

<http://epa.gov/climatechange/ endangerment/downloads/Instructions-comments.pdf>

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**Why Carbon Dioxide is not a pollutant and why there can be no temperature increasing greenhouse effect in our open atmosphere.**

By Hans Schreuder

<http://tech-know.eu/uploads/EPAInput.pdf>

Summary

The importance of this submission lies in the fact that the EPA needs to rapidly come to the conclusion that any and all hype about mankind's carbon dioxide emissions is based on the incorrect application of science. Carbon dioxide has a nil effect on the global climate and does not cause climate change in any way, shape or form. This submission will go against all the established interpretations, including those of many skeptical scientists, yet is based entirely upon the proper application of scientific principles, especially those of **observation based evidence**, none of which has yet been presented to cast doubt, in even the most circumstantial manner, upon the opposite of what is presented to you here.

Researchers in climatology should put aside their present work for a moment and focus their attention on the central and decisive subject of climatology. This is the extremely close correlation between the changes in the mean surface temperature and the small changes in the rotational velocity of the Earth in the past 150 years, which has been ignored by the mainstream climatologists. (See <http://www.fao.org/DOCREP/005/Y2787E/y2787e03.htm>)

***Almost everything in climatology follows from this one central phenomenon.***

By Dr. Gerhard Löbert, Munich. Physicist. Recipient of The Needle of Honor of German Aeronautics.

A lot of *obscurantism* has been thrown at the nature of radiant energy *in order* to make the weird propositions of greenhouse theory seem plausible. The unalterably downward flow of thermal energy is the very essence of the second law of thermodynamics, for instance, but academics will try to argue that the 2nd law of physics only applies to "whole systems," not to heat transfer in each and every particular.

That's obscurantism, a practice that's gotten so common in science that anyone who states a matter plainly is now suspected of being a fake. A sad irony, for it's been the academics, the *pros*, who have tripped all over themselves to explain and defend a theory that the evidence keeps contradicting. So what has this left us with? Just a sour attitude toward science that "if it's incomprehensible, it must be true."

If glass lets visible wavelengths of sunlight in but doesn't let invisible long-wavelengths (infrared) out, thus raising the temperature inside, then glass thermometers have been misleading us for centuries.

According to the theory, glass thermometers necessarily register an extra "greenhouse effect," not the true temperature.

(In reality, however, no extra heating would come about even IF the glass were trapping infrared. The thermometer would simply take longer to adjust to *changes* of temperature. But it would NOT record a higher-than-actual temperature. As a thermos demonstrates, trapping heat doesn't raise the temperature, it only sustains it.)

There is in fact no such mechanism as the greenhouse effect in our open atmosphere and neither carbon dioxide nor water vapor are so-called greenhouse gases.

## The Science

With no atmosphere at all, our moon is very hot in sunshine (over 100°C) and very cold in the shade (less than minus 150°C) (exact temps differ from zone to zone, but the ones given here illustrate the principle). With earth receiving as good as the same amount of solar irradiation, our atmosphere thus acts as a *cooling* medium during the hours of sunshine and a *blanket* during the hours of darkness (alarmists love the blanket analogy, using it to illustrate that the atmosphere is *warmer* during the day than it would be without one. But an actual blanket can at best maintain your body temperature, it can not give you a fever; it does not *make* you warmer, it just *keeps* you warmer ...).

Global warming (which has by now been reversed to pre-alarm days), global cooling and all climate change is caused by the daily revolutions of our earth around its own axis, throughout which time the varying amounts of heat gained during the day and similar variations of heat lost during the night make the weather what it is: ranging from plus 50°C to minus 50°C (even more extreme in places), unpredictable beyond a few days (unless based on solar observations) and at times violent or totally quiet. That's quite apart from the seasonal differences caused by the annual trip around the sun and the varying distance that our planet revolves around our sun and we're not even considering even greater forces of influence.

### **Issue #1: What heats an actual greenhouse during the day?**

An actual greenhouse, whether made from glass or plastic sheeting, reaches higher temperatures inside than outside due to the restriction put on the internal air mass to disperse its acquired heat within the rest of the *open* atmosphere. The air mass in turn has gained its heat from the contents of the greenhouse, such as the soil or other ground cover material and all other objects within the space of the actual greenhouse. The contents of the greenhouse in turn gain their heat from direct sun light, which is made up of a full spectrum of electro-magnetic radiation including infrared, which is absorbed by the contents. Air is hardly receptive to direct solar radiation (or any other radiation, else radio, radar, TV, mobiles, microwave ovens etc. etc. would not work) but is receptive to gaining or losing heat by means of conduction which in turn causes convection, carrying heat to ever greater heights - seldom the other way around.

