Radiated Energy and the Second Law of Thermodynamics

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ABSTRACT

The transfer of thermal energy by radiation is discussed in the context of the Earth's surface and its atmosphere. When considering what happens as the Sun is warming the surface each morning, it is noted that its radiation is being directed onto the land surfaces and some distance below the surface of the oceans. So, additional radiation supposedly transferring further thermal energy from the cooler atmosphere to the warmer surface would violate the Second Law of Thermodynamics. This law must apply (on a macro scale) between any two points at any particular time. An apparent violation cannot be excused on the basis of "net" radiation, because "net" radiation has no corresponding physical entity and is meaningless and useless for determining heat flow in situations when other processes are also involved.

It may be deduced that none of the radiation from a cooler body (and only a portion of the radiation from a warmer body) has any thermodynamic effect on the other body. All such radiation from a cooler source is rejected in some way, and it can be deduced that resonance and scattering occurs without any conversion to thermal energy. The radiation continues in another direction until it strikes a cooler target, which could be in space.

Furthermore, the stability of sub-surface temperatures will tend to maintain the observed close thermal equilibrium at the interface between the surface and the atmosphere. Hence other heat loss mechanisms are likely to adjust, in order to compensate for any reduced radiation.

Some commonly raised questions are answered in the Appendix, where there is also discussion of temperature trends and climate cycles, as well as counter arguments for several possible objections to matters raised herein.

1. Introduction and terminology

Originally it was thought that the Earth's atmosphere acted like a “blanket” and that trace molecules like carbon dioxide helped to absorb radiation and trap “heat” which would then somehow warm the surface. Carbon dioxide represents about one molecule in over 2,500 other molecules and it (together with about 20 to 50 times as many water vapour molecules and some other trace gases) is, in fact, able to capture “photons” and radiate energy away to space. These gases can even absorb some of the incoming infra-red solar radiation. By reflecting and absorbing some incident solar radiation, the atmosphere does indeed keep the Earth's surface cooler in daylight hours.

Furthermore, there is a long-term close thermal equilibrium between it and the surface, which has been established over some four billion years. Fortunately the crust and mantle beneath it act as very good insulators, retaining thermal energy in the core and only allowing a trickle to leak out. This ensures long-term stability of temperatures, even just a few metres below the surface, and that in turn helps to maintain stability in surface and lower atmosphere temperatures. As a result, the mean of such temperatures (when calculated over 60 years) tends to vary little more than about 2ºC above or below the thousand year mean.

But, just as a vacuum flask does not further warm the coffee, neither does any additional temporary thermal energy trapped by the atmosphere warm the surface. Such energy may perhaps “warm up” the atmosphere a little to, say, -35ºC or some such temperature well below freezing, but the real insulation property of the atmosphere has more to do with the rate at which warm air rises and creates an inevitable temperature gradient.

So when these original “greenhouse” conjectures (devised by climate scientists) came under the scrutiny of physicists, it became apparent that warm air rises rather than falls, and that any excess trapped “heat” (as they mistakenly called it) would simply be radiated away pretty quickly. So then, in the early 1980's, they had to turn to “Radiative Transfer Theory” and ensure that radiated energy could be seen to dominate the whole process. So they suggested that radiation from the cooler atmosphere would further warm the surface as it made its way up and down, numerous times it seems, dropping off a bit of “heat” on every visit.

But climate scientists have erred in thinking that any “thermal” radiation can add thermal energy to the surface, regardless of the temperature of the surface. This mistaken belief originates from visualising radiation as a flow of mass-less “photons” colliding with molecules in the surface and automatically warming them, if the photons were not reflected beforehand.

There is a need to clarify the fact that “heat” is not automatically transferred wherever “thermal radiation” flows. The very term “thermal radiation” is misleading because it may be interpreted as meaning radiation only in the infra-red spectrum. But these are not the only wavelengths which can bring about a transfer of thermal energy, which may be thought of as a heating process. Solar radiation is nearly half made up of radiation in the infra-red, but the rest in the visible light and ultra-violet spectra can and does transfer even more thermal energy, which warms the surface of the Earth. **[1]**

For example, when light strikes a yellow target the radiation for red, violet etc will not be reflected and will usually be converted to thermal energy. Ultra-violet light has a strong warming influence and our skin will react, especially when the UV index is high in summer.

