

## CONSENSUS SCIENCE – A SUMMARY OVERVIEW

Updated on 18 September 2012 by Hans Schreuder

From a UK government site:

<http://www.bis.gov.uk/go-science/climatescience/greenhouse-effect>

After gas molecules absorb radiation, they re-emit it in all directions. Some of the infrared radiation absorbed by gases in the atmosphere is therefore re-radiated out towards space and eventually leaves the atmosphere, but some is re-radiated back towards the Earth, warming the surface and lower atmosphere (illustrated by the 'back radiation' term in Figure 2). This warming is known as the greenhouse effect and the gases that are responsible for it are known as greenhouse gases.

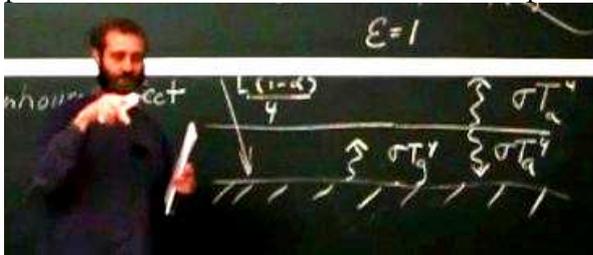
**Gavin Schmidt**

The factor of two for the radiation emitted from the atmosphere comes in because the atmosphere radiates both up and down.

<http://www.realclimate.org/index.php/archives/2007/04/learning-from-a-simple-model/>

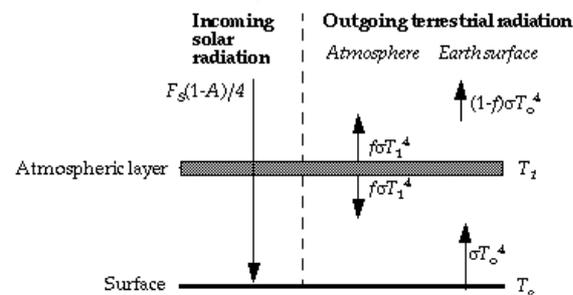
**Professor Archer**

Download the Chapter 3, lecture 5 video lecture: *The Greenhouse Effect* video and you will see professor Archer sketch out the same explanation as professor Lindzen's.



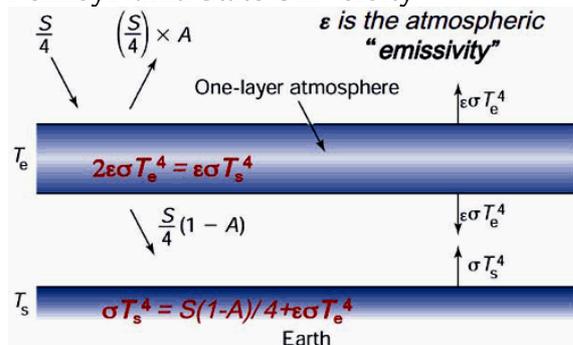
[http://mindonline.uchicago.edu/media/psd/geophys/PHSC\\_13400\\_fall2009/lecture5.mp4](http://mindonline.uchicago.edu/media/psd/geophys/PHSC_13400_fall2009/lecture5.mp4)

**Harvard University's version:**



<http://acmg.seas.harvard.edu/people/faculty/djj/book/bookchap7.html>

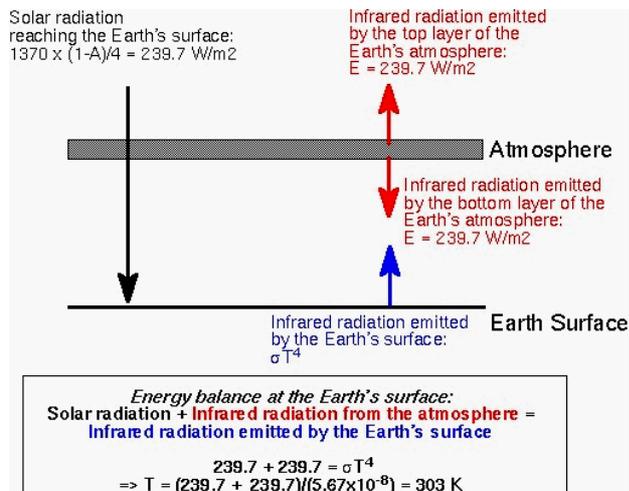
**Pennsylvania State University**



<https://www.e-education.psu.edu/meteo469/node/198>

## University of Washington's Department of Atmospheric Sciences.

The instructor omits the algebraic camouflage and uses simple arithmetic instead. In other words, he does exactly what the others do except he makes it CLEAR.

