ROY SPENCER AND THE VACUUM BOTTLE FLASK

WHY VACUUM OUTER SPACE IS NOT "COLD" (AND COLDER OBJECTS DON'T MAKE HOTTER OBJECTS EVEN HOTTER)

By Alberto Miatello
Febuary 2012

In recent years, I realized that one of the main reasons of success of the bogus theories of AGW (anthropogenic/man-made global warming) + GHE (greenhouse effect) is the ability of their supporters to communicate, propose and impress upon the minds of so many persons some rough, simple (although wrong!) easily understandable, and visually attractive images/concepts, regarding our atmosphere: the "greenhouse" and the "blanket" (our atmosphere like a greenhouse or a blanket "trapping" outgoing infra-red radiation and keeping warm our surface), the "backradiation" (Infra-red emissions from earth's surface allegedly "backradiated" by greenhouse gases, and thereby increasing temperatures) etc.

I must recognize that our challengers have very good ability in spreading the most intriguing and impressive way of several "images" among so many people. Marketing experts could call this: "a successful brand concept campaign"

Unfortunately for them, ability in communication, mediatic support, and "consensus" by part of the scientific community doesn't make true a wrong scientific concept.

Science is not at all "democratic" and a scientific truth does not stand upon the majority of people believing it, but upon the scientific, i.e. rigorous mathematical, physical and experimental, proof of it.

This reflection came upon me, while thinking about an amazing article written in 2010 by the former NASA consultant Dr. Roy Spencer in which (by overturning the 2nd law of thermodynamics) he wrote that a colder object in contact with a hotter object makes the latter even hotter! **[1]**

Surprisingly enough for me (but not so much, after all), not so few readers approved and supported this incredibly wrong article (and that was one of the reasons why I ultimately resolved to writing my modest opinions on these issues).

Fortunately there were also several correct and good replies, proving the fallacy of Spencer's article.

I would mention, in this respect, the exceptional article by Dr. Pierre Latour, who proved with mathematical and physical arguments that backradiation is a totally unscientific concept and Latour mentioned also some "practical" evidences, taken from industrial expertise (furnaces) and insulating materials, proving how wrong Spencer's hypothesis was. **[2]**

It also occurred to me that Spencer's article was dangerously misleading for many readers because there are three basic conceptual/methodological (let's say "visual") mistakes and those deserve to be more deeply analysed. So let me spend some more time trying to illustrate them here.

1) Vacuum outer space is not "cold".

In his article, Spencer wrote that our atmosphere, although colder than earth's surface, is acting like a cold "blanket" insulating a hotter human body from an outer colder environment (as during winter), in this case the outer vacuum space, above our atmosphere.

This is a big – although very widespread, even in a lot of educated persons – false concept: Roy Spencer is wrong because our vacuum outer space, surrounding earth's atmosphere, (nearly 100 km. above our surface, above the so called "Karman line") is not "cold"!

"Cold" and "hot" are physical concepts (and human sensations too) regarding temperatures, which in their turn are connected to the state of bodies and the energetic level of atoms and molecules.

We feel cold and warm just because our bodies are in contact with solids, liquids and gases and their energetic atomic levels.

Our troposphere (surrounding our earth's surface) is not a vacuum space, of course, it is a gaseous fluid and our bodies feel cold or hot because there are cold and hot gases in contact with them.

In other words: temperatures are measurable just whenever you have heat (which is energy in transit) flowing from a hotter to a colder body, and/or whenever you have atoms and molecules displaying a kinetic or energetic level.

A low energetic level of atoms means low temperatures, while high energetic atomic levels are connected with high temperatures.

But in vacuum outer space, where there are almost no atoms or molecules (just very few atoms/molecules having just a "kinetic temperature", in comparison with the dense planetary atmosphere) you have no detectable temperature and so no cold/heat!

Moreover, most persons (including many scientists) confuse the 2.73K (Kelvin; approximately minus 270ºC or minus 455ºF) temperature of the "Big Bang" "fossil" space radiation (discovered by Wilson and Penzias) with an alleged "temperature" of the vacuum space/universe. This is not so, the 2.73K is the blackbody temperature (CMBR) of the very feeble residual radiation of the "Big Bang" filling our universe and proving (or at least making very plausible) the "Big Bang" event, about 14 billion years ago. **[3]**

But radiation traveling in vacuum space is a very different thing than vacuum space itself!