So we should not speak of rays of “light” or “thermal radiation” but rather just “radiated energy” for such is neither light nor heat. This is because we do not know exactly what will happen to the radiated energy contained in any particular ray until it strikes a target. There it may be reflected either as spectral (mirror-like) reflection or as diffuse (scattered) reflection. If it is not reflected it may be transmitted through glass, for example, or absorbed. But the following discussion will point to the need for another different process that must exist in order to explain observations, and to provide a mechanism whereby nature ensures that the Second Law of Thermodynamics is not violated. **[2]**

2. Does radiation transfer heat in both directions simultaneously?

It is well known that, when two parallel plates at different temperatures radiate towards each other, the warmer one cools and the cooler one warms until the temperatures are equal. So there appears to be some feedback mechanism, but is it really a two-way heat transfer?

If thermal energy *could* transfer from cold to hot, then what happens when radiation from the atmosphere penetrates some small distance into the ocean waters? Does it warm the water which then rises to the surface by convection and causes more evaporation? Such a scenario can *not* be right and the only feasible explanation is that, even though there may be two-way radiated energy transfer, the radiation from the cooler body to the warmer one cannot be absorbed and converted to thermal energy when it reaches the warmer body. This is the conclusion drawn by Professor Claes Johnson in his Computational Blackbody Radiation where he suggests that such radiation merely resonates with the warmer body. **[3]**

When calculations are done to estimate the amount of radiation (radiative flux) between two plates, it is normal to use the Stefan-Boltzmann Law to calculate the flux in each direction and assume that the difference is “net” radiation, from which is derived “net heat flow.” **[4]**

It is further assumed that, because this net radiation is in the same direction as the observed heat flow (from the warmer plate to the cooler one) then there is no violation of the Second Law of Thermodynamics, which says this is how it should be.

But does the radiation in each direction somehow cancel out to give a “net” radiative flux in the direction of the heat transfer, or are there still two distinct radiation beams? Or could there be a separate transfer of thermal energy in each direction leading to a net effect?

If you have a beam of sunlight coming into your room you can still shine torch light right through the sunlight and see the effect of the torch light on the wall. It is not affected in any way if the Sun's rays are then blocked. In the atmosphere are numerous radiation beams for radio broadcasts and television transmissions, but they do not affect each other. So radiation with different directions and different wavelengths does not appear to combine into any “net” radiation with a net radiative flux, transferring a net amount of thermal energy.

When the Sun is warming the surface on a clear morning at, say, 11.00am we know that there is a net energy inflow into the surface, simply because it is getting hotter. This heat transfer is calculated even after deducting the outflow, which may be a mixture of radiation, evaporative cooling, chemical processes, conduction or diffusion followed by convection. **[5]**

What happens if we then “add” radiation from the cooler atmosphere into the surface? This process is clearly independent of the solar radiation and other transfers of thermal energy out of the surface.

The models used by the UN Intergovernmental Panel on Climate Change (IPCC) assume this happens 24 hours a day, and that it either increases the warming rate in the morning, for example, or decreases the cooling rate later in the 24 hour cycle. But, when the surface is already warming and there is a net inward flow of energy, then clearly such radiation from the cooler atmosphere cannot transfer thermal energy to the warmer surface, for to do so would amount to heat flow from cool to warm, which violates the Second Law of Thermodynamics.

The Second Law must apply between any two points for each and every separate transfer of thermal energy at any given time. Clearly, if radiation from the atmosphere were to penetrate a small distance into an ocean and then be converted to thermal energy beneath the surface, there is no question of any simultaneous "balancing" flow of thermal energy out of the surface. Even if it took only a second for the warm water to rise and evaporate, this would be a separate process with no "memory" of the first one. You cannot say the Second Law is obeyed because of any subsequent transfer of thermal energy in the other direction. It would be like parking your car in a one hour spot for 80 minutes, and then in another spot for only 20 minutes, hoping you did not break the law because your average stay was 50 minutes.

