Encircling the Dragon

A Response to Certain Criticisms of the Unified Theory of Climate

By AusieDan February 2012

Summary

The Unified Theory of Climate has been developed by Drs. Ned Nikolov & Karl Zeller and demonstrates that the surface temperature (**Ts)** of eight different planets and moons is defined by a combined function of solar irradiance (**So)** and the atmospheric pressure at the surface (**Ps).**

Willis has made a number of criticisms of this theory and while his attack has been vigorous, it has been easily withstood and has actually strengthened the basic argument. The theory emerges more robust than before. It is indeed a General Theory of MacroClimatology.

Incidentally by using the N&Z methodology, it is shown that annual average near surface temperature is independent of the level of atmospheric carbon dioxide.

Background to the United Theory

The theory states that the maximum possible near surface average annual temperature is a function of TOA solar irradiance and atmospheric pressure at the surface. Other factors, such as fluctuations in the amount of cosmic rays coming from space, periodic cycles in the oceans, aerosols in the air, and volcanic eruptions, may indeed cause the temperature to fluctuate downwards from time to time, but play no part in determining the absolute possible maximum level.

The theory has been tested on data from the four inner planets, our moon and the moons of three of the outer planets. These have been chosen to provide as large a spread as possible of illumination conditions and atmospheric pressure, given data availability. Data has been taken from various sources including NASA Fact Sheets, augmented by more up to date information from satellite probes, where appropriate.

The theory may be envisioned as three interlocking equations:

1. Calculation of Grey Body Temperature from solar irradiance, based on standard values for albedo and emissivity, using the equation for Tgb, as described in the N&Z paper:

$$= \frac{2}{5}\left[\frac{(S_o + c_s)(1 - \alpha_{gb})}{\epsilon\sigma}\right]^{\frac{1}{4}} \qquad (2)$$

2. Development of the concept of ATE, the Near Surface Atmospheric Thermal Enhancement, which they calculate in terms of Nte, the ratio of a planet's actual temperature near the surface, to the theoretical Gray Body Value. Put more simply, this is the pro rata boost given by the atmospheric pressure at the surface, in addition to the temperature caused by solar irradiance at the top of the atmosphere. The formula for Nte is given by the equation, where Ps is the atmospheric pressure in Pa:

$$N_{TE}(P_s) = \frac{T_s}{T_{gb}} = \exp\left(0.233001\ P_s^{0.0651203} + 0.0015393\ P_s^{0.385232}\right) \qquad (7)$$

3. Finally the actual near surface temperature may be given by the product of Tgb and Nte, using the simple equality: Ts = Tgb * Nte (N&Z's Equation 8) where Tgb is given by Equation 2 above.

The theoretical values of Tgb compare well with actual observed satellite values.

