# Planetary Core and Surface Temperatures

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## ABSTRACT

The paper explains why the physics involved in atmospheric and sub-surface heat transfer appears to have been misunderstood, and incorrectly applied, when postulating that a radiative “greenhouse effect” is responsible for warming the surfaces of planets such as Venus and our own Earth.

A detailed discussion of the application of the Second Law of Thermodynamics endeavours to settle the much debated issue as to whether or not a thermal gradient evolves spontaneously in still air in a gravitational field. The author is aware of attempted rebuttals of this hypothesis, but cogent counter arguments are presented, together with reference to empirical evidence.

The ramifications are substantial, in that they eliminate any need for any “greenhouse” explanation as to why the surface temperatures are as observed. No other valid reason appears plausible to explain how the required energy gets into the planetary surfaces, this being especially obvious in regard to the high temperatures measured at the surface of the crust of Venus.

The paper includes some counter-intuitive concepts which sceptical readers may be tempted to reject out of hand. Physics sometimes has some surprises, and so you are encouraged to read and understand the argument step by step, for it is based on sound physics, and unlocks some mysteries of the Solar System, including core and mantle temperatures, not previously explained in this manner to the best of the author's knowledge.

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## 1. Radiation and Heat Transfer

Historical records indicate that the world has experienced long-term periods of about 500 years of alternating warming and cooling. The last two thousand years have seen the Roman Warming Period, the Dark Ages Cooling, the Medieval Warming Period, the Little Ice Age and the current warming period. So we have a long-term cycle which appears to cause variations of about 2°C up and down over each 500 year period of alternate warming and cooling. Then, superimposed on this are shorter periods of about 30 years of more rapid warming and cooling, which were discussed in the Appendix of the author's paper *Radiated Energy and the Second Law of Thermodynamics* [1] published in March, 2012 on the *Principia Scientific International* (PSI) website.

In the 30 years from around 1969 to 1998 (inclusive) both the short-term and the long term cycles were increasing simultaneously. The overall rate of warming was not very different from that experienced 60 years earlier, but it was seen to be a cause for alarm. In the 1980's there was talk of a "greenhouse effect" which the Intergovernmental Panel on Climate Change (IPCC) describes as a process in which *"greenhouse gases trap heat within the surface-troposphere system."* They then postulate that *"infrared radiation emitted to space originates from an altitude with a temperature of, on average, -19°C, in balance with the net incoming solar radiation, whereas the Earth's surface is kept at a much higher temperature of, on average, +14°C. An increase in the concentration of greenhouse gases leads to an increased infrared opacity of the atmosphere ..."* [2]

*So* they say, but the physics of heat transfer is not easily understood and, in particular, we should not assume either that radiating gases increase the opacity, or that spontaneous radiation from a cold atmosphere will add extra thermal energy to a warmer region of the Earth's surface. This is discussed at length in the above-mentioned paper and it is recommended that the reader pause to read Sections 1 to 5 and the Appendix thereof.

## 2. The Problems with the Greenhouse Conjecture

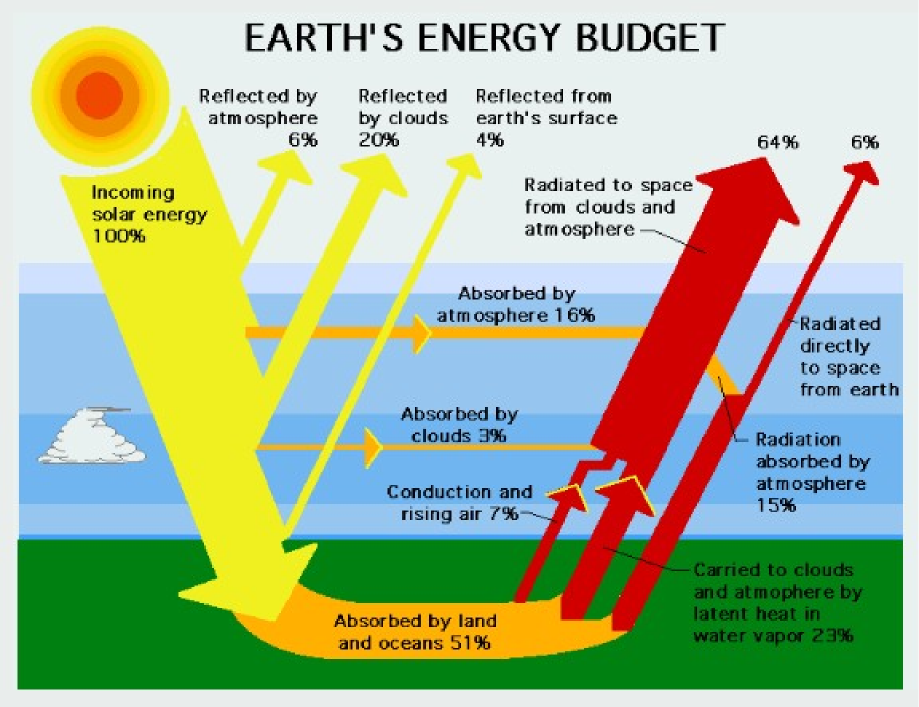
The so called Greenhouse Effect is based on the concept that the Sun warms the surface of a planet and then that surface cools at a rate governed by the composition of the atmosphere. The rate of cooling is thought to have something to do with the amount of upwelling radiation absorbed by the atmosphere, and/or the amount of energy which then returns to the surface by way of radiation.

But, quite apart from radiation, heat is also transferred from the surface to the atmosphere by non-radiative processes. Then nitrogen and oxygen molecules play the main role of insulating the surface, whilst water vapour and carbon dioxide help to radiate energy out of the atmosphere, and thus have an overall cooling effect, as we shall see in later sections.

It is indeed correct to say that radiation from the atmosphere does slow the component of surface cooling which is itself by radiation. But, at the same time, the presence of all air molecules just above the surface will also have a somewhat greater effect slowing the cooling of the surface. Molecules of a gas move around freely between impacts with others, and energy is transferred into these molecules as they collide with the surface. So ordinary nitrogen and oxygen molecules also have an insulating role, and the closer the temperatures get between the surface and these air molecules, the more they will slow the cooling process. They are the real blanket, for the very reason that they do not radiate much at typical temperatures found in the troposphere. Instead, it is water vapour and other radiating molecules like carbon dioxide which radiate energy out of the atmosphere and thus act like holes in the blanket, as you may read in an article *The Greenhouse Gas Blanket that Fails to Warm the World* [3] to which the author contributed.

Radiation from a cooler region of the atmosphere affects radiative cooling of the surface because it provides electro-magnetic energy for some of the "quota" of radiation which the surface is emitting. But this means that this portion of the radiation is not actually transferring thermal energy from the surface to the atmosphere. Hence the rate of cooling by radiation will indeed be slowed, as is well documented in Physics, but much of the radiation coming from the surface is merely returning electro-magnetic energy which was in the back radiation from the atmosphere.

Of all the thermal energy transferred from the surface to the atmosphere, about a third is by way of radiation, as this NASA energy budget diagram [4] shows. There you will see that only 15% of the original incoming Solar energy is transferred by radiation which is absorbed by the atmosphere, whereas twice as much is transferred by non-radiative processes, namely 7% by conduction and 23% by latent heat, which is energy stored in water vapour.



