# What is Global Warming?

Global warming is the slow increase in the average temperature of the earth's atmosphere because an increased amount of the energy (heat) striking the earth from the sun is being trapped in the atmosphere and not radiated out into space.

The earth's atmosphere has always acted like a greenhouse to capture the sun's heat, ensuring that the earth has enjoyed temperatures that permitted the emergence of life forms as we know them, including humans.

Without our atmospheric greenhouse the earth would be very cold. Global warming, however, is the equivalent of a greenhouse with high efficiency reflective glass installed the wrong way around.

Ionically, the best evidence of this may come from a terrible cooling event that took place some 1,500 years ago. Two massive volcanic eruptions, one year after another placed so much black dust into the upper atmosphere that little sunlight could penetrate. Temperatures plummeted. Crops failed. People died of starvation and the Black Death started its march. As the dust slowly fell to earth, the sun was again able to warn the world and life returned to normal.
Today, we have the opposite problem. Today, the problem is not that too little sun warmth is reaching the earth, but that too much is being trapped in our atmosphere.
So much heat is being kept inside greenhouse earth that the temperature of the earth is going up faster than at any previous time in history. NASA provides an excellent course module on the science of global warming.

**How does global warming drive climate change**

Heat is energy and when you add energy to any system changes occur.

Because all systems in the global climate system are connected, adding heat energy causes the global climate as a whole to change.

Much of the world is covered with ocean which heats up. When the ocean heats up, more water evaporates into clouds.

Where storms like hurricanes and typhoons are forming, the result is more energy-intensive storms. A warmer atmosphere makes glaciers and mountain snow packs, the Polar ice cap, and the great ice shield jutting off of Antarctica melt raising sea levels.

Changes in temperature change the great patterns of wind that bring the monsoons in Asia and rain and snow around the world, making drought and unpredictable weather more common.

This is why scientists have stopped focusing just on global warming and now focus on the larger topic of climate change.

## What Causes Global Warming?

There are three positions on global warming: (1) that global warming is not occurring and so neither is climate change; (2) that global warming and climate change are occurring, but these are natural, cyclic events unrelated to human activity; and (3) that global warming is occurring as a result primarily of human activity and so climate change is also the result of human activity.
The claim that nothing is happening is very hard to defend in the face or masses of visual, land-based and satellite data that clearly shows rising average sea and land temperatures and shrinking ice masses.
The claim that the observed global warming is natural or at least not the result of human carbon emissions (see Climate Skeptics below) focuses on data that shows that world temperatures and atmospheric CO2 levels have been equally high or higher in the past. They also point to the well understood effects of solar activity on the amount of radiation striking the earth and the fact that in recent times the sun has been particularly active.
In general, climate scientists and environmentalists either (1) dispute the data based on, for example, new ice core data or (2) suggest that the timing issue – that is, the rapidity with which the globe has warmed and the climate changed simply do not fit the model of previous natural events. They note also that compared to

other stars the sun is actually very stable, varying in energy output by just 0.1% and over a relatively short cycle of 11 to 50 years quite unrelated to global warming as a whole. The data strongly suggests that solar activity affects the global climate in many important ways, but is not a factor in the systemic change over time that we call global warming.
As for the final position that global warming and climate change result from human activity (are "anthropogenic"), scientists attribute current atmospheric warming to human activities that have increased the amount of carbon containing gases in the upper atmosphere and to increased amounts of tiny particles in the lower atmosphere. (NASA offers a good course module on "The Carbon Question.")

Specifically, gases released primarily by the burning of fossil fuels and the tiny particles produced by incomplete burning trap the sun's energy in the atmosphere. Scientists call these gases "greenhouse gases" (GHGs) because they act like the wrong way reflective glass in our global greenhouse.

Scientists call the tiny particles 'black carbon' (you call it soot or smoke) and attribute their warming effect to the fact that the resulting layer of black particles in the lower atmosphere absorbs heat like a black blanket.

Scientists date the beginning of the current warming trend to the end of the 18th or beginning of the 19th century when coal first came into common use.

This warming trend has accelerated as we have increased our use of fossil fuels to include gasoline, diesel, kerosene and natural gas, as well as the petrochemicals (plastics, pharmaceuticals, fertilizers) we now make from oil.

Scientists attribute the current warming trend to the use of fossil fuels because using them releases into the atmosphere stores of carbon that were sequestered (buried) millions of years ago.

The addition of this "old" carbon to the world's current stock of carbon, scientists have concluded, is what is heating our earth which causes global warming.

# What are the most important greenhouse gases(GHGs)?

The most common and most talked about greenhouse gases is CO2 or carbon dioxide. In fact, because it is so common, scientists use it as the benchmark or measure of things that warm the atmosphere.

Methane, another important GHG, for example, is 28-36 times as warming as CO2 when in the upper atmosphere (USEPA GWP – Global Warming Potential – estimate over 100 years), therefore, 1 ton of methane = 28-36 tons eCO2 or CO2 equivalents.

