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Reading: Gases that Vibrate

Many years ago, Eunice Foote was trying to answer some of the same questions you have been asking. She was curious about the gases in the atmosphere and their role in the temperature of the atmosphere. Foote used glass cylinders filled with different gases and placed the cylinders in the sunlight and recorded the temperature. She discovered that some of the cylinders of gas heated up more than others. Can you guess which ones?



Foote reported the following in 1856: "The highest effect of the sun's rays I have found to be in carbonic acid gas." Carbonic acid gas is what we know now as carbon dioxide. She was the first to conclude that "An atmosphere of that gas would give to our earth a high temperature...." Eunice Foote's contribution often goes unnoticed. As a woman, she was not allowed to present her work at science conferences or publish like male scientists. It was a few years later that John Tyndall published a paper identifying the gases responsible for warming our atmosphere. He is often given credit for this discovery, even though Eunice Foote was first to make these claims.

Eunice Foote concluded that carbon dioxide causes our atmosphere to warm. How does carbon dioxide do that? What makes carbon dioxide so special? Water vapor and methane also cause the air to warm. Gases like these absorb energy or heat. The atoms in the molecules of these gases can move within the molecule— they vibrate. Because of their structure, these gases vibrate when heat is transferred to the molecule. Once they start to vibrate,

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they release that heat back into the atmosphere in all directions. Most of the heat from Earth's warmed surface goes into space, but the heat released from these gases causes the atmosphere to warm because they send some heat back to Earth. This process is called the **greenhouse effect**.

Gases that absorb and release heat in the atmosphere are called **greenhouse gases** (GHGs). Three of the most important greenhouse gases include water vapor (H₂O), carbon dioxide (CO₂), and methane (CH₄). We would not be able to survive on Earth if we didn't have greenhouse gases—it would be too cold! These gases help to warm our planet. So, they are not bad gases—they are necessary for life on Earth!

A very important GHG is water vapor. Have you ever thought about why we are not worried about water vapor building up in the atmosphere? The amount of water vapor in the atmosphere stays about the same, though it's going up a little as the temperatures get warmer. If the amount of water gets too high, the water cycle takes care of it. Water condenses and falls as precipitation. However, we know that some GHGs are increasing in our atmosphere—carbon dioxide and methane, for example. They cannot fall out of the atmosphere as precipitation like water vapor can.