Atmospheric greenhouse gas concentrations

Concentrations of greenhouse gases in the atmosphere have risen over time. Levels are expected to remain high for many generations.

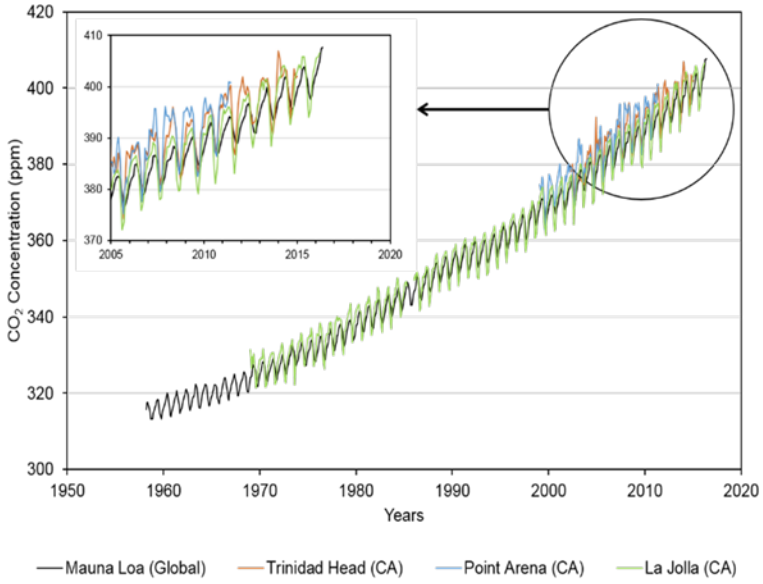
Rising global temperatures are directly linked to increased concentrations of greenhouse gases in the atmosphere. These gases warm the Earth's surface by trapping heat. Most of the increase in their atmospheric levels comes from human activities, particularly the burning of fossil fuels. Other sources include landfills, water treatment facilities and livestock operations.

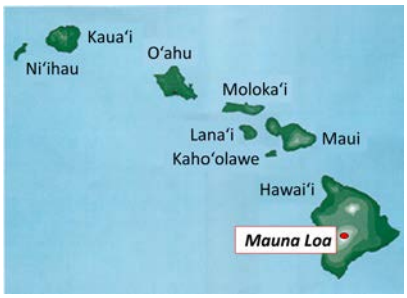
The Earth has warmed at an unprecedented rate since the Industrial Revolution. At that time, the global background concentration of carbon dioxide (CO_2) was estimated to be less than 280 parts per million (ppm). Since then, levels of CO_2 in the atmosphere increased markedly with the burning of fossil fuels and biomass, and with deforestation and other land use changes. Scientists have determined that stabilizing atmospheric greenhouse gas concentrations is necessary to reduce the likelihood of catastrophic climate change. In 2015, the international community adopted the Paris Agreement, which aims to limit global warming to well below two degrees Celsius (°C) above pre-industrial levels and to pursue efforts to further limit this increase to 1.5°C.

What does the indicator show?

Since measurements first started at Mauna Loa, Hawaii, atmospheric levels of CO_2 have risen from 315 ppm in 1958 to over 400 ppm today. Concentrations are expected to stay above 400 ppm for many generations, because CO_2 can remain in the atmosphere for hundreds of years. CO_2 is a long-lived greenhouse gas responsible for roughly 65 percent of the total warming effect caused by greenhouse gases globally.

Monthly average atmospheric carbon dioxide concentrations





Mauna Loa, Hawaii, provides the longest continuous measurements of global atmospheric CO_2 levels. CO_2 mixes well in the atmosphere, so measurements at remote sites such as Mauna Loa represent global CO_2 levels. Measurements at California coastal sites are consistent with those at Mauna Loa.

Map adapted from Hawaii.gov

Sources: NOAA 2016; Conway et al. 2011(Mauna Loa, Point Arena, and Trinidad Head); Scripps Institution of Oceanography 2012 (La Jolla)

Why is this indicator important?

The link between greenhouse gases in the atmosphere and warming temperatures is clear. CO_2 is continuously exchanged between the land, the air, and the ocean. While more than half of emitted CO_2 is removed from the atmosphere through natural processes within a century, about 20 percent remains in the atmosphere for many millennia. Atmospheric CO_2 levels will thus continue to increase even if carbon emissions are substantially reduced from present levels.

As levels of CO_2 increase in the atmosphere, so do levels in the ocean. The ocean absorbs about one third of CO_2 emitted by human activities. This absorption has slowed the rate of global warming. However, because CO_2 forms a weak acid in water, the large amounts of CO_2 absorbed by the ocean have increased the acidity of seawater. This process, called "ocean acidification," can have major effects on marine life.

Concentrations of other greenhouse gases have also risen globally. Some of these gases, specifically methane and certain fluorinated gases, are considered short-lived climate pollutants. They remain in the atmosphere for shorter periods of time than CO_2 but are more powerful warming agents. Reducing concentrations of these short-lived climate pollutants can have more immediate effects in slowing the rate of warming.

Tracking greenhouse gas concentrations provides a better understanding of what happens to emissions, and the role of plants, soils and oceans in reducing atmospheric levels. These data are needed to develop projections for future climate change under various emission scenarios, and to set targets for reducing emissions.

About 20 percent of CO_2 emissions remains in the atmosphere for thousands of years.

Photo: NASA

For more information about this and other climate change indicators, visit:
https://oehha.ca.gov/climate-change/report/2018-report-indicators-climate-change-california