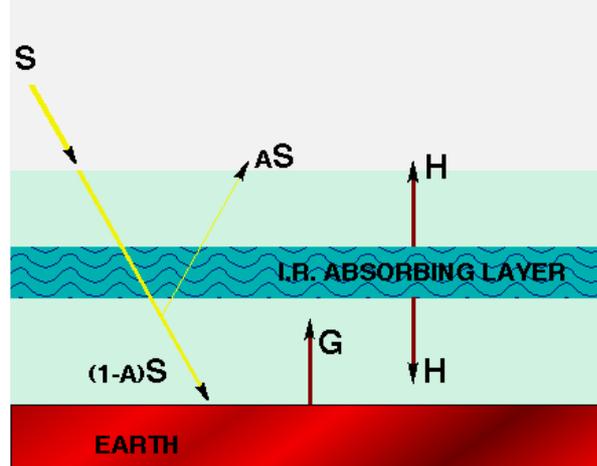


[http://www.atmos.washington.edu/2002Q4/211/notes\\_greenhouse.html](http://www.atmos.washington.edu/2002Q4/211/notes_greenhouse.html)

## Columbia University

ALL of these depictions are based on what had been earlier believed about glass enclosures. These things don't happen in a glass enclosure, though, so the experts forced themselves to insist that they DO happen between the atmosphere and the earth's surface.

A SIMPLE MODEL OF THE GREENHOUSE EFFECT



[http://eesc.columbia.edu/courses/ees/climate/lectures/gh\\_kushnir.html](http://eesc.columbia.edu/courses/ees/climate/lectures/gh_kushnir.html)

## Colorado University

Don't forget the *coup de grâce*! Check out the University of Colorado's demo:

<http://phet.colorado.edu/en/simulation/greenhouse>

Run the demo and see that this "effect" is EXACTLY the same in a glass greenhouse, they claim. The University of Colorado is a prime SOURCE of the IPCC's material.

**An indication of just how “settled” the “science” is can be gleaned from these quotes:**

....the popular depiction of the [greenhouse] effect as resulting from an infrared ‘blanket’ can be seriously misleading, and, as a result, much of the opposition that focuses purely on the radiation is similarly incorrect. — **Richard Lindzen**

<http://www.tech-know-group.com/archives/LMD-March31-2011.pdf>

When you pile all of the layers of greenhouse gases in the atmosphere on top of one another, they form a sort of radiative blanket, heating the lower layers and cooling the upper layers. —

**Roy Spencer**

<http://www.drroyspencer.com/2009/12/what-if-there-was-no-greenhouse-effect/>

**NASA**

Why is this process called "The Greenhouse Effect?"

Because the same process keeps glass-covered greenhouses warm. The Sun heats the ground and greenery inside the greenhouse, but the glass absorbs the re-radiated infra-red and returns some of it to the inside.

<http://www-istp.gsfc.nasa.gov/stargaze/Lsun1lit.htm>

**Bigelow Laboratory for Ocean Sciences**

In a greenhouse, visible light (e.g., from the Sun) easily penetrates glass or plastic walls, but heat (in the form of infrared radiation) does not. The greenhouse effect refers to the physical process by which atmospheric gases allow sunlight to pass through but absorb infrared radiation thus acting like a blanket trapping heat.