Solar irradiance traveling in earth's vacuum space is not the temperature of vacuum space near Earth.

2.73K would be the lowest temperature which a body (provided of course it receives no other radiation from stars, planets, etc.) in the deep outer space would reach, once all its energy is dissipated by irradiation (i.e. when its whole energy is being radiated away).

Therefore it is not true that – as Spencer suggests in his little model – outer vacuum space, surrounding our earth's atmosphere, is 0°F (= - 17.7°C) cold, or it is "cold" in general (whatever temperature could be suggested).

The atmospheric "model" which Spencer proposed makes no sense at all, because the main concept on which it leans is wrong: outer vacuum space is not "cold" in itself.

When astronauts (from Voshkod and Gemini in 1965 till today's Space Shuttles) are making an EVA (Extra Vehicular Activity) outside their space vehicles, they are traveling in vacuum space surrounding our atmosphere and of course they wear spacesuits with helmets to breathe oxygen and to protect their bodies from direct exposure to hot solar radiation traveling in vacuum space.**[4]**

But – as anybody can see – in vacuum outer space there is no air resistance (cables and ropes linking astronauts to the space vehicle remain loose even if they all travel in space at 7.7 km/sec. = 27,700 km/h!), because there is no air at all.

I'd like to quote – in this respect – the very clear words by the former NASA scientist and writer Geoffrey Landis.**[5]** When asked by the interviewer whether a body exposed to vacuum space is freezing: "**Would You Freeze**? **No."**

Vacuum bottle flasks can keep liquids inside hot (or cold) for a much longer time just because the vacuum between the walls inside the thermos is suppressing any convective and conductive heat exchange with its surroundings.

This means that liquids inside the vacuum bottle flasks are slowly losing thermal energy just by radiation: i.e. they are just radiating away their thermal energy and they are receiving energy from outside bodies just through radiation but not through convection or conduction, actually they exchange less thermal energy than non vacuum surrounded bodies

2) Earth's atmosphere is neither a "blanket" nor a "greenhouse"

In the little "model" proposed by Spencer, he put a hot plate at constant temperature of 150°F (= 65.5°C) in contact with another colder plate whose temperature was 100°F (= 37.7°C). These two plates were placed inside a hollow sphere in a vacuum (no air inside) and the outside environment of the sphere was kept at a constant temperature of 0°F (= - 17.7°C).

This ideal model – according to Spencer – should reproduce the same physical situation as our atmosphere, with the hotter plate at 65.5° C acting like our earth surface, whereas the colder plate at 37.7° C in contact with the hotter plate should physically play the role of our atmosphere and the vacuum "cold" space surrounding both plates should be like our outer vacuum space.

Now, according to Spencer, with the colder plate being less cold than the outer vacuum space surrounding both plates, the colder plate would act like a little "buffering body" absorbing cold from vacuum and "reducing the rate of heat loss by the hotter plate" and keeping it hotter than it would be without the colder plate.

This should clearly be, in Spencer's way of thinking, the same "mechanism" as the blanket in our beds in winter, between our bodies and the cold environment of our room. The external side of the blanket gets colder than our bodies, but the internal side in contact with our skin is keeping our bodies hot enough by reducing the rate of heat loss by our bodies, and surely hotter than without a blanket, as everybody is experiencing.

Unfortunately, as we have seen above, at point 1), this simple model fails totally to reproduce the situation of our atmosphere, simply because our REAL atmosphere is not surrounded by a "colder" environment!

Vacuum outer space surrounding our atmosphere is neither cold nor hot, it is neutral and it makes no sense at all even to say "vacuum at 0°F"!

Spencer and GHE supporters are missing a fundamental point: when we put a blanket on our body in the winter, we simply put the blanket in <u>direct contact</u> with the <u>cold air</u> of our room to better protect our body. On the contrary our atmosphere (which in Spencer's model should play the role of the blanket) is <u>not</u> at all in contact with a cold body, outer space being totally neutral, i.e. neither cold nor hot, being almost void of all matter – a perfect insulator.