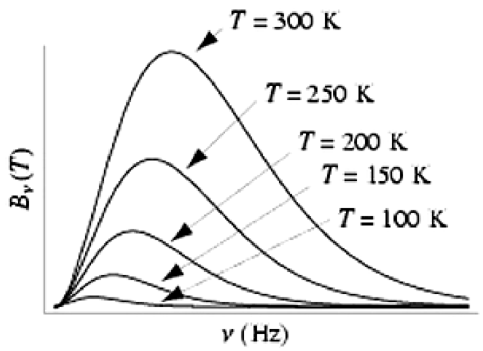
> *So the assumptions of current physics that either radiation is compounded into "net" radiation, or that thermal energy is transferred each way must be incorrect.*
> *Neither happens.*

3. What physical mechanism must determine if thermal energy is transferred?

We have discussed why radiation with different frequencies and directions cannot be compounded into "net" radiation. Indeed, energy which transfers into the oceans may well exit by evaporation rather than radiation. So the mechanism we seek cannot be one involving the compounding of radiation in order to produce a net transfer of thermal energy.

Only thermal energy can be compounded, not radiation. Adding thermal energy to the surface while it is cooling would indeed slow the rate of cooling, but any such "transaction" would be an independent process which would have to occur prior to that energy transferring back to the atmosphere by another process. Hence any such transfer of thermal energy from the atmosphere to the warmer surface must be in violation of the Second Law.

We need to consider the spontaneous radiation from a perfect blackbody, which has a frequency distribution with a shape such as that in each plot below. Here, for the horizontal axis, frequency has been chosen in order to demonstrate Wien's Displacement Law, which states that the peak frequency (the mode) is proportional to the absolute temperature. The shape of these curves thus looks different from those usually shown when discussing Planck's Law, because they are plotted against frequency rather than wavelength. **[6]**



From http://scienceworld.wolfram.com/physics/WiensDisplacementLaw.html

The total radiative flux is represented by the area under the curve for any particular temperature, and Stefan-Boltzmann Law tells us it is proportional to the fourth power of the absolute temperature. **[7]**

But can we just take the difference between the radiative fluxes from two opposing bodies (such as parallel metal plates) at different temperatures and determine the quantity and direction of the heat flow, if any? This usually works, but when additional heat transfer processes (such as solar radiation, evaporation, diffusion etc) are involved in the real world, these processes must be considered separately and each must obey the Second Law of Thermodynamics in its own right. We have already seen that there cannot be a physical transfer of thermal energy from cold to hot bodies under any circumstances, and flow in the opposite direction does not excuse the violation of the Second Law. In any event, in the real world some of the energy going from hot to cold may be transferred by processes other than radiation.

The only logical conclusion to draw from this is that the radiated energy from a cooler body to a warmer one is not being converted to thermal energy in the warmer one, so that the effective absorptivity must be zero. Only a portion of the radiation from the warmer body to the cooler one has any effect, and does all the "heating" work. So we need to quantify what is happening using only the radiation from hot to cold.

4. Quantification of one-way radiation causing heat flow

In calculating heat flow it is found that, for the case of two parallel plates, we get a satisfactory result by determining the radiative flux from each, then taking the difference to get net flux and determining heat flow from that. Such calculations of net flux effectively subtract the area under the curve of the cooler target from the area under the curve for the warmer source. So, in straight forward cases, the calculations are actually working with the area *between* the two curves.

Can any physical significance be placed upon this area between the curves if we are going to use just that area and consider only the radiation from the warmer source, disregarding the radiation from the cooler target?

It is indeed *necessary* to place a physical significance on such an area between the curves, if and only if it represents all the radiation from the warmer body which is actually absorbed by the cooler one. It must do just that, because that is the area which approaches zero when the temperatures approach each other. This area has a corresponding actual heat transfer, whereas the total areas under each curve do not.

Such a hypothesis requires the assumption that the portion of radiation from the warmer body which is represented by the area under the curve for the cooler one is all "rejected" by some physical process, and is thus not converted to thermal energy. An equivalent radiative flux from the cooler body to the warmer one is also not converted to thermal energy, but it does limit the amount by which the temperature of the warmer one can fall until both are at the same temperature. Obviously, if the warmer body's temperature were to fall below the cooler one, then the heat transfer reverses direction, because the latter would then be warmer.

5. The concept of resonant scattering

As quantum mechanics tells us, the electrons in molecules of matter can have various discrete energy levels. When they "drop" from a higher level to a lower one they emit a burst of radiation, referred to as a photon, which will now have the energy which the electron shed. But radiation has a wavelike nature with a frequency which increases with the energy of each photon. Large numbers of molecules acting like this in a blackbody will emit radiation with a distribution of frequencies as we saw in the plots in Section 3. The peak frequency indicates the temperature of the emitting body. Hence, although one photon is not enough to determine the temperature, the frequency distribution of all the radiation does do so.