### **Issue #2. What is a greenhouse gas?**

The only true "greenhouse gas" then is air itself (oxygen and nitrogen). Gases such as water vapor and carbon dioxide have gained the reputation of being "greenhouse gases" (GHGs) because they do react to radiation at various frequencies and thus gain heat directly from sunlight as well as via conduction. In laboratory tests this means that any enclosed space of air heats up more when there are more of these GHGs present in the space of the *enclosure* of the experiment. But there is no experiment possible that mimics the open atmosphere, by definition!

In the open atmosphere, the so-called GHGs actually work to *increase* the scattering of any solar heat, quite the opposite of what we are led to believe. Imagine an actual greenhouse with low humidity and another one with high humidity (any difference in level will prove the point). Actual experiments have proven that a greenhouse with lower humidity takes less energy to heat. This is obvious as water vapor, a celebrated GHG, quite literally absorbs energy *without warming the air that's holding it* - quite the opposite of what we are led to believe, yet again. Carbon dioxide does not have the ability to absorb energy like water vapor (or water or ice for that matter). See below for further information about absorption.

Carbon dioxide is not a greenhouse gas; it does not absorb infrared nor near-infrared in a way that a sponge absorbs water and it does not transmit visible light - it is transparent to visible light.

Any energy that hits a carbon dioxide molecule will create, at the same instant, an equal and opposite emission spectrum, giving the casual observer the false illusion that energy has been "absorbed", whereas it has merely been scattered. Some of the energy that hits the carbon dioxide molecule may well increase the temperature of that molecule (depending on how the energy hits the alignment of the molecule), but that gained heat (theoretical only, can not be measured) will also be instantly dissipated by means of conduction with surrounding air molecules and at less than 400 parts in a million parts of air, those 400 carbon dioxide molecules would collectively need to reach several hundreds of degrees to warm the million parts of air by even a fraction of a degree, all at the same time, all over the world, all the time .... (all the while when the warmer air is rising and sharing its gained heat with ever higher altitude molecules of air and trace gases).

## The Pseudo Science

Apart from the climate change alarmists, many prominent skeptical scientists also make statements which are *opposite* to how the atmosphere works in reality, whilst some even make up new laws of physics to justify their incorrect assessments.

1. "... *all absorb heat radiation, and hence inhibit the cooling emission ...*"
2. "... *the earth is warmer than it would be in the absence of such gases.*"
3. "... *adding to the 'blanket' that is inhibiting the emission of heat radiation ...*"
4. "... *This causes the temperature of the earth to increase until equilibrium with the sun is reestablished.*"
5. "... *the 2nd Law applies to the behavior of whole systems, not to every part within a system.*"
6. "... *a photon being emitted by the cooler star doesn't stick its finger out to see how warm the surroundings are before it decides to leave.*"
7. ... "*The climate system is like the hot jar having an internal heating mechanism (the sun), but its ability to cool is reduced by its surroundings, which tend to insulate it.*"
8. ... "*In contrast, the infrared atmospheric greenhouse effect instead slows the rate at which the atmosphere cools radiatively, not convectively.*"
9. ... "*if there were only radiative heat transfer, the greenhouse effect would warm the Earth to about seventy-seven degrees centigrade rather than to fifteen degrees centigrade.*"
10. ... "*the sun shines on the top of the atmosphere, not the surface, and the emission of energy also comes from the top of the atmosphere, not the surface.*"

1. There is no physical mechanism by which a gas can absorb energy without at the same instant creating an equal and opposite emission spectrum and in the open atmosphere of our planet there is in any case nowhere for energy to hide, other than in ice, water and water vapour. Carbon dioxide can not absorb and preserve energy. At no stage is cooling prevented and even if it was, that would not increase the originally achieved maximum temperature. A blanket can at best *maintain* your body temperature, it can not add heat and give you a fever; it does not *make* you warmer, it just *keeps* you warmer.

2. Quite the opposite. The earth would be *warmer* if there was to be *no* water vapour in the atmosphere and by some margin (but only during the hours of sunshine of course). Observational evidence can be seen on a daily basis when comparing maximum temperatures in deserts that have coastal fringes (e.g. Sahara, Namib, Atacama), where it will be seen that there is a direct link between humidity and maximum as well as minimum daily temperatures. *Absence* of water vapour allows more of the sun's radiation to reach the ground and thus create a *warmer* earth locally when compared to an atmosphere that holds greater water vapour and is at the same latitude. Conversely, the absence of water vapour will allow greater cooling at night whilst high humidity areas benefit from greater preservation of warmth, a sort-of "greenhouse effect" in reverse.