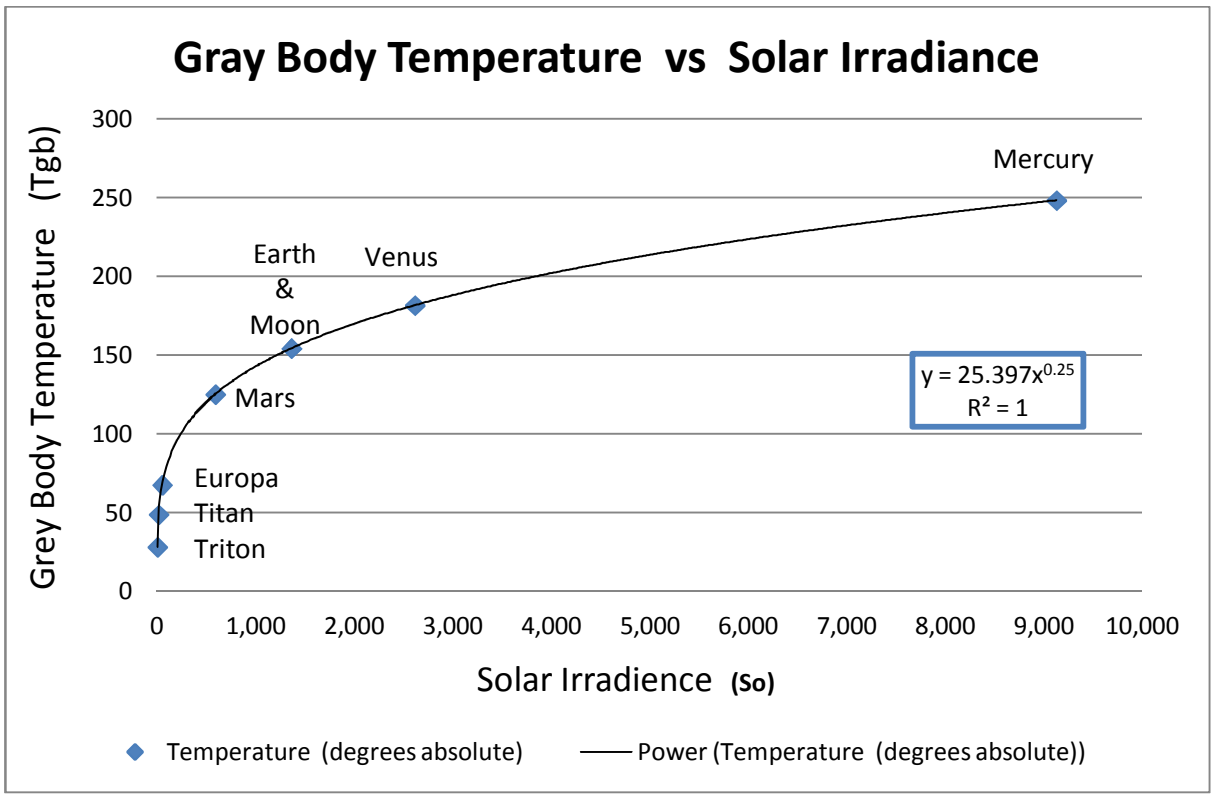

Chart 1 – Gray Body Temperature vs. Solar Irradiance – Note that this implementation of the Gray Body Equation is a mathematically exactly equivalent to the function of the fourth root of Irradiance, which would be expected from its design (R Squared = 1, to the limit of the graphic system to discriminate). It should also be noted that the values for the Earth, Moon and Venus sit exactly on the curve, unlike the Black Body data from the NASAS Fact Sheets (Refer Chart 3 below).

Criticisms

Willis raises five separate criticisms of the Unified Theory and each will now be examined in turn. The first is a mere quibble which has no impact on the result. The second will be shown to be due to a mistake on his part, where he accuses N&Z of circular reasoning, but falls into that trap himself. The third concerns the use of parameters where he fails to realise that the Theory is not just the result of empty curve fitting, but that each section is solidly based on well established and accepted physics laws. The last criticism concerns the need for model testing, which is also addressed.

Academic Niceties

The authors also express the surface temperature (Ts) in the following manner:

$$T_s = 25.3966\ (S_o + 0.0001325)^{0.25} N_{TE}(P_s) \qquad (8)$$

Willis points out that the adjustment of 0.0001325 is so small that it can be left out without significantly altering the result. That is correct. But neither Willis nor I claim to be professional physicists like Doctors Nikolov and Zeller. We come from the practical world of business, where speed is often of the essence and often vies with accuracy in importance. He does not seem to appreciate the scientific need to specify equations exactly, even when the necessary complicating adjustments do not have a significant impact on the outcome. And it is the academic scientific world that N&Z must persuade if progress is to be made in Climate Science and if governments in turn are to be convinced. So Willis is correct on this narrow point from his perspective, but the authors seek to assure their colleges that their equations also correctly describe the temperature, even of outer space, where Willis' approach would fail.

Misunderstanding the Nature of Circular Reasoning

Willis then returns to equations 7 & 8, but in attempting to criticise N&Z, himself engages in circular reasoning. Here are the essentials of his argument in symbolic form;

> Assume that there are three variables, such that A = B * C (Equation 101)
> Then this can be re-arranged as: C = A / B (Equation 102)
>
> Now, substituting for C in Equation 101, using its value "established" in Equation 102, we get the result: A = B * A / B which can be simplified as A = A, as all students of mathematics can attest.

However this is mere circular reasoning, devoid of all meaning.
But in a similar manner, Willis "proves" that Ts = Tgb * Ts / Tgb = Ts.

"TA-DA" as Willis probably correctly points out, but what exactly does that mean?

For it is Willis rather than N&Z who has engaged in circular reasoning. What he fails to acknowledge at this point is that Nte is not merely Ts / Tgb, but in reality is a complex function of atmospheric pressure. It is not merely the result of curve fitting, but has been correctly designed to properly reflect the effect of a considerable range of pressures found on the various planets. That point will be further explained in the next section.

Willis' dilemma may be solved with a more precise use of symbols, language and reasoning.

Now let Ts be the observed surface temperature, and Tc as the calculated surface temperature, derived from the values for Irradiance and pressure per Equation 8.

Thus Tc = Tgb * Nte, where Tgb is a function of irradiance and Nte is a function of surface pressure. This is shown to equate to Ts, the observed temperature, and thus Nikolov and Zeller are correct.

The use of Parameters during Model Construction

Here we return to the issue of the number of parameters used in the three main equations and the criticism that these are the mere result of excessive curve fitting. To further that argument, Willis expresses Equation 7 in symbolic form, to emphasise that it contains four parameters:

Nte(Ps) = **e**^(t1 * **Ps** ^ t2 + t3 * **Ps** ^ t4) (7Sym)

Where "**e**" is the base of natural logs and **Ps** is the surface pressure on the planet or moon. There are four tuneable parameters (t1 through t4) that are "fitted" to the data, which he claims can be easily achieved as there are only eight data points. He does acknowledge that the fit is quite good and that their estimate is quite close to the actual value of **Nte(Ps)**.

