

THE SCIENCE BEHIND CLIMATE CHANGE



What is climate change? How does it work? Why is this important?

What is climate change?

The Earth's atmosphere is full of greenhouse gas molecules (such as carbon, water vapor, methane, ozone, and nitrous oxide) that absorb and re-emit energy, warming the Earth. Without this process, called the *Greenhouse Effect*, the earth would be far too cold to be habitable! When humans add greenhouse gases to the atmosphere, more molecules absorb and re-emit more energy towards the Earth, warming it further.

Climate change is the long-term shift in weather patterns resulting from human emissions of greenhouse gases into the atmosphere.

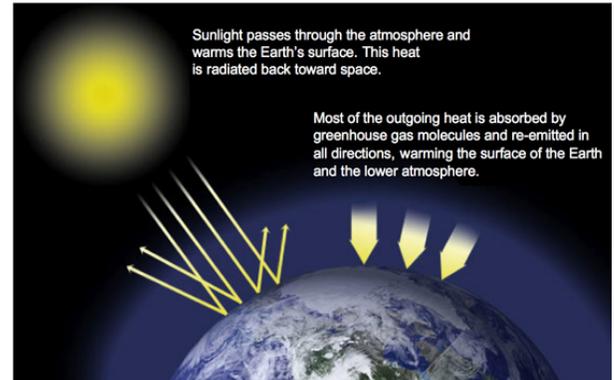


Figure 1 Earth's greenhouse effect

The Scientific Process

The sun emits energy in the form of shortwave radiation. This radiation moves through our atmosphere, not reacting with greenhouse gases, before hitting and warming the Earth. The Earth emits longwave radiation, which greenhouse gases absorb and re-emit in all directions, warming the Earth and the lower atmosphere further (figure 1).

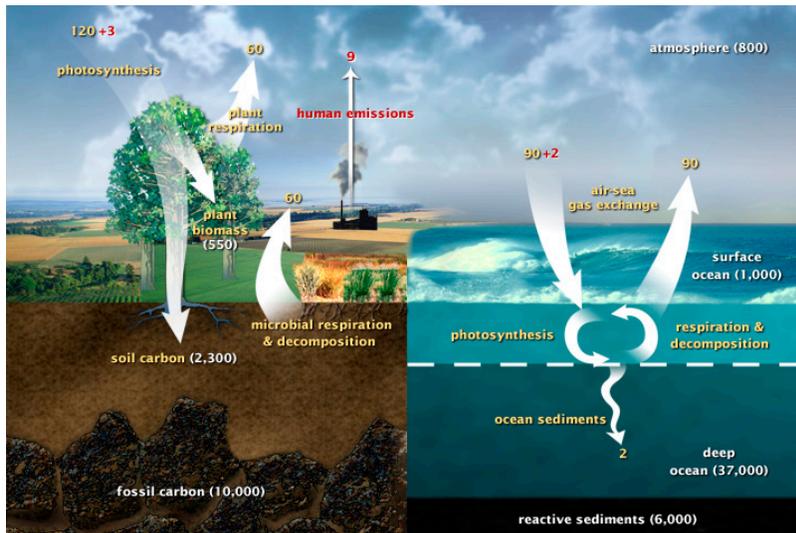


Figure 2 Sources and movement of carbon. Yellow indicates natural fluxes, white indicates stored carbon, and red indicates human contributions. Numbers are in gigatons of carbon per year.

Carbon is the 4th most common element in the universe, and the biggest human contributor to climate change¹. It is stored in plants and animals, soil, the ocean, the atmosphere, and fossilized plants and animals (which make up fossil fuels). The **carbon cycle** describes the movement of this carbon from one form to another. You can see the most significant contributors to the carbon cycle in figure 2².

¹ <http://earthobservatory.nasa.gov/Features/CarbonCycle/page4.php>

² Diagram adapted from U.S. DOE, Biological and Environmental Research Information System

What does this mean?

Humans contribute carbon to the atmosphere in two main forms, **carbon dioxide** (CO₂) and **methane** (CH₄), at a rate of 9 gigatons per year. This carbon comes from energy supply, agriculture, and deforestation, amongst other things (figure 3)³. Three gigatons of carbon are taken up by plants through photosynthesis and 2 gigatons are absorbed by the ocean, leaving 4 gigatons of carbon in the atmosphere.

Compared to the 800 gigatons already in the atmosphere, that doesn't seem like a lot. So why is it a problem? The additional carbon is holding enough extra heat in the atmosphere to substantially affect the climate. Scientists and governments agree that we need to keep warming below 2°C to prevent serious environmental and social harm, which means only 565 more gigatons of carbon can be emitted⁴. At our current rate of emitting 9 gigatons of carbon emissions per year, it won't be long until we reach that level.

The planet warming has numerous environmental impacts such as intense weather patterns and extreme heat waves, warming ocean water, declining food stocks, sea-level rise, droughts, floods, and loss of species and ecosystems⁵.

Other Considerations

There are many more aspects of climate change worth considering, including its effect on humans. Climate change impacts different people around the world differently. Those living in more susceptible environments are already being greatly impacted, especially those without the financial means to mitigate the problems. For more information on the social impacts of climate change, explore climate justice.

Carbon dioxide in the ocean is increasing the ocean's acidity, while climate change is increasing its temperature. Much of life on Earth depends on the oceans for survival, including humans. For more information on climate change's lesser talked about counterpart, see *The Science Behind Ocean Acidification*.

Climate change is sometimes considered a controversial topic. Many people do not believe it is happening at all, or if it is, that it is human caused. A recent survey of over 4000 peer-reviewed climate science papers demonstrated that 97% of them were in consensus on human-caused global warming⁶. This suggests that the controversy stems from a lack of understanding of the science.

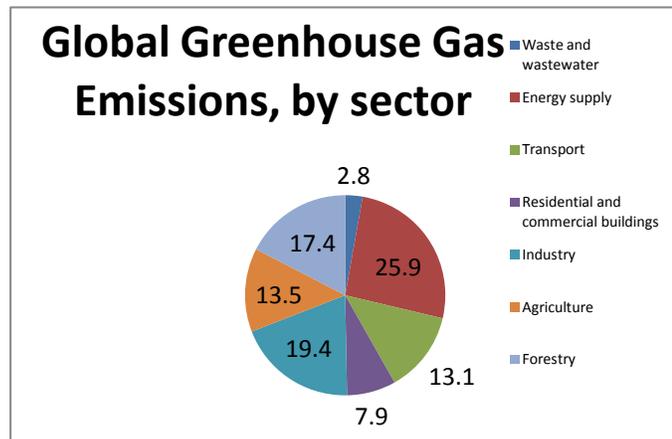


Figure 3. Greenhouse gas emissions per sector.

³ http://www.ipcc.ch/publications_and_data/ar4/syr/en/figure-spm-3.html

⁴ <http://math.350.org/>

⁵ <http://www.worldbank.org/en/news/feature/2012/11/18/Climate-change-report-warns-dramatically-warmer-world-this-century>

⁶ <http://www.theguardian.com/environment/climate-consensus-97-per-cent/2013/may/16/climate-change-scienceofclimatechange>

Related PLOs:

Science 10

D3 evaluate possible causes of climate change and its impact on natural systems

- Describe how climate can be influenced by human activities(e.g., greenhouse gases, depletion of ozone layer)
- Describe how climate change affects natural systems (e.g., shrinking of the permafrost region, melting of ice shelves/caps/glaciers)

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