It will also be noted that 19% of the Sun's incident radiation is absorbed by the atmosphere and clouds, thus warming the atmosphere. This is more than the 15% which is absorbed by the atmosphere from surface radiation, yet some greenhouse proponents say the atmosphere is "transparent" to Solar radiation and "opaque" to IR radiation from the surface.

Now, calculations using standard physics show that direct Solar radiation, such as that received by Earth's surface, could not have raised the mean surface temperature by the observed amount. This is even more obvious on the planet Venus, because the surface there receives barely 10% of the Solar radiation that Earth's surface receives. and yet it has been measured at over 450°C. So there appears to be something very wrong in the assumption that the surface of a planet is 33°C warmer purely because the atmosphere slows the rate of cooling. If the Sun cannot raise the surface to a higher temperature first, we have to ask, "cooling from what?"

As will be explained in later sections, it is the effect of gravity that does the bulk of the warming by spreading energy in the atmosphere and creating a thermal gradient. All this cooling of the surface is merely a marginal process which holds back the small amount of extra energy which is absorbed when the Sun shines, and is then transferred back to the atmosphere. Meanwhile, an underlying stable base thermal profile in the atmosphere ensures that air near the surface cannot cool or warm too much, and nor can the surface.

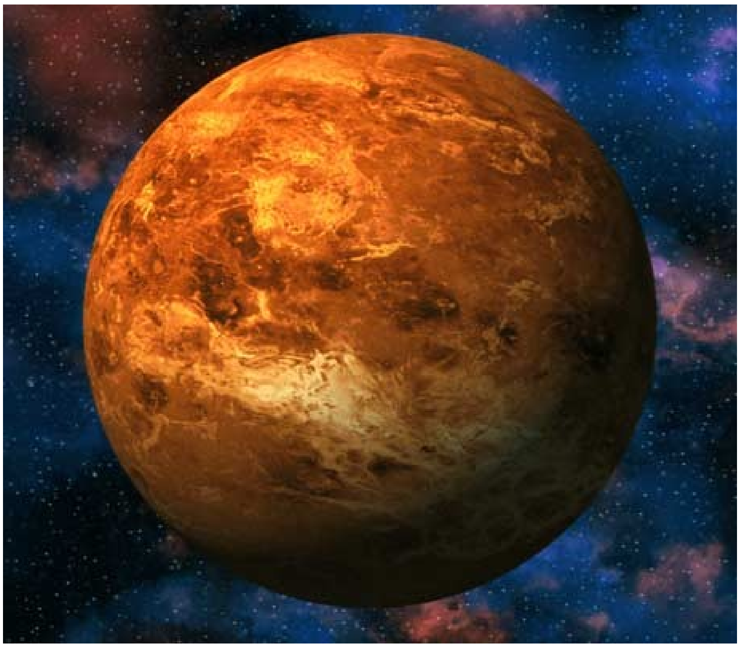
## 3. The Venus Dilemma

So a “greenhouse effect” is even less believable when we consider the planet Venus, or indeed other planets with dense atmospheres, namely Jupiter, Saturn, Uranus and Neptune. Hans Jelbring [5] points out that the carbon dioxide atmosphere of Venus has about 92 times the mass of Earth's atmosphere. He calculated that only about 2.5% of incident Solar radiation gets through to the surface. It is obvious that the atmosphere is being heated primarily by incident Solar radiation, rather than the very small amount of radiation returned by the surface from that 2.5% which made it through the dense atmosphere.

One might indeed assume that the top of the Venus atmosphere would be hotter than the base, as surely more incident radiation would be absorbed up there. But the reality is that the base of the atmosphere is more than 400°C above the mean radiating temperature for the whole “planet plus atmosphere” system. So it is hotter at the base and much colder at the top.

Let us go back to when the planet first formed and imagine the surface temperature to be at about the radiating temperature of the planet which would be a bit warmer than Earth's. Perhaps you are thinking that heat would somehow build up over millions of years to achieve the temperatures we now observe. Well, unfortunately the Second Law of Thermodynamics prohibits that. When radiation leaves the surface, even if all of it returns as back radiation, the net result cannot cause the temperature to rise. Yes, it will slow the rate of cooling, but it will never raise the temperature with any additional heat transfer into the surface, because energy cannot be created in this process. Will the Sun then raise the temperature more the next day? No. Actual measurements by Russian probes dropped onto the Venus surface led to calculations that the mean radiation received at the surface on the illuminated side is of the order of 10 to 20W/m^2 [6] because so much is reflected and absorbed by the thick atmosphere. So it is obvious that direct Solar radiation could never account for an extra 400°C or more, and no “runaway greenhouse effect” could amplify energy 1,000 fold.

Alberto Miatello has written a comprehensive three page analysis of what is happening on Venus in Section 8 of his paper *Refutation of the “Greenhouse Effect” Theory on a Thermodynamic and Hydrostatic Basis*. [7] He shows that the calculated thermal gradient (AKA adiabatic lapse rate) is evident in the atmosphere and can be used to determine the surface temperature of Venus.



We will return to this “calculated adiabatic lapse rate” or “thermal gradient” in Section 6, but it will suffice at this stage to explain that it depends upon the force of gravity and the specific heat of the air or gases in the atmosphere, where the specific heat is the amount of energy required to raise unit mass by one degree. Hence, if we know the gradient we can imagine a graphical “plot” of temperature against altitude having that gradient. The level of the plot is determined as the whole line moves up or down in parallel positions until an equilibrium state evolves in which the total outward radiation is equal to the incident radiation from the Sun.

The important point to note is that the parameters discussed in the above paragraph *pre-determine* the thermal plot, and so we can calculate at what temperature the line would meet the surface. Notice that we have not used any information about back radiation or energy flows into the surface. Yet, with reasonable accuracy, we can calculate “backwards” what the surface temperature ought to be in order to leave us with both radiative balance and the correct thermal gradient.

This accuracy of the surface temperature calculations (which can be made for Earth, Venus and other planets) cannot be coincidental. [8] One has to ask why we on Earth should be so worried about one carbon dioxide molecule in about 2,500 air molecules, when the atmosphere of Venus is nearly all carbon dioxide. Yet the surface temperature is still able to be calculated in the same way.

## 4. The Second Law of Thermodynamics

Ever since the 19th century when Loschmidt suggested that a thermal gradient would evolve in a solid, liquid or gas in a gravitational field the issue has been debated and, more often than not, dismissed. For example, Maxwell at the time just thought it would violate the Second Law of Thermodynamics if there were a warmer region at the base of a column of air.

We need to look more closely at this law, which was first stated by Clausius back in 1850. His statement read “No process is possible whose sole result is the transfer of heat from a body of lower temperature to a body of higher temperature.” [9] This statement is indeed correct if the bodies are at the same level or altitude, but we need to consider what happens when a gravitational field is present. If there is in fact a thermal gradient, then we have to explain why the original Clausius statement of the Second Law of Thermodynamics seems to be violated if isothermal conditions did not develop.

