

# The Top Five Climate-Changing Gases

Since the industrial revolution, humans have been changing the atmosphere. Agricultural, industrial, and other activities have increased the concentrations of heat-trapping “greenhouse” gases such as carbon dioxide, methane, nitrous oxide, low-level “tropospheric” ozone, and halogenated carbon compounds. These gases now affect the climate.

## The Top Five Climate-Changing Gases

Heat-Trapping Gas	Radiative Forcing (W/m <sup>2</sup> )
Carbon dioxide (CO <sub>2</sub> )	+1.66
Methane (CH <sub>4</sub> )	+0.48
Low-level ozone (O <sub>3</sub> )	+0.35
Halogenated carbons	+0.34
Nitrous oxide (N <sub>2</sub> O)	+0.16

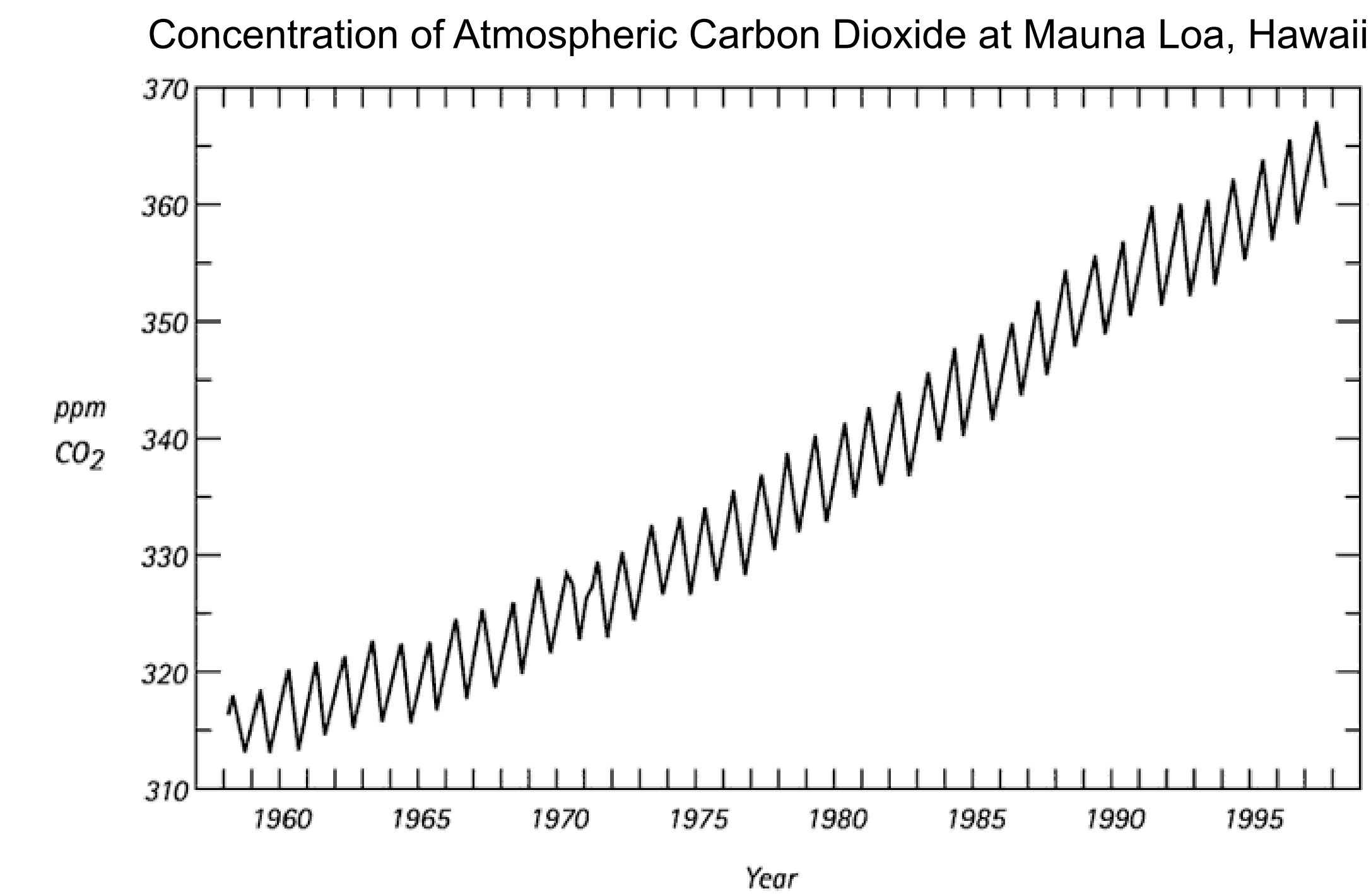


### What is radiative forcing?



- A measure of how strongly the human-caused emissions of a gas are affecting the global average temperature.
- It is measured in watts per square meter or W/m<sup>2</sup>.
- Positive forcings cause warming, and negative forcings cause cooling.
- Because humans don't directly affect water vapor concentrations, this abundant greenhouse gas is not contributing to climate change.

## Carbon dioxide (CO<sub>2</sub>)



Because we release so much of it, **carbon dioxide** is, by far, the most important greenhouse gas. It has a number of human sources, but the major ones are fossil fuel burning power plants (shown above) and deforestation.

The “Keeling Curve” shows that the concentration of CO<sub>2</sub> in air has increased since 1958. Human sources cause the long-term increase. The smaller annual cycles are caused by seasonal patterns of plant growth in the Northern Hemisphere. Atmospheric CO<sub>2</sub> has risen ~35% in 150 years, and is now rising faster than ever.

## Low-level ozone (O<sub>3</sub>)



**Low-level or “tropospheric” ozone** can be produced from chemical reactions between car exhaust pollutants such as carbon monoxide (CO) and nitrogen oxides (NO<sub>x</sub>). Unlike “the ozone layer”, tropospheric ozone is found close to the earth’s surface, and is harmful to health.

## Halogenated carbons



**Halogenated carbons** are carbon compounds with *halogen atoms* (fluorine, chlorine, etc.) like chlorofluorocarbons (CFCs) or carbon tetrachloride (CCl<sub>4</sub>). These halogenated compounds are used in refrigerators and car air conditioners.

## Methane (CH<sub>4</sub>)



Besides rice fields, another major source of **methane** is *ruminants* (hoofed animals with multiple stomachs like cattle, shown above, and sheep). Methane is released during digestion and from their manure.

## Nitrous oxide (N<sub>2</sub>O)



A large proportion of human-produced **nitrous oxide** comes from agricultural soils that use large amounts of nitrogen-based fertilizers (shown above), and from cattle waste in feedlots.