Now, if the warmer body cooled down to the temperature of the cooler one it would have a matching frequency distribution. We can postulate that there will be natural maximum frequencies with which the electrons can vibrate between energy states. So radiation with a matching frequency can resonate with molecules in the target. But the radiated energy in each photon is proportional to the frequency of the associated radiation, and that energy will be just the right amount to excite an electron to a particular higher state, but not enough to go the extra distance required for any of the radiated energy to be converted to thermal energy.

As this resonating process is taking place, a photon in the incident radiation excites an electron to a higher state, let's say at the crest of the wave, and then immediately lets it relax back to its original state at the trough. As it relaxes it sends an equivalent photon off in a different direction, thus seeming to scatter the initial radiation.

However, if one body is warmer than the other, then only that portion of the radiation which corresponds to the area under the smaller curve will experience resonant scattering, whilst the surplus (corresponding to the area between the curves) will be converted to thermal energy in the cooler body, thus warming it. The radiation which is scattered may well strike another target which is cooler again, and so a similar split of its energy could occur. If instead it meets a warmer target, possibly the Earth's surface, it will just undergo resonant scattering without leaving any energy behind. Eventually it will get to space where it will travel on for who-knows-how-long until it strikes another target, which also may be warmer or cooler. The "temperature" of the radiation is really just the temperature of a blackbody for which the peak frequency would be the frequency of the radiation.

If we have two large plates close to each other in parallel planes, then, near the centres of the plates, there would be significant radiation from the cooler plate to the warmer one. So this "backradiation" prevents the warmer one cooling below the temperature of the cooler one.

However, any radiation which reaches the Earth's surface from the atmosphere will have come from much cooler molecules and**,** in the real world, experiments such as that by Prof Nasif Nahle have shown that the atmosphere is usually cooler than the surface (even close to the ground) and it cools faster at night. **[8]**

Hence, while the surface remains warmer than the base of the atmosphere, any radiation from the cooler atmosphere will undergo resonant scattering and this process leaves no additional thermal energy in the surface. So, under normal weather conditions, no thermal energy can be transferred from the atmosphere by radiation or any other spontaneous process.

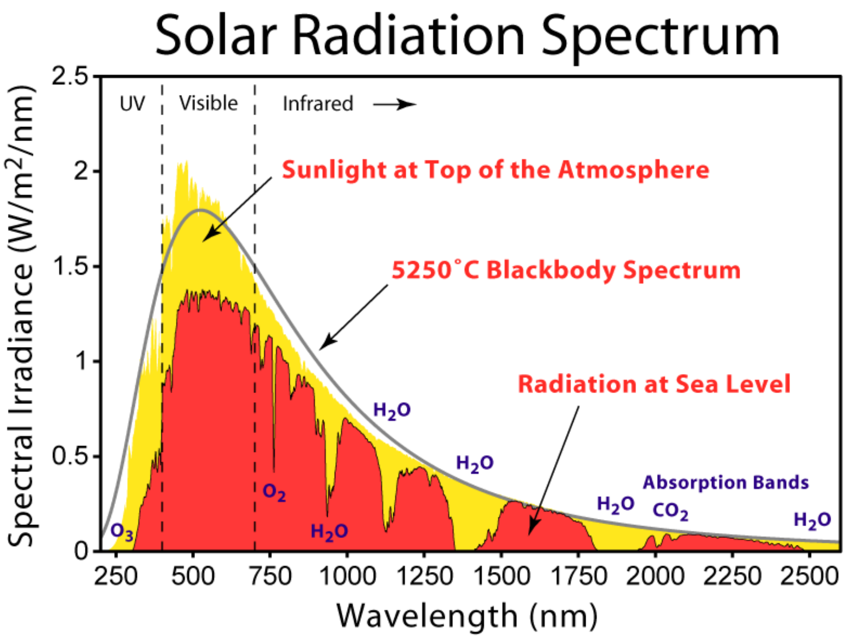
In fairness, there would be a slight slowing of the *rate* of cooling when the temperatures approach each other, because of the way in which the area between the Planck curves reduces. But this only applies to radiation, so evaporation and diffusion could easily compensate and it does not mean energy is added to the surface or the atmosphere.