The most commonly discussed GHGs are:

- CO2 or ~~carbon dioxide~~ is produced any time something is burned. It is the most common GHG, constituting by some measures almost 55% of total long-term GHGs. It is used as a marker by the United States Environmental Protection Agency, for example, because of its ubiquity. Carbon dioxide is assigned a GWP or Global Warming Potential of 1.

- Methane or CH4 is produced in many combustion processes and also by anaerobic decomposition, for example, in flooded rice paddies, pig and cow stomachs, and pig manure ponds. Methane breaks down in approximately 10 years, but is a precursor of ozone, itself an important GHG. CH4 has a GWP of 28-36.

- Nitrous oxide in parean (laughing gas), NO/N2O or simply NOx is a byproduct of fertilizer production and use, other industrial processes and the combustion of certain materials. Nitrous oxide lasts a very long time in the atmosphere, but at the 100 year point of comparison to CO2, its GWP is 265-298.

    - Fluorinated gases were created as replacements for ozone depleting refrigerants, but have proved to be both extremely long lasting and extremely warming GHGs. They have no natural sources, but are entirely man-made. At the 100 year point of comparison, their GWPs range from 1,800 to 8,000 and some variants top 10,000.

- Sulphur hexafluoride or SF6 is used for specialized medical procedures, but primarily in what are called dielectric materials, especially dielectric liquids. These are used as insulators in high voltage applications such as transformers and grid switching gear. SF6 will last thousands of years in the upper atmosphere and has a GWP of 22,800.

## What is black carbon and how does it cause global warming?

Black carbon (BC) is tiny particles of carbon released as a result of the incomplete combustion of fossil fuels, biofuels and biomass. These particles are extremely small, ranging from 10 μm (micrometers, PM10), the size of a single bacterium to less than 2.5 μm (PM2.5), one thirtieth the width of a human hair and small enough to pass through the walls of the human lung and into the bloodstream.

Although BC – think of the plume of smoke from a chimney or a fire – falls out of the lower atmosphere in days, while it is suspended in the air, it absorbs the sun's heat millions of times more effectively than CO2. When wind carries BC over snow, glaciers or ice caps where it falls out onto the white, normally reflective surface, it is particularly damaging because it contributes directly to melting. Overall, BC is considered the second biggest contributor to global warming after CO2.

# What are the most important sources of GHGs and black carbon?

Fossil fuel and related uses of coal and petroleum are the most important sources of GHGs and black carbon (power generation, industry, transportation, buildings).

Agriculture is the second most important source (animals – cows and pigs), feed production, chemical intensive food production, and flooded paddy rice production, as well as deforestation driven by the desire to expand cultivated

(New studies suggest that agriculture is the largest contributor of particulate emissions in the US and other developed agricultural countries.)

Natural sources of GHGs and black carbon include forest fires, savanna fires and volcanos.

## How You Can Stop Global Warming

### Healing the planet starts in your garage, in your kitchen, and at your dining-room table.

Nations around the world are upping their game in the fight against climate change, even as President Trump recently announced the U.S.'s withdrawal from the Paris Agreement. And despite this reckless move, American mayors, state leaders, county officials, governors, major companies, and millions of citizens across our country have pledged that they're "still in" when it comes to the agreement, and supporting the goal of limiting future warming to well below 2 degrees Celsius.

Even better, a new initiative by former New York City mayor Michael Bloomberg gives the urban layer of this movement a boost. He’s asked

mayors from the 100 most populous cities in the country to share their plans for making their buildings and transportation systems run cleaner and more efficiently. The 20 that show the greatest potential for cutting the dangerous carbon pollution that's driving climate change will share a total of $70 million in technical assistance funding provided by Bloomberg Philanthropies and partners.

It's important to remember the equally vital contributions that can be made by private citizens—which is to say, by you. "Change only happens when individuals take action," Aliya Haq, deputy director of NRDC's Clean Power Plan initiative, says. "There's no other way, if it doesn't start with people."

The goal is simple. Carbon dioxide is the climate's worst enemy. It's released when oil, coal, and other fossil fuels are burned for energy—the energy we use to power our homes, cars, and smartphones. By using less of it, we can curb our own contribution to climate change while also saving money. Here are a dozen easy, effective ways each one of us can make a difference:

*1. Speak up!*

What's the single biggest way you can make an impact on global climate change? "Talk to your friends and family, and make sure your representatives are making good decisions," Haq says. By voicing your concerns—via social media or, better yet, directly to your elected officials—you send a message that you care about the warming world. Encourage Congress to enact new laws that limit carbon emissions and require polluters to pay for the emissions they produce.

*2. Power your home with renewable energy.*

Choose a utility company that generates at least half its power from wind or solar and has been certified by Green-e Energy, an organization that vets renewable energy options. If that isn't possible for you, take a look at your electric bill; many utilities now list other ways to support renewable sources on their monthly statements and websites.