Elsewhere in Wikipedia we find a newer statement of the Second Law of Thermodynamics [10]. It reads “An isolated system, if not already in its state of thermodynamic equilibrium, spontaneously evolves towards it. Thermodynamic equilibrium has the greatest entropy amongst the states accessible to the system.”

Physicists have realised that kinetic energy (KE) [11] does not tell the full story. As we saw above, molecules have other energy and, in particular, in our isolated cylinder of nitrogen we need to account for gravitational potential energy (PE) [12] which can interchange with KE, just as happens when a pendulum swings back and forth, or a stone is thrown into the air. [13] But why have they not said that energy just needs to be conserved, as is the theme of the First law of Thermodynamics? [14] Why do we need a Second Law, and what is this strange, abstract concept of “greatest entropy” which they mention in there?

## 5. The State of Greatest Entropy

Entropy [15] has been described as "energy not available to do work" and an increase in entropy is associated with greater disorder. In a horizontal plane, where PE is the same, then, if one region of a solid, liquid or gas is warmer than another, there will be a propensity for molecules with greater KE in the warmer region to share that KE with others that have less KE. This sharing takes place during molecular collisions [16] and there is a propensity for all to end up in "thermodynamic equilibrium" with the same KE. The process is called conduction in a solid (and sometimes also in liquids and gases) though we will use the alternative word "diffusion" [17] strictly in the context of the sharing of KE during collisions involving gas molecules.

Now the above statement requires "the greatest entropy amongst the states accessible to the system" and it is effectively saying that this state is as far as we can go within the restrictions imposed by our isolated system. For example, if an "isolated system" is a room on the tenth floor, then a ball will only drop as far as the floor in that room. Being on the floor is one of the "states accessible to the system" and, when the ball comes to rest on the floor, it has acquired the greatest entropy available to it within the restrictions of the system. Throw the ball out the window and it enters another system where it will acquire a state of somewhat greater entropy.

So we have seen that entropy can increase when PE and/or KE decrease. If we have a perfectly insulated cylinder of nitrogen (where we will assume no external energy can be added, and no internal energy removed) then the state of "greatest entropy" is clearly that in which the mean sum of molecular (PE+KE) is the same in all regions within our cylinder. This conclusion is confirmed by considering what would happen if there were a region in which mean molecular (PE+KE) were greater than in another region. If this were the case, then the region with more energy could "do work" as it transferred energy to the other region, rather like water from a dam generating hydro-electricity as it converts its PE to KE whilst flowing down the pipes to the generator. If it can do work, then it is not a state of greatest entropy.

Hence our final equilibrium state in the vertical cylinder of non-radiating nitrogen has the same entropy in all regions, and we call it an isentropic state. But such a state in a gravitational field must then have less KE where it has more PE at the top, and more KE where it has less PE at the bottom. But temperature [18] is a measure of thermal energy [19] and in this Wikipedia item we read:

*"Microscopically, the thermal energy is the kinetic energy of a system's constituent particles, which may be atoms, molecules, electrons, or particles in plasmas. It originates from the individually random, or disordered, motion of particles in a large ensemble."*

In fact, temperature is a measure of just the average (mean) kinetic energy (KE) of all the molecules in any small region, and it does not include gravitational PE or other forms of non-thermal energy.

But we have just seen that gravity *redistributes* PE and KE in such a way that there is a KE gradient in a column of gas, with less KE at the top and more at the bottom of the column. Hence, assuming adiabatic [20] conditions with no phase change or chemical reactions, we have seen that the thermodynamic equilibrium [21] state of greatest entropy which evolves does in fact have cooler temperatures at the top and warmer temperatures below. This may be considered a direct corollary of the Second Law of Thermodynamics,

## 6. Quantification of the Thermal Gradient

The derivation of the "dry adiabatic lapse rate" (in Wikipedia, for example) [22] is rather cumbersome, starting with the ideal gas law and considering the effect of gravity on pressure, but then eliminating pressure in the final step anyway. A much more logical derivation (which helps us understand what the actual process is) can be derived simply by applying "conservation of energy" principles to every movement of a molecule in its free path motion between collisions. It is only during collisions that the actual process of diffusion of KE takes place.

So, in the free path motion of a molecule we can assume a purely adiabatic process occurs in which the sum of gravitational potential energy (PE) and kinetic energy (KE) remains constant. As we saw above, the temperature of a small region of a gas is a measure of the mean KE of the molecules in the region, and that region could be a very small mass of gas in order to be able to measure temperature.

Let us consider a thought experiment in which such a region of air of mass $M$ all happens to move downwards by a small height difference, $H$ in an atmosphere where $g$ is the acceleration due to gravity. The loss in PE will thus be the product $M.g.H.$ because a force $Mg$ moves the gas a distance $H$. But there will be a corresponding gain in KE and that will be equal to the energy required to warm the gas by a small temperature difference, $T$. This energy can be calculated using the specific heat $Cp$ [23] and this calculation yields the product $M.Cp.T$

Bearing in mind that there was a PE loss and a KE gain, we thus have

$$M.Cp.T = - M.g.H$$
$$T/H = -g/Cp$$

But $T/H$ is the thermal gradient, which is thus the quotient $-g/Cp$, this being the same as that in the Wikipedia derivation of the dry adiabatic lapse rate. [22]

However, the important point to note is that this has nothing to do with pressure, because pressure does not maintain any particular temperature, and does not add any new energy. Different planets have different temperatures at altitudes where the pressure is the same.

## 7. Explanation at the Molecular Level

There is a general perception that the so-called "dry" or "wet" adiabatic lapse rates occur in atmospheres as a result of the surface being first heated by the Sun, and then convection flowing upwards. However, this mechanism cannot possibly explain the observed temperatures, because the Sun could not heat the surface to the observed mean temperature. As discussed above, this is even more obvious on Venus where the poles, for example, appear to receive less than 1W/m^2 of direct insolation from the Sun, and the dark side receives nothing for four months, yet cools only 5°C.

Rather than convection being the only cause of the thermal gradient, it is apparent that the gradient is in fact established in still air at the molecular level by the conduction-like process we have been referring to as "diffusion" involving molecular collisions which share the kinetic energy of the molecules involved. It is well known that diffusion occurs in still air (in a room for example) and, at least in a horizontal plane, has a propensity to equalise temperatures. Thus, if there is a region of warmer air on one side of a room, then there will be diffusion of KE, which will lead to isothermal conditions in that horizontal plane.

We have mentioned in Section 5 that temperature is really just a measure of the average (mean) kinetic energy (KE) of all the molecules in any small region. This KE is the energy of motion in three dimensions, plus additional energy associated with molecular vibration and rotation. But a molecule also has potential energy (PE) which is "stored" energy relating to its height in a gravitational field, as well as energy which could be released in chemical reactions and phase changes, such as when steam condenses to water.

Let us now imagine an experiment with a cylinder of gas. For the present considerations we will assume that no chemical reactions or phase changes take place, and that no other energy enters or leaves our well insulated, sealed cylinder, which we will fill with pure nitrogen, so as to rule out any significant amount of heat transfer by radiation inside the cylinder.

