How global warming works, in 35 words, or 52 seconds

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Earth transforms sunlight's visible light energy into infrared light energy, which leaves Earth slowly because it is absorbed by greenhouse gases. When people produce greenhouse gases, energy leaves Earth even more slowly – raising Earth's temperature.

And that, in an ultra-brief nutshell, is how global warming works.

This 35-word description can be a powerful tool in helping people understand the science behind global warming and climate change, said GSE Professor Michael Ranney, a cognitive psychologist. Global climate change seems urgent, given that it was just announced that November was the 345th straight month with temperatures above the 20th-century average.

Ranney's research focuses on the nature of explanation and understanding in both formal and informal settings. Along with GSE student Lee Nevo Lamprey, undergraduate Kimberly Le, other students (e.g., Myles Crain) and other collaborators (e.g., Lloyd Goldwasser, Rachel Ranney, and Chemistry's Prof. Ronald Cohen, among many others), he has been looking at how much people understand global warming – and with brief explanations of the phenomenon – how that understanding changes.

In their paper, "Changing Global Warming Beliefs with Scientific Information: Knowledge, Attitudes, and RTMD (Reinforced Theistic Manifest Destiny Theory)," Ranney and his co-authors – Dav Clark,

Daniel Reinholz and Sarah Cohen – surveyed 270 people in San Diego to find out what they knew (or didn't know) about global warming. Not a single person could explain it correctly at even the basic level, he said.

The researchers developed a 400-word explanation – including the 35 words from above – as well as a series of videos (ranging from 52 seconds to 4 minutes and 45 seconds) to explain how global warming works. Within four days after the videos were launched, the videos had more than 35,000 site-views.

Interestingly, for California and Texas undergraduates, who had little to no knowledge of why the Earth's temperature is rising, reading the 400-word explanation increased not only the students' understanding of global warming, but also their acceptance that it's actually occurring. Such effects have since been replicated with other groups (e.g., Clark, Ranney, & Felipe, 2013, with high-school students, etc.), including a more nationally representative sample of adults. Clark and Ranney have also recently found that even a handful of critically germane statistics (e.g., seven of them) can significantly yield attitudes and concerns that are more in keeping with accepted climate science.

To boost the website's reach, the videos are being translated into some ubiquitous non-English languages. Lamprey, Le, and other students, along with Ranney, will also be analyzing the site's "naturalistic" data to better hypothesize about which videos are most informative and satisfying.

Ranney's Reasoning Group also plans to run controlled experiments to more diagnostically determine which of the videos' elements are most effective. (One can't necessarily fully tell which video is more effective for one's self, as one is hardly naïve when viewing a 2nd, 3rd, 4th, or 5th video.) Ranney's RTMD theory, which has a good deal of empirical evidence – and inspired the 400-word explanation and the videos – is

itself also slated for more experimental assessment.

400-Word Explanation

How does climate change ("global warming") work? The mechanism of the greenhouse effect

[Or: "Why do some gases concern scientists – like carbon dioxide (CO2) – but not others, like oxygen?"]

Scientists tell us that human activities are changing Earth's atmosphere and increasing Earth's average temperature. What causes these climate changes?

First, let's understand Earth's "normal" temperature: When Earth absorbs sunlight, which is mostly visible light, it heats up. Like the sun, Earth emits energy – but because it is cooler than the sun, Earth emits lower-energy infrared wavelengths. Greenhouse gases in the atmosphere (methane, carbon dioxide, etc.) let visible light pass through, but absorb infrared light – causing the atmosphere to heat up. The warmer atmosphere emits more infrared light, which tends to be re-absorbed – perhaps many times – before the energy eventually returns to space. The extra time this energy hangs around has helped keep Earth warm enough to support life as we know it. (In contrast, the moon has no atmosphere, and it is colder than Earth, on average.)

Since the industrial age began around the year 1750, atmospheric carbon dioxide has increased by 40% and methane has increased by 150%. Such increases cause extra infrared light absorption, further heating Earth above its typical temperature range (even as energy from the sun stays basically the same). In other words, energy that gets to Earth has an even harder time leaving it, causing Earth's average temperature to increase –

producing global climate change.

[In molecular detail, greenhouse gases absorb infrared light because their molecules can vibrate to produce asymmetric distributions of electric charge, which match the energy levels of various infrared wavelengths. In contrast, non-greenhouse gases (such as oxygen and nitrogen – that is, O2 and N2) don't absorb infrared light, because they have symmetric charge distributions even when vibrating.]

Summary: (a) Earth absorbs most of the sunlight it receives; (b) Earth then emits the absorbed light's energy as infrared light; (c) greenhouse gases absorb a lot of the infrared light before it can leave our atmosphere; (d) being absorbed slows the rate at which energy escapes to space; and (e) the slower passage of energy heats up the atmosphere, water, and ground. By increasing the amount of greenhouse gases in the atmosphere, humans are increasing the atmosphere's absorption of infrared light, thereby warming Earth and disrupting global climate patterns.

Shorter summary: Earth transforms sunlight's visible light energy into infrared light energy, which leaves Earth slowly because it is absorbed by greenhouse gases. When people produce greenhouse gases, energy leaves Earth even more slowly – raising Earth's temperature.

More information: See the entire set of videos at www.howglobalwarmingworks.org/

Read the full research paper: hamschank.com/convinceme/downl … yEtAl-CogSci2012.pdf

Provided by University of California - Berkeley

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