6. Warming or Cooling Effects?

So we have seen that radiation from the atmosphere will usually be scattered after resonating with molecules on the surface, the end result being very much like diffuse reflection, though not technically the same. Only in fairly rare weather events would there be the possibility of warmer air existing just above the surface, and such air could warm the surface.

The most likely warming could be when water vapour close to the surface reaches higher temperatures in times of high humidity when the adiabatic lapse rate is also reduced. But water vapour also plays *the* major role in cooling the atmosphere by radiating away to space all the thermal energy which it acquires by diffusion in molecular collisions.

We need water for life but we also need it to moderate the climate. Water vapour cools the atmosphere by radiation and the ocean and earth surfaces by evaporation. It also reflects and absorbs some of the Sun's powerful incoming infra-red radiation, as may be seen below. **[9]**



Carbon dioxide also absorbs incoming solar infra-red radiation and helps cool the atmosphere, radiating away to space not only the energy it captures from solar and surface radiation, but also that diffused from other air molecules. But, with its limited range of frequencies, it would not be very effective in slowing the rate of radiative cooling of the surface.

7. So where have the models gone wrong?

When scientists measure the "absorptivity" of a target material (which could be a gas, a liquid or a solid) they direct rays of visible light onto the target. They may well use photocells to measure the reflected and transmitted light, assuming the rest is the proportion absorbed and converted to thermal energy. **[10]**

But how does this tie in with the Second Law of Thermodynamics? It cannot do so unless the absorptivity is a function of both the source and target temperatures. Furthermore, the absorptivity must reduce to zero whenever the temperature of the source no longer exceeds that of the target.

The models are based on calculating net radiation in and out of the surface. But we should not assume that we can perform vector-like compounding of rays of radiation, as we would for forces, and then deduce that heat flow is in the direction of this compound radiation. The Sun's radiation does not combine with the atmospheric radiation and, furthermore, there are other heat transfer processes involved.

> *Net radiation is meaningless for determining heat flow in some situations when other processes are also involved.*

The models supporting the assumed greenhouse effect have all used incorrect values for absorptivity relating to the radiation from a cooler atmosphere to a warmer surface, because none of that radiation is absorbed and converted to thermal energy in the surface. The absorptivity for that radiation is zero.

8. Conclusion.

Consideration of the effect of the processes involved when the Sun is warming the Earth's surface in the morning leads to the logical conclusion that each such process must stand alone and not violate the Second Law of Thermodynamics. Thus radiation from a cooler atmosphere cannot transfer thermal energy to a warmer surface.

As a corollary, the absorptivity of spontaneous radiation from a cooler source to a warmer target must be zero.

As the assumption of a far greater absorptivity is inherent in the models and explanations of the so-called Atmospheric Greenhouse Effect (in which radiation from the atmosphere is assumed to warm the surface) such models and explanations do not reflect reality.

It is noted that radiation from the atmosphere can reduce the loss of thermal energy by the surface in rare situations related to weather conditions, usually in times of high relative humidity. But water vapour, as well as trace gases like carbon dioxide, can also have cooling effects absorbing some incoming solar infra-red radiation and radiating to space much of the thermal energy in the atmosphere.

References:

[1] http://en.wikipedia.org/wiki/Sunlight
[2] http://en.wikipedia.org/wiki/Second_law_of_thermodynamics
[3] http://www.csc.kth.se/~cgjoh/blackbodyslayer.pdf
[4] http://amrita.vlab.co.in/?sub=1&brch=194&sim=802&cnt=1
[5] http://en.wikipedia.org/wiki/Heat_transfer
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[10] http://naca.central.cranfield.ac.uk/reports/arc/cp/0601.pdf