As you probably know, molecules move about in random directions, colliding at various angles with other such molecules. But, as they move between collisions, they will be affected by the force of gravity and, just like an apple falling off a tree, when molecules move in a general downward direction some of their PE will be converted to extra KE. The opposite happens when they move upwards, and so, as we saw in Section 5, there will be a lower mean KE among molecules at the top than among those at the bottom. In other words, the temperature will be lower at the top and higher at the bottom.

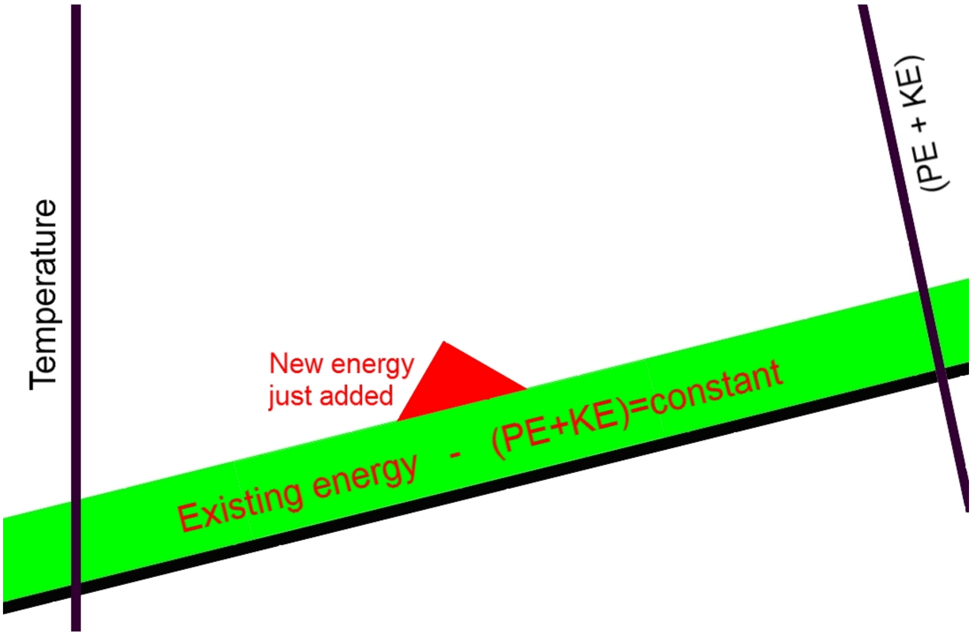
You could also imagine a cylinder which has removable insulated dividers that form three equal compartments. With the dividers in place, heat the middle compartment, turn off the heater and wait for diffusion to establish equilibrium. Then remove the dividers and some of the "warmer" molecules will move into each compartment. However, those that move to the top one will lose some KE, whereas those that move to the bottom compartment gain some KE. Hence, once again, we see that the warm air both rises and falls until a new thermodynamic equilibrium state is reached in which there will be a temperature gradient as before. This is an example of "heat creep" which we shall now discuss.

## 8. The Concept of "Heat Creep"

In this section we shall see that gravity, in effect, makes a sloping thermal plot into a "level playing field" in which energy can spread in all directions, just like a bucket full of water poured into the middle of a swimming pool.

For example, let us consider what happens when a supply of extra thermal energy is added somewhere in the middle of this sloping thermal profile. The effect can be visualised by turning the graph of the temperature-altitude relationship on an angle such that it is perpendicular to the gravitational force in the room where you are. That is, you make it look like a level playing field.

So, in the diagrams below you would be turning the page until the green section is horizontal and the line marking the (PE+KE) axis is vertical. In each diagram the green bar represents the (PE+KE) in the initial state of thermodynamic equilibrium. Then we are going to imagine what happens when an additional quantity of absorbed thermal energy (indicated in red) is added in the middle of this playing field.

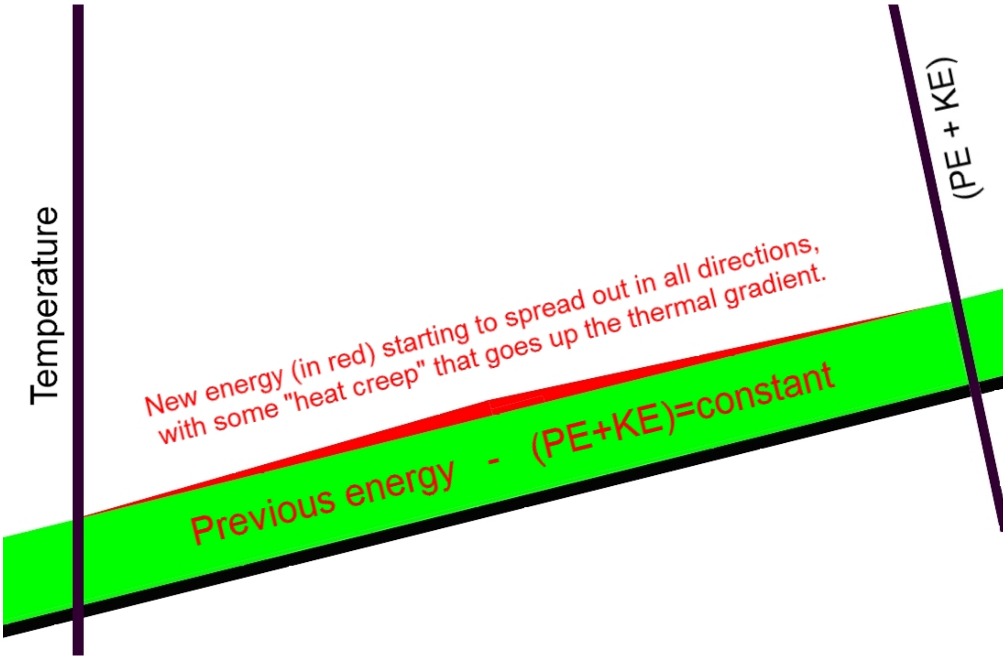


Now, when a rain storm falls on a section of the ocean, the extra water spreads out in all directions, eventually over the whole surface of the ocean, following the curved surface produced by gravity. So it is with extra energy deposited in the atmosphere if it makes the local temperature greater than the theoretical thermal profile would indicate it ought to be at that location.

But the extra energy actually creates a situation in which more molecules move outward than inwards. This was not the case with the "pure" diffusion process (wherein there were random movements) at least if the pressure gradient was not changed in the process. So this provides us with a distinction between convection (where there is adiabatic movement of air) and diffusion of KE which can happen in totally still air. In practice, both work together with the same result.

In general, convection requires an additional source of energy, and the most common form is that provided by the Sun. When the surface absorbs Solar energy, that energy then transfers from the surface into the atmosphere by conduction (diffusion) and thus provides a continuous supply of extra energy which creates convection.

A consequence of the above discussion of the "level playing field" is that, when a supply of "latent heat" is released from water vapour, there could be some downward convection apparently moving against the temperature gradient. The original extra energy shown in red in the above diagram now spreads out as shown in this diagram:



On Earth, upward rising air by normal convection would probably overpower this to some extent. But the situation would be different on Venus because so little direct Solar radiation gets through the thick atmosphere and into the surface. What must happen, in order to explain how the Venus surface receives the required energy to keep it so hot, is that incident Solar energy is absorbed at all levels of the atmosphere and then it spreads out over the thermal plane, just like rain falling on a section of a lake leads to extra water spreading out over the whole surface.

