A Seventh Demonstration of The "Green Plate" Effect

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There have been many recent claims that there is no Green House Effect in the Earth's atmosphere due to CO2. These claims are based on a foundational argument that the Second Law of Thermodynamics does not allow energy to be transferred from a body with lower temperature to one at a higher temperature. This is generally true for conduction and convection, absent other energy input, however the effects of radiative energy transfer can result in a situation which gives the appearance that this is occurring, when something else is happening.

All solids and fluids emit infrared radiation as a function of their temperature and the rate of emission is a function of the fourth power of absolute temperature. For gases, this emission only occurs in discrete frequency "bands" and the upward and downward emissions in these bands for the various gases within the atmosphere result in the poorly named Green House Effect. The process involves a body which is supplied energy at a constant rate and emits infrared radiation as a result, which then is warmed further by the addition of an intervening body between the warmed body and the colder surroundings. This warming is caused by the absorption of energy emitted by the intervening colder body, so called back radiation, which has a net effect of adding to the fixed energy flow into the higher temperature body. A mathematical model of this effect was provided by the blogger known as Eli Rabbit (1). This analysis was named the "Green Plate Model", which has since been the subject of considerable disagreement by those who question the science of Global Warming. Three earlier demonstrations also presented visualizations of the effect (2).

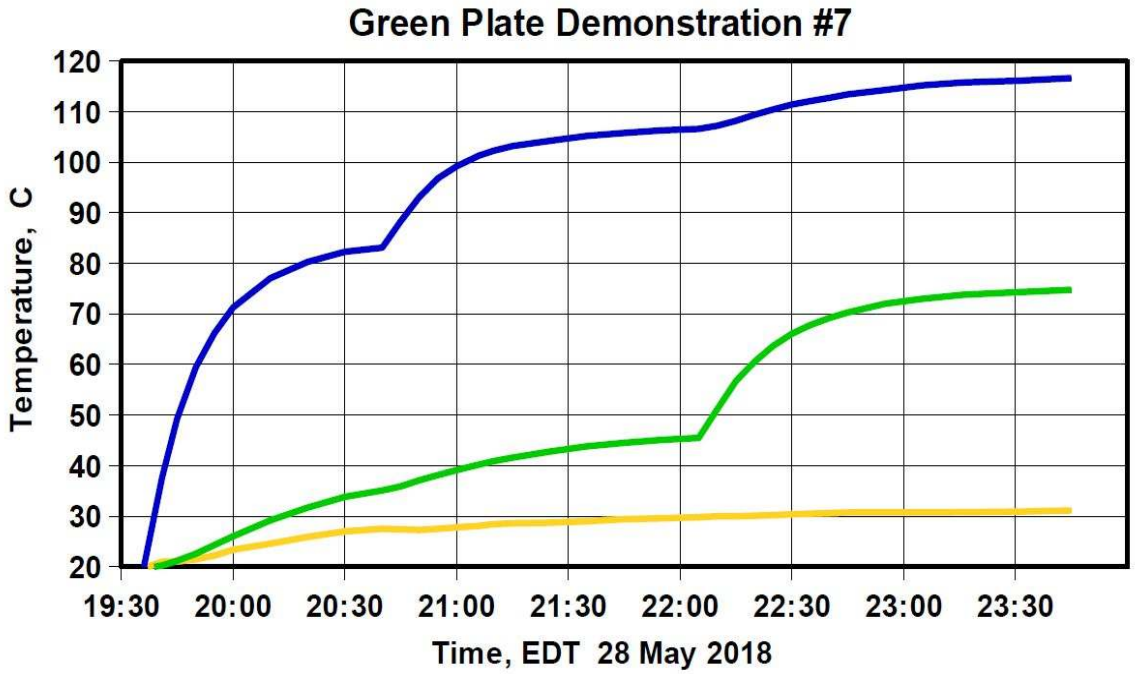
With the previous demonstrations, the effect was shown during operation under normal atmospheric conditions and convection could cool the heated plate. In fact, the convection was increased thru the use of a fan, which was intended to decouple possible convective interference which might have resulted when the "Green" plate (a cookie sheet) was placed above the high temperature "Blue" plate, placed on top of an electric stove element. The resulting demonstration was criticized because of the potential for convective interference, even though the third demonstration conclusively showed that such interference, if any, was trivial.