APPENDIX

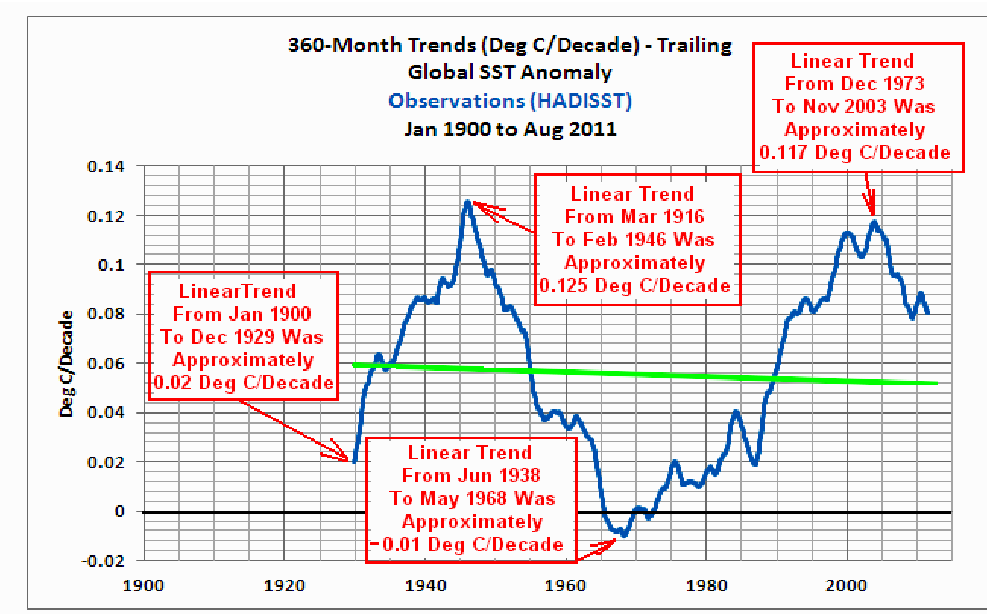
Frequently Asked Questions

It is suggested that the reader studies the answers to all these seven questions in order, because they build upon each other. The arguments herein can lead to no other conclusion than that any surface warming by trace gases in the atmosphere is a physical impossibility.

Q.1 How do you explain the fact that the Earth has been warming?

Technically the Earth is currently in an interglacial period and the last few glacial periods have occurred at roughly 100,000 year intervals. This indicates the possibility of there being natural cycles, short and long, which appear to be related to astronomical orbital events. For example, the planet Jupiter has an effect on the eccentricity of the Earth's orbit in such a way that the difference in the distances between the Sun and the Earth at the aphelion and perihelion can vary (over many thousands of years) from just over 0% when its orbit is nearly a true circle, up to about 5% when it is elliptical. Such variations affect the mean distance and that will then affect the mean radiative flux over the course of a year.

Many scientists also believe there is clear evidence of a 60-year cycle which may be related to the alignment of the planets Jupiter and Saturn every 59.6 years. This cycle appears to have been the main cause of the observed temperature increases which raised alarm in the 30 years or so leading up to the maximum in 1998. However, there is also a longer cycle which appears to be very approximately 1,000 years. The underlying trend in the *rate* of increase can be detected when a trend line is added to the plot below (from this site) which shows 30 year trend gradients.



It appears that the mean rate of increase per decade has decreased from about 0.06°C early in the 20th century to about 0.05°C per decade in recent times, as you can see from the green trend line. Perhaps the 1,000 year trend will reach a maximum in the next 100 to 200 years and be 0.5 to 1.0°C warmer than at present. So natural trends can and do explain the historic climate record, right up to the current slight decline which is probably due to the 60 year cycle declining, but being mostly countered by the underlying upward trend of the 1,000 year cycle.

Q.2 Why is the surface 33ºC warmer than the -18ºC we calculate?

That -18ºC figure was calculated using Stefan Boltzmann's Law which relates to radiation from a perfect blackbody, which should be totally insulated from its surroundings, so that no thermal energy can escape by conduction or any means other than radiation. The radiative flux is proportional to the fourth power of the absolute temperature. But the Earth's surface is only an internal interface with the atmosphere in the complete Earth-plus-atmosphere system, which is much more like a blackbody. Roughly half of the thermal energy transferred from the surface to the atmosphere is not radiated, so that throws the calculations of that -18ºC (255K) figure way out. Furthermore, it is based on a flat Earth model where there is no variation in solar radiation received by the surface at any time in the 24 hour daily revolution. One could calculate a more accurate value by integrating over a 24 hour cycle, but it would also have to take into account the rate of heat conduction into the surface each morning and out of the surface later in the 24 hour cycle. Furthermore, solar radiation penetrates deep into the oceans almost instantly, and then has to work its way out slowly by convection. If we could properly model all these parameters then perhaps we could work out a more accurate figure, but even then it would apply to the whole system including the atmosphere, which after all, does emit a lot of the radiation, as is observed from space.