Therefore, in the real universe, we have just our relatively "warm" (average temperature 14.5° - 15°C) earth's surface, which is surrounded by a colder (-18°C average temperature) tropospheric layer whose thickness is ranging between 17 km (equatorial latitude) and 8 km (at the poles), average thickness around 12 km. In this cold layer there is about 99% of the gases of our atmosphere and almost all meteorogical phenomena taking place on our surface due to the water cycle within it.

Then, going upwards above the troposphere, you have other layers (stratosphere, mesosphere, thermosphere, and exosphere) up to 100 km high. But of course in the layers above the troposphere, you have an increasingly lower density of gases (only 1 molecule/cm^3 in thermosphere), while the temperature in some layers is not at all low (as wrongly indicated by Roy Spencer): in our thermosphere temperature reaches 2,700°C, but this is just a "kinetic temperature", i.e. a temperature relating to motions and high kinetic energy of molecules more strongly heated by the Sun and escaping gravitational force in open space, but being extremely rarefied "air", it is not perceived by man "hot" as in our dense troposphere at the earth's surface.

And then, above 100 km. we have the vacuum outer space, which is neither “cold” nor “hot”, as already explained above.

Hence, Spencer’s “model” is totally misleading and wrong: here on Earth we don’t have – as he and many people wrongly believe – a “hot” surface surrounded by a colder atmosphere acting like a blanket and keeping our surface “protected” from an alleged very cold vacuum outer space.

Here on Earth we have just:

a) a relatively warm (nearly + 15°C) surface (soils + oceans)
b) a colder troposphere (nearly – 18°C) surrounding our earth’s surface, containing 99% of gases of the atmosphere, and in which all meteorological phenomena are taking place.

And then, above the troposphere, we have several atmospheric layers in which the air is highly rarefied and gaseous isolated molecules have mostly just a “kinetic temperature”.

And so this is the reason why our atmosphere is acting like a refrigerator/heat pump, cooling earth’s surface (through the water cycle) and not like a “blanket” or a “greenhouse”.

Without the atmosphere and the oceans, our Earth would not be colder; it would be even hotter than the Moon (which is receiving the same solar energy, up to 1367 W/m^2 max.), having a faster rotation on its axis.

3) <u>Calculation of the real heat exchanged between a hotter and a colder body: a colder body doesn’t heat a hotter body</u>

In several recent interventions on Jennifer Marohasy’s blog, prof. Nasif Nahle was right in saying that it is very difficult to compare ideas with many supporters of GHE + AGW theories, because they normally spend a lot of “void words” to support their opinions, but they fall down once someone is asking them to <u>prove</u> their theories with precise calculations, by applying established physical laws. **[6]**

Unfortunately Spencer’s article makes no exception to this rule, because there is no formula, equation or calculation displaying <u>how really</u> a colder body could make another hotter body even hotter.

Therefore I tried to calculate what would really take place should a plate at 65.5°C (= 150°F) be put in direct contact with a colder plate at 37.7°C in a vacuum space.

First of all, the most important step to take, to correctly solve a problem, in physics, is to apply the right formula/equation to the relevant situation.

As a result, there is a sound and proper formula to calculate the “thermal equilibrium” between two bodies having different temperatures, namely the final equal temperature being reached by two bodies in contact, exchanging thermal energy only between them, once the thermal exchange ends.

The equation is:

$$Ca*Ma*(Ta - T) = Cb*Mb*(T - Tb) \qquad (1)$$

Where:

Ca = specific heat of the hotter body (a)
Ma = mass of the hotter body
Ta = starting temperature of the hotter body (a)
T = final temperature of thermal equilibrium reached by both bodies
Cb = specific heat of the colder body (b)
Mb = mass of the colder body (b)
Tb = starting temperature of the colder body.

The equation above is very important and is commonly used in thermodynamic engineering, architecture and the building industry, thermo chemistry etc., to calculate the final temperature reached by two different bodies in direct contact.

In our problem, we have a hotter plate in contact with another colder plate, both heated from an outside source, to keep them at constant temperatures (65.5°C and 37.7°C).

Let's suppose that the hotter body A is copper (a metal having big heat capacity, i.e. transmitting heat very easily), while the colder body B is plastic pvc for electric cables (material having a low heat capacity and commonly used as an insulator).