For this demonstration, a physical model of the Green Plate mathematical model was constructed which could be placed within a ball jar. The goal was to show the effect of adding an Green Plate near to a heated Blue Plate under vacuum conditions. As may be seen in the top panels of the attached photos, two plates were constructed of aluminum cut from scrap 1/8 x 2 inch angle. Four pieces were used for each plate, 2 horizontal and 2 vertical, joined by epoxy adhesive. A channel was formed in each plate to allow the placement of a thermocouple in the middle. A frame was constructed to support the plates, the upper (Blue) plate being held in place by thin copper wire and the lower suspended from 2 pulleys on the frame. The lower (Green) plate was attached to threads which were connected to a balance weight made of steel pipe filled with lead, the weight of which was adjusted to be slightly less than that of the suspended plate. With this arrangement, the Green plate could be moved from the lower position upwards next to the Blue plate using a small magnet outside the bell jar as may be seen in the photos.

These photos display the latest implementation of the device, which has been upgraded to address problems with vacuum leakage. This version includes a 1/2 inch thick polycarbonate plate and different thermocouples with improved sealing are now installed, as the previous high temperature thermocouples appeared to leak thru the fiberglass braid insulation. Also, a ½ inch tube is used instead of the red HVAC tube in the fourth photo. A two stage vacuum pump capable of achieving a pressure of 25 microns was used and a CPS model VG100a HVAC vacuum gage attached to the inlet port was used to measure pressure. A third thermocouple was attached to the outside of the bell jar insulated with a small piece of foam rubber at the lower edge behind the Green plate, as can be seen in the fourth photo. A 300 watt halogen work light was used to provide energy to heat the Blue plate, with baffles placed to limit illumination to just the Blue plate. One baffle on the outside of the bell jar is made of 1/2" styrofoam covered with reflective mylar, seen in the fourth photo, and a second, made of aluminum tape, shields the Green plate in it's lowered position, seen in the second and third photos.

For this run, the light was switched on at 19:36 EDT with the bell jar at atmospheric pressure. After the blue plate temperature stabilized at 20:40 EDT, the vacuum pump was switched on. The gage showed that the pressure within the ball jar reached 100 microns within 8 minutes and stabilized of 50 microns. With the application of a vacuum, the temperature of the Blue plate increased 23.5 C, while the Green plate lagged behind. After the temperature of the Blue Plate stabilized again at 22:05 EDT, the Green plate was raised into position next to the Blue plate.

The graph below shows the temperature history of the run, the Blue plate (shown in blue), the Green plate (shown in green) and the bell jar (shown in orange). As may be seen in the graph, the temperature of the Blue plate begun to increase after the Green plate was raised into position, due to the back radiation from the Green plate. The Blue plate warmed to a higher equilibrium temperature by 23:45 EDT, increasing 10.0 C as the Green plate temperature increased 29.3 C.



I contend that this demonstration and the previous versions (2,3) provide clear evidence that the Green Plate model correctly describes reality, which is that IR thermal radiation from a cooler body can cause a warmer body to exhibit an increase in temperature. These results agree with the widely accepted results from text book physics, such as the mathematically model presented by Eli Rabbit in his blog post (1). These demonstrations refute claims that Infrared "Back Radiation" violates the Second Law of Thermodynamics because energy flowing from a hot body can result in warming of that body when there is another body situated between the hot body and the colder surroundings.

NOTES:

1. http://rabett.blogspot.com/2017/10/an-evergreen-of-denial-is-that-colder.html
2. Results of earlier "cookie sheet" demonstrations are available at these links:
   https://app.box.com/s/wcego4vf3hevzrah43alw83icxgm55xk
   https://app.box.com/s/ljxuos03dko48iab1292cgmksqbpax4n
   https://app.box.com/s/al1duvn2aq3blkyqecivh5y3yyvlno4i
3. Earlier versions of this demonstration using an evacuated bell jar may be found at:
   https://app.box.com/s/gjjt0liv74m386wc2cj0qbhlfsmljy2q
   https://app.box.com/s/j6i1jb1huzeruljhigmkie6qdxy0quaz
   https://app.box.com/s/w6gzam9tbk9oa1h8geio1p4lnufe0yrv