3. That statement only holds true in high humidity areas and then only during the hours of darkness. The presence of water vapour creates a *cooler* daytime atmosphere and a less cold (*not warmer*) atmosphere at night. *At no stage is heat added nor created by the presence of water vapour or any other substance.* In any case, earth is already enveloped in the perfect "blanket": the vacuum of space - void of matter and having no temperature of itself, we could not ask for a better insulation. As per #1 above, a blanket can at best maintain your body temperature, it can not give you a fever and neither can a thermos make its contents warmer.

4. If ever there was an equilibrium between temperatures on earth and solar irradiance, the weather as we know it would cease to be. As is, solar radiation often varies from mile to mile along any longitude and latitude that anyone could ever imagine and all climate related "averages" are purely mathematical entities that bear no relation to the actual situation at almost any point on our planet other than perhaps the coldest areas of the poles during their respective long periods of winter darkness when there is not enough energy entering the local climate system to create the greater variations witnessed in more temperate climate zones. Just looking at the maximum and

minimum temperature of a particular place in a moderate climate zone and deriving an "average daily temperature" from such observations bears no resemblance to the ever-changing temperatures throughout the day. In between the observed maximum and minimum temperature of the day, it could have hailed or snowed or rained or have been overcast in several episodes. The struggle to reach equilibrium is what makes the weather so unpredictable and equilibrium can never be reached.

5. A brand new Law of Physics here, where parts within a system can behave contrary to the 2nd Law but the whole obeys. Only in "climate science" can such chicanery be accepted as academic judgement. Thermal energy cannot flow into itself, only into something that has less energy than itself. That's a law of nature, not a law of "systems".

6. A photon will not be able to raise the temperature of the object it is hitting if that object is at an equal or higher energy level. In IPCC graphics, that photon warms the earth and the process starts again - quite impossible (see IPCC graphic below). As per #5 above: Thermal energy cannot flow into itself, only into something that has less energy than itself. That's a law of nature, not a law of "systems".

7. Thermal insulation in the setting of our open atmosphere does not make the system one degree warmer than it would be without that insulation (the widely accepted "insulation" being the "greenhouse gases", not the air itself (nitrogen, oxygen)). For a given energy input, a resultant maximum temperature is achieved and regardless of the amount or type of insulation, that maximum temperature can not be increased. As per #1 above, a blanket can at best maintain your body temperature, it can not give you a fever and a thermos does not make the contents warmer, it merely slows down the rate of cooling.

8. An infrared "greenhouse effect" (whatever next?) would need "greenhouse gases" to hang on to received radiation and only water has that ability which is best seen during the hours of darkness, not whilst the sun is adding energy, when in fact water and water vapour keep soaking up energy and prevent the atmosphere from warming up as much as it would without water and water vapour (quite the opposite to what is being proposed).

9. A 77° average surface temperature due to the purely radiative impact of the greenhouse effect? Radiant units do NOT combine in reality — 101 W/m<sup>2</sup> directed at a blackbody that's radiating 100 W/m<sup>2</sup> raises its energy to 101 W/m<sup>2</sup>, not 201 — but in the much heralded Kiehl-Trenberth budget they DO combine. Let's look at the numbers, then. According to the accepted Kiehl-Trenberth radiation budget (see below), the earth's surface averages 168 W/m<sup>2</sup> for solar absorption. K-T has the surface lose much of that energy by convection and evapotranspiration, though, so that 324 W/m<sup>2</sup> of back-radiated power brings the surface up to 390 W/m<sup>2</sup>, corresponding to 15°. But in this case we'll reduce convective and evapotranspirative heat loss to zero, which leaves us with the original 168 W/m<sup>2</sup>. Now, within these parameters, how much extra back-radiation is required to bring the surface up to 77°? SIX HUNDRED EIGHTY FOUR W/m<sup>2</sup>, for a total of EIGHT HUNDRED FIFTY TWO W/m<sup>2</sup>, which corresponds to 77°.