Nevertheless, Willis is concerned about this issue and even goes on to formulate his own model with a much reduced data set. That will be discussed below. But for now it is enough to point out that the relation of pressure to temperature is complex and cannot be fully described by a simple model of the type that he developed.

By way of illustration, there are still those with extensive knowledge of the massive sports racing cars of the English, German and Italian teams, which battled it out for supremacy on road and track throughout Europe in the 1920's and the 1930's. These were huge, supercharged beasts; the four and a half litre Bentleys in particular being boosted by Amherst Villiers blowers. These monsters started off with a rush, but when engine revs reached a certain level, in came the boost of the supercharger and acceleration was pushed to another level altogether. By analogy, that is exactly the purpose of the two stage Nte expression.

The following chart and table use theoretical data to explain this process in detail. The approximate position of each planet and moon is also shown in the table, as an aid to illustration.

It will be seen, that with Nte values from 1 to just on 1.2, the first expression provides all the value and none comes from the second. From then on until about Nte of 1.4, 99.9% of the value comes from the first half of the expression. Then Nte starts rising more rapidly and it is from about 1.5 onwards, that the second expression begins to have an influence. By 2.0 it is important and above 2.5 it predominates. Thus the two halves of the equation provide additional information and accuracy. The so called four parameters are in reality two closely linked pairs of parameters.

For practical people like Willis and myself, near enough is very often good enough and being fast rather than super accurate often means the difference between making a sale or missing out to a competitor and having no bread on the table. Professional scientists need to be accurate.

The equation 7 is as follows: Nte = EXP((0.233001*Ps^0.0651203)+(0.0015393*Ps^0.385232))

Which is exactly equivalent to: Nte = EXP(0.233001*Ps^0.0651203)*EXP(0.0015393*Ps^0.385232)

The first half of the Nte equation is the exponent of (0.233001*Ps^0.0651203) and is labelled as Series 1 in following chart and table. The second half is labelled in a similar manner.

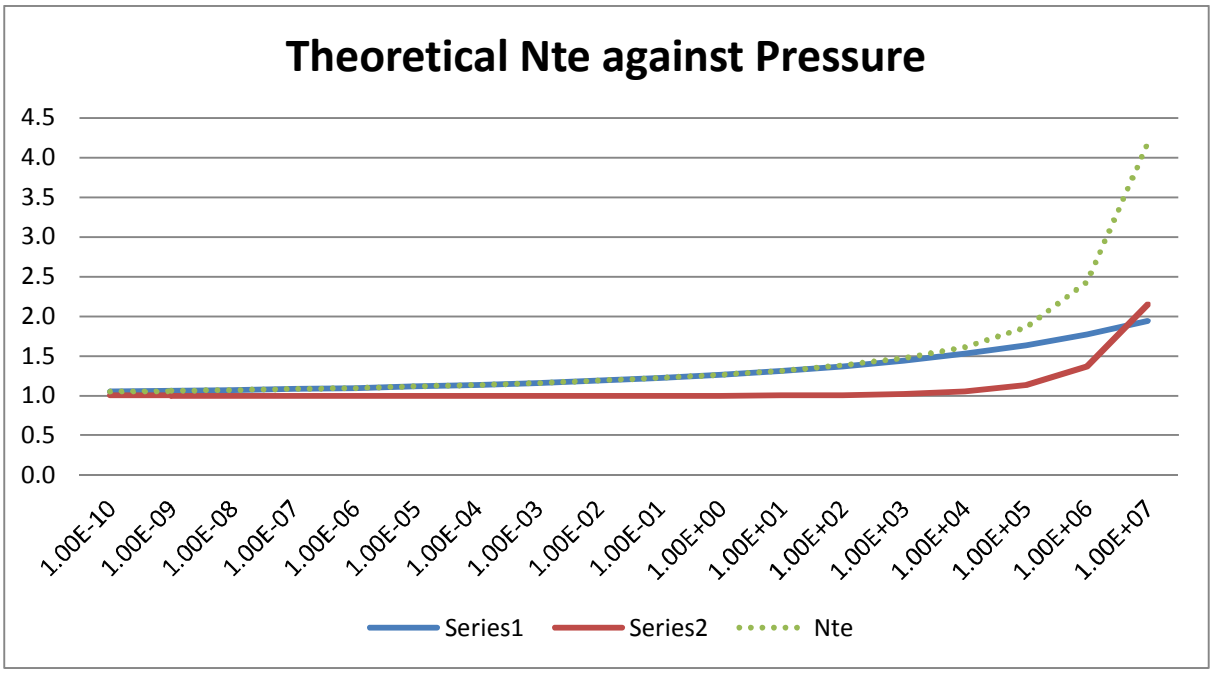

Chart 2 and Table 1 – Nte against Pressure, using theoretical data.