We can imagine that these two plates (taken as one cubic meter each) are being kept in close contact, someway simulating the contact between our earth's surface and our atmosphere.

Copper specific heat = 386 joule
Copper mass = 8,300 kg/m^3

Pvc specific heat = 900 joule
Pvc mass = 1,280 kg/m^3

Now, to calculate the equilibrating temperature of the 2 bodies above in close contact, according to the eq. above, we will have:

386 * 8,300 * (338.6K – T) = 900 * 1280 * (T – 310K)

1,084,806,680 – T*3,203,800 = 1,152,000*T – 358,041,600

T*4,355,800 = 1,442,844,208 and finally

T = 331.24K = 58.14°C

Thus, it is not true that a colder body can heat a hotter body, as Roy Spencer maintains.

In fact, perfectly in accordance with the 2nd law of thermodynamics, the hotter copper plate reduced its temperature from 65.5°C to 58.14°C by transmitting heat to the colder pvc, while the colder pvc plate was heated by the hotter copper plate, and increased its temperature from 37.7°C to 58.14°C

We can also calculate how much time this heating/cooling and mutual "equilibrating" process is taking.

If we take as "*x*" the unknown mutual cooling/heating rate, i.e. the rate (in joule/second) of heat exchanged by the two bodies and Qa (in million joule) the thermal energy of the copper plate at 65.5°C and Qb (in million joule) the thermal energy of the pvc plate at 37.7°C, then we have:

$$\mathbf{Qa} - x = \mathbf{Qb} + x \qquad (2)$$

Namely $1084 - x = 358 + x$

And finally $x = 363$ joule/sec

Therefore, both the copper plate and the pvc plate, to exchange nearly 23,5 million joule (Qa at 65.5°C = 1,084.7 million joule – Qa at 58.14 °C = 1,061.2 million joule; Qb at 58.14°C = 381.5 million joule -Qb at 37.7°C = 358.0 million joule) to reach the equilibrating temperature, will take **18 hours** (23,500,000/363 = 64,738 sec./3,600 = 17.98 hours).

At this point we can assume that both bodies A (copper) + B (pvc), receiving from the external source no more heating to keep them at a constant temperature (we switch off the heat source), will start to radiate no more than 363 j/sec. in the vacuum. In fact they will slowly radiate less and less energy and as an average much less than 363 j/sec., but in order to simplify things for our purposes, it is enough if we suppose that they are radiating away 363 j/sec.

Thus, we find that our **copper plate** having reached an energy Q at 58.14°C = 1,061 million joule, by radiating away 363 j/sec, **would reach 0°C** (273.1K) corresponding to a Q1 energy level = 3,203,800 * 273.1 = 875 million joule **in a time** = (1061 – 875 = 186) million joule/ 363 = 512,000 sec **= 142 hours (5.9 days).**

Whereas, to reach 0K (theoretically, or 2.73K in the real universe), it will take 875 million joule/ 363 j/sec = 2,405,000 seconds = 668 hours = **27.8 further days.**

In the meantime, our **pvc plate**, by radiating away no more than 363 j/sec., after reaching a Q energy level of 381.5 million joule (corresponding to 58.14°C), **would reach 0°C** (273.1K) corresponding to a Q1 energy level = 1,152,000 * 273.1 = 314.6 million joule **in a time** = (381.5 – 314.6 = 66.9) million joule/ 363 = 184,300 sec = **51,1 hours (2.1 days)**

Whereas, to reach 0K (or 2.73K in the real universe), **it will take** at least 314.6 million joule/363 j/sec = 866,666 sec = **240.7 hours = 10 further days**

We should repeat again that, after reaching the equilibrating temperature at 58.14°C, both copper and pvc plate would radiate away – on average – much less than 363 j/sec, probably a figure around 150-180 j/sec. would be more realistic, since they would radiate less and less as their temperatures decrease.

But our calculation with 363 j/sec. was performed just to show that, even allowing the highest possible heating loss rate to our two plates; **it would take <u>days</u> just to reach 0°C in a vacuum space!**

And now comes the most intriguing part of our (apparently boring) calculation.