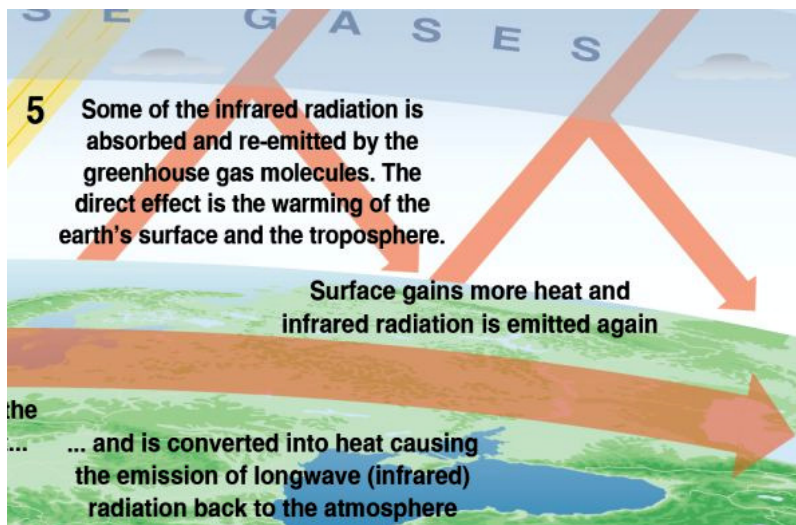
(Bonus question: If the greenhouse effect generates enough radiative power to raise the earth's temperature to 77°, but most of this heat is dissipated, then why is there no sign of this excess energy being blasted away from the earth? Satellites only see the earth emitting 240 W/m<sup>2</sup>.)

The average solar irradiance for a blackbody earth — one that absorbs every photon the sun can provide — is 342 W/m<sup>2</sup>, corresponding to an average temperature of 5.5°. Yet here illustrious academia estimates conjure 852 W/m<sup>2</sup> out of nothing ....

10. "Radiative equilibrium" is an arbitrary construct to BEGIN with. You just subtract a planet's reflectance from the available irradiance and divide by 4. **That's IT.** There ARE no other steps. Since Earth reflects about 30% of sunlight, then, 1368 W/m<sup>2</sup> × 0.7 = 957.6 W/m<sup>2</sup>. Dividing by 4 gives you 239.4 W/m<sup>2</sup>, so that becomes earth's equilibrium figure, which corresponds to a temperature of 255Kelvin. Now, is the earth's average SURFACE temperature 255K? No, it's warmer. So you say that "somewhere up there" is where earth's radiative equilibrium is to be found, somewhere in the troposphere. It's all so silly. But once you convince yourself that the earth's temperature is NOT principally determined by the surface, you can convince yourself that it IS determined by the atmosphere and that "greenhouse gases" RAISE the "equilibrium point" higher and higher. And as you see, *you can even go as far as asserting that the surface absorbs no sunlight.*

## The Settled Science Unsettled

In spectroscopy, an absorption spectrum does not mean that energy is actually absorbed; it means that an equal and opposite emission spectrum is created, indicating that intercepted energy is scattered and re-radiated at different frequencies. Looking only at the absorption spectrum gives the wrong impression, as so clearly illustrated by the overall emission spectrum of earth as seen by the satellites. Radiation input from our sun equals emitted radiation from the earth back into space, in expected accordance with the basic and well-proven laws of physics. No energy is lost nor created, whereas the widely and incorrectly accepted "greenhouse" mechanism has it that carbon dioxide somehow re-radiates the same amount of infrared energy towards space as well as back to earth, thus apparently doubling the energy quantity - quite an impossibility yet described in great detail by the greatest institutions on earth - see below for the latest list. The UN's IPCC graph reproduced below is the classic and accepted view of the mechanism by which the earth gains heat, but this mechanism can not exist; if it did, our energy problems would have been solved long ago by the engineering community: "*Surface gains more heat and infrared radiation is emitted again*" - if only that were true!

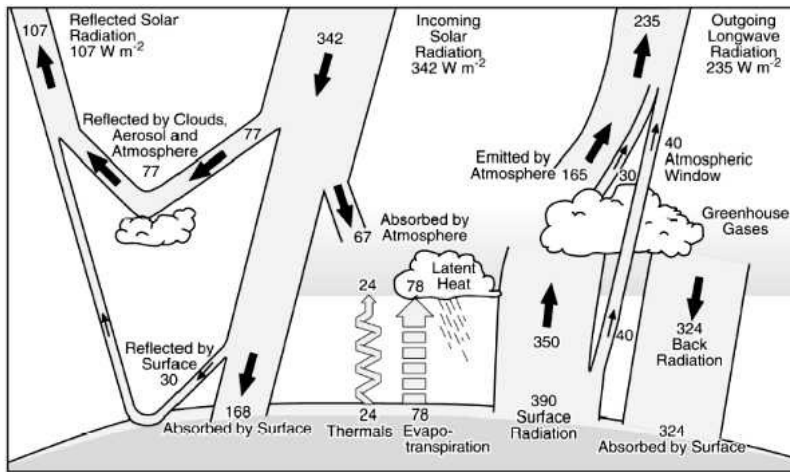


Whatever method of heat transfer is used, net energy flow will only take place if the receiver is cooler than the emitter, unless external energy is applied as is the case in refrigerators, for example. With earth emitting infrared energy and carbon dioxide molecules re-emitting some of this energy back to earth, it is absolutely physically impossible for this re-radiated energy to warm the earth again. If that was not the case, the basic three laws of physics would need to be rewritten. Yet this re-radiation of infrared is the very rock upon which the entire global warming panic rests. All who read this Submission would do well to study the information on this page: <http://jennifermarohasy.com/blog/2009/04/on-the-first-principles-of-heat-transfer-a-note-from-alan-siddons/>