*3. Weatherize, weatherize, weatherize.*

"Building heating and cooling are among the biggest uses of energy," Haq says. Indeed, heating and air-conditioning account for almost half of home energy use. You can make your space more energy efficient by sealing drafts and ensuring it's adequately insulated. You can also claim federal tax credits for many energy-efficiency home improvements.

*4. Invest in energy-efficient appliances.*

Since they were first implemented nationally in 1987, efficiency standards for dozens of appliances and products have kept 2.3 billion tons of carbon dioxide out of the air. That's about the same amount as the annual carbon pollution coughed up by nearly 440 million cars. "Energy efficiency is the lowest-cost way to reduce emissions," Haq says. When shopping for refrigerators, washing machines, and other appliances, look for the Energy Star label. It will tell you which are the most efficient.

*5. Reduce water waste.*

Saving water reduces carbon pollution, too. That's because it takes a lot of energy to pump, heat, and treat your water. So take shorter showers, turn off the tap while brushing your teeth, and switch to WaterSense-labeled fixtures and appliances. The EPA estimates that if just one out of every 100

American homes were retrofitted with water-efficient fixtures, about 100 million kilowatt-hours of electricity per year would be saved—avoiding 80,000 tons of global warming pollution.

*6. Actually eat the food you buy—and make less of it meat.*

Approximately 10 percent of U.S. energy use goes into growing, processing, packaging, and shipping food—about 40 percent of which just winds up in the landfill. "If you're wasting less food, you're likely cutting down on energy consumption," Haq says. And since livestock products are among the most resource-intensive to produce, eating meat-free meals can make a big difference, too.

*7. Buy better bulbs.*

LED lightbulbs use up to 80 percent less energy than conventional incandescents. They're also cheaper in the long run: A 10-watt LED that replaces your traditional 60-watt bulb will save you $125 over the lightbulb's life.

*8. Pull the plug(s).*

Taken together, the outlets in your home are likely powering about 65 different devices—an average load for a home in the U.S. Audio and video devices, cordless vacuums and power tools, and other electronics use energy even when they're not charging. This "idle load" across all U.S. households adds up to the output of 50 large power plants in the U.S. So don't leave fully charged devices plugged into your home's outlets, unplug rarely used devices or plug them into power strips and timers, and adjust your computers and monitors to automatically power down to the lowest power mode when not in use.

*9. Drive a fuel-efficient vehicle.*

Gas-smart cars, such as hybrids and fully electric vehicles, save fuel and money. And once all cars and light trucks meet 2025's clean car standards, which means averaging 54.5 miles per gallon, they'll be a mainstay. For good reason: Relative to a national fleet of vehicles that averaged only 28.3 miles per gallon in 2011, Americans will spend $80 billion less at the pump each year and cut their automotive emissions by half. Before you buy a new set of wheels, compare fuel-economy performance here.

*10. Maintain your ride.*

If all Americans kept their tires properly inflated, we could save 1.2 billion gallons of gas each year. A simple tune-up can boost miles per gallon anywhere from 4 percent to 40 percent, and a new air filter can get you a 10 percent boost.

*11. Rethink planes, trains, and automobiles.*

Choosing to live in walkable smart-growth cities and towns with quality public transportation leads to less driving, less money spent on fuel, and less pollution in the air. Less frequent flying can make a big difference, too. "Air transport is a major source of climate pollution," Haq says. "If you can take a train instead, do that."

*12. Shrink your carbon profile.*

You can offset the carbon you produce by purchasing carbon offsets, which represent clean power that you can add to the nation's energy grid in place of power from fossil fuels. But not all carbon offset companies are alike. Do your homework to find the best supplier.

*Ways to Stop Global Warming*

# Want to help stop global warming? Here are 10 simple things you can do and how much carbon dioxide you'll save doing them

**Change a light**
Replacing one regular light bulb with a compact fluorescent light bulb will save 150 pounds of carbon dioxide a year.

**Drive less**
Walk, bike, carpool or take mass transit more often. You'll save one pound of carbon dioxide for every mile you don't drive!

**Recycle more**
You can save 2,400 pounds of carbon dioxide per year by recycling just half of your household waste.

**Check your tires**
Keeping your tires inflated properly can improve your gas mileage by more than 3 percent. Every gallon of gasoline saved keeps 20 pounds of carbon dioxide out of the atmosphere.

**Use less hot water**
It takes a lot of energy to heat water. Use less hot water by taking shorter and cooler showers and washing your clothes in cold or warm instead of hot water (more than 500 pounds of carbon dioxide saved per year).

**Avoid products with a lot of packaging**
You can save 1,200 pounds of carbon dioxide if you reduce your garbage by 10 percent.

**Adjust your thermostat**
Moving your thermostat down just 2 degrees in winter and up 2 degrees in summer could save about 2,000 pounds of carbon dioxide a year.

**Plant a tree**
A single tree will absorb one ton of carbon dioxide over its lifetime.

**Turn off electronic devices**
Simply turning off your television, DVD player, stereo, and computer, when you're not using them, will save you thousands of pounds of carbon dioxide a year.