Let's see what happens to the temperatures of our copper and pvc plates, should you place them inside an atmospheric environment with cold air surrounding them slightly above 0°C (say 0.5°C). We can then see what time it takes for them to reach a temperature near 1°C, for instance.

The well known and established physical formula to calculate the cooling of bodies, knowing the temperature of the environment, is the famous **Newton's equation of cooling, i.e.**:

$$(\theta F - \theta A)/ (\theta I - \theta A) = e \wedge -k*\Delta t \qquad (3)$$

Where:

θI = initial temperature of the body
θF = final temperature of the body
θA = ambient temperature
e = Euler's number = 2.71
k = rate of heat loss/decay
Δt = time interval

Eq. above, of course, can be more practically re-written as follows:

$$- k * \Delta t = \ln (\theta F - \theta A/ \theta I - \theta A)$$

And finally:

$$\Delta t = - \ln (\theta F - \theta A/ \theta I - \theta A)/ k$$

It should be noticed that the constant k, i.e. the rate of heat loss, is normally calculated through experimental data, by taking some direct surveys of temperatures and times, and then calculating and "plotting" a proper and precise logarithmic curve of each cooling body.

But, for our purposes, it is sufficient to remember that, according to the definition of the Newton's Law of cooling: <u>"The rate of heat loss of a body is proportional to the difference in temperatures between the body and its surroundings."</u> (provided the differences are not too big).

Therefore, since we have, in forensic science, for heat loss of human corpses at 37°C in normal environments at 20°C, a typical "k" constant = 0.15, then we can roughly calculate for a copper plate cooling from 65.5°C inside an environment at 0.5°C, a k constant which is: (65.5 – 0.5)/ (37 – 20) = 65/17 = at least 3.8 times bigger than 0.15, namely 0.15* 3.8 = 0.57

Whereas, for the pvc plate, we have a difference in temperature which is: 37.7 – 0.5 = 37.2°C. Thus, 37.2/17 = 2.1, namely 0.15 * 2.1 = 0.31.

Let's start with the **copper plate**.

Introducing magnitudes, we have:
θI = 65.5°C
θF = 1°C
θA = 0.5°C
k = 0.57

Thus we have:

Δt = - ln (1 – 0.5/65.5 – 0.5)/0.57 = - ln 0.0076 /0.57 = 4.86/0.57 = **8.5 hours = <u>8 hours and 30 minutes</u>**

Our copper plate inside an atmospheric environment at 0.5°C, will take nearly 8 h and 30' to cool from 65.5°C to 1°C.

And now, with respect to the **pvc plate**, we have:

θI = 37.7°C
θF = 1°C
θA = 0.5°C
k = 0.31

which becomes:

Δt = - ln (1 – 0.5/37.7 – 0.5)/0.31 = -ln 4.3/0.31 = 1.45/0.31 = **4.7 hours = <u>4 hours and 42 minutes</u>**

To summarize:

1) It is not true that vacuum space surrounding our earth's atmosphere is "cold". Being almost totally void of atoms/molecules, vacuum space is neither cold nor hot. Only radiations traveling in vacuum outer space (as the solar radiation, for instance) can heat bodies and bodies in a vacuum are slowly cooling by radiating their energy away. The figure of 3K (or 2.73K) which is often and incorrectly mentioned as the "temperature of the universe" is just the "fossile" cosmic microwave background radiation (CMBR), i.e. the very feeble blackbody temperature of the thermal radiation filling the universe, which should prove the "Big Bang" some 13.7 billion years ago, but it is not the "temperature" of the vacuum space.

2) The fundamental concept/cornerstone on which the theory of greenhouse effect leans is thus proven to be wrong: our atmosphere is neither a greenhouse nor a blanket protecting our earth's surface from a "cold" outer space. Actually we have just a warm earth's surface (average +15°C) which is surrounded by a cold troposhere (average - 18°C; plus stratosphere with the ozone layer screening many UV rays), which is cooling our earth's surface through the water cycle and by screening and filtering sunlight. The major heating factor on Earth therefore is the irradiance from Sun and its cycles.