Theoretical Pressure	Series 1	Series 2	Theoretical Nte	% Explained By Exp 1	Approx Values
0.0000000001	1.0533948	1.0000002	1.0534	99.99998%	
0.0000000010	1.0622966	1.0000005	1.0623	99.99995%	Moon, Mercury
0.0000000100	1.0727328	1.0000013	1.0727	99.99987%	
0.0000001000	1.0849862	1.0000031	1.0850	99.99969%	Europa
0.0000010000	1.0993976	1.0000075	1.0994	99.99925%	
0.0000100000	1.1163809	1.0000182	1.1164	99.99818%	
0.0001000000	1.1364414	1.0000443	1.1365	99.99557%	
0.0010000000	1.1602001	1.0001076	1.1603	99.98925%	
0.0100000000	1.1884267	1.0002612	1.1887	99.97389%	Earth
0.1000000000	1.2220831	1.0006342	1.2229	99.93662%	
1.0000000000	1.2623827	1.0015405	1.2643	99.84619%	
10.0000000000	1.3108734	1.0037443	1.3158	99.62697%	
100.0000000000	1.3695523	1.0091151	1.3820	99.09673%	
1000.0000000000	1.4410299	1.0222747	1.4731	97.82107%	Mars
10000.0000000000	1.5287680	1.0549437	1.6128	94.79179%	
################	1.6374294	1.1386716	1.8645	87.82163%	Titan
################	1.7734043	1.3706618	2.4307	72.95746%	Triton
################	1.9456175	2.1500770	4.1832	46.50996%	Venus
################	2.1667979	6.4145669	13.8991	15.58952%	
################	2.4555223	91.1437767	223.8056	1.09717%	
################	2.8396028	57,284.14	162,664.0000	0.00175%	

As part of his argument, Willis quoted Fermi who in turn was quoting von Neumann **"***with four parameters I can fit an elephant, and with five I can make him wiggle his trunk*.**"**

On reading this at WUWT, I put out the challenge "*Willis – go ahead – fit an elephant. Please!*"

I then went on to describe an experiment that I had witnessed on the internet, which clearly demonstrated that energy and pressure raise the temperature and that the presence or absence of green house gases make no difference.

In a later comment, Willis repeated my challenge and the first two lines of my following explanation:

> *Seriously N&Z are only demonstrating in algebra what has been observed in experiments, that heating a gas in a sealed container increases both pressure and temperature.*

However, in stopping there, he seriously misrepresented what I had written, for I then went on to make my main point about the effect of experimenting with gases such as carbon dioxide in a sealed containers. I repeat this now in bold:

> *A gas that expands by a larger amount than air will rise to a higher temperature.*
> *When each vessel is allowed to vent to the atmosphere, so pressure is not increased, then they will both rise to the same level, which will be lower than either when fully contained.*
> ***No Greenhouse effect involved, only the effect of pressure in the presence of incoming heat**.*

However, to do him justice, Willis then proceeded to create his own elephant. He went on to develop a series of progressively simpler, more concise models, using the same variables but with fewer parameters. These culminated in the following combined equation, using the minimum possible number of free parameters:

Ts = 25.394 * **Solar**^0.25 * e^(0.092 * **Pressure** ^ 0.17)

He also produced several very attractive charts and claimed that his "*equation is not only simpler, it is more accurate"*. Now I do not understand how he was able to make such a claim.

The following two tables show my calculations using first Willis' simple equation, followed by my calculations using the N&Z equations 2, 7 and 8. In each I show the errors between the projected (Tc) and observed (Ts) surface temperature values using both formulations. As would be expected, the more complex N&Z equations have a better fit. That in no way criticises the work that Willis has done, it's just that a more detailed equation better reflects the effect of pressure on temperature. The figures to compare are the final total average Error Squared percentages, which are highlighted in yellow. The first table uses Willis' equation, the second N&Z.

Object	Willis Equation Tc		Error	Error Squared	Percentage Error %
Mercury	248.87	-	0.64	0.42	0.2%
Venus	739.90	-	2.70	7.30	1.0%
Earth	295.51	-	7.91	62.60	21.8%
Moon	154.68	-	0.38	0.15	0.1%
Mars	165.40		16.60	275.41	151.3%
Europa	68.10		5.30	28.11	38.3%
Titan	97.91	-	4.21	17.70	18.9%
Triton	31.13		5.67	32.13	87.3%
Totals	1,802		11.72	423.82	23.4%

Ts = 25.394 * **Solar**^0.25 * e^(0.092 * **Pressure** ^ 0.17)

Table 2 – Willis Formulation - Differences between actual and forecast Tc (423.82 / 1,802 = 23.4%)

