



This is the print version of the [Skeptical Science](http://sks.to/falsify) article '[Greenhouse effect has been falsified](http://sks.to/falsify)', which can be found at <http://sks.to/falsify>.

Has the greenhouse effect been falsified?

What The Science Says:

The greenhouse effect is standard physics and confirmed by observations.

Climate Myth: Greenhouse effect has been falsified

"[T]he influence of so-called greenhouse gases on near-surface temperature - is not yet absolutely proven. In other words, there is as yet no incontrovertible proof either of the greenhouse effect, or its connection with alleged global warming.

This is no surprise, because in fact there is no such thing as the greenhouse effect: it is an impossibility. The statement that so-called greenhouse gases, especially CO₂, contribute to near-surface atmospheric warming is in glaring contradiction to well-known physical laws relating to gas and vapour, as well as to general caloric theory.' ([Heinz Thieme](#))

At a glance

Did you know that in the late 1700s, astronomers calculated the Earth-Sun distance to within 3% of the correct average value of 149.6 million kilometres? That was an incredible feat for the time, involving painstaking measurements and some pretty serious number crunching, with no help from computers.

Why is that mentioned here, you might ask. It's because not long afterwards, in the 1820s, French physicist Jean Joseph Baptiste Fourier made another crucial calculation. He worked out that at this distance from the Sun, Earth should have been an uninhabitable iceball.

Fourier suggested there must be some kind of insulating 'blanket' within the atmosphere. By the end of that century, Eunice Foote and John Tyndall had proved him quite correct through their experiments with various gases and Svante Arrhenius quantified matters in 1896, even calculating the effect of doubling the concentration of CO₂. They had it largely figured out all that time ago.

If you are still sceptical about the existence of a greenhouse effect on Earth, there's something you can do in order to double-check. Go to the moon.

Well, you don't have to go personally, thanks to remote sensing and lunar landings by both unmanned and manned craft. Such intrepid expeditions mean we have a stack of data regarding lunar properties. The moon is pretty much the same distance from the Sun as Earth, but the lunar atmosphere is so thin it may as well not exist at all. There's virtually nothing to inhibit heat transfer, in or out.

In addition, the Moon turns but slowly on its axis compared to Earth. While a mean Solar day here lasts 24 hours, on the Moon it lasts just under a month. You get the best part of a fortnight of relentless Solar heating followed by a similar period of cooling in the long lunar night. So what's the temperature?

In the vicinity of the Lunar equator, daytime temperatures eventually reach a boiling hot 120°C. During the lunar night, that temperature drops away to -130° C. No atmosphere so no greenhouse effect. All that heat accumulated in the long lunar day just shoots straight back out into space. Nights on Earth may be much shorter, but nevertheless in the absence of a greenhouse effect they would be brutal.

Our approximately Earth-sized near neighbour, Venus, closer to the Sun, is different again. It has a massive dense atmosphere mostly consisting of CO₂ with a side-helping of sulphur dioxide. Surface atmospheric pressure on Venus is so great that on Earth you would need to go a kilometre down in the ocean to find similar values. The planet rotates very slowly on its axis so days and nights are even longer than on the

Moon. But unlike the Moon, Venus is always a hot place. Its surface temperature is over 450°C, day or night. An extreme greenhouse effect maintains that heat.

Remember: no atmosphere, no greenhouse effect and unimaginably cold lunar nights - but the example of Venus shows you can also have too much of a good thing. Earth really is a Goldilocks planet.

Please use [this form](#) to provide feedback about this new "At a glance" section. Read a more technical version below or dig deeper via the tabs above!

Further details

Some climate science deniers dispute the existence of the 'greenhouse effect'. This is where their arguments lurch from silly - to beyond silly. The greenhouse effect keeps the surface temperature of Earth approximately 33°C warmer than it would be if there were no greenhouse gases in the atmosphere. In other words, without the greenhouse effect, Earth would be effectively uninhabitable.

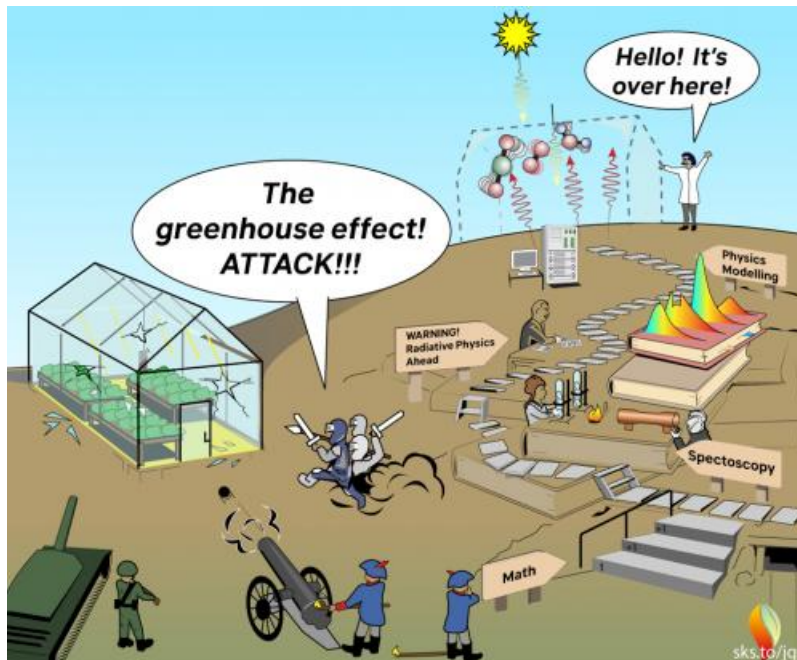


Fig 1: The greenhouse effect is an analogy not meant as a scientific model of effect; hence, detractors have attacked the wrong model. ([source: jg](#))