The extra energy absorbed will only spread out evenly in all directions if there was already thermodynamic equilibrium in the region. When such equilibrium is established, the additional KE at some location unsettles the equilibrium, and it is just as "easy" for the energy to spread up the thermal plane, as it is to spread down the plane, or in any other direction. So the thermal plane, even though it actually has a thermal gradient, acts like a "level playing field" because of the effect of the gravitational field.

Hence we have this rather strange concept that additional energy can in fact cause "heat creep" up the thermal gradient to warmer regions, provided that there was thermodynamic equilibrium initially. This process explains how energy can get to the base of the atmosphere and keep it warm (or very hot on Venus) quite independently of any energy received back from the surface.

## 9. How Earth's Surface Temperature is Supported

If we apply the equation for the thermal gradient (derived in Section 6) using data for Earth we calculate a gradient of 9.8°C of warming for each kilometre reduction in altitude, and vice versa for cooling. This is called the "dry adiabatic lapse rate" though it does not require any "lapsing" as is assumed to happen with warm air rising by convection. If there were a maximum amount of water vapour, we would observe the "wet" or "moist" rate, which is about two thirds of the dry rate. The reduction is due partly to the release of energy during phase change, but probably mostly because water vapour transfers heat by radiating it to cooler molecules at higher altitudes in the troposphere, thus having an opposite effect to that of diffusion.

Now, if you imagine plotting a graph of the temperature against the altitude, the slope of the plot is pre-determined by gravity, specific heat and the amount of water vapour and other radiating molecules (like carbon dioxide) which reduce the absolute value of the thermal gradient. But the overall mean level of the plot is determined mostly by the intensity of radiation from the Sun, adjusted for reflection and some other factors. In other words, the plot moves up and down through parallel sloping lines if the insolation (as it is called) varies up or down, as can happen in natural cycles, which may relate to variations in Solar intensity.

What this all comes down to is the fact that the temperature level at which the pre-determined plot intersects the surface is itself pre-determined primarily by the above-mentioned parameters, and not much else of any great significance. Water vapour and, to a much smaller extent, carbon dioxide radiate heat to higher levels (never transferring heat to a warmer region or surface) and so they reduce the gradient, and thus also reduce the surface temperature.

*So gravity in dry conditions creates a steeper gradient, but water vapour reduces it by about a third, bringing the surface temperature back down to the observed levels.*

But this cooling effect of water vapour is the exact opposite of what is claimed in the greenhouse conjecture, namely that water vapour warms and has a positive feedback, supposedly amplifying the assumed warming effect of carbon dioxide. A brief study was carried out by the author to see if temperature records in real cities in the real world confirmed any warming. The study is in the Appendix to this paper and the conclusions are that there is no evidence of any warming, but instead an indication of the cooling which was explained in the last paragraph above.

The pre-determined plot mentioned above is maintained by the process of diffusion with its resulting “heat creep” which transfers thermal energy absorbed by the atmosphere in all directions, including downwards towards the base of the atmosphere. This lowest region of the troposphere then “supports” the surface temperature, preventing it getting much colder at night.

Of course, on Earth the Sun does heat the surface to higher temperatures during the day, but the close surface temperatures slow down all the radiative and non-radiative cooling processes. The surface could not have reached the observed mean temperature without this “ratchet” effect whereby the temperature of the base of the atmosphere is pre-determined, and then this temperature supports the surface temperature and makes it easy for the Sun to warm the surface with additional temporary energy which comes and goes each day and night. Energy “creep” up the thermal gradient provides our answer as to how sufficient energy gets into the surface of Venus, and also explains Earth's surface temperature without any need for any radiative greenhouse conjecture.

## 10. Laboratory Evidence for the Gradient

Can the above-mentioned interchange of potential energy and kinetic energy take place in a sealed cylinder of air in a laboratory, thus creating a thermal gradient in a gravitational field? Well, Roderick Graeff [24] believes he has demonstrated that it can.

However, Graeff appears to be mistaken when he multiplies the temperature difference by the number of degrees of freedom, namely 5 for most air molecules which are diatomic. This amounts to multiplying the vertical KE gain by five, thus creating energy. Instead, it is suggested that equipartition between the degrees of freedom takes place at the moment when molecules collide, and then that extra vertical translational KE is shared equally, not multiplied.

Removing the multiplication by the number of degrees of freedom then brings the equation for the temperature gradient into line with that derived in Section 6 for the dry adiabatic lapse rate, so the temperature gradient $T/H = -g/Cp$, where $T$ is the temperature differential, $H$ the height differential, $g$ the acceleration due to gravity and $Cp$ the specific heat.

It is apparent that the non-radiative processes, conduction, diffusion and convection all have a propensity to create a thermal gradient equal to $-g/Cp$ where $g$ is the acceleration due to gravity, and $Cp$ the specific heat. This happens because molecules following their free path between collisions will exchange kinetic energy with potential energy, no matter how short or long is the path length. Hence this happens in solids, liquids and gases, and so the value used for the specific heat, $Cp$ should be close to the weighted mean specific heat of any substances in the region.

So, when Roderich Graeff included fine glass powder in one of his water cylinders, that would have reduced the mean specific heat, and thus increased the thermal gradient. The walls of the container would also have increased the gradient because of their much lower specific heat. Furthermore, the first cylinder would have had some interaction with the other one containing only water. The second cylinder displayed a gradient of about 3 to 4 times the $-g/Cp$ value, but he cannot blame the difference on convection, because convection also produces a gradient of $-g/Cp$. The extra temperature difference could very well have been due to the reasons discussed above, as well as errors in his measurements as he tried to detect what should be a difference of only about 0.002 degree. Hence, Graeff has no empirical evidence to support his claim that the theoretical thermal gradient of $-g/Cp$ should then be multiplied by 18 degrees of freedom for his experiments with water. However, this is not a reason to dismiss his main claim that a negative temperature gradient of some measurable magnitude does occur. This is proved by virtue of the fact that a positive gradient was measured on the inside of the outermost walls of the apparatus.

The empirical results achieved by Graeff only after several months were probably exaggerated by the effect of steeper gradients in solids. There appears to be no reason why they should be about five times the dry adiabatic lapse rate observed in atmospheric air at similar temperatures.

## 11. Planetary Evidence for the Gradient.

Many seem to think that the Venus surface is somehow kept hot by the enormous pressure exerted by the “weight” of the atmosphere which has about 92 times the mass of the Earth's atmosphere.

Others claim that there is a “runaway greenhouse effect” somehow utilising radiation that passes back and forth between the surface and the atmosphere, supposedly multiplying the very small amount of direct Solar radiation, which gets through the atmosphere in the first place, and into the surface. But if that were the only energy the surface received, it would be far colder than Earth's.

A third group of people seem to think the planet is still cooling off, and so energy from its core is doing all the work, but that is also implausible for the planet has had plenty of time to cool off, and would have done so if its atmosphere were more like that of Earth.