[http://www.bigelow.org/virtual/handson/greenhouse\\_make.html](http://www.bigelow.org/virtual/handson/greenhouse_make.html)

**The U.S. government's Environmental Protection Agency**

The energy that is absorbed is converted in part to heat energy that is re-radiated back into the atmosphere. Heat energy waves are not visible, and are generally in the infrared (long-wavelength) portion of the spectrum compared to visible light. Physical laws show that atmospheric constituents—notably water vapor and carbon dioxide gas—that are transparent to visible light are not transparent to heat waves. Hence, re-radiated energy in the infrared portion of the spectrum is trapped within the atmosphere, keeping the surface temperature warm. This phenomenon is called the "greenhouse effect" because it is exactly the same principle that heats a greenhouse.

<http://www.epa.gov/ne/students/pdfs/activ13.pdf>

**Enviropedia.org.uk**

Greenhouse gases like water vapour, carbon dioxide, methane and nitrous oxide trap the infrared radiation released by the Earth's surface. The atmosphere acts like the glass in a greenhouse, allowing much of the shortwave solar radiation to travel through unimpeded, but trapping a lot of the longwave heat energy trying to escape back to space. This process makes the temperature rise in the atmosphere just as it does in the greenhouse. This is the Earth's natural greenhouse effect and keeps the Earth 33°C warmer than it would be without an atmosphere, at an average 15°C. In contrast, the moon, which has no atmosphere, has an average surface temperature of -18°C.

[http://www.enviropedia.org.uk/Climate\\_Change/Greenhouse\\_Effect.php](http://www.enviropedia.org.uk/Climate_Change/Greenhouse_Effect.php)

**University of Alaska-Fairbanks, Physics Department**

Greenhouse gases act as a blanket. Some of you may wonder how a green house takes solar energy and turns it into thermal energy. A good example of this is something you can observe every day in the summer in you own car. It happens when you leave you car in a sunny parking lot with the windows up. The solar energy is passing through the glass and is

heating the cars interior. What's really happening is the short wave infrared waves are going in and are turning into long wave infrared waves, which cannot escape.

[http://ffden-2.phys.uaf.edu/102spring2002\\_Web\\_projects/C.Levit/web%20page.html](http://ffden-2.phys.uaf.edu/102spring2002_Web_projects/C.Levit/web%20page.html)

### **Weather-Climate.org**

This warming effect is called the "greenhouse effect" because it is the same process as that which occurs in a greenhouse on a sunny day. The glass is transparent to short-wave radiation but absorbs the outgoing long-wave radiation, causing a rise in temperature inside the greenhouse.

<http://www.weather-climate.org.uk/04.php>

### **Hunan University, China**

- Light from the sun includes the entire visible region and smaller portions of the adjacent UV and infrared regions.
- Sunlight penetrates the atmosphere and warms the earth's surface.
- Longer wavelength infrared radiation is radiated from the earth's surface.
- A considerable amount of the outgoing IR radiation is absorbed by gases in the atmosphere and reradiated back to earth.

The gases in the atmosphere that act like glass in a greenhouse are called greenhouse gases.

<http://jpkc.lzjtu.edu.cn/hjhx/jpkc/7.ppt>

### **The Public Broadcasting Service**

In part, we owe our existence to a process called the greenhouse effect. Inside an artificial greenhouse filled with plants, the surrounding glass traps the sun's energy, making it warm inside, even while outside the temperature may be much colder. This same effect happens every day on the Earth. Gases within the atmosphere act like glass, trapping the sun's heat.

<http://www.pbs.org/wgbh/nova/ice/greenhouse.html>

### **BBC**

A greenhouse works because of the glass panels that line the roof and walls. The glass is transparent to the visible light from the sun, so sunlight can shine in and warm things inside the greenhouse. Now a body at about 35°C emits mostly infrared radiation. (On the other hand our sun, with a surface temperature of about 5500°C, emits mostly visible light.) The glass panels are opaque to infrared light. The result is that the glass lets the energy of the sun in, but won't let it back out. This keeps the inside of a greenhouse warm.

Replace the greenhouse with Earth and glass panels with atmosphere in the above example, and that is how the Earth's greenhouse effect works.