How do we know for sure this effect is real? The principle is demonstrated through basic physics, because a bare rock orbiting the Sun at the Earth-Sun distance (mean = 149.6 million kilometres) should be far colder than the Earth actually is. This was realised by Jean Joseph Baptiste Fourier in the 1820s, but the explanation why it was the case was not forthcoming for a few more decades. Fourier considered it to have something to do with the atmosphere having the properties of a kind of insulating blanket.

The existence of Fourier's hypothetical 'blanket' was confirmed by the experimental studies done by Eunice Foote and John Tyndall, working independently on either side of the Atlantic in the 1850s. Foote's results were announced at the 1856 meeting of the American Association for the Advancement of Science, and published in the American Journal of Science and Arts in the same year. The paper was entitled, 'Circumstances Affecting the Heat of the Sun's Rays', with an excellent recent review by [Ortiz and Jackson \(2020\)](#). A key passage is as follows:

"The highest effect of the sun's rays I have found to be in carbonic acid gas. An atmosphere of that gas would give to our earth a high temperature; and if as some suppose, at one period of its history, the air had mixed with it a larger proportion than at present, an increased temperature from its own action, as well as from increased weight, must have necessarily resulted."

In his 1861 paper, "On the absorption and radiation of heat by gases and vapours, and on the physical

connexion of radiation, absorption, and conduction” (PDF [here](#)), Tyndall stated:

“Now if, as the above experiments indicate, the chief influence be exercised by the aqueous vapour, every variation of this constituent must produce a change of climate. Similar remarks would apply to the carbonic acid diffused through the air; while an almost inappreciable admixture of any of the hydrocarbon vapours would produce great effects on the terrestrial rays and produce corresponding changes of climate.”

Tyndall had in his own words identified methane as an even more potent greenhouse gas than CO₂. Later that century, Swedish scientist Svante Arrhenius put the numbers on the relationship between greenhouse gas concentrations and surface temperatures. He was able to calculate the effect of doubling the CO₂ concentration in the air. The result was a globally-averaged figure of 5-6°C of warming, not that dissimilar to modern values.

Empirical Evidence for the Greenhouse Effect

We only have to look to our moon for evidence of what the Earth might be like, without an atmosphere and greenhouse effect. It's not as though we're short of data about our satellite. While the moon's surface reaches 120°C (248°F) in direct sunlight at the equator during the long lunar day, when it gets dark the temperature drops down to a frigid -130°C (-202°F).

Since the moon is virtually the same distance from the sun as we are, it is reasonable to ask why at night the Earth doesn't get as cold as the moon. The answer is that, unlike the Earth, the moon has no insulating blanket of greenhouse gases, because it has virtually no atmosphere at all. Without our protective atmosphere and its greenhouse effect, the Earth would be as barren as our lifeless moon. In the absence of the heat trapped overnight in the atmosphere (and in the ground and oceans) our nights would be so cold that few plants or animals could survive even a single one.

Conclusive evidence for the greenhouse effect – and the role CO₂ plays – can also be seen in data from the surface and from satellites. By comparing the Sun's heat reaching the Earth with the heat leaving it, both things we can measure with great accuracy, we can see that less long-wave radiation (heat) is leaving than arriving. Since the 1970s, less and less radiation is leaving the Earth, as the levels of CO₂ and other greenhouse gases build up. Since all radiation is measured by its wavelength, we can see that the frequencies being trapped in the atmosphere are the same frequencies absorbed by greenhouse gases.

To conclude, disputing that the greenhouse effect is real is to attempt to discredit centuries of science, the laws of physics and indeed direct observation. Without the greenhouse effect, we would not even be here to argue about it.



The Skeptical Science website by [Skeptical Science](#) is licensed under a [Creative Commons Attribution 3.0 Unported License](#).

 **Skeptical Science**.com



Skeptical Science explains the science of global warming and examines climate misinformation through the lens of peer-reviewed research. The website won the Australian Museum 2011 Eureka Prize for the Advancement of Climate Change Knowledge. Members of the Skeptical Science team have authored peer-reviewed papers, a [college textbook on climate change](#) and the book [Climate Change Denial: Heads in the Sand](#). Skeptical Science content has been used in university courses, textbooks, government reports on climate change, television documentaries and numerous books.



The [Skeptical Science](#) website by Skeptical Science is licensed under a Creative Commons [Attribution 3.0 Unported License](#).