Firstly, it is incorrect to think that the fact that 96.5% of the Venus atmosphere is carbon dioxide will make it act like an insulating blanket. There will be plenty of radiation going on between all those carbon dioxide molecules but, as explained in Section 1, heat will only be transferred from hot to less hot molecules in the Venus atmosphere. There is a steady decline in temperatures in the troposphere of Venus, just like on Earth, and so all heat transfer by radiation will be outwards towards space. And, with temperatures around 730K (over 450°C) there would be a huge amount of radiative cooling if nothing were supplying energy to keep the base of the atmosphere about as hot as the Venus surface.

Pressure cancels out in that round-about Wikipedia derivation of the dry adiabatic lapse rate. [22] That is because pressure has nothing to do with it, and so does not feature in the result. Pressure does not maintain those hot temperatures. In order to compensate for the loss of energy by radiation there must be another continual source of thermal energy headed towards the base of the atmosphere and, some of it, into the surface. And this must be all by non-radiative processes, because radiation cannot transfer heat from the less hot atmosphere to the Venus surface.

Only the "heat creep" explained in Section 8 can transfer energy towards the hotter surface. With the help of the pull of gravity, this mechanism (resulting from application of the Second law of Thermodynamics) is the only possible mechanism, and it must be the process which keeps the Venus surface so hot. It is the height of the atmosphere which allows the thermal plot to reach such temperatures, as it follows the thermal gradient formed autonomously by the force of gravity.

## 12. The "Pseudo" Lapse Rate.

Although "lapse rate" is not an appropriate description for the thermal gradient, this terminology is being used here in recognition of the work done by Dr Hans Jelbring [5], initially for his PhD in Climatology in 1998, and then published in a peer-reviewed journal in 2003. Very few, it seems, have recognised how he was perhaps the first to postulate that the gravitationally induced thermal gradient negated any need for the alternative (and fallacious) concept that back radiation was needed to create such a gradient. In discussing the influence of gravity, Dr Jelbring wrote in 2003 that this *"has rarely been acknowledged by climate change scientists for unknown reasons. Its numerical value can be calculated using familiar knowledge in physics."*

So, why has the influence of gravity been largely ignored for yet another decade? We could postulate that, here on Earth it seems intuitive that the base of the atmosphere is in fact warmed by the heat of the Sun which first warms the surface, which then warms the air. A close look at those energy diagrams, however, usually shows that something like 50% of incident Solar radiation is absorbed by the surface, but only about 7% actual enters the very base of the atmosphere by conduction processes, sometimes called "diffusion" when gases are involved. Most of the energy which enters the atmosphere (either on the way down or back up) is actually spread unevenly over a wide range of altitudes. This does not appear consistent with any concept of a fairly uniform gradient in temperature.

Now Jelbring explains that what he calls the "pseudo adiabatic lapse rate" on Earth is only about 70% of the theoretical lapse rate calculated for an ideal gas in a closed system, perhaps shaped like a tall cylinder with uniform cross-section.

It has been common practice on Earth to explain the less steep "wet" rate as being due to the release of "latent heat" when water vapour condenses in the clouds. Indeed this would release extra thermal energy which would spread out in all directions over the sloping thermal plane, but it would be a localised weather event which would soon disappear. Furthermore, it does not explain an observed reduction in the lapse rate on other planets, which have no precipitation in the form of rain. And nor would it explain the apparent reduction in the thermal gradient in Earth's outer crust, which is discussed in Section 15.

So, if both diffusion and convection in the atmosphere have a propensity to produce a dry adiabatic lapse rate of about 9.8C degrees per kilometre on Earth, why then is the measured mean value only about 7C degrees per kilometre? I suggest that the reason has a lot to do with radiation between all radiating molecules at different altitudes within the troposphere.

Unlike the non-radiative processes (which involve an exchange between kinetic energy and potential energy) radiation has a propensity to make the different levels more equal in temperature as they radiate towards each other. So this will have a levelling effect working against the non-radiative processes, and thus reducing the lapse rate.

So the wet adiabatic lapse rate is less than the dry one because there are more water vapour molecules at different levels radiating towards each other, and also because the specific heat of water vapour is higher than that of dry air. There will always be some water vapour and carbon dioxide at most levels in the troposphere, so the observed “pseudo” lapse rate is indeed less. Over the course of many years, a lower thermal gradient causes a lower surface temperature because the whole temperature plot swivels around an anchor point somewhere between its ends. So water vapour, suspended water droplets, carbon dioxide and other radiating molecules all contribute towards this cooling effect. As mentioned above, this appears to be the case in the data analysed in the study documented in the Appendix to this paper.

## 13. Non-Radiative Heat Transfer Processes

You will recall that, in the process we have called diffusion, there is no overall movement of air in any one direction when thermodynamic equilibrium is established. When an additional supply of thermal energy is added, there will be a net flow of molecules away from that source, as we saw in the discussion of “heat creep” in Section 8. This can be observed as a very slow adiabatic movement of air which is correctly referred to as convection.

We tend to think of convection as always moving warm air upwards, but that is because of our experience here on planet Earth, where the Sun warms the surface and creates a “one-sided” supply of extra thermal energy which generally over-powers any convection coming from thermal energy absorbed in the atmosphere.

Wind will over-power the slow process of adiabatic convection. But note that wind should not be lumped in with convection, because it is important to understand the difference. Whilst net downward convection is rare in Earth's troposphere, net downward wind movement is common, and it is indeed the process which returns the air that rose by convection back towards the surface.

To understand the wind cells, we need to consider the “funnel effect” in the troposphere as wind travels from the Equator towards the poles. Not only does the height of the tropopause “ceiling” get lower, but the volume of air between successive equally spaced “circles” of latitude surrounding the globe also reduces rapidly as the poles are approached. Hence, when air rises by convection in the tropics it is replaced by incoming Trade Winds, and it also “squeezes out” pole-bound winds under the tropopause ceiling, because the temperature inversion in the stratosphere stops further rising. Then the funnel effect inevitably causes some downward component in the pole-bound winds, much of which returns to the surface about a third of the way to the poles. Wind cells are more complex than this simple description, but at least it provides the general concept of air rising by convection and returning in downward wind.

## 14. Rebuttal of Counter Arguments

Sometimes it is argued that the gravity effect is not evident in the oceans, but we must recognise that the processes of adiabatic diffusion and convection are very slow indeed, and are easily over-ridden by local weather conditions such as winds, ocean currents and even by an excessive supply of new absorbed energy, such as is observed in the stratosphere.

Just as we see a temperature inversion in the stratosphere, where the Sun warms the top, so too do we see it in the top layers of the ocean. Solar radiation penetrates the top layers of the ocean, but more of it has already been absorbed the deeper it goes. So this produces a steep cooling in the thermocline, whereas the temperatures are fairly homogeneous at deeper depths. You can see a typical plot here [25] and learn more about the thermocline on this [26] page, where we read

*Thermoclines may be a permanent feature of the body of water in which they occur, or they may form temporarily in response to phenomena such as the solar heating of surface water during the day. Factors that affect the depth and thickness of a thermocline include seasonal weather variations, latitude and longitude, and local environmental conditions.*

So it is evident that currents and variations in Solar radiation play havoc with ocean temperatures, and they over-ride what would be a much less steep gravity gradient because of the much higher specific heat of water. In a nutshell, there will be a supply of extra energy from the Sun which, even beyond the depth where radiation reaches, will continue to warm from the top by current flow and downward convection, just like the "heat creep" in the atmospheres of Venus and even Earth.

