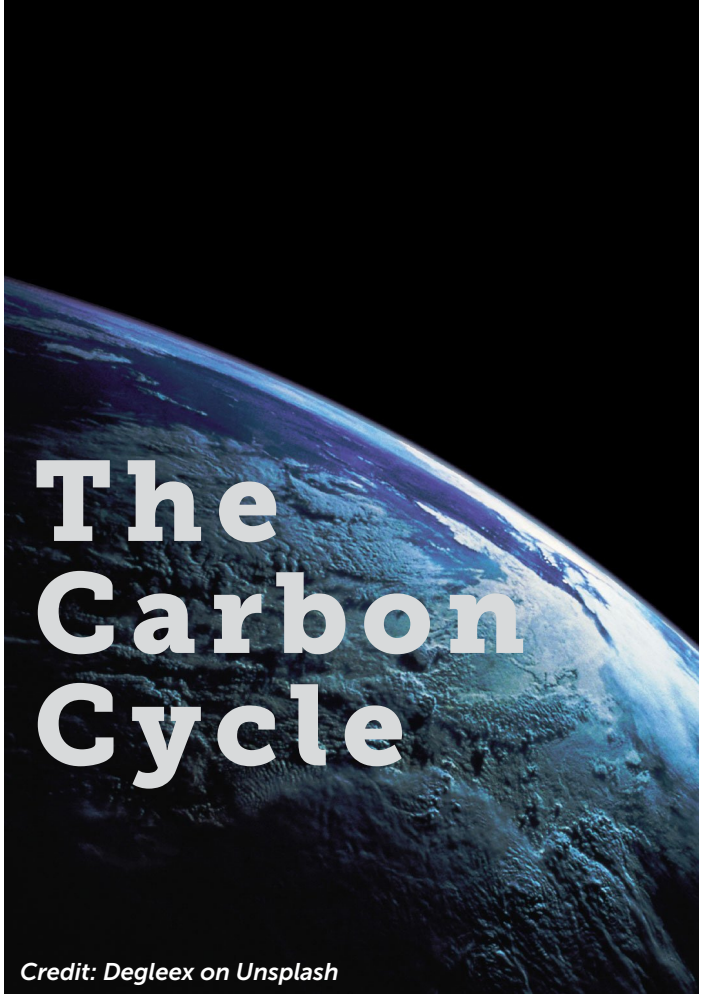


# The Carbon Cycle

*Credit: Degleex on Unsplash*

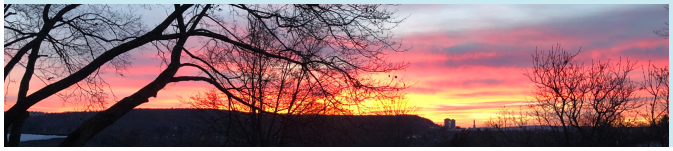
## What is the carbon cycle?

Carbon is an essential element and makes up all life on this Earth. It is in you and me, in the trees around us, in the soil beneath your feet, and in the deep ocean. It moves constantly from state to state and compound to compound, creating a cycle within the Earth's system. You can picture carbon's movement among the Earth's systems as a flow in and out of reservoirs. A source is a reservoir that releases carbon and a sink is a reservoir that absorbs carbon. Carbon reservoirs store carbon for varying amounts of time—it can be as short as days or as long as hundreds of millions of years, such as carbon in coal deposits.

## What is the Atmosphere?

The atmosphere envelops Earth, and is composed of gases like nitrogen (78%), oxygen (21%), and water vapor (1-4%), with trace amounts of carbon dioxide ($CO_2$) and several other gases. It's vital to the carbon cycle, facilitating carbon exchange between Earth's land, ocean, and life.

This dynamic mixture of gases is a key part of Earth's climate system, and it also gives rise to the stunning displays of colors we see during sunrise and sunset.



## Atmosphere and Climate Change

When sunlight warms the Earth's surface, the Earth radiates heat (infrared radiation). Greenhouse gases in the atmosphere, including $CO_2$ and methane ($CH_4$), absorb some of this heat and then re-radiate it, some of it back down toward the Earth. This natural greenhouse effect is essential for maintaining our planet's temperature at levels that support life.