Object	Observed Temperature Ts	Grey body Temperature Tgb	Calculated Nte	N & Z Equation Tc	Error Ts - Tc	Error Squared E Sqrd	Error % %
* Mercury	248.2	248.2	1.000	248.23	-0.00	0.00	0.0%
Venus	737.2	181.6	4.069	738.82	1.62	2.61	0.4%
Earth	287.6	154.3	1.863	287.38	-0.22	0.05	0.0%
* Moon	154.3	154.3	1.000	154.28	-0.02	0.00	0.0%
Mars	182.0	125.1	1.456	182.15	0.15	0.02	0.0%
Europa	73.4	67.7	1.085	73.46	0.06	0.00	0.0%
Titan	93.7	48.9	1.927	94.17	0.47	0.22	0.2%
Triton	36.8	28.2	1.275	35.90	-0.90	0.81	2.2%
Totals	1,813.2	1,008	13.675	1,814.37	1.14	3.71	0.2%

* If the Mean Surface air Density equals zero, than Nte =1, which yields TC=Tgb
Otherwise, Nte = EXP((0.233001*Ps^0.0651203)+(0.0015393*Ps^0.385232))

Correlation Ts & Tc		0.999998
Correlation squared		0.999997
Proportion of Ts explained by Tc	approximately	100.00%

Table 3 – Nikolov & Zeller Formulation - Differences between actual and forecast Tc

The simplified Willis' equation provides quite a good match between calculated and observed near surface temperature. It is just that N&Z's formulation is much better. Their method conforms to the laws of theoretical physics and most importantly, better describes exactly how pressure augments incoming irradiance.

As a final point on this issue, Willis did state at one juncture that he has repeated the calculations and confirmed N&Z's numbers. (Incidentally I have also done the same). Nikolov & Zeller's equations do indeed correctly predict the surface temperature of eight solar planets and moons from only two variables, irradiance and surface pressure.

Use of Different Variables

Willis also claimed that it is not even necessary to use atmospheric pressure as a variable and shows that Density can be substituted instead. Again he provides a model which produces respectable results.

However, he does not stop to consider that density and pressure, while not identical, are closely related and if fact the two sets of numbers for the eight solar bodies have a correlation of 0.998, which means that 99.6% of the data of one explains the data of the other (correlation squared).

Again and again, Willis confirms that near surface maximum annual temperature for a number of the planets and moons of the solar system can be explained by a combined function of the irradiance and surface pressure of each body.

Model Testing

Willis makes one final criticism which is indeed valid, although his suggested tests would themselves be inappropriate. This issue will now be examined in some detail and an alternate test method proposed. Unfortunately, the outcome is inconclusive because of inadequate range and availability of good quality data.

Willis correctly notes that N&Z have not provided any evidence of statistical testing. He makes two suggestions:

- Omit some of the data points and fit it again.
- Divide the dataset in half and fit one half against the other.

However neither of these methods would provide valid results:

- Firstly any reduction of data points increases the problem of validity.
- However, that is not the main problem. As already explained, the effect of pressure on temperature cannot be explained by any simple expression, be it linear, exponential logarithmetic or power. That is the reason for the twin exponential expressions in the Ts equation. Dividing the data in two would not replicate the shape of the function. This can be cleanly seen from the second chart and first table above.

The only other alternative is to search for additional data, although satisfactory examples are hard to find. Many of the remaining planets and moons have not yet been surveyed in sufficient detail and much of the work that has been done is very preliminary or questionable at best.

After consideration the best additional example is Pluto, although as will be seen, severe questions arise about the accuracy of some of the observational data.

The gray body temperature (24.67 degrees K) as calculated by N&Z Equation 2, exactly matches the value derived from a formula of the power function derived from a chart of the eight planets and moons under study ($y = 25.397x^{0.25}$, R Squared = 1.0).

However, the match between the NASA Fact figure for Surface Temperature (50 K) and calculated from Equation Eight (30.6K) is quite bad. Two likely explanations suggest themselves; either the data or the theory is wrong. Now whenever theory and observation conflict, it is normal to expect that the theory is wrong. However as already seen, there are a number of other planets and moons where the N&Z theory and the data do coincide, so what would normally be considered the least likely explanation is examined first.

Dr. Nikolov has pointed out that Pluto's temperature has been recently revised downward by NASA from 50K to 44K (see http://en.wikipedia.org/wiki/Pluto) and that even 44K is much higher that the emission temperature calculated from the simple SB law in Eq. 3 of their Reply Part 1. Since that equation has been shown to significantly overestimate the actual mean surface temperature, it is very likely that Pluto's mean surface temperature is even lower than 44K, and probably around 33K.

It is not uncommon for initial data from early NASA explorations to be significantly changed as later, more detailed surveys are made. The current detailed Diviner exploration of our moon is but one prominent example. The following chart has been taken from NASA Fact Sheets and demonstrates quite clearly that the data values for Earth and Venus must be incorrect.

