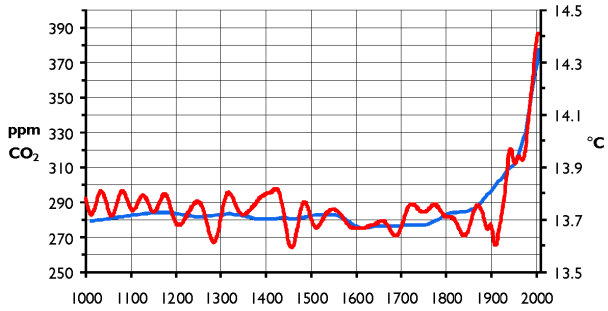
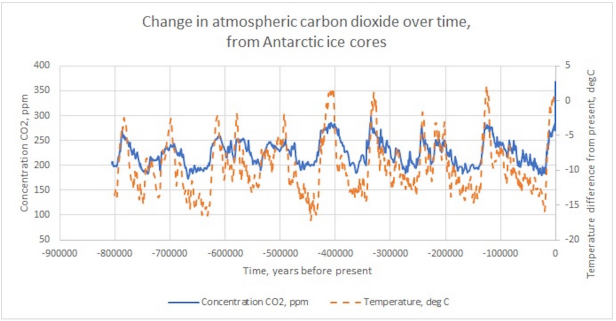
Atmospheric Carbon Dioxide

In Lesson 2, you examined these graphs that show the changes in atmospheric carbon dioxide and temperature over time:



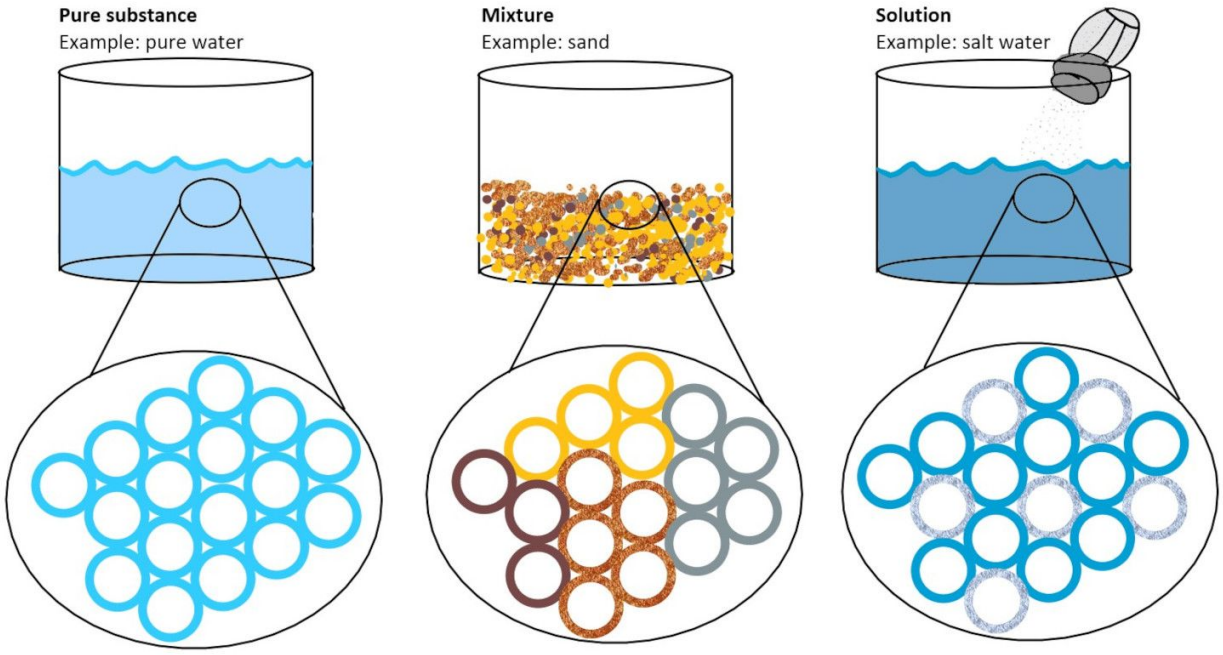
Hanno, CC BY 3.0



Carbon dioxide affects temperature a lot, but it only makes up only a small portion of the atmosphere. Both graphs list the *concentration*, or relative amount, of carbon dioxide using units called *ppm*. This is an abbreviation for "parts per million." This means that of every one million molecules in the atmosphere, at least 410 are carbon dioxide (according to the latest measurements).