If we were to derive such a figure it would be a weighted mean which would be found somewhere up in the atmosphere. Even if the atmosphere were only 20% oxygen and 80% nitrogen, with nothing else, there would be a natural adiabatic lapse rate (which is a function of the acceleration due to gravity) and that alone would be sufficient to ensure that the surface was much warmer than the above weighted mean temperature. Note also that, in the real world, if some layers of the atmosphere become a little warmer than the natural lapse rate indicates they ought to be, they will radiate away the extra thermal energy until the local temperature falls back to the natural temperature gradient, which is determined by gravity and, to a lesser extent, by the relative humidity. None of the excess energy can make it back into the surface by any means, radiation or otherwise. Besides, any such warm air is of a temporary nature, relating to weather conditions, not long-term climate.

Q.3 How can sub-surface temperatures stabilise climate when heat flow is low?

It is quite true that the mean net rate at which thermal energy exits the surface from the inner crust, mantle and core is quite low compared with the daily influx from the Sun. This is an important point, because it is held back by the rate of conduction in the crust and deeper down, and this shows us that the crust is a very good insulator, keeping most of the massive amount of thermal energy down there for a long time.

Underground temperatures from boreholes show that the temperature falls on its way to the surface by approximately 30ºC per kilometre. Even the 9Km deep KTB borehole in Germany shows a near linear temperature trend from about 270ºC down to a base surface temperature, which is normally observed on calm winter nights. The fact that these temperature trends all appear to extrapolate to surface temperatures from deep underground demonstrates a physical property of conduction, namely that the gradient adjusts (within limits) in such a way that the end points of the line are "controlled" by the external temperatures.

So the trend runs all the way from the core (at about 5700K) to the surface at a little under 300K. This trend is determined by the mean temperature of the base of the atmosphere and that of the core, though it is complicated by the fact that energy is also added along the way.

The important point to note is that the whole trend can only change *very* slowly, perhaps taking many thousands of years for any rise of the order of 5 to 10ºC in the mean of that 1,000 year cycle, for example. So, when the 1,000 year cyclic trend starts to vary by about 2ºC above or below its mean, there is a propensity for that trend to pull back towards the mean, because it would take far too much energy to flow into or out of the underground regions in order to raise or lower that sub-surface trend line all the way from the core to the surface.

Q.4 How can an Infra-red thermometer measure cooler temperatures?

The original types of infra-red thermometers measure the frequency of the radiation, and then calculate the temperature using Wien's Displacement Law. Infra-red cameras can do likewise to form an image by representing temperatures with different colours. However, the newer microbolometers have sensors which warm or cool at different rates, and these rates are used to determine temperature. As explained in the last paragraph of Section 5, radiation from another body at a slightly lower temperature can cause the rate of heat transfer from the warmer body to vary as the temperature difference between the two bodies varies. The instrument's sensors are warmed (using electric input) but while they are warming they are also radiating energy to the object whose temperature is to be measured. Such radiation will reduce the rate of warming, so that net rate of warming will be affected by the temperature of the object because the energy transfer rate from the instrument to the object varies with the area between the Planck curves.

Q.5 Do lasers or microwave ovens disprove the hypothesis?

Lasers depend on artificially generated radiation which can have characteristics quite different from natural spontaneous emission with its Planck distribution of frequencies. The radiation generated in a laser is stimulated emission which can have a very different effect on the target, basically because the target cannot handle a kind of "doubling up effect" in the radiation, so the surplus that cannot resonate has to be converted to thermal energy.

Microwaves, like broadcast radio waves, are not absorbed much by a composite surface. However, in a certain frequency range water molecules, as well as some fats and sugars, do in fact absorb microwaves and convert their energy to thermal energy. Food is cooked because it contains water, but many materials are not heated in microwave ovens. So microwaves and other radio waves do not have much effect on blackbodies, and that is why broadcast radio waves can travel long distances without being absorbed by the atmosphere or the surface. The equivalent temperature of a blackbody emitting radio wave frequencies would be colder than the atmosphere, so this is in keeping with the hypothesis.

Q.6 What happens to the radiation which is absorbed by carbon dioxide?

When spectrometers near the top of the atmosphere (TOA) are pointed at a source of radiation on the surface they will detect rays which get straight through, but the rays with frequencies which can be absorbed by carbon dioxide are mostly missing, indicating that they have been absorbed by carbon dioxide molecules. When this happens some of the surplus radiated energy will be converted to thermal energy. This energy might or might not be shared with, for example, water vapour molecules. Whatever happens, subsequent spontaneous emission is more likely (because of the warming) but the new ray is highly unlikely to strike the spectrometer. If the new radiation heads towards warmer regions in the atmosphere, or to the surface itself, it will undergo resonant scattering. But if it heads upwards to cooler regions it will either get through to space or strike another molecule further up, where the process starts over again. One way or another, the energy gets out to space by another gate.