Another argument relates to the conjecture that a perpetual cycle of energy would occur if a wire were run up the outside of Graeff's cylinders of air. But this is not the case, because all matter, solid, liquid and gas has molecules which move to some extent and have kinetic energy that they share with neighbouring molecules in collision processes, such as conduction in solids. So, as Loschmidt postulated, we do indeed expect thermal gradients in solids and liquids, as Graeff observed in his experiments. So the wire would also develop a thermal gradient which would be effective in preventing a continuous flowing cycle of energy. In essence, the wire and the gas should be considered as a single system with a mean specific heat. If you had two tubes of water at different slopes, and then joined the ends at the top and bottom, would water flow continuously in an endless loop? No, and neither would thermal energy through the wire and the cylinder.

## 15. Support for the Mantle and Core Temperatures

The mystery of planetary core and mantle temperatures can now be unravelled with the concept of heat creep. Borehole measurements [27] indicate a thermal gradient of about 25 to 30°C/Km in the outer 10Km or so of the Earth's crust. This is what we would expect, because the mean specific heat of earth, rock and clay is about a quarter that of atmospheric air, and a "pseudo" rate would also develop because of intra-molecular radiation. But specific heat increases significantly at higher temperatures, leading to the thermal gradient in the deep mantle being perhaps even less than 1°C/Km because the specific heat is in the denominator of the $-g/Cp$ quotient.

Now, we need to see the big picture. There must be a continuous thermal plot which rises, at least from the top of the troposphere, down to the surface and then, at a steeper upward gradient in the outer crust, curving over to an almost level plot as it approaches the core. The whole plot has evolved autonomously by conduction and diffusion processes over the life of the Earth, and presumably similar plots have evolved on other planets like Venus.

*Energy from the Sun "creeps" up the thermal plane, not only supporting surface temperatures, but even those of the crust, mantle and core. So, if insufficient energy is generated beneath the surface, then the shortfall will come from the Sun, at least over the course of many years.*

The key point is that this plot would be very stable, and we should have nothing to worry about for thousands of years because it would take a huge amount of extra energy (which could only come from the Sun) to raise the whole length of the plot from the tropopause to the core.

When the Sun warms the surface by day, it merely deposits extra thermal energy at the boundary so that some flows into the crust and top layers of the ocean, and some provides extra warmth in the first 100m or so of the atmosphere. This extra pile of energy dissipates at night, the marginal cooling process being slowed by non-radiative and radiative processes.

But the big picture is, that the underlying thermal plot "supports" both the surface temperatures and even those in the crust, mantle and perhaps the core. It does not matter if extra energy is created in the core, or trapped temporarily at the surface, because the cooling process will accelerate if the temperature gap widens, or slow down when the gap narrows. Even the apparent loss of energy in the calculated terrestrial flow is misleading, because it is based on a thermal gradient that gravity formed and over which energy might even be flowing up towards the mantle, from where it may be released in volcanoes, thermal springs or undersea vents.

## 16. Conclusions

When Maxwell and Boltzmann dismissed Loschmidt's postulate of a gravity gradient they did the world a great disservice, and they contributed to a belief in a non-existent warming by an imaginary radiative greenhouse effect. The subsequent "calls to authority" should be a lesson for all in the scientific world, for this has resulted in an absolute travesty of physics. The greenhouse conjecture will inevitably take its brief place in history as the biggest and most costly mistake ever in the field of human scientific endeavour. Hopefully that will be soon.

Scientists, be they climatologists, physicists or whatever, need to step outside the square and to adopt a paradigm shift based on, and supported by 21st century science. Dr Hans Jelbring and Roderich Graeff have each made significant contributions which must now be heeded before the mistake is perpetuated by those who now have personal vested interests in maintaining the status quo.

Climate has in fact been following natural cycles [28] as shown in the Appendix to the author's paper on Radiated Energy [1] and the world can expect a period of about 500 years of cooling to start within 50 to 200 years from now.

The Loschmidt gravity-induced thermal gradient is more than enough to explain the proverbial "33 degrees of warming" and in fact the dry adiabatic lapse rate would lead to a mean surface temperature of about 25°C were it not for water vapour and, yes, to a much smaller extent, carbon dioxide reducing the gradient and causing lower base surface temperatures. In the Appendix is an outline of methodology that would almost certainly produce studies which would demonstrate the cooling effect of water in locations around the world.

Thermal energy can and does "creep" up the very shallow thermal gradients in planetary atmospheres and also in their solid crusts and mantles, supporting sub-surface temperatures. Indeed the physics of "heat creep" resolves the long-term puzzles of planetary core and surface temperatures, and, for this very reason, begs attention and claims validity for this 21st century new paradigm shift in climate change science. [29]

## 17. Appendix – Study of Temperature / Rainfall Correlation

It is a fundamental AGW requirement (for there to be a radiative greenhouse effect) that water vapour and suspended water droplets in the atmosphere should have a warming effect. This warming effect is supposed to account for most of the "additional 33 C degrees" in surface temperatures, increasing the thermal gradient from an assumed initial isothermal (level gradient) state to one in which the surface temperature is about 30°C warmer. Then carbon dioxide and other radiating molecules are supposed to raise the temperature a little more up to a total of 33 degrees above the level gradient value. Furthermore, if carbon dioxide levels increase, it is assumed that the level of water vapour would increase as a result, and so more warming is expected, multiplying the effect of carbon dioxide with this extra positive feedback.

However, it is well known and acknowledged that water vapour leads to a lower thermal gradient, otherwise known as the "wet" or "moist" adiabatic lapse rate. Rather than the dry rate (calculated from the $-g/Cp$ quotient to be 9.8C/Km) high levels of water vapour are known to reduce the gradient to about 7C/Km and even down to 6.5C/Km in the very humid Equatorial regions. The main argument in this paper would thus suggest that, because water vapour makes the thermal gradient less steep, we should expect a lower surface temperature when the new radiative equilibrium is established. Thus it appears that water vapour should have a negative feedback.

It seems remarkable that this apparent contradiction does not appear to have been investigated with what could be a relatively low cost study, compared with the funds that have been spent on other climate research. Because of this, the author spent just a few hours analysing temperature and rainfall data for 15 cities, in order to give an indication of how a more comprehensive study could be conducted.

It was considered most appropriate to select towns and cities within the tropics, which extend between the Tropic of Cancer (at about 23.5° North) to the Tropic of Capricorn (at about 23.5° South) because the Sun will be directly overhead any particular city twice a year. By selecting data for the hottest month this will usually correspond to the month in which the Sun passed through its Zenith, or the following month. As other variables may have affected the Northern Hemisphere, it was decided to limit the study to the Southern Hemisphere and to select the hottest month out of January, February or March, though nearly all turned out to be January. Such a selection avoids the need to make compensations for the angle of the Sun at latitudes outside the tropics.