The world has all too easily accepted greenhouse effect explanations which confuse the familiar reduction of CONVECTIVE heat loss with the production of radiative heat GAIN. A physical greenhouse merely slows down the normal cooling rate by limiting the volume of air in which heat loss is occurring. So here's a key feature to notice as the argument jumps to the atmospheric theory of a greenhouse effect, that proponents will concede that the atmosphere provides no physical canopy, no actual pane of glass or blanket that confines heated air.

What's left, then?

Radiant energy itself. Rather than confining a fixed number of vibrating air molecules, the atmospheric "blanket" they're arguing for is a RADIATIVE canopy under which infrared photons accumulate, and this extra energy buzzing around raises the temperature of all bodies under the canopy. Thus the greenhouse effect amounts to a "light battery" or generator that is continuously being fed by solar radiation, continuously being discharged at an EQUAL rate by terrestrial radiation, and yet is continuously AMPLIFYING the radiant energy inside it.



As the Kiehl-Trenberth model shows, 235 units go in, 235 go out, and 324 are generated in between.

So the question naturally arises, "Is this even POSSIBLE?" Can photons of LIGHT be collected and multiplied like this? Can you turn on a flashlight, say, put it inside a reflective thermos, close the lid, and convince yourself that a million watts of radiative power will eventually be generated if you wait long enough? For that matter, has anyone ever INVENTED a device that captures light, like capturing wind in a bottle?

**Or do the laws of thermodynamics forbid this? You decide.**

We need to realise that blackbody equations are unable to predict a physical body's temperature to begin with — minus 18°C for the earth is a meaningless figure. No physical object radiates at a blackbody's rate, for one thing. And why? Because a real body has DEPTH: its response to light is not merely to heat up and immediately radiate the same amount in turn but to conductively store the heat it acquires. Considering that the oceans alone are able to hold and circulate heat for decades, when do THEY reach a point of equilibrium with the radiation it has absorbed? Yet radiant energy budgets give it a year.

Who will get the message about the non-existence of an atmospheric greenhouse effect through to the academics, the powers that be at EPA and most of the world's acknowledged institutions, NASA included, who all describe this non-existent "greenhouse effect" with its "greenhouse gases" in a language that mirrors the once celebrated justification for the existence of phlogiston?

### The Conclusion

To quote from one of the best peer-reviewed papers on the subject of our atmosphere and its non-existent "greenhouse effect" filled with non-existent "greenhouse gases":

"The atmospheric greenhouse effect, an idea that many authors trace back to the traditional works of Fourier (1824), Tyndall (1861), and Arrhenius (1896), and which is still supported in global climatology, essentially describes a fictitious mechanism, in which a planetary atmosphere acts as a heat pump driven by an environment that is *radiatively* interacting with but radiatively equilibrated to the atmospheric system. According to the second law of thermodynamics, such a planetary machine can never exist. Nevertheless, in almost all texts of global climatology and in a widespread secondary literature, it is taken for granted that such a mechanism is real and stands on a firm scientific foundation. In this paper, the popular conjecture is analyzed and the underlying physical principles are clarified. By showing that (a) there are no common physical laws between the warming phenomenon in glass houses and the fictitious atmospheric greenhouse effects, (b) there are no calculations to determine an average surface temperature of a planet, (c) the frequently mentioned difference of 33 degrees C is a meaningless number calculated wrongly, (d) the formulas of cavity radiation are used inappropriately, (e) the assumption of a radiative balance is unphysical, (f) thermal conductivity and friction must not be set to zero, the atmospheric greenhouse conjecture is falsified." ([http://arxiv.org/PS\\_cache/arxiv/pdf/0707/0707.1161v4.pdf](http://arxiv.org/PS_cache/arxiv/pdf/0707/0707.1161v4.pdf))

*There is not one piece of evidence that supports the notion that carbon dioxide causes warming in the setting of our open atmosphere and in any case the physics involved in assessing a material's property will indicate that carbon dioxide, just like water vapor, is in fact a cooling agent (fossil fuel-fired power stations with their massive cooling towers are a classic illustration of the cooling power of water), an aid in the scattering of energy. At least water vapor has the ability to absorb energy and hang onto it (latent heat); carbon dioxide has no such ability.*

In the reality of our open atmosphere it is thus the case that the only actual "greenhouse gas" is air itself (oxygen and nitrogen), whose presence allows an actual greenhouse to warm up. But quite opposite to an actual greenhouse, during the hours of sunshine it is this same air that keeps our *open atmosphere cooler* (compare the moon), whilst during the hours of darkness it prevents the atmosphere from *cooling* too rapidly (compare the moon). At no stage is our atmosphere *warmer* than it could possibly be due to the presence of water vapor, or carbon dioxide for that matter.