Q.7 Why not just treat all radiation as having a thermal effect each way?

If you do not accept the resonant scattering hypothesis, then you must say that the radiation is either reflected or absorbed when it strikes the Earth's surface. But if it is absorbed and converted to thermal energy, then that energy would be added to the thermal energy already there, perhaps from that day's solar radiation. So it now has a choice of several exit gates probably later that day. Normally about half of it will *not* exit as radiation, but by evaporation or diffusion.

That immediately throws your radiation out of balance and creates a situation in which only about half of the so-called "backradiation" which was absorbed comes back out as radiation from the surface. It also creates a need for additional evaporation and diffusion from the surface, for which there would be no physical explanation, because the original evaporation and diffusion would have been the maximum allowed by the temperature difference between the surface and the first few millimetres of the atmosphere.

> *You cannot force the standard physics formulas for these transfer rates to give you inflated values just because you have all this extra thermal energy supposedly from the "backradiation".*

Consequently, *all* the thermal energy allegedly generated by the "backradiation" would have to stay in the surface because there is already a "traffic jam" caused by the initial volume of thermal energy escaping to the atmosphere, before the first lot of "backradiation" started to return. Hence you would have a scenario of extreme excess heating of the surface which is not observed. You are, in essence, assuming about twice as much radiation is warming the surface, rather than just that from the Sun. But the surface cannot possibly rid itself of all the thermal energy gained at that rate of absorption, because the temperature of the base of the atmosphere is usually observed to be close to that of the surface, and this slows the flow. If we assume that the surface absorbs radiation from a cooler atmosphere (contrary to the Second Law of Thermodynamics) then we have to explain how that extra energy gets back out of the surface into the base of the atmosphere, irrespective of what happens further up in the atmosphere.

We cannot explain all this with recognised physics because the long-established formulas of physics do not allow such. This leaves nothing but the resonant scattering hypothesis to explain reality and such a hypothesis negates a key assumption which is fundamental for there to be any validity in the Anthropogenic Global Warming conjecture.

Acknowledgements

Somewhat belatedly, I should express gratitude to the 1960's team at Sydney University Physics Department led by Professor Harry Messel and his colleagues including the late Professors Werner von Braun and Julius Sumner Miller well known for his "Why is it so?" television series. While attending their lectures I could not help but be inspired with a love of Physics and an inquiring mind. Whilst the lure of business subsequently diverted me to an Economics degree and Business Administration course, I have kept in touch with physics and mathematics through part-time private tutoring of secondary and tertiary students, as well as through the development of "computer tutor" software, which is now popular throughout Australia.

I should also thank many who have written comprehensive responses to several thousand posts I have submitted on Internet climate forums. Some have pointed me to relevant papers and, above all, many have posed questions, such as those in the Appendix, all of which I believe I was able to answer, as a result of extensive research into the physics of the atmosphere. The most prevailing message I received from these forums is that those who have been educated in the Greenhouse Era have a propensity to rush in with equations for the Laws of Physics, without really thinking about the prerequisites for such laws to be applicable. The treatment of the Earth's surface as if it was anything like a near perfect blackbody is, of course, the prime example.

The whole world should acknowledge the work of Claes Johnson, who is a Professor of Applied Mathematics in Sweden. His *Computational Blackbody Radiation* [3] and other articles set out mathematical proof of why blackbodies do not absorb radiation from cooler sources. Johnson has extended the work of the early scientists like Planck, and has answered questions that left Einstein pondering all his life. This reality that blackbodies do not absorb all such radiation is the foundation for my writings here.

I also found helpful other papers such as those on the experiments conducted by Professor Nasif Nahle which appear on the Principia Scientific International website. It is to this organisation that I owe my greatest appreciation for putting me in contact with Hans Schreuder from the UK who has worked tirelessly in the final stages of this document, in which I have endeavoured to bring together both theory and climate evidence. Also, to Alan Siddons and Dr Matthias Kleespies who reviewed my work, I likewise extend my sincere gratitude.

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