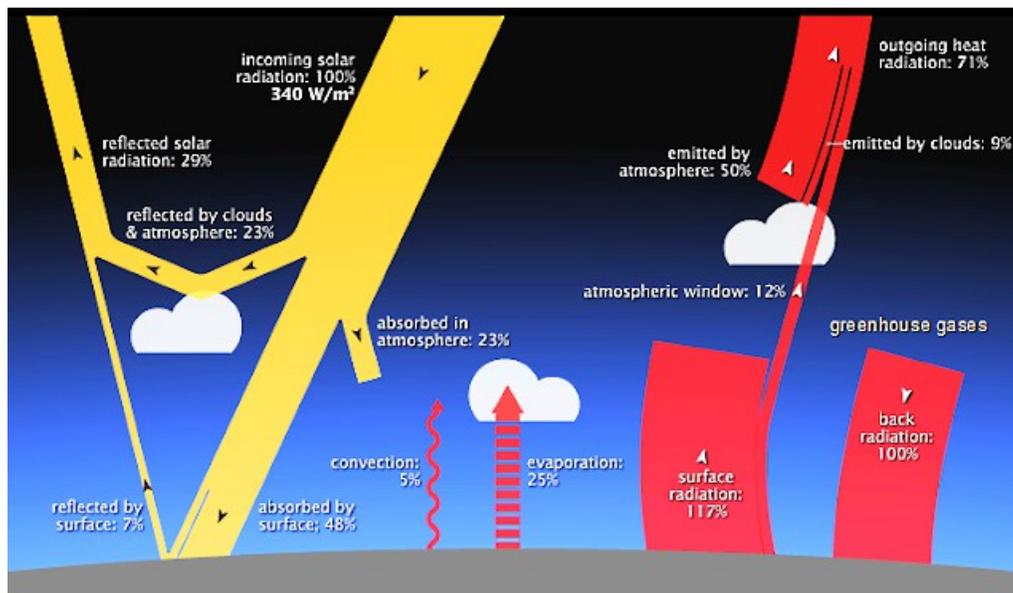


A Summary of Some of the Physics Errors of the NASA Earth Energy Budget

Written by Charles R. Anderson, Ph.D.

I have previously discussed many errors in the physics of the NASA Earth Energy Budget which are critical to the argument backing the catastrophic man-made global warming hypothesis. These errors are essentially the same in the Earth Energy Budgets of the UN IPCC reports, though there are minor variations in the values of the heat transport powers in the Earth system consisting of its surface and its atmosphere. The NASA Earth Energy Budget is shown below, where the heat transport is denoted as a percentage of the average solar insolation at the top of the atmosphere:



Among these errors are:

- The transport of heat in the atmosphere does not address the critical role in the temperature profile played by the action of gravity on air molecules. This is not an actual error in the Earth Energy Budget, but that budget does serve to misdirect attention toward a completely radiation and heat transport dominated view of the problem.
- The 117% surface radiation from the Earth's surface requires the Earth's surface to directly interface to vacuum, with no atmosphere present. The Earth's surface must be at 289.4 K, be a black body radiator with an emissivity of 1.00, and be surrounded only by space at very nearly 0 Kelvin (K). Note that 289.4 K is a higher temperature than that usually taken to be the Earth's average surface temperature and that the Earth's surface emissivity is usually said to be about 0.95. The lack of vacuum at the interface with the Earth's surface is a serious problem because the surface oscillating dipoles that radiate infrared energy cannot provide that same kinetic energy that creates radiated energy to evaporating water or transfer it to air molecules colliding with the surface. Energy must be conserved. The higher temperature and emissivity used for the surface is a smaller error, but indicative of a cavalier attitude to the science.