***Trapped heat can never make the source of the heat hotter than it was in the first place - how could it?***

#### The Near Total Deception

"Human-generated greenhouse gases are warming the earth but not as much as alarmists say" never was a good strategy for winning the debate, and it's probably too late now. The only battle that remains is trying to limit the extent of emission controls on practical grounds, but the principle of emission controls has already been conceded.

Dissenters should have just stuck with the evidence: there is no sign of CO<sub>2</sub>-caused warming *at all*, the "well established physics" of greenhouse theory be damned."

With thanks to Alan Siddons for the list and major input into the above arguments.

Here is a partial list of respected organizations, institutions and authorities that perpetuate the myth. [http://www.ilovemycarbon dioxide.com/pdf/Greenhouse\\_Effect\\_Poppycock\\_updated.pdf](http://www.ilovemycarbon dioxide.com/pdf/Greenhouse_Effect_Poppycock_updated.pdf)

#### **NASA**

There are many greenhouse gases, but the most abundant greenhouse gases are water vapor and carbon dioxide. Shortwave radiation from the sun passes through greenhouse gases, but longwave radiation is absorbed by them.

Greenhouse gases absorb longwave radiation that is emitted by the surface of the earth.

Subsequently, they re-emit the energy as longwave radiation in all directions. About half of the re-emitted longwave radiation does escape into space, and contributes to the planet's radiative equilibrium.

About half of the longwave radiation emitted by the gases is directed back toward the surface of the earth. As a result, a continual exchange of longwave radiation takes place between the surface of the earth and the atmosphere above it.

The longwave radiation contained in this exchange causes the warming effect known as the greenhouse effect.

This phenomenon is known as the greenhouse effect because, like the glass on a greenhouse, the atmosphere traps some of the energy beneath it.

[http://earthobservatory.nasa.gov/Laboratory/PlanetEarthScience/GlobalWarming/GW\\_Movie3.html](http://earthobservatory.nasa.gov/Laboratory/PlanetEarthScience/GlobalWarming/GW_Movie3.html)

#### **National Oceanic and Atmospheric Administration (NOAA)**

The greenhouse effect occurs when the atmosphere of a planet acts much like the glass in a greenhouse. Like the greenhouse glass, the atmosphere allows visible solar energy to pass through, but it also prevents some energy from radiating back out into space. The greenhouse effect insures that the surface of a planet is much warmer than interplanetary space because the atmosphere traps heat in the same way a greenhouse traps heat. Certain gases in our atmosphere, called greenhouse gases, tend to reflect radiant energy from the Earth's atmosphere back to the Earth's surface, improving the atmosphere's ability to trap heat.

<http://www.fsl.noaa.gov/outreach/education/sam1/Activity5.html>

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[http://www.fsl.noaa.gov/outreach/education/samii/SAMII\\_Act6.pdf](http://www.fsl.noaa.gov/outreach/education/samii/SAMII_Act6.pdf)

### **Draft of IPCC Fourth Assessment Report**

The name "greenhouse effect" comes from the analogy with a greenhouse made of glass which allows sunlight to enter but restricts infrared energy from leaving, thus warming the interior. [...] The natural greenhouse effect is neither harmful nor mysterious. Its basic principles are well-understood and are firmly based on fundamental physics.

[http://ipcc-wg1.ucar.edu/wg1/Comments/drafts/AR4WG1\\_Ch01\\_FOD.pdf](http://ipcc-wg1.ucar.edu/wg1/Comments/drafts/AR4WG1_Ch01_FOD.pdf)

### **The National Oceanic and Atmospheric Administration (NOAA)**

What is the Greenhouse Effect?

The glass walls and roof of a greenhouse allow most of the sun's light in, but do not allow most of the heat to escape. This causes the temperature inside the greenhouse to be warmer than outside. The earth's atmosphere, and in particular carbon dioxide (CO<sub>2</sub>) and water vapor (H<sub>2</sub>O), acts like a greenhouse, trapping heat and making the earth warmer.