It is noted that flat islands such as Singapore have very regular maximum and minimum daily temperatures, and this is almost certainly due to diffusion, convection and wind from the air just above the ocean surface, where the air temperature is governed by the water temperature. A similar effect occurs to a lesser extent with coastal cities, as well as with some cities that are close to large inland bodies of water. Hence it was decided not to include cities that were less than 100Km from the coast or such bodies of water.

It was also considered that there would be a need to adjust temperatures to what would be expected at a common altitude, and 600m was selected. Cities with altitudes outside the range 0 to 1200m were then excluded so that errors relating to assumed thermal gradients (lapse rates) would be unlikely to exceed about half a degree at the most. It was decided to use a gradient of 7C/Km for the third with the greatest rainfall, 8C/Km for the third with the least rainfall and 7.5C/Km for the middle third of the cities in the sample.

The above exclusions tend to rule out Indonesia, Papua New Guinea and other Equatorial island regions such as are found to the North of Australia.  As the study was restricted to the Southern Hemisphere, it was decided to limit it to latitudes from 16.0 to 24.0 degrees south as this would include Alice Springs in Australia (latitude 23°40'S) which was considered close enough to the Tropic of Capricorn, as well as most tropical regions in Australia (AU) except those close to the Northern coastline.  It also of course included a slice of both Africa (AF) and South America (SA) and, from these three continents, a total of 15 cities were selected, there being six in Australia but only four  in South America where several were ruled out by altitude.

Cities which were within one degree of either the latitude or longitude of a previously selected city were not considered.  However, once it was determined that a city met the requirements for altitude and coordinates, it was included in the study before referring to any temperature or rainfall data, so none were excluded for any "exceptional" reasons relating to such data, except for Emerald in Queensland Australia for which the source of data [30] had no rainfall information.

It is appreciated that rainfall may not be an accurate indicator of the thermal gradient, but neither would relative humidity be any better, because suspended water droplets also play a part in reducing the gradient, as does the release of latent heat when it rains.

The data is presented below in a format which the reader could use for further spreadsheet analysis:

**City, Country/State, Continent, Altitude, Maximum, Minimum, Rainfall, Adj* Max, Adj Min**

01:  Manaus, Brazil, SA,  39m, 27.3, 18.7, 238.7, **23.4, 14.8**

02:  Goiania, Brazil, SA,  749m, 30.1, 19.5, 209.6, **31.1, 20.5**

03:  Kadoma, Zimbabwe, AF,  1160m, 28.6, 17.7, 183.2, **32.5, 21.6**

04:  Halls Creek, Western Australia, AU, 422m, 36.6, 24.4, 164.9, **35.4, 23.2**

05:  Charters Towers, Queensland, AU, 336m, 33.5, 22.4, 164.7, **31.7, 20.6**

06:  Pedro Juan Caballero, Paraguay, SA, 563m, 29.9, 20.4, 160.4, **29.6, 20.1**

07:  Mariscal Jose Felix Estigarribia, Paraguay, SA, 151m, 35.4, 22.9, 129.3, **32.0, 19.5**

08:  Mount Isa, Queensland, AU, 356m, 36.4, 23.7, 117.3, **34.6, 21.9**

09:  Francistown, Botswana, AF, 1001m, 30.8, 18.9, 115.5, **33.8, 21.9**

10:  Maun, Botswana, AF, 943m, 32.2, 19.8, 109.4, **34.8, 22.4**

11:  Ghanzi, Botswana, AF, 1100m, 32.4, 19.3, 104, **36.4, 23.3**

12:  Longreach, Queensland, AU,  193m, 37.1, 23.3, 73.0, **33.8, 20.0**

13:  Beitbridge, Zimbabwe, AF, 456m, 33.5, 21.9, 56.8, **32.3, 20.7**,

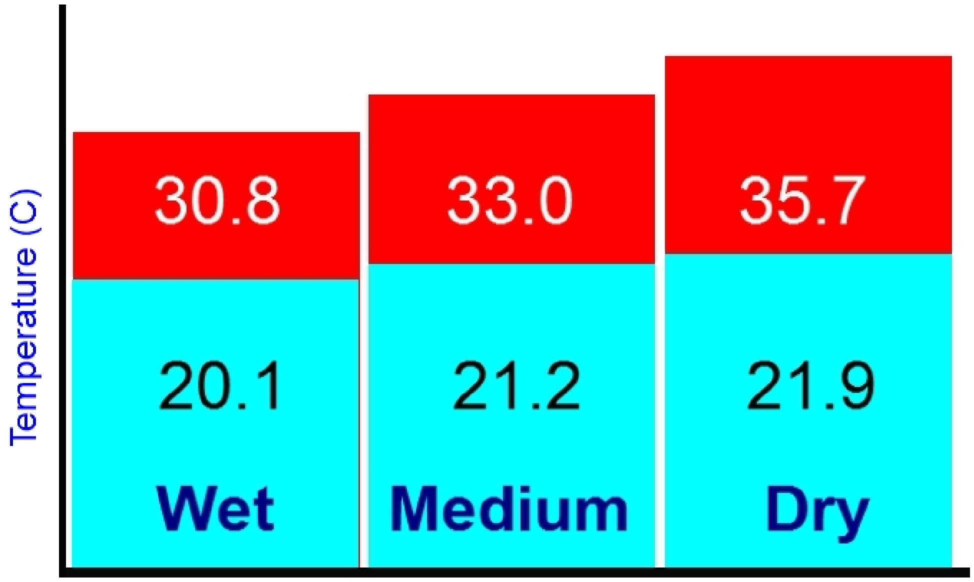
14:  Paraburdoo, Western Australia, AU, 389m, 41.2, 26.0, 51.4, **39.5, 24.3**

15:  Alice Springs, Northern Territory, AU, 545m, 36.9, 21.8, 39.9, **36.5, 21.4**

* At 600m: for 01 to 05 use gradient 7C/Km, 06 to 10 use 7.5C/Km, 11 to 15 use 8C/Km

**Means of Adjusted Daily Maximum and Daily Minimum Temperatures**

| | | |
|---|---|---|
| Wet (01-05): | **30.8°C** | **20.1°C** |
| Medium (06-10): | **33.0°C** | **21.2°C** |
| Dry (11-15): | **35.7°C** | **21.9°C** |



## Conclusions:

There is clearly no indication of any warming effect related to water vapour, and so no evidence for the assumed positive feedback, which is a fundamental building block for the greenhouse conjecture. Rather, the opposite appears to be the case, and water vapour does in fact appear to have the cooling effect anticipated by the hypothesis in the main body of this paper.

It may well be argued that the sample was not large enough, but this must surely indicate a need for some attempt to validate such a crucial assumption, which is vital for there to be any validity in the greenhouse conjecture that carbon dioxide has a warming effect. If water vapour does in fact have a negative feedback (as it radiates heat to higher, cooler regions, or direct to space) then so too would carbon dioxide have such a cooling effect, albeit far less in magnitude.

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