- The Conservation of Energy in a system in equilibrium does not allow the flow of energy into the Earth's surface to exceed the rate at which energy enters the system. Energy enters this system at 100%, yet this NASA Earth Energy Budget claims it is incident upon the Earth's surface at a rate of 7% reflected solar insolation plus 48% absorbed solar insolation plus 100% back radiation from the atmosphere for a total of 155%.
- The atmosphere cannot possibly absorb as much radiation from the surface of the Earth as is claimed to be absorbed, because the atmosphere is not as absorbing as would be a black body absorber and a black body absorber would have to be at a lower temperature than any temperature in the Earth's atmosphere to absorb as much radiation as the so-called settled science Earth Energy Budget claims is absorbed. This is because the power absorbed by a black body absorber at temperature T_A from a black body emitter at a temperature of T_E at equilibrium is $P = \sigma T_E^4 - \sigma T_A^4$. In the above schematic diagram, it is not possible for the surface to emit $1.17 P_{SI}$, where P_{SI} is the solar radiation at the top of the atmosphere, and have $(1.17 - 0.12) P_{SI} = 1.05 P_{SI}$ be absorbed by the atmosphere. See my discussion of this issue in [A Critical Lesson from the NASA Earth Energy Budget](#).
- [In Solving the Parallel Plane Black Body Radiator Problem and Why the Consensus Science is Wrong](#), I proved that the consensus science method of applying the Stefan-Boltzmann Law of Thermal Radiation causes the essential characteristic energy density of a black body cavity in equilibrium to double relative to the energy density given by Stefan's Law. Stefan's Law states that the electric field energy density in a black body cavity is $e = aT^4$, where T is the temperature in Kelvin and a is Stefan's constant. The correct energy density is maintained in the case of two parallel planes at temperatures T_W and T_C with $T_W > T_C$ in the limit that T_C approaches T_W , if the radiation from the warmer plane toward the cooler plane is given by $P_W = \sigma T_W^4 - \sigma T_C^4$ and the radiation from the cooler plane toward the warmer plane is given by $P_C = 0$. The settled science thinks $P_W = \sigma T_W^4$ and $P_C = \sigma T_C^4$, which causes there to be many more photons with real energy between the planes than there really are and causes the doubling of the energy density known in Stefan's Law. Applying this result to the NASA Earth Energy Budget one realizes that there is no equilibrium back radiation from the cooler atmosphere to the warmer surface, so the 100% back radiation is fictitious. Equally important, if the atmosphere were a black body, the radiation from the surface would also be much reduced to the extent that the atmosphere were absorbing some of it. Other critics have made the claim that cooler bodies do not radiate toward warmer bodies using a simple argument based on the Second Law of Thermodynamics, which by itself is not sufficient. However, coupling that law with a minimization of the total energy in the system, which provides the correct result to many a physics problem, does provide a pretty good argument for the same result that I worked out from electromagnetic field thermodynamics. Note that the elimination of back radiation eliminates a power incident upon the surface of 100% and therefore eliminates the violation of the Conservation of Energy at the Earth's surface discussed in the third bullet above. There are serious consequences of using black body radiation theory in a manner that doubles the energy density of a black body cavity.

Further Discussing the Diminished Role of Radiation in the Lower Atmosphere

Let us consider the equilibrium condition now at the Earth's surface that the flow of energy into the surface per unit area must equal the flow of energy out of the surface per unit area. The power absorbed by the surface from solar insolation, P_{ABS} , according to the NASA Earth Energy Budget is 48%. We now know that the other input to the surface they claim from back radiation is zero in the equilibrium case in which the air cools with increasing altitude from the surface. This is not quite true on average for the real Earth system since there are occasions, commonly in the dawn hours and shortly afterwards, when the air temperature just above the surface is warmer than the surface. This is easily recognized as the cause of dew and ground fog. Consequently, I will allow that back radiation might be 1 or 2%, but the upcoming discussion will ignore this small effect.