<http://wdc.obs-mip.fr/globalwarming/greeneffect.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 Atmosphere, Climate & Environment (ACE) Information Programme (UK)**

The greenhouse gases in the atmosphere act in a similar way to panes of glass in a greenhouse (see Figure 2 below). Radiation from the Sun (consisting mainly of visible and ultraviolet (UV) radiation) can travel through glass into the greenhouse. When this radiation is absorbed by objects in the greenhouse, it is re-radiated as infrared (IR) radiation, or heat. This heat cannot escape through the glass, so the greenhouse warms up.

[http://www.ace.mmu.ac.uk/Resources/Teaching\\_Packs/Key\\_Stage\\_4/Climate\\_Change/01p.html](http://www.ace.mmu.ac.uk/Resources/Teaching_Packs/Key_Stage_4/Climate_Change/01p.html)

(But look at the self-contradictory illustration! AS)

### **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)



### **University of Michigan**

The "greenhouse effect" is the heating of the Earth due to the presence of greenhouse gases. It is named this way because of a similar effect produced by the glass panes of a greenhouse. Shorter-wavelength solar radiation from the sun passes through Earth's atmosphere, then is absorbed by the surface of the Earth, causing it to warm. Part of the absorbed energy is then reradiated back to the atmosphere as long wave infrared radiation. Little of this long wave radiation escapes back into space; the radiation cannot pass through the greenhouse gases in the atmosphere. The greenhouse gases selectively transmit the infrared waves, trapping some and allowing some to pass through into space. The greenhouse gases absorb these waves and reemit the waves downward, causing the lower atmosphere to warm.

<http://www.umich.edu/~gs265/society/greenhouse.htm>

### **Cary Academy, North Carolina**

The term "greenhouse effect" describes how the gasses in Earth's atmosphere retain the radiant energy from the sun instead of letting it fly back out into space. The glass of the greenhouse works the same way. In short, the gasses in the atmosphere let energy in and don't let all the energy back out.

[http://web1.caryacademy.org/chemistry/rushin/StudentProjects/CompoundWebSites/2000/CarbonDioxide/greenhouse\\_effect.htm](http://web1.caryacademy.org/chemistry/rushin/StudentProjects/CompoundWebSites/2000/CarbonDioxide/greenhouse_effect.htm)

### **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>

### **The University of Colorado at Colorado Springs**

3. greenhouse effect

a. transmission can depend on wavelength of radiation

b. glass

1) readily transmits shortwave radiation but not longwave radiation

2) that's why heat builds up in a closed automobile

c. greenhouse effect: the trapping of heat in the lower troposphere because of differential transmissivity for short and long waves

1) greenhouse gases readily transmit incoming shortwave radiation from the sun but do not easily transmit outgoing longwave terrestrial radiation

2) most important greenhouse gases: water vapor and CO<sub>2</sub>

3) terrestrial radiation is absorbed by greenhouse gases and reradiated back toward the surface

<http://web.uccs.edu/geogenvs/ges100-online/Chapt4.doc>

### **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>

### **Grandview High School, Missouri**

Have you ever walked through a green house in late January? The temperature on the outside may have been quite cold but the temperature on the inside might have felt almost balmy!

This is not because of a giant furnace located in the back of the green house, but because of the green house effect. When rays from the sun travel through the glass, it strikes all materials within the greenhouse. Because of this, the object

s will heat up as does everything that comes in contact with the suns infrared rays (heat). These rays generally bounce back towards where they came from unless there is a barrier to keep them in. Yes that's right, a barrier such as glass!

*The Green House Effect*

Once the infrared rays bounce off of the objects contained in the green house, some of the rays get trapped inside of the greenhouse because of the glass. The rays then bounce off of the glass and back towards all of the objects in the green house. As the rays of infrared radiation (found in sunlight) bounce all over the greenhouse, the greenhouse heats up.

<http://www.csd4.k12.mo.us/egits/MAP%20TAP/Andy%20Leech/greenhouse.ppt>

### **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>

### **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.

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

### **Department of Environmental Affairs and Tourism, South Africa**

Energy coming from the sun passes through the atmosphere and warms the Earth - but the emitted infra-red radiation coming from the Earth's surface is partly absorbed by gases in the atmosphere and some of it is re-emitted downwards, further warming the surface of the Earth and the lower levels of the atmosphere. This effect has been called the 'greenhouse effect' because of a similar effect caused by glass in a greenhouse: it lets sunlight into the greenhouse but in turn traps a portion of infra-red radiation (heat) inside the greenhouse.