<http://www.bbc.co.uk/dna/h2g2/A283277>

### **University Corporation for Atmospheric Research (UCAR)**

Have you ever been inside a greenhouse on a cold winter day? It might be cold outside, but inside the greenhouse lush green plants flourish in the warmth and sunshine. Greenhouses are made of glass and are designed to hold heat inside. The atmospheres of some planets are able to trap energy just like a greenhouse. Energy from the Sun can enter the atmosphere, but not all of it can easily find its way out again.

What blocks the Sun's energy from escaping a planet's atmosphere? Unlike a greenhouse, planets do not have a layer of glass over them! Instead, molecules in the atmosphere called greenhouse gases absorb the heat.

[http://www.windows.ucar.edu/tour/link=/earth/interior/greenhouse\\_effect.html](http://www.windows.ucar.edu/tour/link=/earth/interior/greenhouse_effect.html)

## **Appalachian State University, North Carolina**

selective Absorbers and Greenhouse Effect.

Our atmosphere is a selective filter since it is transparent to some wavelengths and absorbs others.

The greenhouse effect occurs when the energy absorbed is not all be radiated because of the filtering of the atmosphere. Some of the earth's radiated energy is reflected back to the surface. Consequently the earth's atmosphere has an increased temperature. This process is much like the action of glass in a greenhouse.

<http://www.physics.appstate.edu/courses/FirstExamReview.rtf>

## **Nathan Phillips, Associate Professor, Geography and Environment Boston University**

A simple greenhouse effect model

- A. Glass represents the 'normal' greenhouse effect on earth and is at top of atmosphere
- B. Solar shortwave radiation  $S$  largely makes it to surface
- C. For energy balance, top of glass must send  $S$  back out
- D. Greenhouse gases don't have a preferred direction; they send  $S$  units in both directions – up and down
- E. Thus, the surface of the earth receives  $2S$  due to the greenhouse effect – instead of  $1S$  if there were no atmosphere!
- G. Thermal radiation emitted from earth =  $2S$

[http://people.bu.edu/nathan/ge510\\_06\\_6.pdf](http://people.bu.edu/nathan/ge510_06_6.pdf)

## **ThinkQuest Education Foundation**

In a greenhouse, heat from the sun enters the glass. The heat in the form of infra-red light bounces and heads back up towards the glass. The glass then allows only some of this heat to escape, but reflects back another portion. This heat remains bouncing within the greenhouse. In the case of planet Earth, there is no glass, but there is an atmosphere which retains heat or releases heat.

<http://library.thinkquest.org/11353/greenhouse.htm>

## **Moorland School, Earth Science (UK)**

Imagine that Earth has been encircled by a giant glass sphere. The heat of the sun penetrates through the glass. Some of the heat is absorbed by the Earth, and some of it is radiated back towards space. The radiated heat reaches the glass sphere and is prevented from dispersing any further.

Similarly, the earth is surrounded by a blanket of gases. This blanket traps energy in the atmosphere, much the same way as glass traps heat inside a greenhouse. This results in an accumulation of energy, and the overall warming of the atmosphere. The 'greenhouse effect' is the popular expression for the above process.

<http://www.moorlandschool.co.uk/earth/greenhou.htm>

## **Eli Rabett**

What happens in a greenhouse is the same mechanism that heats a car up when you close the windows. The sun's light (radiation) shines through the glass. The light energy checks in, but it can't get out because both air flow (most important) and conduction are closed off. The fancy name for air flow is convection. We might fall into the habit of using that below.

That leaves radiation. The wavelength of radiation emitted from a surface depends on the temperature of the surface according to a formula first derived by Max Planck. It turns out that the emission from the sun is peaked in the green which can pass through the glass windows, but the radiation from surfaces at 300 C is peaked at much longer wavelengths in the infrared (IR), which is absorbed by the glass.

The IR radiation inside the car can heat the air inside the car, but, because it is adsorbed by the glass windows and the metal, it cannot get out.