The flow of energy out of the Earth's surface according to NASA is given by the sums of 5% power lost in convection, 25% power loss through evaporation, and the radiated power P_R . Consequently, we have

$$P_{ABS} = (0.48)(340 \text{ W/m}^2) = (0.05 + 0.25)(340 \text{ W/m}^2) + P_R$$

Solving for P_R , we get

$$P_R = (0.18)(340 \text{ W/m}^2)$$

From the NASA Earth Energy Budget we know that radiation passing through the atmospheric window into space from the surface without any atmospheric absorption is a power, P_{AW} , of 12% of the top of the atmosphere solar insolation. The remaining power radiated from the Earth's surface is absorbed by the atmosphere and converted into an upward power loss as convection, P_{CC} . Thus we have

$$P_R = P_{AW} + P_{CC}$$

$$(0.18)(340 \text{ W/m}^2) = (0.12)(340 \text{ W/m}^2) + P_{CC}$$

$$P_{CC} = (0.06)(340 \text{ W/m}^2)$$

Consequently, if NASA has correctly measured the radiation emitted from the surface through the atmospheric window into space, the absorption of solar insolation by the surface, and the sum of the heat loss from the surface due to convection and water evaporation, then the fraction of the radiation from the surface which is absorbed in the atmosphere is only half that of the radiation from the surface that escapes into space without absorption in the atmosphere and it is one-third of the total radiation emitted by the surface. According to the NASA Earth Energy Budget the radiation emitted by the surface of 117% has all but 12% absorbed by the atmosphere, which means that water vapor and carbon dioxide and the various minor infrared-active gases, the greenhouse gases, are playing a huge role in absorbing a power of 105%. In the next to last bulleted item above, I showed that the atmosphere cannot possibly absorb so much infrared radiation from the surface. In reality, we see above that these gases only absorb 6% according to the NASA numbers after we eliminate those that are clearly wrong. The role of infrared-absorbing gases has thus been falsely magnified by a factor of

$$(105\%) / (6\%) = 17.5$$

In light of these observations, is it not interesting that so many are claiming that the science is settled and that there is a scientific consensus that mankind is faced with catastrophic global warming resulting from his generation of carbon dioxide and the use of fossil fuels?

Given the errors in the science of climate change that I have pointed out here, one should wonder how accurate any of the NASA and the similar values used in the UN IPCC reports might be.

There is another way in which the NASA Earth Energy Budget is quite misleading with respect to the atmospheric absorption of infrared radiation from the surface. In reality, in most of the world the main part of the surface radiation that is absorbed is absorbed within a very few meters of the surface and not far up into the atmosphere as the diagrams for energy budgets picture the absorption. There are some areas such as the polar regions and a few deserts where the distance for absorption is significant, but in most of the world the humidity is high enough that the absorption length is very short based on laboratory measurements of absorption cross sections or mean free path lengths. Surface radiation in the colder polar regions is substantially less than that from the warmer regions of the Earth, so the longer absorption lengths in those polar regions are also of less importance to the energy budget. That much smaller part of the absorption of surface radiation performed by carbon dioxide is also occurring very close to the surface, though it is a few times greater than the average distance for water vapor, but is also more uniform over the Earth since the concentrations of carbon dioxide in the atmosphere are more uniform.

If the surface infrared emission is 18% and the atmosphere absorbs 6%, then the temperature a black body absorber in the atmosphere, T_A , would have to be at to absorb so much infrared radiation can be calculated from:

$$(0.06)(340 \text{ W/m}^2) = (0.18)(340 \text{ W/m}^2) - \sigma T_A^4$$
$$T_A = 163.8 \text{ K}$$

This is a temperature lower than that found in the Earth's atmosphere, so even a black body absorber cannot absorb such a large fraction of the infrared radiation emitted from the Earth's surface as is implied by the NASA values in the Earth Energy Budget after we have eliminated the errors I pointed out in the bullets at the start of this post. The infrared-active gases can only absorb a fraction of what a black body absorber can, so they certainly cannot remove as large a fraction of the surface-emitted infrared as could a black body absorber.

I expect the easiest power value for NASA to measure accurately is the 12% surface-emitted radiation through the atmospheric window into space. But, I expect that their measurements of the surface absorption of solar insolation, the loss of surface energy due to convection, and the loss of surface energy due to the evaporation of water are not very well-established numbers. Clearly, the fraction of the surface-emitted infrared energy absorbed by the atmosphere cannot be as high as one-third. NASA has probably substantially underestimated the sum of the heat loss of the surface by means of water evaporation and convection.

Such is the sad state of the so-called settled science of man-made global warming and such is the foolishness of the scientific consensus on climate change, insofar as that exists.