[http://www.environment.gov.za/ClimateChange2005/Greenhouse\\_Gases\\_and\\_the\\_Greenhouse\\_Effect.htm](http://www.environment.gov.za/ClimateChange2005/Greenhouse_Gases_and_the_Greenhouse_Effect.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)

### **University of Cincinnati College of Engineering, Ohio**

Greenhouses are much warmer inside than the air is outside because the glass is transparent to light and allows short-wavelength light to pass through and heat the contents of the greenhouse. It also reflects back the longer wavelength heat radiating within the greenhouse, thus preventing it from passing back out.

In a glass greenhouse, heat builds up and gets trapped due to presence of carbon dioxide and other heat trapping gases in the upper atmosphere. CO<sub>2</sub> is analogous to glass.

<http://www.eng.uc.edu/~pbishop/Chapter-3-Slides.ppt>

### **Miami-Dade Environmental Resources Department, Florida**

The phenomenon gets its name from the similarity to a garden greenhouse. Visible light passes through the glass ceiling and walls of a greenhouse. Some of the light is absorbed, some is reflected back, and a portion of it is radiated out as heat. Glass, like carbon dioxide (CO<sub>2</sub>) and other "greenhouse gases" doesn't allow heat to escape back out.

[http://www.miamidade.gov/derm/climate\\_change\\_greenhouse\\_effect.asp](http://www.miamidade.gov/derm/climate_change_greenhouse_effect.asp)

### **University of Washington, School of Oceanography**

Greenhouse effect: a blanket of water vapor and CO<sub>2</sub> and methane CH<sub>4</sub> traps the upward infra-red 'long-wave' or 'heat' radiation. The pane-of-glass model assumes total absorption of upward infrared waves yet no absorption of visible light..both of which are not completely accurate, hence the numbers are not applicable to the real atmosphere, yet demonstrate the effect.

— incoming solar radiation, I in watts/meter<sup>2</sup>

— some is simply reflected back to space the rest is absorbed by ocean and land and atmosphere yet re-radiated as infrared heat, both upward and downward (red arrows)

— The net effect of the 'blanket' of atmosphere is to have more downward radiation toward the Earth's surface than just the incident sunlight.

[http://www.ocean.washington.edu/courses/as222d/lecture2\(6\)-slides07.pdf](http://www.ocean.washington.edu/courses/as222d/lecture2(6)-slides07.pdf)

### **Saskatchewan Schools and School Divisions, Canada**

The heat-trapping gases in the atmosphere behave like the glass of a greenhouse. They let much of the Sun's rays in, but keep most of that heat from directly escaping. This is why they are called greenhouse gases. Without these gases, heat energy absorbed and reflected from the Earth's surface would easily radiate back out to space, leaving the planet with an inhospitable temperature close to -19°C (2°F), instead of the present average surface temperature of 15°C (59°F).

[http://www.saskschools.ca/~greenall/scienceprojects/greenhouse\\_effect.htm](http://www.saskschools.ca/~greenall/scienceprojects/greenhouse_effect.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/>

### **Torfaen County, Environment and Planning, Wales**

Some of the energy from the sun is trapped inside our atmosphere as it is reflected back from the earth towards space. This natural process is called the greenhouse effect, as the atmosphere acts like the glass walls of a greenhouse, which allows the sun's rays to enter but keeps the heat in.

<http://www.torfaen.gov.uk/EnvironmentAndPlanning/EnergyEfficiencyAdviceAndAssessment/ClimateChange/GreenhouseEffect.aspx>

### **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>

### **Fort Lewis College, Physics Department, Colorado**

This partial trapping of solar radiation is known as the greenhouse effect. The name comes from the fact that a very similar process operates in a greenhouse. Sunlight passes relatively unhindered through glass panes, but much of the infrared radiation reemitted by the plants is blocked by the glass and cannot get out. Consequently, the interior of the greenhouse heats up, and flowers, fruits, and vegetables can grow even on cold wintry days.

<http://physics.fortlewis.edu/Astronomy/astronomy%20today/CHAISSON/AT307/HTML/AT30702.HTM>

### **The National Assessment Synthesis Team, US Global Change Research Program**

The composition of the atmosphere is particularly important because certain gases (including water vapor, carbon dioxide, methane, halocarbons, ozone, and nitrous oxide) absorb heat radiated from the Earth's surface. As the atmosphere warms, it in turn radiates heat back to the surface, to create what is commonly called the "greenhouse effect."

<http://www.usgcrp.gov/usgcrp/Library/nationalassessment/overviewclimate.htm>

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[www.ilovemycarbon dioxide.com/carbondioxide.html](http://www.ilovemycarbon dioxide.com/carbondioxide.html)

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