Natural Change

1

Greenhouse Gases Don't Really Trap Heat

This is perhaps the easiest myth to debunk because it requires a mere scientific experiment to disprove, and fortunately that experiment and many others have already been carried out. In fact, they were first carried out in the 1800s! But before we get to these experiments, let's provide a little context and history about the origins of climate science and how such experiments came to be.

Interestingly, research and understanding about global warming was born out of concern for potential global cooling. Nineteenth century European scientists observing glacial movements in the Alps noticed that in some areas glaciers appeared to have been much higher and widespread at one point. They wondered whether a prior ice age had occurred. And more importantly, might it return? An understanding as to what caused the climate to change over time was key to answering these questions.

Dating back even further, the earliest inkling of a "greenhouse effect" came from a Genevan professor, mountain climber, and explorer named Horace Bénédict de Saussure. With a fascination for temperature and altitude, Saussure mused about why Earth's heat didn't all escape into space after sunset. To understand this, he constructed a "hot box," consisting of darkened cork on the sides and clear glass over the top. Resembling a modern-day greenhouse, the structure allowed light to pass in during the day, yet retained some of the heat at night. Perhaps, he wondered, the atmosphere behaved in the same fashion, allowing sunlight to pass through in the day, yet preventing the escape of heat at night. French mathematician Joseph Fourier also took to this idea. He admired Saussure's work and agreed with his hypothesis about the atmosphere. However, proving it mathematically turned out to be a difficult and frustrating feat, leaving Fourier to ultimately abandon the problem.

By 1837, the Swiss scientist Louis Agassiz declared that an ice age had indeed existed at one time, covering much of Europe with massive glaciers akin to those in Greenland. After relocating to the U.S. as a professor at Harvard, and demonstrating that past glaciers were responsible for carving the landscapes of the Great Lakes, Agassiz confirmed his declaration of a prior ice age, becoming arguably the founder of the notion of climate change.

The existence of a prior ice age and a possible "hot box" effect set the stage for what would soon become the first key experiments to demonstrate the warming effects of certain gases, or so-called greenhouse gases. At this point, we must turn to the work of a well-known Irish physicist named John Tyndall. Like his predecessors, Tyndall was obsessed by the movements of glaciers. He also wondered whether the atmosphere influenced temperatures on Earth. He got to work building an instrument called a spectrophotometer that would help him find answers. Consisting of a heat source, a receptor, and a small tubular chamber in the middle, Tyndall could test whether certain gases had the capacity to absorb infrared (longwave) light energy, and in turn trap heat.

The first gases Tyndall tested were those that are most abundant on Earth; namely, oxygen and nitrogen. After introducing each gas into the chamber, he found that neither gas dampened or absorbed the longwave light passing through. This was a disappointment as it didn't support the notion of a greenhouse effect. However, Tyndall pressed on. As luck would have it, light in those days (pre-electricity) was provided by burning coal gas, or "town gas." This was a mixture consisting mostly of methane. When Tyndall pumped coal gas into the testing chamber he discovered that the gas, though invisible to the eye, was not transparent to light energy. The receptor detected less energy when coal gas was present in the chamber, which meant the gas was trapping it. After testing water vapor and CO_2, he found the same result. These gases prevented some light energy from passing through. This was the proof Tyndall needed. Gases could in fact absorb longwave light, and thus trap heat. And there it happened in a lecture to the Royal Institution shortly after his discovery in 1859, Tyndall demonstrated for the first time in public an experimental account of the greenhouse effect!

Research by Tyndall and other scientists confirmed his earlier findings and built on the results. Not only could certain gases trap heat, they were also sufficiently abundant to have a major influence on of Earth's temperature and climate. By the end of the century, the Swedish chemist Svante Arrhenius even calculated the global warming impacts that doubling atmospheric CO_2 levels would have on the planet. Without the benefit of a computer, his estimate of a 9-11°F (5-6°C) increase in global temperatures was surprisingly well within the estimates of modern science.

All of this, and we haven't even made our way to the 1900s! Although, I think by now you get the point. That is, the physics and light absorbing capacities of CO_2 and other greenhouse gases is no mystery and has been demonstrated repeatedly. It was proven and even publicly showcased over a century and a half ago. For those curious, you can conduct a similar experiment to that of Tyndall's in your own home. Simply get two thermometers, a couple empty water bottles, and some CO_2 gas. When shining a proper lamp on the bottles containing either the air or CO_2, you'll find that after about a half hour the temperature in the CO_2-filled bottle is noticeably higher. It's not magic, it's the greenhouse effect! If you don't want the hassle of rigging your own experiment, check out one of the many fun video demonstrations online!