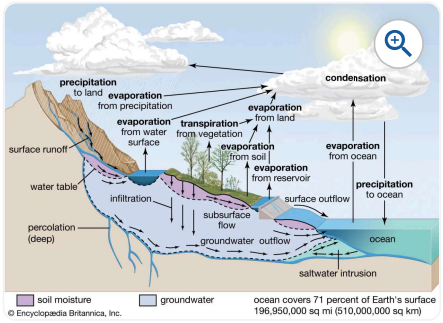
Major greenhouse gases

Water vapour

Water vapour is the most potent greenhouse gas in Earth's atmosphere, but its behaviour is fundamentally different from that of the other greenhouse gases. The primary role of water vapour is not as a direct agent of radiative forcing but rather as a climate feedback—that is, as a response within the climate system that influences the system's continued activity. This distinction arises because the amount of water vapour in the atmosphere cannot, in general, be directly modified by human behaviour but is instead set by air temperatures. The warmer the surface, the greater the evaporation rate of water from the surface. As a result, increased evaporation leads to a greater concentration of water vapour in the lower atmosphere capable of absorbing infrared radiation and emitting it back to the surface.



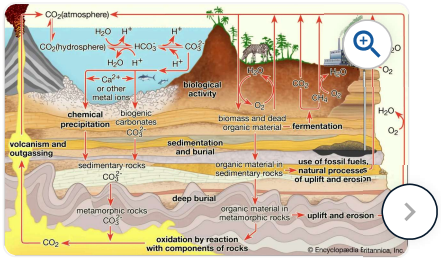
hydrologic cycle This diagram shows how, in the hydrologic cycle, water is transferred between the land surface, the ocean, a...(more)

Carbon dioxide

Britannica Quiz

Pop Quiz: 18 Things to Know About Global Warming

Carbon dioxide (CO_2) is the most significant greenhouse gas. Natural sources of atmospheric CO_2 include outgassing from volcanoes, the combustion and natural decay of organic matter, and respiration by aerobic (oxygen-using) organisms. These sources are balanced, on average, by a set of physical, chemical, or biological processes, called "sinks," that tend to remove CO_2 from the atmosphere. Significant natural sinks include terrestrial vegetation, which takes up CO_2 during photosynthesis.



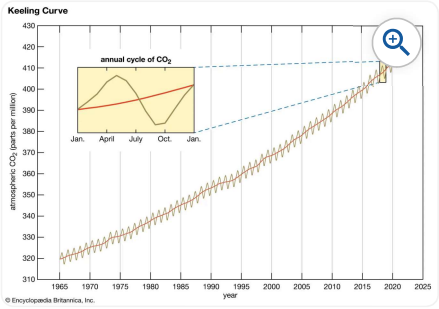
carbon cycle Carbon is transported in various forms through the atmosphere, the hydrosphere, and geologic... ...(more)

A number of oceanic processes also act as carbon sinks. One such process, the "solubility pump," involves the descent of surface seawater containing dissolved CO_2. Another process, the "biological pump," involves the uptake of dissolved CO_2 by marine vegetation and phytoplankton (small, free-floating, photosynthetic organisms) living in the upper ocean or by other marine organisms that use CO_2 to build skeletons and other structures made of calcium carbonate ($CaCO_3$). As these organisms expire and fall to the ocean floor, their carbon is transported downward and eventually buried at depth. A long-term balance between these natural sources and sinks leads to the background, or natural, level of CO_2 in the atmosphere.

In contrast, human activities increase atmospheric CO_2 levels primarily through the burning of fossil fuels (principally oil and coal, and secondarily natural gas, for use in transportation, heating, and electricity production) and through the production of cement. Other anthropogenic sources include the burning of forests and the clearing of land. Anthropogenic emissions currently account for the annual release of about 7 gigatons (7 billion tons) of carbon into the atmosphere. Anthropogenic emissions are equal to approximately 3 percent of the total emissions of CO_2 by natural sources, and this amplified carbon load from human activities far exceeds the offsetting capacity of natural sinks (by perhaps as much as 2–3 gigatons per year).

deforestation Smoldering remains of a plot of deforested land in the Amazon Rainforest of Brazil.

CO_2 has consequently accumulated in the atmosphere at an average rate of 1.4 parts per million (ppm) by volume per year between 1959 and 2006 and roughly 2.0 ppm per year between 2006 and 2018. Overall, this rate of accumulation has been linear (that is, uniform over time). However, certain current sinks, such as the oceans, could become sources in the future. This may lead to a situation in which the concentration of atmospheric CO_2 builds at an exponential rate (that is, at a rate of increase that is also increasing over time).



Keeling Curve The Keeling Curve, named after American climate scientist Charles David Keeling, tracks changes in the.....(more)

The natural background level of carbon dioxide varies on timescales of millions of years due to slow changes in outgassing through volcanic activity. For example, roughly 100 million years ago, during the Cretaceous Period, CO_2 concentrations appear to have been several times higher than today (perhaps close to 2,000 ppm). Over the past 700,000 years, CO_2 concentrations have varied over a far smaller range (between roughly 180 and 300 ppm) in association with the same Earth orbital effects linked to the coming and going of the ice ages of the Pleistocene epoch. By the early 21st century, CO_2 levels reached 384 ppm, which is approximately 37 percent above the natural background level of roughly 280 ppm that existed at the beginning of the Industrial Revolution. Atmospheric CO_2 levels continued to increase, and by 2018 they had reached 410 ppm. According to ice core measurements, such levels are believed to be the highest in at least 800,000 years and, according to other lines of evidence, may be the highest in at least 5,000,000 years.

Radiative forcing caused by carbon dioxide varies in an approximately logarithmic fashion with the concentration of that gas in the atmosphere. The logarithmic relationship occurs as the result of a saturation effect wherein it becomes increasingly difficult, as CO_2 concentrations increase, for additional CO_2 molecules to further influence the “infrared window” (a certain narrow band of wavelengths in the infrared region that is not absorbed by atmospheric gases). The logarithmic relationship predicts that the surface warming potential will rise by roughly the same amount for each doubling of CO_2 concentration. At current rates of fossil-fuel use, a doubling of CO_2 concentrations over preindustrial levels is expected to take place by the middle of the 21st century (when CO_2 concentrations are projected to reach 560 ppm). A doubling of CO_2 concentrations would represent an increase of roughly 4 watts per square metre of radiative forcing. Given typical estimates of “climate sensitivity” in the absence of any offsetting factors, this energy increase would lead to a warming of 2 to

5 °C (3.6 to 9 °F) over preindustrial times. The total radiative forcing by anthropogenic CO_2 emissions since the beginning of the industrial age is approximately 1.66 watts per square metre.