3) As we have seen, if we put in contact two bodies at different temperatures, like copper and plastic pvc in a vacuum space, we will discover that – in perfect accordance with the 2nd law of thermodynamics – the hotter body (copper at 65.5°C) will start to heat the colder body (pvc at 37.7°C) until they will both (after nearly 18 hours) reach an equilibrium and mutual temperature of 58.14°C. Then (if they don't receive anymore external heating) they will slowly radiate away their thermal energy, reaching, after several days, a freezing temperature of 0°C. Hence, it is wrong that a colder body in a vacuum could heat a hotter body, as Roy Spencer wrote.

4) On the contrary, if we put those two bodies (copper + pvc) inside a "normal" atmospheric environment with a temperature near 0°C, we will soon discover that our two plates, separately, will quickly cool in just a few hours and not in days, as in a vacuum space. This is the physical and mathematical proof that our earth's atmosphere is not a "blanket" protecting our surface from an alleged "cold" outer space. Actually our atmosphere is cooling – and not heating - our surface.

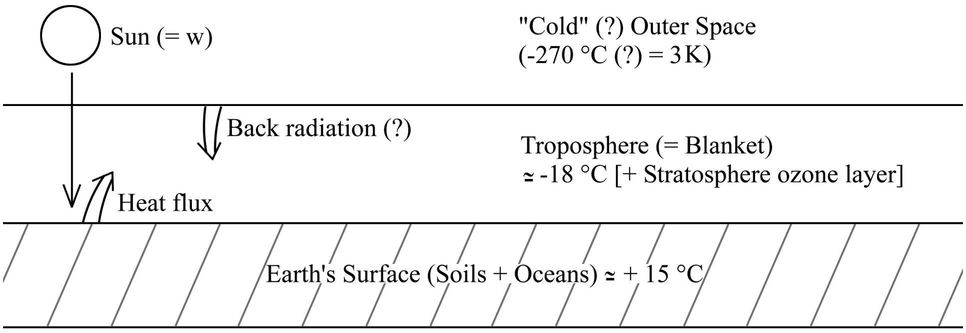
In my opinion it is necessary to promote a new "Copernican revolution" in the usual and mediatic approach (after all we live in a mediatic era) to our atmosphere and climate vision.

Too many persons – including highly educated scientists – are imagining our atmosphere as a "blanket", instead of a "refrigerator", or at least an "air conditioning chiller" surrounding our surface, as it is in reality.

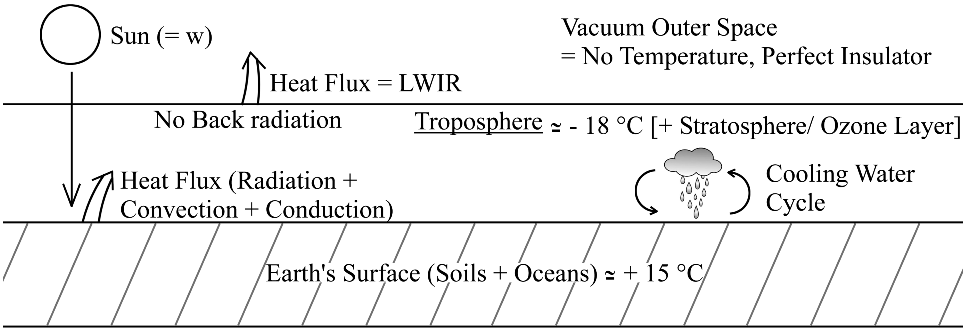
Below I propose to visually compare the two models in order to try and eradicate this widespread idea of our atmosphere acting as a "blanket".

Alberto Miatello

Model 1: The accepted paradigm that the atmosphere acts like a blanket



Model 2: With vacuum space providing the perfect insulator



References:

[1] http://www.drroyspencer.com/2010/07/yes-virginia-cooler-objects-can-make-warmer-objects-even-warmer-still/

[2] http://co2insanity.com/2011/11/08/no-virginia-cooler-objects-cannot-make-warmer-objects-even-warmer-still/

[3] http://en.wikipedia.org/wiki/Cosmic_microwave_background_radiation

[4] http://en.wikipedia.org/wiki/Extra-vehicular_activity

[5] http://www.geoffreylandis.com/vacuum.html

[6] http://jennifermarohasy.com/2011/03/total-emissivity-of-the-earth-and-atmospheric-carbon-dioxide/