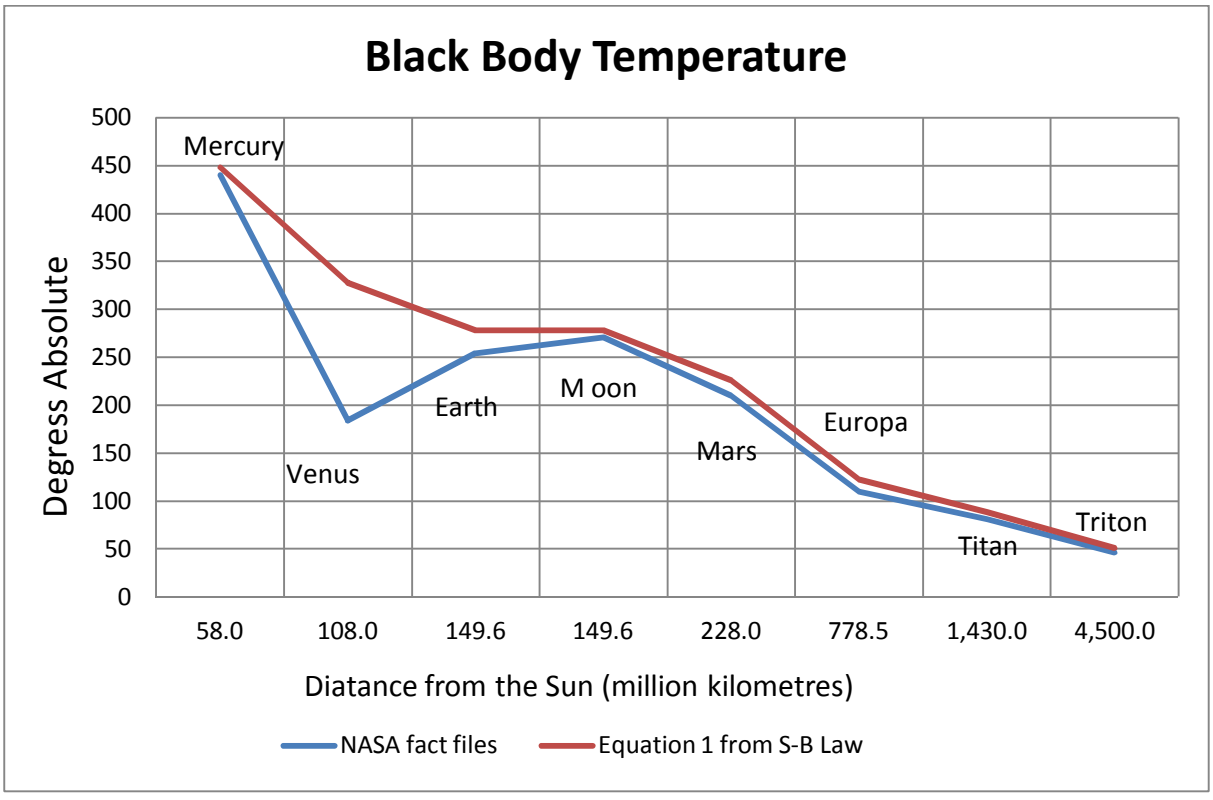

Chart 3 - Black Body Temperatures – Venus & Earth - differences between reported and theoretical values. The actual data (in blue) for Venus and Earth, as well as for Mars and Europa to a lesser extent, differ from the theoretical values calculated from the Stefan-Boltzmann Law (red line).

It is therefore possible that the NASA figure for the surface temperature on Pluto is far too high and that the theoretically calculated temperature may instead be correct. It is a great pity that there are not dozens of out of sample planets which could be examined.

Fortunately however there is another completely different approach which supports the United Theory. We therefore leave the critics to examine an aspect of the theory that has not so far received the attention it deserves.

Climate Implications of the Ideal Gas Law

Nikolov and Zeller show that it is also possible to accurately estimate the surface temperature of solar bodies from the Ideal Gas Law, providing there is at least a minimal atmosphere. They express the standard Gas Law as their Equation 5: PV = nRT

Where P is pressure, V is gas volume, 'n' is the gas amount in moles and R is the universal gas constant, 8.314 J K^{-1} mol^{-1}.

Now 'n' may be replaced by m / M, where 'm' is the mass of a gas (kg) and M is its molecular weight (kg / Mol). Equation 5 then becomes PV = mRT / M.

Dividing each side by V gives P = mRT/ (MV) Equation 5a.
Now the density (*p*) of a gas is its mass divided by its volume, so *p* = m / V
Substituting *p* for m / V in equation 5a, gives P = *p*RT / M

Rearranging this, we get Equation 6 *p*T = constant = PM / R Or T = PM / (R*p*)

This last equation can then be used to calculate the average annual temperature of those planets and moons which have an effective atmosphere. The equation collapses when P ≈ 0 and thus the effective temperature becomes the grey body value. These values were shown on the third last line of N&Z Table 1 and have been re-calculated as follows:

Object	Surface Pressure	Molecular Air Mass	Gas Constant	Air Density	Calculated Temperature	Measured Temperature
	Ps	M	R	*p*	Tc	Ts
Mercury	1.00000E-09	n/a	8.314	0.00	0.0	248.2
Venus	9.20000E+06	0.0434	8.314	65.00	738.8	737.2
Earth	9.88882E+04	0.029	8.314	1.20	287.4	287.6
Moon	1.06900E-09	n/a	8.314	0.00	0.0	154.3
Mars	6.85400E+02	0.0434	8.314	0.02	178.9	182.0
Europa	1.00000E-07	0.032	8.314	5.24E-12	73.5	73.4
Titan	1.46700E+05	0.0278	8.314	5.24	93.6	93.7
Triton	1.70000E+00	0.0278	8.314	0.000158	36.0	36.8
Formula					Tc = (Ps * M)/(R * *p*)	

Table 4 – Near Surface Temperature estimated from the Ideal Gas Law

As the authors pointed out during an exchange of emails: *p*T is a constant ONLY for a fixed pressure P, which means that there is an isobaric process on a planetary scale. For a certain pressure, changes in absorbed radiation (due to changes in cloud cover for example) cause change in temperature in a way that temperature increases are associated with decreases in density, while temperature decreases cause increases in density, keeping the product *p*T constant.

Equation 5 can also be arranged as V = nRT/P, when 'n' is the fixed number of molecules in the atmosphere, R is the fixed Universal Gas Constant, T is determined by Irradiance and pressure, while pressure itself is the result of gravity acting on the mass of gas, which presses down on the area of the planet (P = gMat/As). The climate circle is then complete.

A Brief Comment on Carbon Dioxide

It has been established that gray body temperature is directly proportionate to the 4th root of the solar irradiance, which in turn is proportional to the inverse of the square of the distance. It has also been shown that the additional boost to surface temperature due to the presence of atmosphere (Nte) is explained entirely by near surface pressure.

The question arises whether carbon dioxide could also explain this ratio in place of atmospheric pressure? This may be easily answered by charting both carbon dioxide and atmospheric pressure against the Nte Ratio. It will then be seen that it is atmospheric pressure rather than carbon dioxide that determines temperature.

The following Charts 4 and 5 show quite decisively that it is not the carbon dioxide content of the atmosphere, expressed in parts per million, that explains the augmentation (Nte) which increases the gray body temperature (Tgb) to the actual measured near surface temperature (Ts). Rather, it is the atmospheric pressure, regardless of atmospheric content, that does all the work.

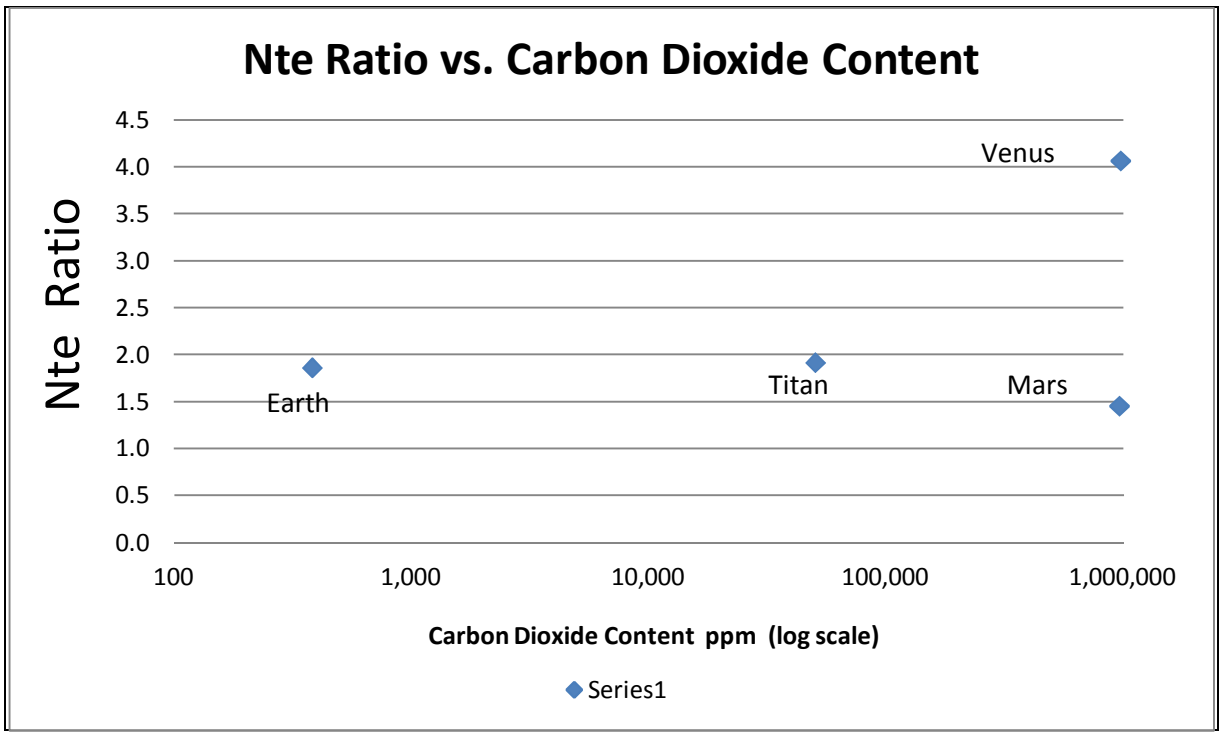

Chart 4 – There is no consistent relationship between carbon dioxide level and Nte Ratio