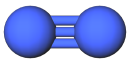
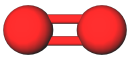
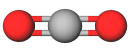
Air is actually a solution made up of many types of gases. In chemistry, we use different words to describe different types of "stuff." These terms are shown in the table and image below.

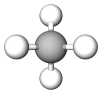
Term	Description	Examples
Pure substance	Made up entirely of the same type of particle	Pure water or ice Iron
Mixture	Made up of two or more types of particles	Sand Soil
Solution	A type of mixture, made up of small and well-mixed particles of different types	Air Salt water



In Your Notebook: Jot down a summary sentence of what you just read or a question you now have.

The table below shows the concentrations of different gases in Earth's atmosphere. Each is measured as a percentage of all particles. The matter in the atmosphere is held to Earth by gravity and cannot escape into space easily, so this matter stays in the atmosphere or cycles between Earth's systems.

Gas	Structure	Concentration in Atmosphere (% of particles)
Nitrogen, N_2	 MolView, GNU AGPL	78.084%
Oxygen, O_2	 MolView, GNU AGPL	20.946%
Water vapor, H_2O	 MolView, GNU AGPL	variable, 1-4%*
Argon, Ar	 MolView, GNU AGPL	0.934%
Carbon dioxide, CO_2	 MolView, GNU AGPL	0.0412%

Neon, Ne	 MolView, GNU AGPL	0.001818%
Methane, CH_4	 MolView, GNU AGPL	0.000179%
Other gases		<0.002% of total
*Water vapor is not included in the total percentage because it is variable based on humidity in an area		

In Your Notebook: Jot down a summary sentence of what you just read or a question you now have.

In this lesson, you saw an investigation of the *enhanced greenhouse effect.* The atmosphere naturally absorbs some energy from the Sun and keeps it from going back into space. However, the presence of high levels of some substances--like carbon dioxide and methane--traps even more energy in the atmosphere. These substances are called *greenhouse gases.* Because it takes time for energy to enter Earth's atmosphere as sunlight, greenhouse gases continue to cause increases in temperature as long as they are in the atmosphere.

Carbon dioxide is a particularly important greenhouse gas because it is being released at a high rate as we burn fuels like gasoline and coal. It also sticks around the atmosphere for a long time. Some molecules might be used quickly by plants in photosynthesis, but others might stay in the atmosphere for hundreds or even thousands of years before they are removed through other chemical reactions. Scientists estimate that even if people and companies (especially those in wealthy countries like the United States) stop releasing carbon dioxide into the atmosphere tomorrow, it would take thousands of years for CO_2 levels to return to what they were before humans began using large amounts of fossil fuels.

If we did stop releasing carbon dioxide into the atmosphere tomorrow, global temperatures would still end up about 0.5°C (0.9°F) higher in 2100 than they were in 2000. More realistic scenarios in which humans do continue to release carbon dioxide result in predictions of warming of between 1.2°C (2.2 °F) and 4°C (7.2 °F). This is a wide range in part because scientists are uncertain which path countries, companies, and people will take. Any scenario would result in significant continued sea level rise, but these predictions are helpful because they give scientists, activists, and policymakers the tools to identify possible solutions.

In Your Notebook: Jot down both:

- a summary sentence of what you just read AND
- a question you now have about the effects of carbon dioxide staying in Earth's atmosphere.

References

Air - composition and molecular weight. Engineering ToolBox. (n.d.). Retrieved December 15, 2022, from https://www.engineeringtoolbox.com/air-composition-d_212.html

Environmental Protection Agency. (2022, August 1). *Climate Change Indicators: Greenhouse Gases*. EPA. Retrieved December 15, 2022, from https://www.epa.gov/climate-indicators/greenhouse-gases

Forster, P., V. Ramaswamy, P. Artaxo, T. Berntsen, R. Betts, D.W. Fahey, J. Haywood, J. Lean, D.C. Lowe, G. Myhre, J. Nganga, R. Prinn, G. Raga, M. Schulz and R. Van Dorland, 2007: Changes in Atmospheric Constituents and in Radiative Forcing. In: *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA

If emissions of greenhouse gases were stopped, would the climate return to the conditions of 200 years ago? Royal Society. (2020, March). Retrieved December 15, 2022, from https://royalsociety.org/topics-policy/projects/climate-change-evidence-causes/question-20/