<http://rabett.blogspot.com/2005/10/people-who-tell-you-that-greenhouse.html>

### **Science Encyclopedia**

The greenhouse effect is the retention by the Earth's atmosphere in the form of heat some of the energy that arrives from the Sun as light. Certain gases, including carbon dioxide (CO<sub>2</sub>) and methane (CH<sub>4</sub>), are transparent to most of the wavelengths of light arriving from the Sun but are relatively opaque to infrared or heat radiation; thus, energy passes through the Earth's atmosphere on arrival, is converted to heat by absorption at the surface and in the atmosphere, and is not easily re-radiated into space. The same process is used to heat a solar greenhouse, only with glass, rather than gas, as the heat-trapping material.

<http://science.jrank.org/pages/3148/Greenhouse-Effect.html>

### **California Environmental Protection Agency**

Simply put, the greenhouse effect compares the earth and the atmosphere surrounding it to a greenhouse with glass panes. Plants in a greenhouse thrive because the glass panes keep the air inside at a fairly even temperature day and night, and throughout the four seasons of the year. Just as the glass lets heat from sunlight in and reduces the heat escaping, greenhouse gases and some particles in the atmosphere keep the Earth at a relatively even temperature.

<http://www.arb.ca.gov/cc/factsheets/ccbackground.pdf>

### **The University of Winnipeg**

As glass in a greenhouse traps heat inside, gases in the upper atmosphere trap some of the heat escaping the Earth, creating a greenhouse effect.

[http://theory.uwinnipeg.ca/mod\\_tech/node204.html](http://theory.uwinnipeg.ca/mod_tech/node204.html)

### **The University of the Western Cape, South Africa**

A greenhouse is made entirely of glass. When sunlight (shortwave radiation) strikes the glass, most of it passes through and warms up the plants, soil and air inside the greenhouse. As these objects warm up they give off heat, but these heat waves have a much longer wavelength than the incoming rays from the sun. This longwave radiation cannot easily pass through glass, it is re-radiated into the greenhouse, causing everything in it to heat up. Carbon dioxide is the pollutant most responsible for increased global warming.

<http://www.botany.uwc.ac.za/envfacts/facts/gwarming.htm>

### **U.S. Department of the Interior, U.S. Geological Survey**

The gases that encircle the Earth allow some of this heat to escape into space, but absorb some and reflect another portion back to the Earth. The process is similar in Mountain View, only, the greenhouse there is made of glass instead of gas.

[http://hvo.wr.usgs.gov/volcanowatch/1998/98\\_10\\_22.html](http://hvo.wr.usgs.gov/volcanowatch/1998/98_10_22.html)

### **The Institute for Educational Technology, Italy**

Just as it happens in a greenhouse where the function carbon dioxide performs in the atmosphere is played by glass-rafters, the sun's energy arrives down at the earth, where it is partially absorbed and partially reflected. Such reflected heat, however, is reflected again, by glass as for the greenhouse, by carbon dioxide as for the atmosphere, down on earth: it is as if a part of the heat were entrapped, thus determining a growth of temperature on the ground.

[http://www.itd.cnr.it/ge8/rivista/inglese/num\\_2/galil3.htm](http://www.itd.cnr.it/ge8/rivista/inglese/num_2/galil3.htm)

## **U.S. House of Representatives Select Committee on Energy Independence and Global Warming**

Just like the glass of a greenhouse traps warm air inside, certain gases in the atmosphere trap heat that would otherwise escape into space.

<http://globalwarming.house.gov/issues/globalwarming?id=0002>

### **The Austrian JI/CDM- Programme**

The Earth's atmosphere is comparable to a glass roof of a greenhouse: the short-wave solar radiation passes through nearly unhindered and warms the Earth's surface. From the Earth's surface, the short-wave radiation is partly absorbed and partly reflected back as long-wave thermal radiation. However, this long-wave thermal radiation cannot pass the atmosphere unhindered due to the greenhouse gases but is partly reflected back again to the Earth's surface. In absence of this natural greenhouse effect the average temperature on the Earth would not reach the present level of about plus 15 degrees Celsius, but about minus 18 degrees Celsius.

<http://www.ji-cdm-austria.at/en/portal/kyotoandclimatechange/ourclimate/greenhouseeffect/>

Originally supplied by Alan Siddons, this summary compiled by Hans Schreuder and after original posting in July 2011, this updated version, with all links checked for validity, posted 18 September 2012