However, human activities like burning fossil fuels and deforestation have significantly increased the concentration of $CO_2$ and $CH_4$ in the atmosphere, intensifying this greenhouse effect. This is responsible for the rising global temperatures and the resulting climate changes we're witnessing.

## Global Carbon Emission Policy

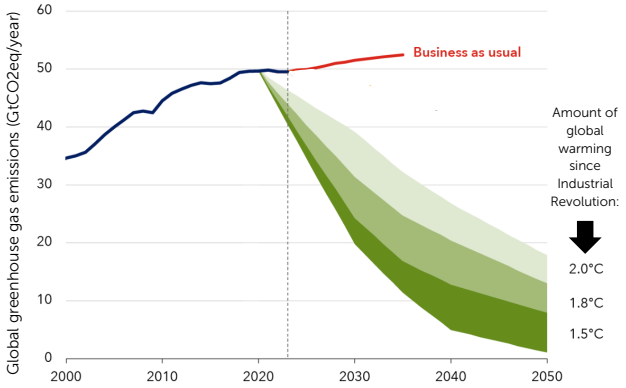



Image adapted from figure by the International Monetary Fund, https://www.imf.org/en/Blogs/Articles/2023/11/27/world-needs-more-policy-ambition-private-funds-and-innovation-to-meet-climate-goals

The concentration of greenhouse gases in the atmosphere depends on the choices we make, such as whether to continue burning fossil fuels or to switch to renewable energy. This graph shows different future scenarios of greenhouse gas emissions levels for different policy pathways, up to the year 2050. It shows the path we need to follow, for example, to limit the increase in global temperature to 2° C.

## What is the 350 Movement?

The concentration of $CO_2$ in the atmosphere is measured in parts per million (ppm). The value of 350 ppm of $CO_2$ gained significance as a target to maintain a stable climate. This threshold was considered crucial by many scientists and environmentalists, as exceeding it could lead to irreversible and detrimental impacts on the planet's ecosystems. However, by 1990 we had already surpassed this threshold. We are seeing more dangerous, extreme weather, and sea level rise that is irreversible on the scale of human lifetimes. This emphasizes the pressing need for continued efforts to reduce greenhouse gas emissions.


*Source: 350.org Visit for more details.*

# The atmosphere interacting with other Earth systems

Chemically weathered rock (basalt) in Hawai'i.
Photo: Alexandra Moore

## The Lithosphere and Biosphere

Carbon forms the backbone of life on Earth. Through photosynthesis, plants that live on land, in the ocean, and in lakes absorb carbon dioxide ($CO_2$) from the atmosphere, converting it into organic compounds. Animals, in turn, consume these plants, incorporating carbon into their own structures. Decomposition and respiration return some carbon to the atmosphere. The carbon cycle intricately links the atmosphere and the sustenance of life.

See the pamphlet "Terrestrial Life in the Carbon Cycle" for more information about the biosphere.

Surface rocks, like the weathered basalt pictured above, are part of the lithosphere. They store carbon and they also release it through interactions with the atmosphere: chemical weathering (chemical reactions between rocks and air or rainwater) and physical weathering from wind and rain.

## The Hydrosphere

Our planet is predominantly water, with oceans covering approximately 71% of its surface. This vast expanse interacts significantly with the atmosphere. Carbon dioxide ($CO_2$) dissolves from the atmosphere into the ocean, while the ocean also releases $CO_2$ back into the atmosphere. For further details, refer to the pamphlet "Oceans in the Carbon Cycle."

Lakes, like Cayuga Lake shown below, also exchange $CO_2$ with the atmosphere, influenced by sources such as runoff and sediment washing into lakes. Both oceans and lakes emit methane, with studies revealing that lakes globally release more methane than oceans, despite covering less land area. A 2022 study* estimated that lakes worldwide emit approximately 42 million metric tons of methane annually.

Cayuga Lake in Ithaca, NY. Photo: PRI

*Johnson, M. S., Matthews, E., Du, J., Genovese, V., & Bastviken, D. (2022). Methane emission from global lakes: New spatiotemporal data and observation-driven modeling of methane dynamics indicates lower emissions. Journal of Geophysical Research: Biogeosciences, 127, e2022JG006793. https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2022JG006793



# CHANGING CLIMATE

OUR FUTURE, OUR CHOICE

# The Atmosphere in the Carbon Cycle

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