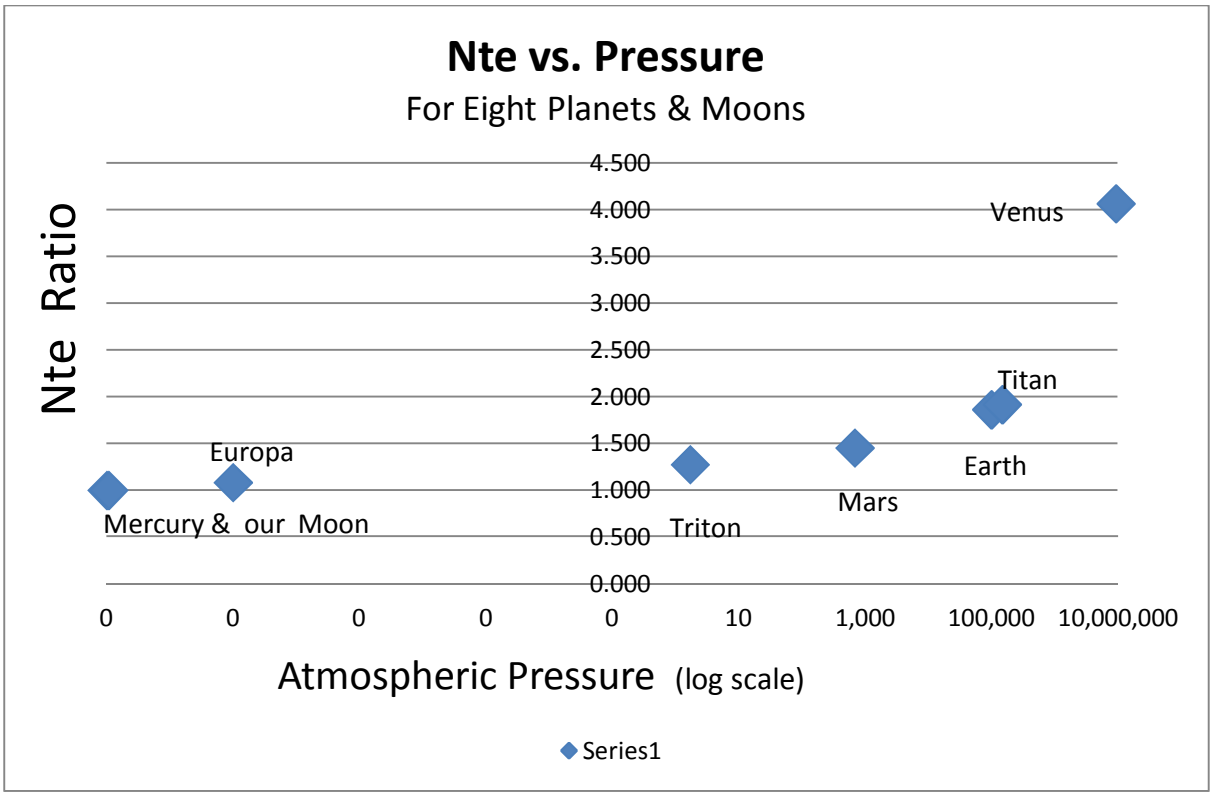

Chart 5 - Rising Nte levels are directly due to Increasing atmospheric pressure

Conclusion

In giving the appearance of attacking Nikolov and Zeller, Willis has in fact confirmed both their calculations and their theory. He has therefore done them a favour, although that possibly may not have been his original intention. Notwithstanding, by providing simpler, slightly less accurate models with the less parameters, he has demonstrated the robustness of the theory.

The Greenhouse focus on radiative physics is analogous to an attempt to determine the path of steel balls, solely from the way they ricochet from post to post in a pinball machine. The Ultimate Theory of MacroClimatology in contrast is the study of how the force in using the plunger (solar radiation) and the slope of the playing surface (atmospheric pressure) combine to define the action in the climate machine.

Planetary long term equilibrium near-surface temperature is determined by solar irradiance, itself a function of distance from the sun, together with atmospheric pressure at the surface.

The good news is that, while the hubbub surrounding the Unified Theory has gone on, nobody has noticed that the carbon dioxide dragon has quietly returned to his deep, dark greenhouse, where he now sleeps peacefully at rest, no more to frighten the children and the innocent with fanciful nightmares of doom and disaster.

End of story.